

Understanding and Responding to Climate Change
An Analysis of the Sundarbans World Heritage Area

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*A thesis submitted for the degree of Doctor of Philosophy at the University of Otago,
Dunedin, New Zealand*

March 2019

Abstract

Examining the understandings of and responses to anthropogenic climate change is important to help climatically vulnerable communities enhance their resilience. Lack of climate change understanding is an obstacle to appropriate climate response. Social understandings of climate change consist of general awareness, knowledge, and risk perceptions. Responses to climate change are derived from the understandings of the members of a society about the impacts and risks of climate change. The typical strategies in response to climate change are mitigation, adaptation, and resilience building. Responding to climate change is necessary at every scale to enhance the resilience of social and ecological systems. Climate change responses driven by management agencies are often helpful for vulnerable marginal communities, but not all the management interventions contribute to resilience equally.

This research addresses the highly climatically vulnerable UNESCO World Heritage Sundarbans mangrove forest area (Bangladesh and India) as the study context. The mangroves biodiversity of the Sundarbans is important for buffering climate events, as well as for forest resource collection and tourism. The existing literature about the understandings of climate change of different key stakeholder groups of the Sundarbans is very limited. The available literature informs that awareness of climate change is low in the vulnerable Sundarbans area. The effectiveness of existing response strategies, particularly for adaptation to climate change, needs to be understood in relation to the efficient use of limited resources of those developing countries. It is also unknown how the Sundarbans World Heritage helps local people to think about and act in response to climate change.

To fill these knowledge gaps, the aim of this thesis is to examine the social understandings of climate change and responses of management agencies to climate change in the Bangladesh Sundarbans including how the Sundarbans World Heritage Area is managed by Bangladesh and India. In doing so, a constructivist research paradigm is adopted aligning with a relativist ontology, subjectivist epistemology and qualitative methodology to explore understandings of and responses to climate change in the Sundarbans. Semi-structured interviews were conducted with 42 stakeholders including community people, conservation and management agencies, tourism management organisations, tourism business operators, and tourists. Thematic analysis was utilised to analyse the qualitative materials of the interview programme. A range of documents including policy papers is analysed to validate and enrich the empirical materials.

The findings of this research indicate that the stakeholders of the Bangladesh Sundarbans believe that climate change is anthropogenic, they have the first-hand experience of changes in the weather system. The degree of climate risk perceptions of the stakeholders can be defined by their relative vulnerabilities and adaptive capacity. The core response to climate change in the Bangladesh Sundarbans is adaptation where sustainability depends on how the adaptation interventions contribute to resilience. In

the cross-border comparative analysis, this research finds that both Bangladesh and India focus on conserving the forest ecosystem in response to climate change, but legal enforcement systems, politics, and governance systems are shaping the success of conservation management. Overall, the thesis argues that the social resilience and ecological resilience of the Sundarbans are highly related, and tourism can be utilised for resilience building in the vulnerable World Heritage area.

This thesis addresses several theoretical and empirical knowledge gaps in the current literature in the context of developing nations. Firstly, it expands the theoretical components (awareness, knowledge, and risk perceptions) with related attributes of the social understandings of climate change. Secondly, it examines the effectiveness of climate adaptation functions based on their relative contribution to building resilience. Thirdly, it utilises a cross-border analysis between Bangladesh and India to critically examine the climate change management actions by the management agencies of the Sundarbans in terms of local vulnerabilities, forest biodiversity, World Heritage and tourism; and proposes three dimensions - community, forest, wildlife - of biodiversity conservation for resilience. These contributions have implications beyond the Bangladesh and Indian contexts, with application to a range of scenarios where researchers are seeking greater insights into understandings of and responses to climate change.

Acknowledgements

I would like to express my sincere gratitude to all the people who have supported me in many ways through my PhD journey. Most particularly, my supervisors Professor James Higham (Otago, NZ), Associate Professor Ben Wooliscroft (Otago, NZ), and my project advisor Dr Debbie Hopkins (Oxford, UK) have all offered great advice and guidance over the duration of the project and for that I am very grateful to them. In addition to his role as my primary supervisor, I would like to thank Professor James Higham further for his incredible guidance and assistance since 2013 for the admission and scholarship application processing at University of Otago. It is, indeed, a thrilling and unforgettable journey - three years of my life - with my supervisors in New Zealand.

I would like to thank all my colleagues at the Department of Tourism, the University of Otago for offering a prestigious and comfortable study environment. Especially I want to mention the name of Associate Professor Brent Lovelock (my project convener), Professor Neil Carr (Head of Department), Associate Professor Hazel Tucker (Former Head of Department), Dr Sebastian Filep (Former PhD Coordinator), Dr Tara Duncan (Former PhD Coordinator), Pip Lennon (Office Administrator), Trudi McLaren (Department Administrator), and Stuart Grant (Former Department Administrator). I also like to thank the outstanding Administration of the University of Otago - they arrange everything for the students who want to learn in this place of the world.

I am thankful to the persons who made my fieldwork easy. By the grace of Almighty, I found many people who assisted me in all four of the data collection locations. I want to name the four-persons whom I do not want to forget: Dalim - a college student from Satkhira in Bangladesh, Joyanta - a resort manager working in the Indian Sundarbans, Rashid - a tour operator from Khulna in the Bangladesh Sundarbans, Nipun - my former student who works in Dhaka for the Public Service in Bangladesh. They helped me during my fieldwork for free, and few of them worked with me from the early morning to midnight and assisted me to reach my desired potential participants who were quite unreachable to me as a newcomer in the fieldwork locations. I also want to acknowledge the interview participants who take time to enrich my PhD project.

I am grateful to my family back in Bangladesh for encouraging me to complete this journey. And I am thankful to my wife and my daughter who sacrificed my company almost every afternoon during the whole PhD tenure.

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List of acronyms

BPC	Bangladesh Parjatan Corporation
BCCRF	Bangladesh Climate Change Resilience Fund
CBT	Community-Based Tourism
CMC	Co-Management Committee
CPG	Community Patrol Group
CPP	Cyclone Preparedness Programme
ECA	Ecologically Critical Area
GHG	Greenhouse Gas
IPCC	Intergovernmental Panel on Climate Change
IUCN	International Union for Conservation of Nature
NGO	Non-governmental Organisation
NTO	National Tourism Organisation
PSF	Pond Sand Filter
SDGs	Sustainable Development Goals
SMART	Spatial Monitoring and Reporting Tool
SNP	Sundarbans National Park [India]
SRF	Sundarbans Reserve Forest [Bangladesh]
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organisation
UNFCCC	United Nations Framework Convention on Climate Change
UNWTO	United Nations World Tourism Organisation
USAID	United States Agency for International Development
VCF	Village Conservation Forum
WHA	World Heritage Area
WHS	World Heritage Site
WWF	World Wildlife Fund

Chapter 1

Overview

1.1 Introduction

More than 150 years have passed since scientists first warned the world about anthropogenic climate change (Black, 2011; Darby, 2016). In the past, what scientists predicted about impacts of climate change like extreme temperature, loss of polar ice, sea level rise, and more intense weather events, are now realities (NASA, 2015). Future predictions of climate change are more alarming and might be a historic threat to human civilisation on earth (Kahn, 2015b). The actions taken to date by the global community to control and manage climate change are inadequate (IPCC, 2014). Many nations - in the developing and developed worlds - do not address climate change adequately to deal with current impacts and long-term risks (Paris Agreement, 2015). Despite being recognised as a global threat by scientists, climate change continues to be widely ignored (Nuccitelli, 2015).

In late 2015, the United Nations Framework Convention on Climate Change (UNFCCC) in Paris - identified as COP21 - put in place the overarching goal to reduce global GHG emissions to hold global temperature increase to 2°C above pre-industrial levels (Paris Agreement, 2015). The 2°C threshold will be crossed over large part of the world by 2040 if emissions follow the existing rate of increase (Joshi, Hawkins, Sutton, Lowe, & Frame, 2011). Even if it is possible to limit global temperature rise to 2°C, coastal communities around the world may face a rise of sea level at least six metres (20 feet) in future (Kahn, 2015a). This type of sea level rise would lead to displacement of 78% of the world population who live within 50 kilometres of the coastline (Small & Nicholls, 2003, p. 590). Human consciousness, preparedness and engagements to reduce climate change remains insufficient.

Climate change impacts can amplify the effects by accelerating other socio-economic vulnerabilities (IPCC, 2014). The global temperature rise is reducing sea ice, mountain glaciers and continental ice sheets which raise up the sea level (NASA, 2015). Under climate change, glaciers are retreating and may entirely disappear from many mountain ranges including the Himalayas by the end of the 21st century - putting at risk water supplies for billions of people (World Glacier Monitoring Service, 2008). Climate change impacts like temperature variabilities, sea level rise, salinity intrusion, intense hydro-meteorological events, ocean acidification, erratic rainfall, and drought are not only bringing a lot of vulnerabilities but also threatening the survival of many

living beings. IPCC (2014) states that the net damage costs of climate change are likely to be significant and to increase over time.

Climate change is anthropogenic and its effects threaten humanity (Paris Agreement, 2015). Carbon-emitting behaviours create a trade-off between present consumption and future environmental security (Dalby, 2017; Nhamo, 2017). What can people do - wait for hundred percent clean technologies by 2050 (Merchant, 2015) or start reducing emissions from now? Even if the people of the world stopped GHG emissions now, the climate change effects would continue to occur for at least several more decades if not centuries (NASA, 2015). The crisis arising due to climate change needs to “be resolved in conjunction with other sustainable development concerns” (Lawn, 2016, p. 46). The challenge is not only to slow climate change but also to cope with the impacts of climate change for sustainable growth (UNDP, 2015).

Climate change strategies in terms of mitigation, adaptation, and resilience building depend on how properly the vulnerabilities and risks of climate change are understood by a society (McNaught, Warrick, & Cooper, 2014). The level of achievement to handle climate change relies on the degree of understanding within a society (Weber & Stern, 2011). Understanding the cause of climate change, present impacts and future risk stimulate people to act in dealing with and reducing climate change (Lee, Markowitz, Howe, Ko, & Leiserowitz, 2015). Climate action¹ in terms of adaptation to the effects and vulnerabilities and mitigation for reducing emissions is urgent to build resilience. For ensuring sustainability, response strategies to climate change need to be place-specific, based on effects and emissions (McNaught et al., 2014).

Tourism can be utilised as a means of sustainable development, but it is highly vulnerable due to climate change, particularly in the coastal forest (UNWTO-UNEP-WMO, 2008). Climate change affects the vegetation and wildlife which reduces the aesthetic tourism value of the forests such as mangroves (Hall, Scott, & Gössling, 2013). As tourism is a ‘highly climate-sensitive’ industry, climate change can reduce or destroy the distinctive quality of a destination (Mutana, 2017, p. 235). Tourism is also responsible for climate change in many ways such as usage of fossil fuel, and degradation of forest resources (Becken & Hay, 2007). Uncontrolled tourism activities

¹ Climate action refers any response to combat climate change and its impacts (UNDP, 2015).

disturb forest biodiversity which might be a threat to the sustainable tourism growth by accelerating climate change impacts in the long-term.

Bangladesh, a South Asian developing country situated on the delta of Bay of Bengal – made up of the sediment flow of the Ganges river of the Himalaya, is highly vulnerable due to climate change² (Shahreen & Rana, 2014). The major climate effects in Bangladesh are increased air and surface temperature, sea level rise, enhanced monsoon precipitation and run-off, reduced dry season precipitation, increase in the intensity of tropical cyclones, floods, salinity intrusion and prolonged droughts (Planning Commission of Bangladesh, 2010). However, per capita carbon dioxide emissions in Bangladesh are very low compared to the global average (IPCC, 2014, p. 950; Jamieson, 2011). If sea levels rise - according to the scientific prediction, up to one meter by the end of this century, Bangladesh could lose up to 15% of its land area and more than 30 million people of the coastal area could become climate refugees (Huq & Ayers, 2008). Climate change understanding and response are critical to the region of the Bengal delta.

1.2 Framing climate change

1.2.1 Definition of climate change

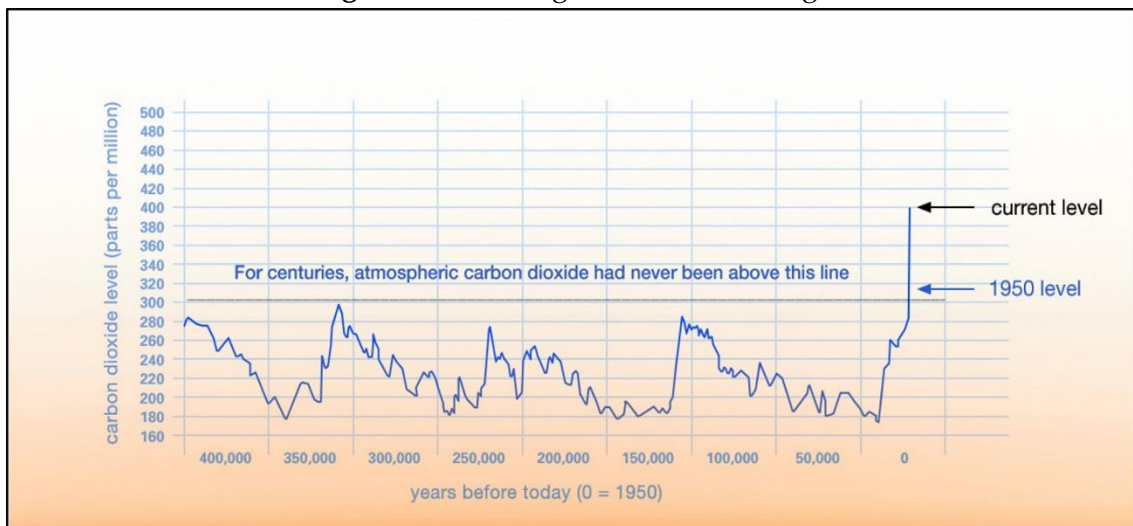
Climate change is a transformation in the global or regional weather system, specifically a change in the climate patterns apparent from the mid to late twentieth century onwards and attributed mainly to the increased levels of atmospheric carbon dioxide produced by the utilisation of fossil fuels such as petroleum and coals (Stevenson, 2010). Due to massive industrialisation, the loading of carbon particles in the atmosphere has been increasing rapidly since the 1950s; and at present, carbon dioxide (CO₂) levels in the atmosphere have reached the highest point (400 particles per million) for many millennia (NASA, 2015). The growing presence of carbon particles after 1950 is the vital evidence that emissions from developed and rapidly developing worlds are the cause of climate change (**Figure 1.1**).

According to NASA (National Aeronautics and Space Administration) and IPCC, GHG emissions from human activities are directly responsible for climate change (Roston &

² Bangladesh is one of the top 20 vulnerable countries in the world based on ‘vulnerability-resilience indicators’ and ‘country-level risk measures’ (Eriksen & Kelly, 2007, p. 503).

Migliozzi, 2015). Four international scientific research institutes - NASA's Goddard Institute for Space Studies, NOAA National Climatic Data Center, Met Office Hadley Centre/Climatic Research Unit and the Japanese Meteorological Agency - have reached an accord that the Earth has experienced rapid temperature rise for the last few decades (NASA, 2015). According to NASA's Goddard Institute for Space Studies, Climatic Research Unit, and the National Oceanic & Atmospheric Administration, based on 1951-1980 average temperature, the planet has had the hottest 10 years between 1998 and 2014 in the last 134 year record and in January 2014 the temperature was 0.68 °C higher than the base years average (NASA, 2015).

Figure 1.1: Vital signs of climate change



Source: NASA (2015)

The IPCC states climate change is: “any change in climate over time, whether due to natural variability or as a result of human activity” (IPCC, 2007, p. 27). In the definition of the UNFCCC, only human activities are identified as the reason for present climate change. As stated by the UNFCCC (Article 1) climate change is: “a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods” (UNFCCC, 1992, p. 3). The latest report of the IPCC (2014, p. 1255) articulates “climate change refers to a change in the state of the climate that can be identified (e.g. by using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer”. This definition highlights the way of measuring climate change without pointing to the anthropogenic cause of present climate change.

The core issue involved in the definition of climate change is that human activities are responsible for climate change. The activities include burning coal and other fossil fuels by industrial machinery and transportation vehicles such as automobiles, occupying the substantial land of the Earth, and using chemicals including in the agriculture sector for meeting human needs (Hein & Garrelts, 2014; Mayor & Tol, 2008). The smoke and gas discharged by industrial emissions, aerosol loading³ (e.g. dust and smoke) for land use change, and chemical pollution in the major cities are the visible and easy communicable examples of human-induced emissions (NASA, 2015). Humans not only increase carbon emissions but also destroy trees (known as carbon reserve banks) which increase overall CO₂ in the atmosphere.

1.2.2 Climate change vs. global warming

Global warming generally means the enduring warming of the earth. Scientific evidence shows that the global temperature has been rising significantly since the middle of the twentieth century. By considering mid-twentieth century as a baseline (of 1951-1980), it is observed that surface temperature has gone up by about 0.8 °C (1.4 °F) globally (NASA, 2015). Human-induced emissions are responsible for this worldwide temperature rise which is known as global warming (Hopkins, 2013b). Often, the terms 'climate change' and 'global warming' are used synonymously; however, they are two different physical phenomena (Whitmarsh, 2008b). 'Climate change' includes 'global warming' but indicates a variety of changes, e.g. rising sea levels, glacial retreat, accelerating sea ice depletion, and shifts in flower/plant blooming times that are happening to the earth. These changes are the results of the warming, which is triggered by humans through burning fossil fuels and emitting the heat-trapping GHGs into the atmosphere (Karl, 2009).

GHGs like carbon dioxide (CO₂), methane (CH₄), nitrous oxide (N₂O), chlorofluorocarbons (CFCs) produced through human activities are the major contributors to climate change (NASA, 2015). For this reason, people often label climate change as the greenhouse effect⁴. Among these terms 'global warming' has become

³ The main aerosol types include sea salt, dust, sulphate compounds, and black carbon emitted from incomplete combustion (Samset, 2016)

⁴ Climate change is caused by the increase in the greenhouse effect which is the process wherein GHGs in the atmosphere absorb and re-emit heat being radiated from the Earth, trapping warmth by absorbing infrared radiation/heat (IEA, 2016).

popular for communicating the worldwide environmental changes to the general public since the 1990s, but 'climate change' has always been the more commonly-used term in academic literature, beginning from 1920s (Wayne, 2015). Global temperature rise is a considerable issue of climate change, but climate change comprises a few other changes in the weather system. This thesis will consistently use the term 'climate change' to indicate the rapid human-induced changes in the global and regional climatic systems.

1.2.3 The areas of climate change research

There are two major areas of climate change research (IPCC, 2014). One is physical science, which determines scientifically the causes and effects of climate change. Scientific research on climate change dates to the middle of last century (Hulme, 2009). By physical science research, scientists provide technical information about climate change including impacts, evidence, and predictions of future risks. Globally, many physical scientists are working on developing clean and green technologies for mitigation, and safe and effective technologies for adaptation. The achievements of physical climate change science are considerable for managing existing vulnerabilities and reducing overall emissions. Physical science research at first discovers the anthropogenic climate change (Goodall, 2008).

The other foundation of climate change research is social science, which deals with the social implications of the findings of physical science research in relation to mitigation and adaptation. Social science research works on the real world implications of physical science research for the well-being of broader society (Hulme, 2009). More specifically, it deals with examining lived experience, perceptions, and strategy for vulnerabilities and risks management. The scientific understandings of climate change (e.g. cause of climate change, ways of emissions reduction, role of biodiversity against climate change, predictions of sea level rise) need to be communicated to people to create public understanding (Moser & Dilling, 2011). When people properly understand that scientists agree on human-induced climate change, they are more likely to support policy for mitigation (Lee et al., 2015). In addition to the science communication, social science research on climate change also applies to early diffusion of technologies for mitigation and adaptation.

In comparison to physical science research, social science research on climate change is new, dating from the late 1980s with a gradual increasing trend (Hulme, 2009). But the social science aspects regarding “understandings of and responses to climate change in developing countries are less researched, for a variety of reasons, than those in developed nations” (Whitmarsh, Lorenzoni, & O'Neill, 2012, p. 278). One of the reasons of gaining little attention on climate change research by the social science scholars is that developing nations have so many poverty-related current problems such as food security, housing, health and hygiene which distracts the interest of research on emerging problems like climate change (IPCC, 2014). Whitmarsh et al. (2012) argue that investigating social understandings of and responses to climate change can assist to build an adaptive and resilient society. Social science research can examine the public understandings and response strategies related to climate change and can suggest how to improve climate change management at national and local scales (Hopkins, 2013b).

The common areas of social science research on climate change are environmental management, disaster risk mitigation, climate change adaptation, and poverty alleviation (Thomalla, Downing, Spanger-Siegfried, Han, & Rockström, 2006). Adaptation research across a range of sectors including health, water and sanitation, waste management, food security, planning, economic development, and disaster risk reduction (DRR) in the context of urban setup is quite noticeable (Roberts, 2010). However, social science researchers of climate change have covered very few in cases of rural adaptation and climate responses in the context of developing nations. Besides, the understandings of climate change held by the developing nations in terms of awareness, knowledge is largely unidentified by the academic realm (OECD & UNEP, 2011). Management stakeholders' misconceptions (e.g. climate change is a matter of physical science research) often creates obstacles for conducting social science research on climate change (IPCC, 2014).

The outcomes of physical science research such as rapid temperature variation, sea level rise, decreased sea ice and mountain glaciers, intense extreme weather events, ocean acidifications provide the evidence which confirm that emitting GHGs by humans is the main cause of climate change. All these forms of scientific evidence are the base of social science research on climate change including this research project.

1.3 Key theoretical concepts

This research project adopts a social science research approach that will explore the understandings of and responses to climate change in the context of developing countries. In doing so, this research draws upon the theoretical concepts - understanding, adaptation, and resilience in relation to climate change. All these concepts collectively contribute to the framing of this research project.

Understanding the science of climate change is necessary to address the vulnerabilities and risks. The scientific understanding needs to be transmitted to create social understanding for action. Climate change understanding is not only a general awareness of but also a set of knowledge regarding vulnerabilities, potential impacts, and future uncertainties (Niebert & Gropengiesser, 2013). General understanding of climate change is important but more important is to understand how to manage climate change in terms of mitigation, adaptation and resilience building. General understanding or awareness of climate change also results in climate action. Understandings of climate change develop from different types of direct and indirect communication through formal or informal interactions (Kuntzman & Drake, 2016). The degree of understanding of climate change depends not only on communication efforts but also on demographic characteristics, and personal experience and observation (Lee et al., 2015). Climate change understanding, indeed, is a prerequisite for climate action.

Any effort of reduction of and/or adjustment to climate change is known as climate action. Climate change responses (or actions) comprises two approaches: 1) mitigation - reducing the emissions into the atmosphere; and 2) adaptation - coping with the impacts of climate change (NASA, 2015). Climate responses might be further described as any actions, for example - an environment-friendly policy, which encourages mitigation and adaptation. In consideration of climate change responses, mitigation is a worldwide process - as emissions reduction has global implications, whereas adaptation is a local challenge (Pittock, 2013). The nature of climate responses, of course, depends on the level of vulnerabilities and risks, and capacity and scope of a society (Tang, Dai, Fu, & Li, 2013). Vulnerabilities reduction by adaptation functions (or adaptation interventions) is the most common strategy in response to managing

climate change impacts. Educating the members of a society about how to respond to the climate change is helpful for managing present vulnerabilities and future risks.

Climate change adaptation is learning to live and cope with the impacts which have already been set in motion (IPCC, 2012). It is a process of adjusting to climate impacts for avoiding loss or gaining benefits. Adaptation might require for communities, ecosystems, industries like agriculture, tourism which is affected by climate change impacts (WTO & UNEP, 2009). Adaptation strategies may vary in terms of geographic location and the capacity of a society (IPCC, 2012; Tegart, Sheldon, & Griffiths, 1990). The type of adaptation actions depends on the economic, institutional, and technological capacity of a society (Kelly & Adger, 2000). In the long-term, the adaptation measure can be inadequate to sustain the climate change impacts or can have negative effects, which is defined as maladaptation. Adaptation is very good for a short-term solution (and can contribute to the system resilience in short-term), which mostly does not function in the medium to the long-term timeframe (Barnett & O'Neill, 2010). For ensuring the resilience of a vulnerable system, adaptation interventions need to incorporate mitigation and to consider future risks of climate change.

Resilience, a widely used notion in climate change study, is the capacity of a system to bounce back after having a turbulent shock (Davoudi et al., 2012). The resilience of a system can be increased or decreased because of shocks (Holling, 1973). A system which has capability to face a shock can be defined as a resilient system. The use of the term 'resilience' is different in different disciplines like environmental science and social science (Davoudi et al., 2012). For instance, in ecology study, resilience means how properly an ecosystem can rebound or adjust after a natural disaster. Social resilience means how properly a society adjusts after an external shock, such as a natural disaster. In climate change studies, resilience is used to indicate the capabilities of a system (e.g. social, ecological system) to tackle climate change impacts (Davoudi et al., 2012). The usual goal of management agencies is to build up resilience so that a society or biodiversity can withstand the impacts of climate change (Brown, 2011; Martin, O'Donnell, Joseph, & Wodon, 2015).

The reason for building resilience is to ensure the long-term sustainability of adaptation interventions and to avoid the drawbacks of maladaptation. For

contributing to the resilience of a social or ecological system, the adaptation interventions will not only address the present vulnerabilities but also the future risks of climate change. Consideration of the future risks of climate change while undertaking adaptation interventions is important for sustainable adaptation (Eriksen & Brown, 2011; O'Brien & Leichenko, 2007; Wilkinson, Remøy, & Langston, 2014). Sustainable adaptation comprises of the features of sustainability (e.g. persistent and equitable well-being in the long run, effective and efficient utilisation of available resources), adaptation (e.g. strengthening the capacity of the vulnerable community, addressing the reasons of vulnerabilities), and resilience (e.g. addressing future climate risks, less carbon-emitting solutions). Enhancing system resilience through adaptation interventions can confirm sustainability in climate change response (Adger & Tompkins, 2004).

Based on this theoretical background, this thesis examines the 'understandings of climate change' and 'responses to climate change' in the study context Sundarbans World Heritage area. The key theoretical concepts are understandings, adaptation, and resilience (building).

1.4 Context of the study: The Sundarbans

The forest Sundarbans gets its name from its prominent mangrove tree '*Sundari*'. In English, the Bengali word *Sundarbans* means 'the beautiful forests' (*sundar* means beautiful and *bans* means forests or jungles). The area of the mangroves eco-region is about 10,000 square kilometres (with 45% wetlands). The Sundarbans is situated on the delta of the Ganges, Brahmaputra and Meghna rivers on the Bay of Bengal and the mangrove ecosystem is shared by Bangladesh (60%) and India (40%) (**Map 1.1**). The forest consists of about 200 islands⁵, separated by about 400 interconnected dynamic tidal rivers, creeks and canals which are retaining the unique ecosystem in this 'intertidal zone'⁶. The mangrove forest is settled close to the sea level - the utmost point of the forest is nearly two metres above the sea level⁷. The Sundarbans is famous for its dense population of Royal Bengal Tigers (*Panthera tigris*). The existing economic

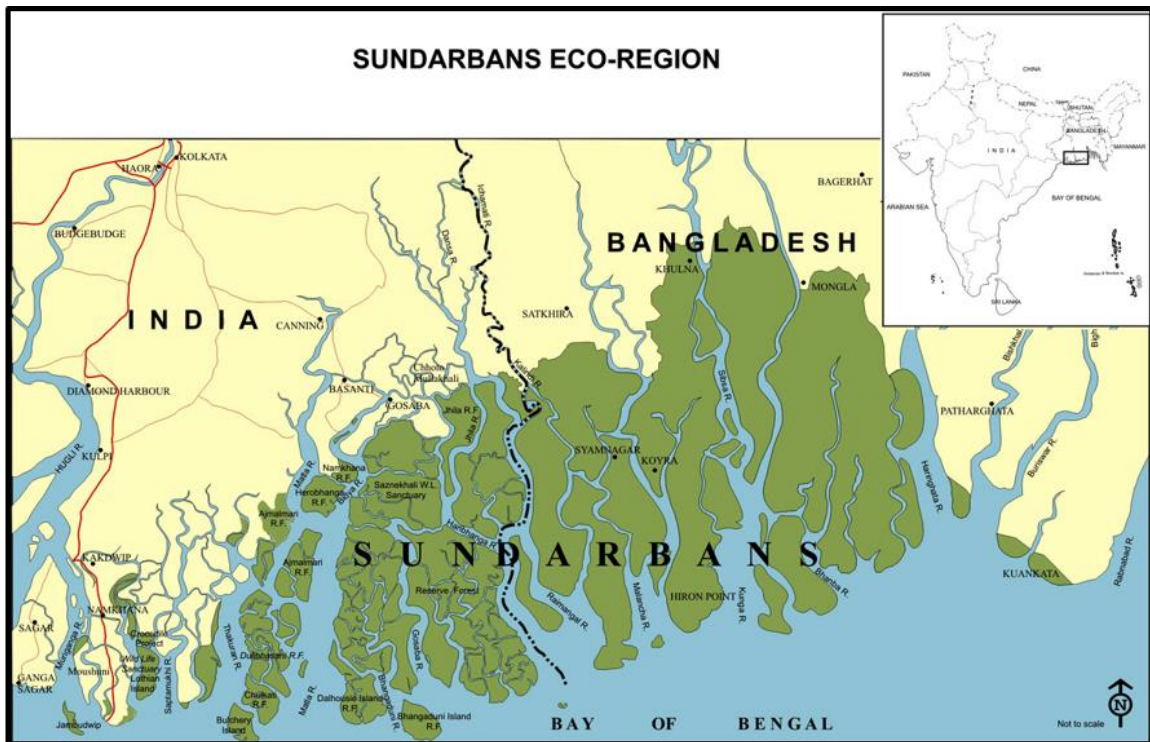
⁵ The island landscape of the Sundarbans is highly dynamic due to the interplay of coastal marine dynamics and riverine deposition on the Ganges delta.

⁶ The forest is above the water during low tide and under water during high tide. The mangroves can grow between low and high tide balance.

⁷ The forest floor is 0.91 metre to 2.11 metre above the sea level (Khan, 2011).

functions surrounding the forest are non-timber forest products collection and tourism. Due to population pressure and climate change, the present Sundarbans is only one-third of the size from when it first mapped in 1764; and the forest area is continuously shrinking (World Bank, 2014b).

Map 1.1: Sundarbans eco-region shared by Bangladesh and India



Source: Choudhury (2015)

The Sundarbans mangrove forest is an open ecosystem (Karim, 1995). The interconnected riverine system provides freshwater supply to the mangrove ecosystem, part of which also influxes with saline water twice in a day during tidal excursion (Khan, 2011). According to scientific assessment, the Sundarbans mangrove forest came into existence approximately 4000 years ago (Ali, 1998). The growth of the Sundarbans mangroves can be determined by four interdependent factors: climate (rainfall, temperature, humidity, evaporation, wind and cyclone); hydrology (tidal regime, quality of tidal water and tidal inundation); edaphic (soil salinity, nutrient status, aeration) and biotic (man and other living organisms) (Karim, 1995). The unique ecosystem of the Sundarbans consists of two ecological regions – ‘Freshwater Swamp

Forests⁸ which is nearly extinct⁹ and 'Mangroves'¹⁰ (Rawat & Wikramanayake, 2016). Mangroves are highly adaptive salt-tolerant plants that live along tidal estuaries in a complex biological ecosystem. As a result of anthropogenic forest reduction, half of the mangroves have disappeared from the face of the earth since the middle of twenty century (Seetharaman, 2015).

The Sundarbans – the world's largest mangrove forest, and a United Nations Educational, Scientific and Cultural Organisation (UNESCO) World Heritage Site (WHS) shared by Bangladesh and India, is a critical biodiversity hotspot which is highly vulnerable due to climate change (Loucks, Barber-Meyer, Hossain, Barlow, & Chowdhury, 2010). The mangrove is valuable to the local community for two reasons: i) it can reduce effects of hydro-meteorological events like cyclones and tidal surges; and ii) the forest provides a range of livelihoods opportunities including forest resource collection, fishing, and tourism (Uddin, de Ruyter van Steveninck, Stuij, & Shah, 2013a). The mangrove forest and its communities are engaged in a continuous struggle with severe weather events that are being exacerbated by climate change (O'Donnell & Wodon, 2015). Overexploitation and non-sustainable extraction of forest resources by the community people (the residents) further threaten the mangrove ecosystem (World Bank, 2014b).

1.4.1 Flora and fauna

The Sundarbans mangrove forest is full of biodiversity with 334 plant species (including 27 native mangrove species), 693 animal species and 315 bird species (World Bank, 2014b). The mangrove tree Sundari (*Heritiera fomes*), from which the forest gets its name, is found in the forest in large numbers. The other prominent and continuously distributed mangrove trees in the unique ecosystem are Gewa (*Excoecaria agallocha*), Goran (*Ceriops decandra*) and Keora (*Sonneratia apetala*). Among the palm species, Nipa Palm (*Nypa fruticans*), locally known as *Golpata* (the long and feathery leaves mostly used as roof material for houses by local people) is renowned for its

⁸ A slightly brackish swamp forest lies behind the Sundarbans where freshwater comes during the rainy season, when the water from the Ganges, Brahmaputra and Meghna rivers push the intruding salt water out and bring a deposit of silt (Chacraverti, 2014).

⁹ Lack of fresh water flow towards the Sundarbans delta is the cause of the extinction of Freshwater Swamp Forests.

¹⁰ Mangroves are special types of salt tolerant trees and shrubs which grow in the coastal intertidal zone of the tropical and subtropical regions. These types of plants contain complex breathing roots named pneumatophores and salt filtration system and can live in waterlogged mud.

economic value (Iftekhhar & Saenger, 2008). The mangroves work as a bio-shield to reduce the wind of the storms up to 90% which protects lives and assets of the nearest villages and towns from tropical storms and cyclones (Seetharaman, 2015). Mazda, Magi, Kogo, and Hong (1997) note that mangroves can reduce the tidal waves – a sea-wave of one metre (more than three feet) crossing over 1.5 kilometres of mangrove forest is reduced to a height of only 0.05 metre or less than two inches. Overall, those plants make the coastline stronger by holding on to sediments in the river and provide habitats for animals and fish.

The mangrove is a sanctuary for the single largest tiger population in the world known as Royal Bengal Tigers (*Panthera tigris*) which are guarding the forest from resource depletion¹¹. In the Sundarbans, tigers are at the top of the food chain, and mangroves are the bottom of the food chain (World Bank, 2014a). The other abundant animals of Sundarbans are spotted deer, macaques (monkey), saltwater crocodiles, Indian pythons, fishing cats, wild boars (pig), foxes, jungle cats, leopard cats, pangolins, wild boars, otters, squirrels, and porcupine. The Sundarbans is also home to giant Asian honeybees. The mangrove forest is also habitat for marine turtles, crocodiles, frogs, and freshwater dolphins (popularly known as Gangetic dolphins). In rivers and canals of the Sundarbans, there are a lot of different types of fish, crabs, shrimps, and snails (Chacraverti, 2014). On the mud flood, there are trillions of micro-organisms which enriches the fertility of the ecosystem (Kanopy, 2015). All the plants and animals are interdependent to live and grow in this unique biodiversity hotspot (World Bank, 2014a).

1.4.2 Local communities: Lives and livelihoods

The history of human civilisation in the Sundarbans area can be traced back from the ancient period (Dey, 2016). There are some signs of a ruined city built in around 200 to 300 AD in the forest. Irrespective of debates on the timing of first human habitation in the Sundarbans region, permanent settlements were enabled through the clearing of the mangroves for subsistence farming and through the construction of embankments on the dynamic delta (Ghosh, Schmidt, Fickert, & Nüsser, 2015). The settlement process started in the late 19th century and continued through to the 20th century (O'Donnell & Wodon, 2015). Before the management efforts of the British East India Company,

¹¹ Sundarbans is the only mangrove forest in the world with a population of tigers.

historically management of the mangrove forest was only limited to the forest resources collection (Dey, 2016). The East India Company depopulated parts of the Sundarbans that were reclaimed by the human habitation to enlarge the forest area. **Table 1.1** provides a brief overview of the major historical events of the Sundarbans.

At present, the Sundarbans mangroves belong to Satkhira, Khulna, and Bagerhat districts under the Khulna division in Bangladesh and South 24 Parganas in India. The unique ecosystem is divided by rivers (the Harinbhanga and Baleswar rivers) between Bangladesh and India. The socio-economic situation between the two parts of the Sundarbans is quite similar as there was no political boundary before 1947 (Ghosh et al., 2015). Over time, the community structure between the two parts of the Sundarbans changed gradually, but still they share many common traditions. The number of people in the Sundarbans increased rapidly in the post-colonial period, particularly after the partition of India and Bangladesh (Dey, 2016). Many people migrated to this region because of political instability and the income opportunities presented by forest resource collection (O'Donnell & Wodon, 2015; World Bank, 2014a). In the 1990s, both Bangladesh and India provided important protection to the wild animals and forest ecosystems (Ghosh et al., 2015; Mohammad, 2013). Despite these conservation efforts, human settlement continues to compromise the density and total area of the forests.

Table 1.1: History of the Sundarbans eco-region

Year / Time Period	Major historical events
Mauryan Empire (321-226 BC)	<ul style="list-style-type: none"> - Human settlement in the mangrove region in the form of proto-urban settlements (Pandit, 2013). - Classifying the forests by the management based on the intended use of the trees.
Gupta Dynasty (AD 320-415)	<ul style="list-style-type: none"> - There was no management for harvesting forest resources. - Extensive tracts of mangroves land were cleared and converted into farmland (Dey, 2016).
Pre-Mughal Era (1204-1575)	<ul style="list-style-type: none"> - The region was known to be inhabited by Hindu Bengali caste people who practised fishing as livelihoods. - The increase of wet rice cultivation that contributed to the reduction of forest area (Eaton, 1990).
Floods in 1584	<ul style="list-style-type: none"> - Relocation of villagers of the Sundarbans due to floods in 1584. In the following years, the region was overrun by forests. - Increased salinity in the agricultural land due to the shift in the river course (Chakraborty, 2005).
Mughal Empire (1600-1857)	<ul style="list-style-type: none"> - The Mughal kings used to lease the forests of the Sundarbans to the people from the neighbouring community (Dey, 2016). - Criminals would take refuge in the Sundarbans forest from the advancing armies of the Mughal Emperors.
Colonial Period (1858-1947)	<ul style="list-style-type: none"> - East India Company surveyed and identified boundaries of the Sundarbans forest in 1765 and divided the forest into 236 blocks – total area 1.7 million acres (Dey, 2016). - Reclamation by converting the forests into farmland (Ghosh et al., 2015). - Imposed charge on timber extraction. - The tribes were adopting subsistence method of living that started harming the ecosystem (O'Donnell & Wodon., 2015). - The reclamation continued until the Sundarbans was declared a protected forest in 1878. - Marked restriction of the use of forest resources in selected areas (Mukherjee, 1969). - There were huge events of tiger attack during this period and reward was declared for tiger killing. - Between 1881 to 1912, there were 2400 adult tigers killed in the Sundarbans region (Chakraborty, 2005).
Post-colonial Era (After the partition of Bengal in 1947)	<ul style="list-style-type: none"> - Division of the Sundarbans between Bangladesh (60%) and India (40%). - Rapid deterioration of forest and biodiversity after the partition of the Sundarbans (Mukherjee & Tiwari, 1984).
After the Liberation of Bangladesh (1971)	<ul style="list-style-type: none"> - Increase human population on the Indian Sundarbans area after the 1971 civil war in Bangladesh (Dey, 2016). - Indian Sundarbans was declared as Sundarban Tiger Reserve in 1973. - Construction of embankments in the locality of the forest area. - Included as UNESCO World Heritage Sites. - Unregulated alteration to the forest ecosystem. - Biodiversity conservation was emphasised by the management authorities (Ghosh et al., 2015; Mohammad, 2013).

There are around 12 million (7.5 million in Bangladesh and 4.5 million in India) people living in and around the Sundarbans (Seetharaman, 2015). The communities who live on the fringes of both parts of the Sundarbans are very poor and have very limited scope of livelihoods (O'Donnell & Wodon, 2015). Their typical occupations are fishing, crab catching, honey hunting, and nipa palm collecting (Islam, 2011). Other than non-timber forest resources collection, the people of the Sundarbans are involved in subsistence farming, and about 85 percent of people who live in the edge of the mangroves depend on rain-fed agriculture (Seetharaman, 2015). All households used to depend on Sundarbans for fuel wood, mostly for cooking (Islam, 2011). About 50 percent of people of Sundarbans in both Bangladesh and India live below the poverty line (World Bank, 2014a, 2014b). Illegal money collection by pirates¹², the bribery of forest staffs and high-interest rates of money lending¹³ push the dependents of the Sundarbans to low income (Islam, 2011). Approximately two-thirds of the people have no source of safe water; only 17 percent have electricity connection; a fifth get only one meal in a day and one-third get only a sub-standard one; half of the children suffer from malnutrition in the Sundarbans region (World Bank, 2014a).

The local community of the Sundarbans has many current problems regarding basic needs like food security, proper dwelling, education, health and nutrition (O'Donnell & Wodon, 2015; World Bank, 2014a). They have very limited land for cultivation. For the community of the Sundarbans, there are few schools which are too far away from most of the locality, few hospitals and limited medical facilities, and very few roads often washed away by storms. This community people are struggling to survive different natural disasters - flooding and severe storms are endangering them frequently. The embankments, which protect the local communities particularly the farmland from floods, are often crushed. Climate change impacts such as high intense cyclones, tidal waves, salinity intrusions, sea level rise, make lives and livelihoods harder in the coastal Sundarbans (World Bank, 2014b).

The local people are mostly responsible for degrading the forest ecosystem (Islam, 2014), despite the Government of Bangladesh declaring the Sundarbans as Ecologically

¹² Pirates (water hijackers) kidnap the poor people of the Sundarbans particularly fishermen and ask for ransom.

¹³ Community people of the Sundarbans take loan particularly for their farming from the local money lenders at a higher rate (couple of times higher) than commercial bank rates because of having improper banking facilities in their localities.

Critical Area (ECA) under the Environment Conservation Act 1995. The resources of the forest are being exploited by cutting trees, catching fish, illegal animal poaching and pilferage of trees (World Bank, 2014b). About 10,000 deer are illegally poached every year from the Sundarbans (Kanopy, 2015). Prawn seed collection, making dykes for fishing and pushing salt water further upstream are harming the bio-diversity of the Sundarbans (Seetharaman, 2015). In order to protect the forest from human exploitation, it is important to generate alternative employment for the local people and making them the custodian of the forest (World Bank, 2014b). After cyclone Aila (May 25, 2009), people of Sundarbans are more aware of the importance of mangroves and since then many have been involved in tree plantation (Seetharaman, 2015).

1.4.3 Environmental degradation in the Sundarbans area

At present, pollution is one of the challenging issues for the forest Sundarbans (Seetharaman, 2015; World Bank, 2014a). The coastal environment of the forest is being polluted by illegal brick kilns, unauthorised construction, use of contaminated oil for boats, and building illegal dykes for fishing (Seetharaman, 2015). For inappropriate industrialisation in the upstream of the mangroves, the Sundarbans delta has contended with chemical pollutants such as toxic heavy metals (copper, zinc and lead), organochlorine pesticides, polychlorinated biphenyls and polycyclic aromatic hydrocarbons those may degrade the estuary's geochemistry of the region (World Bank, 2014a). Shrimp farming around the Sundarbans further pollutes the forest area by throwing wastes with antibiotics and chemicals and using viral epidemics in shrimps which directly affect the marine life, particularly destroying the diversity of fishes of the Sundarbans (Sahgal, Sen, & Grewal, 2007). People reduce the mangrove forest area for shrimp farming, as shrimp have high export value (Ahmed, 2013). Pollution and unplanned fishing in the rivers of the Sundarbans is one of the major reasons for the reduction of Gangetic dolphin (Gupta, 2012).

The land-use practice of the catchment of the Sundarbans often threatens the biodiversity of the ecosystem. In the 1960s, the Government of Bangladesh and India built embankments to protect the agricultural land from river water entrance, however, the solution (the embankment) became a problem because of riverbed siltation – as silt cannot replenish to develop the islands of the delta (Roy, 2015). There are about 20 large cement factories at the edge of the Bangladesh Sundarbans which often dump

industrial waste into the river (Roy, 2015). The governance authority also put the forest in severe pollution threat by allowing commercial cargo vessels¹⁴ through the Sundarbans which are responsible to water pollution by oil spill¹⁵, river bank erosion, sound pollution (Das, 2015); and by deciding to establish coal-fired power plants at the edge of the forest (Muhammad, 2013; Roy, 2015). Islam (2011) indicates the necessity of good governance for harvesting the forest resources and protecting the mangrove ecosystem from degradation.

1.4.4 UNESCO World Heritage Site status

Both Bangladesh and Indian Sundarbans have received UNESCO World Heritage Site (WHS)¹⁶ status. In 1987 the Indian Sundarbans received UNESCO WHS status. The Bangladesh Sundarbans received the same status ten years later in 1997. The Indian part of Sundarbans is called Sundarbans National Park (SNP, established in 1984) and the Bangladesh part of the Sundarbans is known as a Sundarbans Reserve Forest (SRF) which are protected areas of the countries. UNESCO declared a significant portion of SNP and SRF as WHS. By satisfying Criteria ix and x of UNESCO, the Sundarbans of Bangladesh has become a natural WHS. For being a natural WHS, under criteria ix - a site needs to be outstanding examples of continuous ecological and biological systems in the evolution and development of terrestrial, freshwater, coastal and marine ecosystems and communities of vegetation and wildlife; and under criteria x - a site needs to consist of important natural habitats and biological diversity, including those containing endangered species of outstanding universal value in terms of science or conservation (UNESCO, 2004). The UNESCO considers the whole Sundarbans eco-region as a single 'biosphere reserve' (Kenneth, 2015).

There are some advantages which motivated both India and Bangladesh to be enlisted in WHS. From 1999 to 2015, after providing the Sundarbans World Heritage status, UNESCO has taken several states of conservation (SOC) to inspire the authorities of both Bangladesh and India for developing two parts of Sundarbans as a trans-frontier

¹⁴ Because of lack of proper dredging, the actual Mongla-Ghushiakhali route to the Mongla port (the second important sea port in Bangladesh) silted up and became unnavigable from the year 2011. Therefore, authority allows the cargo vessels to transport through the Sundarbans. There are about 100 cargo vessels operated throughout the Bangladesh Sundarbans which is accelerating habitat fragmentation of the forest animals.

¹⁵ On December 9, 2014, an oil tanker spilled 350 tons of furnace oil into a river that runs through the Sundarbans in Bangladesh.

¹⁶ WHS is the part of the protected area which is declared as World Heritage by UNESCO.

single site which might facilitate conservation of the unique ecosystem. The organisation supports both countries for protecting the endangered tiger population of the forest. UNESCO identifies the possible factors which might negatively affect the biodiversity of forest and tries to assist in resolving the issues, particularly environmental degradation. The organisation provides funds for promotion of the Sundarbans (UNEP & WCMC, 2008) and to address conservation issues including environmental impact assessment (EIA), strategic environmental assessment (SEA), mitigation measures against pollution, and ecological monitoring (World Heritage Centre, 2012).

1.4.5 Tourism in the Sundarbans

Due to the rich biodiversity, the Sundarbans mangroves ecosystem is an attractive domestic tourist destination in both Bangladesh and India. Having WHS status accelerates the arrival of international tourists (Hassan & Rahman, 2015). But the number of international tourists in the Bangladesh Sundarbans is very significant. In terms of number of tourist visit, the tourism industry of Indian Sundarbans is larger than that of Bangladesh Sundarbans because of the big domestic market of India (Chakraborty & Eagle, 2017; Molla, 2017). Tourism in both parts of the Sundarbans is river cruise-based. In both contexts, the Forest Department of the country manages the tourism in the Sundarbans. The common tourism infrastructure in the Sundarbans is waking trails, watchtowers, and jetties (Chakraborty & Eagle, 2017). Besides, Bangladesh Sundarbans has a crocodile-breeding centre at Karmajal, and Indian Sundarbans has Biosphere Resource Information Centre and tiger rescue centre at Jharkhali.

Unlike WHSs in many developed countries, tourism in the Sundarbans is not well-organised (Khanom & Buckley, 2015). As a tourist destination, it is underdeveloped in terms of infrastructure (e.g. roads, transport, communication) and tourism superstructure (e.g. hotels, resorts, restaurants). In addition to these limitations, tourism in the coastal WHA is highly sensitive to climate change. Tourism operations in the Sundarbans are often affected by intense hydro-metrological climate events like cyclones. Due to climate change, the vegetation quality and animal diversity of the forest is disrupted (Islam, 2014), which has implications for tourism operation in the Sundarbans. WHS status is important for the tourism in the Sundarbans, now it is

important to know the scope of tourism in the WHA of the developing countries in response to climate change. Chapter 3 (section 3.6) of this thesis contains a detailed description of tourism in relation to climate change in the Sundarbans.

1.4.6 Forest management: Laws and regulations

The forest of the Sundarbans was managed under a single management system before the partition of British India in 1947. Formal management of the Sundarbans started in 1869 by taking it under government jurisdiction, and later the mangrove was declared as a reserve forest in 1875-76 (Rahman, 2010). Due to population pressure, people cleared a significant part of the forest for subsistence farming before the declaration; however, no human resides inside the protected reserve forest in the Sundarbans. The Forest Departments of both countries consider the locality beside the forest as part of Bangladesh Sundarbans as 'Sundarbans impact zone'. The West Bengal Government (India) tries to convert the Sundarbans as a separate administrative 'district' as the need for this high climate vulnerable region is different from other less vulnerable districts. Both Bangladesh and India have environmental legislation, conservation acts and policies, climate change regulations, and tourism laws and policies (Government of India, 2014; Ministry of Civil Aviation and Tourism, 2016; Ministry of Environment and Forests, 2016; Ministry of Environment Forest and Climate Change, 2016; Ministry of Tourism, 2016; Saini, 2014). Those acts and legislations have implications for the conservation of the Sundarbans (Mohammad, 2013; Singh, 2016).

To ensure proper management of the Sundarbans, the Forest Department of Bangladesh and India have divided the forest into different zones and administrative areas. The Bangladesh Sundarbans is managed under two forest divisions and four administrative ranges, which has three wildlife sanctuaries - Sundarbans East, Sundarbans West and Sundarbans South. The three wildlife sanctuaries (West, East and South) of Sundarbans in Bangladesh were established in 1977 under the Bangladesh Wildlife (Preservation) (Amendment) Act, 1974, having first been gazetted as forest reserves in 1878. The total area of wildlife sanctuaries was extended in 1996 for conservation. The biosphere reserve of the Indian Sundarbans is divided into three inter-related categories: a) core zone - protected area free from external disturbance b) buffer zone - open for fishing, honey collection and tourism c) transition zone -

combined with mangrove and reclaimed area; besides these zones there is a wildlife sanctuary zone where harvesting is prohibited, but open for tourism.

The two countries follow different regimes for managing the Eastern (Bangladesh) and Western (India) part of the Sundarbans. The entire Sundarbans in Bangladesh is a reserve forest, established under the Indian Forest Act, 1878. On the other hand, Sundarbans in India is enforced under the Forest Conservation Act 1980 (Amendment of Indian Forest Act, 1927), Wildlife Protection Act, 1972 and Environment Protection Act 1986. In 2001, as a part of UNESCO's Man and Biosphere Programme (MAB)¹⁷, around 9600 square kilometres area is declared as the Sundarbans Biosphere Reserve in India, where about 56 percent is non-forest area (World Bank, 2014a). Because of inadequate infrastructure (e.g. roads, patrolling station, utilities), deficit of human capital (e.g. skilled staff, limited number of staff), limited resources (e.g. telecommunication, transportation), and organisational capacity (e.g. lack of coordinated management), the efforts of the Government, non-governmental organisations (NGOs) and international development agencies to develop the forest region often unsuccessful (World Bank, 2014a).

The key responsibility of managing the Bangladesh Sundarbans belongs to the Forest Department under the Ministry of Environment and Forests. The Ministry of Environment and Forests of Bangladesh has established the Bangladesh Climate Change Trust (BCCT) under the Climate Change Trust Act (2010) with a vision: 'to enhance the capability to create climate resilience Bangladesh'. The BCCT mainly deal with the climate change issues including managing climate change trust fund (CCTF) with the association of the Forest Department. On the other hand, the SNP in India consists of the tiger reserve and biosphere reserve, is managed by the Forest Department under the Ministry of Environment, Forest and Climate Change. 'Climate change' division has been added with the Ministry of Environment and Forest of India in 2014, by recognising the threats and association of climate change with the Ministry (ET Bureau, 2014). In India, a dedicated government institute, the 'Department of Sundarban Affairs', works through the 'Sundarban Development Board', mainly for the betterment of people of the Sundarbans region (Ghosh, 2012).

¹⁷ An Intergovernmental Scientific Programme, launched by UNESCO in 1971, that aims to establish a scientific basis for the improvement of relationships between people and their environments.

1.4.7 The degree of regional cooperation in forest management

Since the Sundarbans is a dual national asset, the unique forest has different management system between its East (Bangladesh) and West (India) parts in terms of utilisation, conservation and development (O'Donnell & Wodon, 2015). The existing management of the two sides of the mangrove forest is different with nearly no collaboration (Seetharaman, 2015). From long since, the importance of cross-boundary effort for managing the forest has been raised by different bodies including international agencies (Agrawala, Ota, Ahmed, Smith, & Aalst, 2003). In order to optimise the mutual goals of Bangladesh and India, co-management for biodiversity protection, afforestation, mangrove restoration, and reduction of vulnerability of natural disasters can assist to protect the coastal areas of the mangrove forest (Iftekhar, 2008). For instance, World Bank (2014a) emphasises that Bangladesh and India might find mutual benefit from collaborative research efforts on climate change and climate action programme.

In 2011, a Memorandum of Understanding (MOU)¹⁸ was signed between Bangladesh and India with an overarching goal of conservation of the Sundarbans. The MOU has recognised that the Sundarbans represent 'a single ecosystem' and both countries have also recognised the necessity to monitor and conserve the rich biodiversity of the forest under a joint management programme, to exploit the potential of the Sundarbans for economic development specifically poverty alleviation, to develop a comprehensive plan for protecting the endangered biodiversity, and to handle floods and other climate-related disasters, human-animal conflict, and pollution. The MOU (article V) says, "Both Parties will carry out research to develop a common and shared understanding of the impacts of climate change along with adaptation strategies that can be implemented". Article II (section 2) and article VI (section 6) highlight the importance of developing a long-term mutual strategy for promoting and developing tourism in the Sundarbans for sustainable socio-economic development especially greater revenue generation. The two countries of the Sundarbans, however, have to work together to establish the provisions of the MoU.

¹⁸ MOU between India and Bangladesh on Conservation of the Sundarbans, September 06, 2011, available at the website of Ministry of External Affairs, Government of India.

In order to protect both parts of the Sundarbans in Bangladesh and India, the necessity of collaboration between the two countries is urgent (Seetharaman, 2015). The Sundarbans receives freshwater inflow from the Gorai River - a tributary of the Padma River (this river is known as the Ganges in India). Freshwater flow from the upstream is very important for the existence of freshwater mangroves and reduction of water salinity of the rivers of the Sundarbans. Since 1975, India has operated the Farakka Barrage on the Ganges River which has been used to divert the water through Hoogly River (supplies water to Indian Sundarbans), reduces the discharge of water flow in the Padma River (to the Gorai River in Bangladesh Sundarbans) significantly during dry season, which is threatening the mangrove ecosystem of the Bangladesh Sundarbans (Rahman, 2012; Rouillard, Benson, & Gain, 2014). Bangladesh needs cooperation from India for receiving a 'fair share of water'¹⁹ to protect the upstream of the country and the Sundarbans. The forest management authorities also need to search for collaborative management scope such as tourism development, species management, community involvement, and revenue management.

1.4.8 Climate change and the Sundarbans

1.4.8.1 Impacts and risks of the Sundarbans

Due to the geographic location of the Sundarbans in the Bay of Bengal delta, it is one of the few vulnerable places in the world for high intensity of weather events (Danda, Sriskanthan, Ghosh, Bandyopadhyay, & Hazra, 2011). The vulnerabilities of extreme weather events have increased severely in the delta, because of rapid climate change (World Bank, 2016). Scholars are predicting that climate change impacts would amplify other type of vulnerabilities - for instance, "sea level rise of 32 cm will intrude 10-20 ppt salinity level more in the Sundarbans" (Nishat & Mukherjee, 2013, p. 48). Increased waterlogging, soil and water salinization pose serious threats to agriculture and livelihoods of a majority of the residents of the Sundarbans area (Ortolano, Sánchez-Triana, & Ferdausi, 2016; Uddin, Shah, Khanom, & Nesha, 2013b). Sea level rise is the most exposed impact of climate change in the Sundarbans (Loucks et al., 2010; Payo et al., 2016; Sarwar, 2005) which affects the availability of sediment, directly hindering the

¹⁹ The Ganges Treaty 1996 has been signed between India and Bangladesh on the basis of "principles of equity, fair play and no harm to either party" in order to resolve the transboundary disputes about sharing the water of the Ganges at Farakka point. However, many environmentalists and people of civil society of Bangladesh consider this Treaty as an agreement of no outcomes.

creation of new groves (Mahadevia & Vikas, 2012). Mangroves can adapt to slow sea level rise, but a rapid sea level rise might destroy the forest at once (Kanopy, 2015).

Environmental specialists are predicting the world's largest ever human migration in history from the Sundarbans area due to sea level rise in next 15 to 25 years (Jayalakshmi, 2015a). By considering the year 2000 as a baseline, scholars have estimated that another 28 cm rise in sea level can diminish 96 percent of the tiger habitat of Sundarbans (Loucks et al., 2010). If the Sundarbans loses its tiger population, it is highly likely the forest will lose its World Heritage status. The Sundarbans forest lies at 0.9 to 2.1 metre above the sea level (Iftekhar & Islam, 2004); approximately 60cm sea level rise is enough to submerge and destroy the whole Sundarbans (World Bank, 2010a). The predicted sea level rise in the year of 2020, 2050 and 2100 is 10 cm, 25 cm and 1 metre respectively, which would inundate 15%, 40% and 100% of the Sundarbans ecosystem respectively (Khan, 2011). Recent research states that sea level rise in the context of the Sundarbans is more than twice as fast as the global average (Jayalakshmi, 2015a).

The coastline of Sundarbans has been experiencing more frequent and intense cyclones and tropical storms in recent years (Kabir, Khan, Ball, & Caldwell, 2016b; Sujana, 2011; World Bank, 2014b). Between 1951 and 2010, a positive relationship is observed between an increase of the sea surface temperature and the intensity of cyclonic storms in Sundarbans (Mahadevia & Vikas, 2012). More especially, the super cyclone Sidr²⁰ (November 15, 2007) and severe cyclone Aila²¹ (May 25, 2009) caused devastating damage in terms of falling thousands of trees and killing animals in the Sundarbans forest. Every year the forest faces several small and medium extreme events like cyclones. The high intensity of recent cyclones and storms has damaged more of ecological balance and has abolished species of flora and fauna of the forest (Danda, 2010; Harun-or-Rashid, Biswas, Böcker, & Kruse, 2009; Seetharaman, 2015). Both extreme events and sea level rise are responsible for pushing brackish water further in the coastland of the Sundarbans and to reduce the flow of fresh water in the delta

²⁰ The 'Sidr' is the name of a cyclone with highest winds of 260km/h (one minute sustained), formed in the central Bay of Bengal and hit the coastline of Bangladesh on 15 November 2007. The cyclone has caused a large-scale of damage in Bangladesh including 3500 deaths. And one-third of the Sundarbans mangrove forest have destroyed for the cyclone (Arefin, 2011).

²¹ The "Aila" is the name of a cyclone with highest winds of 120km/h (one minute sustained), formed over the Bay of Bengal and caused extensive damage in India and Bangladesh on 25 May 2009. The cyclone is blamed for about 440 deaths and more than one million people homeless across the two countries.

(World Bank, 2014b). In some places, the salinity in the rivers of the Sundarbans is as same as in the ocean (Seetharaman, 2015). Due to salinity ingress in the Sundarbans, freshwater mangrove is converting into marine mangrove (Ghosh et al., 2015; Sarker, Reeve, Thompson, Paul, & Matthiopoulos, 2016).

1.4.8.2 Local vulnerabilities

The community people of the Sundarbans live beside the islands of the SRF. The mangroves were cleared from those islands about 100 years ago for subsistence farming. To protect the farmland from sea water entrance, with the assistance of FAO (Food and Agriculture Organisation), the Government of Bangladesh built embankments around the islands (Roy, Hanlon, & Hulme, 2016). The place inside the embankments, known as polders, is used for community residence and farming. The Sundarbans World Heritage Area (WHA) consists of the protected area and the polders (islands where the community people live) of the Sundarbans. The polders and SRF are separated by rivers and canals. The embankments are especially important for the community people of the Sundarbans who live in the polders. If the embankments break²², due to cyclones or tidal waves, water enters in the polders and flooding the whole islands with saline water. The floods threaten all the houses, fresh water sources, and farm crops. After a disaster and flood, all the plants die because of high salinity in the soil.

Climate change has a direct influence on lives and livelihoods of the people living at the edge of the Sundarbans mangrove forest. Climate change increases vulnerabilities not only by compromising the resources of the ecosystem but also by keeping them into severe effects including loss of cultivable land by sea level rise, erosion, salinity intrusion; loss of properties and lives from extreme events (Pramanik, 2012; Sujana, 2011). After encountering climate disasters like cyclones, the people of the Sundarbans face a lot of vulnerabilities in terms of food security and diseases such as respiratory and gastrointestinal diseases (World Bank, 2014b). In the post-disaster period, the previous adaptation functions need to be renewed (O'Donnell & Wodon, 2015). The freshwater sources including ponds and canals are filled with saline water. The community people do not have fresh water for irrigation, household works (e.g. cleaning, bath) and even to drink (O'Donnell & Wodon, 2015). Their previous ways of

²² Embankments are getting weaker because of sea level rise and erosions (Nishat & Mukherjee, 2013).

livelihoods disrupt, and they fall into severe poverty. This poverty often leads the community people to destroy the forest resources – because they do not have any earning sources left after a disaster.

The user group of the Sundarbans World Heritage are community people - who collect different resources, and tourism demand-supply stakeholders (e.g. tourism business and tourists) – who travel in the heart of the fragile forest. Since climate change understanding has strong implications for the response (Boyer, 2013; Lee et al., 2015), it is significant to know the understandings of climate change of the user groups of the Sundarbans World Heritage. Despite the fact that the Sundarbans area is vulnerable due to different climate change impacts (e.g. intense cyclones, high tidal waves, sea level rise, salinity intrusion, extreme temperature variability), understandings of climate change (e.g. awareness, feelings and thinking, attitudes, knowledge to respond, perceptions about the vulnerabilities and risks, sources of information) by community people are quite unknown (Ayers, Huq, Wright, Faisal, & Hussain, 2014; Kabir et al., 2016a). Investigating the tourism demand-supply stakeholders' understandings of climate change also are important for contributing to conservation and climate response (Howard, 2013; Miller, Rathouse, Scarles, Holmes, & Tribe, 2010).

To deal with the contextual (the Sundarbans WHA) vulnerabilities of climate change, the management agencies that are involved in conserving and managing the Sundarbans have taken many actions. The management of the Sundarbans includes a range of conservation and management agencies – the government departments (e.g. the Forest Department), NGOs, and a few international agencies including UNESCO, International Union for Conservation of Nature (IUCN), United States Agency for International Development (USAID), World Bank – which have been involved in managing the impacts of climate change, particularly helping the community with adaptation. The management agencies also work on conserving the SRF for enhancing the resilience of the mangrove ecosystem. However, it is almost unknown²³ what the agencies do to create climate change awareness, how the management functions are helping the vulnerable communities, what the implications of WHS and tourism are for the vulnerable community, and how the transboundary ecosystem of the

²³ A description of climate change understanding and climate response strategies of Bangladesh and the Sundarbans which is informed by the researchers is presented in Chapter 2 and Chapter 3.

Sundarbans is managed in response to climate change (Aziz & Paul, 2015; Ghosh, 2012; Mahadevia & Vikas, 2012; O'Donnell & Wodon, 2015; Ortolano et al., 2016; Sarker et al., 2016; World Bank, 2014a).

1.5 Research gaps: Structuring aim and objectives

This thesis addresses several important research gaps on climate change in the current social science literature. First, it explores existing awareness, views, beliefs, perceptions, and knowledge regarding climate change within a range of stakeholders of a vulnerable World Heritage area in the context of a developing country. It also explores the sources of constructing climate consciousness in the developing world context. Second, this research explores management functions of climate change for a vulnerable mangrove community in a developing country and addresses the usefulness of current adaptation functions for the vulnerable coastal community. The third research gap addressed in this thesis is how climate change is managed in a nature-based World Heritage area by two developing nations in relation to forest biodiversity, forest community, WHS, and tourism management. To fill the research gaps, this study is designed to address an overall aim and two specific research objectives along with three research questions.

Aim:

This thesis explores the understandings of climate change held by multiple stakeholders (local communities, tourism demand-supply stakeholders, and conservation and management agencies), and investigates how the conservation and management agencies are responding to climate change in the context of the Sundarbans. The aim extends to an international comparative analysis of how the Sundarbans World Heritage is managed by Bangladesh and India in response to climate change.

First objective

To critically examine the understandings (awareness, knowledge, and perception) of climate change held by multiple stakeholders of the Sundarbans in Bangladesh.

Research question

1. What are the current understandings of key stakeholders of the Sundarbans in Bangladesh regarding climate change and how are those understandings constructed among them?

Second objective

To critically examine how the conservation and management agencies of the Sundarbans are responding to climate change in terms of adaptation and resilience building.

Research questions

2. What are the management functions that support community adaptation in the Sundarbans in Bangladesh?
3. What are the areas of convergence and divergence in the management actions of the Sundarbans World Heritage in response to climate change across the international border of Bangladesh and India?

1.6 Research approach

This thesis follows the philosophical principles of constructivism to investigate the aim and research objectives. In cases of social knowledge accumulation, constructivism is a classic research paradigm (Guba & Lincoln, 2005). The principles of the paradigm address that there are multiple realities (relativist ontology), and the researcher and research participants are the co-creators of knowledge (subjectivist epistemology). Aligning with the research philosophy, this research adopts qualitative methods to collect empirical data. Semi-structured interviews and document analysis have been utilised to accomplish the research objectives. This thesis also attempts to ensure the quality of qualitative data by checking essential criteria proposed by Lincoln and Guba (1985), those are credibility, neutrality, consistency, and applicability.

The research was conducted in different locations of Bangladesh Sundarbans (Satkhira district and Khulna division), Dhaka (capital of Bangladesh), Indian Sundarbans (Canning area), and Kolkata (capital of West Bengal state of India) from May to August 2016. To address the research objectives, this research collected empirical data from two broad groups of stakeholders - user groups of the Sundarbans (community

people, tourism business, and tourists), and conservation and management agencies (Government, NGOs, and international agencies). The participants for semi-structured interviews were selected by following judgemental sampling technique. Thematic analysis was applied to the empirical materials coming from the interviews to achieve the research objectives. A range of documents was analysed to enrich the empirical data and to crosscheck the participants' claims.

1.7 Thesis structure

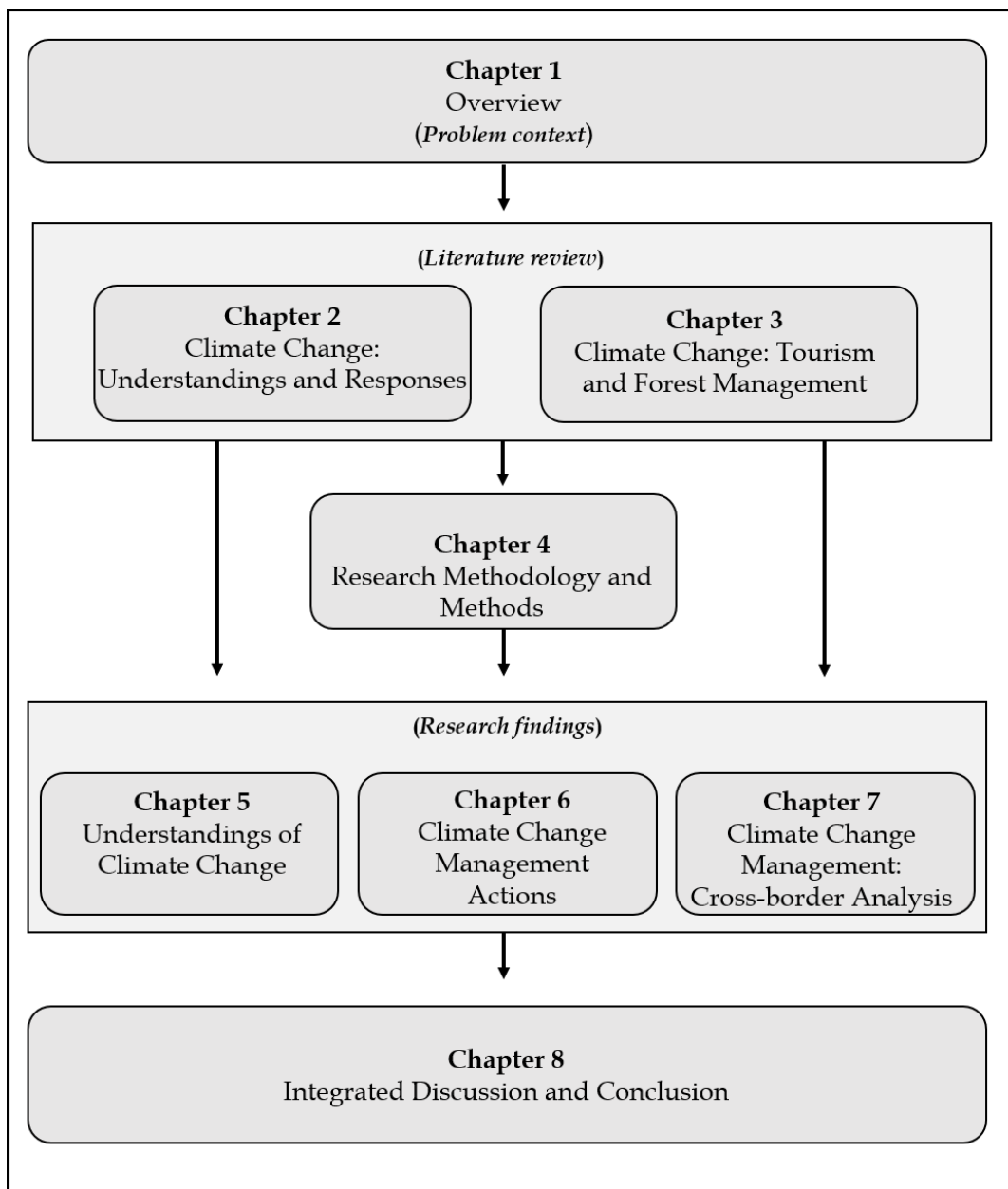
This thesis is organised into eight chapters (**Figure 1.2**). Following the first chapter of the thesis, Chapters 2, and 3 provide the literature and context to frame the thesis. Chapter 2 focuses on the literature of climate change understanding (awareness, knowledge, and risk perceptions) and climate change response (mitigation, adaptation, and resilience building). It provides the climate change governance and management scenario of Bangladesh and Sundarbans in terms of climate understanding and response. Chapter 3 addresses the literature regarding climate change and tourism, climate change forest management, integrated forest management, and World Heritage management associated with stakeholders' common understandings of and responses to climate change. Later the chapter describes the Sundarbans context in terms of tourism, transboundary tourism, community and tourism, and the threats of climate change on tourism. That chapter outlines the tourism and forest management phenomena under climate change from general perspective to specific contextual perspective. The methodology and methods utilised in this research are presented in Chapter 4.

The findings of this qualitative research are presented in Chapter 5 to Chapter 7. These three findings chapters are designed to accomplish the overall aim of the thesis. The findings chapters - contain research background, literature, and methodology that are relevant to the findings - are presented in the format of publications, as allowable under the regulations of the University of Otago for the preparation of PhD thesis²⁴. Each findings chapter represents the themes arising from the analysis process. Chapter 5 presents understandings of climate change and sources of constructing the understandings, Chapter 6 presents functions and usefulness of the contextual climate change management, and Chapter 7 presents cross-border comparative responses

²⁴ <https://www.otago.ac.nz/graduate-research/study/phddoctoral/programme/otago406003.html>

(Bangladesh vs. India) in terms of climate change management in the World Heritage. In each findings chapter, the relevant thematic literature, contextual background and methods utilise for uncovering the research question are presented prior to the research findings. Among the two objectives of the thesis, the first objective (research question 1) is presented in Chapter 5, and the second objective is presented in Chapter 6 (research question 2) and Chapter 7 (research question 3).

Figure 1.2: Structure of the thesis



This thesis is concluded in Chapter 8, which summarises the literature and contextual background presented in Chapters 2 and 3, and specific outcomes of the three findings

chapters. Chapter 8 identifies the implications of the research findings to the real-world situation – why and how the investigation of contextual climate change understanding and response is important, how understandings of and responses to climate change assist in enhancing resilience. It also presents how the thesis contributes to filling the contextual and general knowledge gap. Later, that chapter involves an overarching discussion of cumulative findings of the research in relation to the objectives. The concluding chapter also outlines methodological contribution of this research – methods for uncovering the two objectives of this thesis. Finally, the chapter enlists future research opportunities.

Chapter 2

Climate Change: Understandings and Responses

2.1 Introduction

This chapter critically examines climate change understanding and response (action) from theoretical and contextual perspectives. Since social understandings about scientific knowledge are critical to climate responses, this chapter highlights the concept ‘understanding’ along with its components - awareness, knowledge, and perception. Based on available literature, this chapter also depicts the significance of, sources of, obstacles to, and ways of improving social understandings of climate change. Later, this chapter incorporates common response strategies of climate change, such as mitigation, adaptation, and resilience building. The discussion regarding the response strategies of climate change leads to a growing conceptualisation of ‘sustainable adaptation’. Here, it is argued that by applying resilience building strategies, sustainability in adaptation interventions can be enhanced.

As social understandings of and responses to climate change are primarily derived from climate change governance and management frameworks, this chapter critically examines climate governance from the global scale to local scale including the role of management agencies (government, international agencies, and NGOs) for mitigation and adaptation. This chapter also explores climate change scenarios in Bangladesh with relevant socio-economic background of the country. Later, it illustrates the specific impacts, effects (vulnerabilities), and future risks of climate change in Bangladesh. By explaining the status of Bangladesh in terms of climate change understanding and response, this chapter indicates the research gaps which this thesis intends to address. Finally, this chapter illustrates the climate understandings and responses in the Sundarbans study context so that this thesis can contribute to context-specific knowledge.

2.2 Climate change understanding

2.2.1 Understanding the science of climate change

Understanding of something, in general, means the set of learnings. In the case of defining the term ‘understanding’ in the aspect of science communication, indeed, scholars are divided in their opinions. The popular meaning of the word ‘understanding’ is a type of ‘knowledge’ about something (Grimm, 2006), ‘awareness’ of an object (Zagzebski, 2001), the ‘true beliefs’ (Kvanvig, 2003). Here, ‘knowledge’ implies deep understanding and familiarity with a subject whereas ‘awareness’ means

shallow understanding (Hasan, 2016). De Regt (2004) has defined understanding differently and has said it is a kind of 'ability' to use knowledge. For instance, if a person knows about the cause and effects of climate change but does not exhibit any climate action in personal and social life, then it can be said that the knowledge is not enabled accordingly. Human action based on awareness and knowledge is the reflection of perceptions (e.g. beliefs, feelings, intentions) develops through a complex psychological process (Blakemore & Decety, 2001). When people become aware of something (get stimuli such as information, clues), the human brain may process to take decisions and keep the decisions in mind which is called perception (Dittrich, 1993).

The terms 'awareness' and 'knowledge' are often utilised to indicate similar meaning. Of course, these two concepts have overlapping features – but conceptually these are different (Grimm, 2006). Academically 'awareness' is the first step and 'knowledge' is the second step of understanding (Kvanvig, 2003). When people come to know (hear) about something, they become aware of it. Then they start gathering information for action (or reaction). That accumulated information contributes to developing knowledge if the information help people to take the desired action (De Regt, 2004). 'Perception' cannot be separated from awareness and knowledge. Perceptions build up when people come to know about something - no awareness (or knowledge) no perception (Dittrich, 1993; Rock, 1985). Perception can be changed through the accumulation of information - further information gathering makes the perception of something stronger or weaker (Blakemore & Decety, 2001; van der Linden, 2014). Here, awareness is the outer world way of expression and perception is the human's internal (mental) thing. The three concepts 'awareness', 'knowledge' and 'perception' are not mutually exclusive, but they collectively contribute to constructing 'understanding' about something.

Communicating scientific understandings of climate change is one way to create climate change understanding among members of a society (Lee et al., 2015). Varied levels of awareness and understanding surround a range of scientific findings including climate change as human-induced, carbon emissions as a cause of climate change, burning fossil fuel is the cause of emissions, plants can absorb CO₂, wildlife is important for forest and plants, and one metre sea level rise is projected for the end of

21st century. The IPCC notes that it is important to communicate to creating social understandings of climate change (IPCC, 2014). Awareness and knowledge of scientific findings may lead a person to adopt certain climate actions. For example, when people come to know trees can reduce the effects of emissions on climate, then they might get motivated to plant trees. Awareness of climate change creates risk perceptions among people that motivate them to accumulate information for action. People need to know the risks of climate change and how to manage the impacts of climate change. If a person, for instance, does not know why climate change is happening then he/she will not be empowered to act. Scientific knowledge relating to climate change is, therefore, a precursor to climate action within a society.

Understanding about something develops through a multifaceted cognitive psychological process over time through experiencing, examining, accumulating information from different sources (Cook, 2008). Society has great influence to shape individuals' understanding about science, however, an individual's understandings may not represent the social understandings (Patrick & Nick, 2004). All the individuals' common understandings form the social understandings which have a strong influence on the social action (Lyttle, 2014). When people think that something is risky, for instance, then they start working to reduce the risk. The attitude to climate change follows the same socio-psychological process (Clayton et al., 2015; van der Linden, Maibach, & Leiserowitz, 2015a; Van Pelt et al., 2015), which means climate change understanding is the initial determinant of climate action. For initiating climate change actions, knowledge related to adaptation and mitigation is a further requirement. Based on the researches conducted by Cohen, Higham, Gössling, and Peeters (2014), Hopkins (2013b), Masud, Akhtar, Afroz, Al-Amin, and Kari (2015), Wolf and Moser (2011), this research project conceptualises that awareness, knowledge, and risk perceptions conjointly develop the understandings of climate change.

2.2.1.1 Climate change: awareness and knowledge

Climate change awareness denotes the general understandings in terms of basic information regarding cause, effects, risks, or observed changes in the weather system (Lee et al., 2015). There are many people in the world never heard about climate change (Hopkins, 2015c). Therefore, they do not have any information about climate change. A high portion is highly vulnerable to climate change, but they are not aware

of the cause of the impacts (or effects). Despite having climate effects, people who do not have any information about climate change may think that the environmental changes are occurring because of natural causes (Lee et al., 2015). As a result, they do not take any precautionary actions. Scientists identify so many place-specific climate risks in different time-scales, but people hardly aware of those risks and their consequences. Awareness is the preliminary stage of climate action - if people do not become aware of this that humans are responsible for climate change (by their GHG emissions), it is entirely unexpected that they will act to mitigate climate change (Dal, Alper, Özdem-Yilmaz, Öztürk, & Sönmez, 2015).

Awareness is a necessary but not sufficient condition to take climate change actions (Boyer, 2013). Appropriate knowledge about mitigation and adaptation is a further requirement. General understandings (awareness) may lead a person to pro-environmental behaviour (Lyttle, 2014), but detailed relevant knowledge is urgent to deal with vulnerabilities and risks of climate change (Sterman, 2011; Zakaria, 2015). Though the type of vulnerabilities and risks of climate change is different in different geographic locations, knowledge requirements are different for adaptation, mitigation, and resilience (Moser, 2017). Knowledge requirement is also different in different sectors such as agriculture, forestry, and tourism. Again, the sector-wise adaptation knowledge is highly context-specific, as the type and extent of climate impacts are different (Albouy et al., 2014; Hopkins, 2013a). For example, small island and low-lying countries and their economic sectors are suffering more from sea level rise, and salinity intrusion; whereas the countries at higher altitude are vulnerable to droughts (IPCC, 2014).

Awareness without knowledge to act may not be helpful to achieve the desired and required climate actions (Wolf & Moser, 2011). Relevant and verified knowledge is required for adaptation, mitigation, or resilience building. Applying inappropriate adaptation knowledge to reduce vulnerabilities may be a further threat to the resilience of a society (Barnett & O'Neill, 2010; Fünfgeld & McEvoy, 2012). Knowledge about mitigation options and scopes should also be available to the people of society for action. However, the required knowledge for adaptation and mitigation is inadequate to most of the nations (IPCC, 2014). Research related to climate change knowledge in the developed nations context is quite visible, but the developing world is highly

ignored by the research communities in terms of climate change knowledge creation (Chinowsky et al., 2011; Ford & Berrang-Ford, 2011; McNaught et al., 2014). Innovation (e.g. technological, procedural, methodical) is required for adaptation and mitigation, and that scientific knowledge needs to be communicated to society for climate action. When all the people of a society have access to relevant and required knowledge of climate change, the society will be able to manage the wicked problem of climate change.

2.2.1.2 Climate change: perceptions of risk

Awareness creates the initial perception which drives people to gather knowledge to reduce the risks of climate change through adaptation and mitigation (Stermann, 2011). Risk perception is the human feeling that climate change impacts may harm (Weber, 2006). It is human habit that people do not like to act unless they get a motivator – pleasant or fearful (Ryan & Deci, 2000). Perceiving climate change as a fearful risk can be a strong motivator to take action (Leiserowitz & Smith, 2017; van der Linden, 2017). For instance, by perceiving obesity as a risk to human health, people get involved in physical exercise. If people perceive that climate change is not risky for them, then it is highly likely that they will not support climate action (Lee et al., 2015). Lack of information about future threats of climate change is the major reason for lack of risk perceptions. To perceive climate change as a risk, however, people need to be aware of the specific global and local climate risks and related consequences in the weather system (Weber, 2006).

Risk perceptions of climate change do not only vary between countries: they also vary strongly among individuals from same countries (van der Linden, 2015b). There is a striking contrast observed regarding public risk perceptions of climate change between developed and developing countries; people who are from developed countries possess more scientific information (knowledge) about the risks of climate change than their counterparts from developing countries, however, climate change is generally perceived as a higher risk by developing nations in comparison to most of the developed nations (Lee et al., 2015; Shi, Visschers, Siegrist, & Arvai, 2016). One of the prime reasons for this variation in risk perceptions is that the developed countries have a higher capacity for facing natural catastrophes that arise due to climate change (Chinowsky et al., 2011). Coping capacity (e.g. available robust infrastructure, access to

technology, skills to cope with the impacts) profoundly determines the risk perception of climate change (Safi, Smith, & Liu, 2012). Risk perceptions are also geographic location dependent (Hopkins, 2015b). For example, people who live in the coastal area perceive more risk than people live far away from the sea (Shao & Goidel, 2016).

Risk perceptions of climate change largely rely on how an individual evaluates the negative consequences of future impacts based on the experience (Clayton et al., 2015; Marlon et al., 2018). Personal experience is considered as a fast and associative information processing heuristic that frames the risk perceptions (van der Linden, 2014; Weber, 2010). It means that people will consider climate change as a risk when they can relate the potential consequences of scientific predictions with their previous experience of encountering a similar type of events (Milinski et al., 2008). The negative experience of extreme heat waves or record floods has an influence on the perception of climate change (Hansen, Sato, & Ruedy, 2012). The reason is people already know about the vulnerabilities of those weather disasters. There is considerable evidence that personal experience of negative impacts shapes the risk perceptions, attitudes (worldviews) and behavioural responses to of climate change (Whitmarsh, 2008a). However, personal experience of extreme weather events is rare in many places around the world (Weber, 2006).

Social learning processes also form individuals' risk perceptions of climate change (Marlon et al., 2018; van der Linden, 2014). People of a society will consider climate change as a risk according to beliefs of the other members of the society (e.g. the same social class or peer group) consider about this type of threats (Milinski et al., 2008). Personal risk judgement follows a socio-psychological perception model where social cultures, norms and values are strong determinants (van der Linden, 2015b; Weber, 2010). It never means all the people of a society perceive climate change in a similar way - but the social settings influence the perception of the large portion of people. For example, a certain social faith (religious or non-religious) may drive people to ignore climate change (Wolf & Moser, 2011). If a society has huge other current problem (e.g. economic, social) which disrupts the people a lot, they may not perceive the future risks of climate change (Safi et al., 2012), despite having access to sufficient climate information. By categorising the all available risks (e.g. poverty, food security, health),

the people of a society pick some risks for attention and choose to ignore others (Weber, 2006).

The people who are informed about climate change, most of them perceive it as a 'distant risk' rather than 'immediate risk'. Many behavioural science researchers have found that people regard climate change as a nonurgent and psychologically distant risk - spatially, temporally, and socially (van der Linden et al., 2015a). Psychological distance on climate change relates to the degree of public concern about climate change - generally lower psychological distance was associated with higher concern about climate change (Spence, Poortinga, & Pidgeon, 2012). When people perceive that climate change consequences will occur in distant location (e.g. coastal area - far away from the home of the man of reference), in distant future (e.g. 50 years later), in distant society (e.g. developing countries), it leads to defer public action about adaptation and mitigation responses (Hopkins, 2015b; van der Linden et al., 2015a). People are more likely to act when they consider climate change as a more near, local and immediate risk (Spence et al., 2012).

In many cases, people perceive climate change as a 'societal risk' rather than 'personal risk', which complicates personal action (Spence et al., 2012). Climate change risk is common for everyone in a society. When people perceive climate change as a collective societal risk - a common threat to everyone, then they are unlikely to act, as they think that individual actions may not reduce or contribute to lessening climate change significantly (Milinski et al., 2008; Santos, Vasconcelos, Santos, Neves, & Pacheco, 2012). For example, people are more likely to take precautions against personal diseases but more unlikely to take actions for reducing environmental pollution of their society. Here, social risk judgements also shape the individual's perceptions - people like to do what the other people of the society do or will do (van der Linden, 2015b). Climate change is a collective societal risk, but personal risk perceptions determine individuals' collective adaptive responses and mitigation behaviours (Hopkins, 2015b).

Perceiving climate change as a 'gradual risk' or 'catastrophic risk' has implications for climate action (Wibeck, 2014). Gradualism involve the believes that climate change is not entirely occurring because of human-induced emissions, but the global climate is

changing slowly, and it is possible to cope with the changes (Szerszynski & Urry, 2010). The philosophy of gradualism emphasises human responses to climate change should be based on risk calculation and practice modification supported by reasonable economic incentives (Wibeck, 2014). On the other hand, catastrophism – focuses on ‘non-linearity’ and ‘unpredictable sudden change’ – addresses climate change is anthropogenic, while also emphasising scientific uncertainty and the limits of scientific knowledge (Szerszynski & Urry, 2010). In response to climate change, catastrophism supports that climate change is already occurring, but humans can do a little to stop its progress (Wibeck, 2014). The people who perceive climate change as gradual or catastrophic risks usually highlight on adaptation and they see little point in mitigation.

The degree of risk perceptions of climate change varies from person to person, both within and between different countries. The available academic literature confirms that cognitive, affective, social, and cultural elements all highly influence the risk perceptions of people, and these elements interact with each other in complex ways to stimulate mental process (Swim et al., 2011; van der Linden, 2017). Modelling risk perceptions are difficult because of this complex psychological process (Hopkins, 2015b). Despite the complexity, many scholars including Hopkins (2013a), Lee et al. (2015) Moser (2017), van der Linden, Leiserowitz, and Maibach (2018) indicate to the availability of and accessibility to scientific information related to impacts and threats lead people to perceive climate change as a risk. Here, awareness communication is the primary stage to public risk perceptions, and as soon as people perceive climate change as a risk they start gathering knowledge (relevant information) for mitigation (Spence et al., 2012; Sterman, 2011; Wibeck, 2014; Wolf & Moser, 2011) and adaptation. This is the argument for framing the ‘understandings of climate change’ with three components – awareness, knowledge and risk perceptions.

2.2.2 Public understandings of climate change

Many scholars consider climate change as the most challenging issue in the history of human evolution (IPCC, 2014). However, people living in the developed world know very low than the requirement of information about the cause and effects of global climate change, and very few are aware of it in the context of developing countries (Lee et al., 2015). Overall 40% of people living around the world have never heard the

phrase 'climate change', and this percentage rises to more than 65% in some developing countries, like Bangladesh and India (Yale Project on Climate Change Communication, 2015). Around 97% of global scientists and scholars agree that humans are responsible for this present climate change (Cook et al., 2013), whereas public perception consensus is around 50% even in the context of developed countries (Lee et al., 2015). A big gap exists between the scientific consensus and the public perception regarding anthropogenic climate change (Yale Project on Climate Change Communication, 2015). To take appropriate climate actions, this gap need to be minimised (Cook, 2016; Lewandowsky, Gignac, & Vaughan, 2012; van der Linden, Leiserowitz, Rosenthal, & Maibach, 2017).

Public (or social) understandings of scientific consensus increasingly contribute to accelerating the belief that "that climate change is (a) happening, (b) human-caused and (c) a worried-some problem" (van der Linden, Leiserowitz, Feinberg, & Maibach, 2015b, p. 6). The degree of diffusion of climate understandings is very low as climate change is time-delayed (for some region of the world), abstract, and often statistical in nature (Weber, 2006; Whitmarsh, 2008a). Another reason why climate change does not evoke strong reactions is the uncertainty of scientific findings (Retzbach & Maier, 2015; Schneider, 2016; Spence et al., 2012; Stephen, 2000), however, people are usually positive about visible scientific innovations of health service or computer science (Bauer, 2009; Retzbach & Maier, 2015). Despite strong scientific consensus, the association between climate change and its risks are different from other scientific issues such as the relationship between lung cancer and smoking, or unsafe blood transfusion and HIV-AIDS (Lewandowsky et al., 2012). Kahan et al. (2012) find that public divisions over climate change (e.g. anthropogenic or natural) originate not from the public's incomprehension of science but from a distinctive conflict of choice between individual interests (e.g. sacrificing immediate personal consummation) and societal interests (e.g. contributing to collective welfare).

Understandings of climate change have a positive influence on climate actions, but this relationship does not follow a linear trend. Actions to mitigate climate change are always unattractive to people because those require immediate sacrifices in consumption for highly-uncertain benefits at a much later point in time. (Weber, 2006). Humans are more likely to take actions to get immediate benefits or get rid of the

immediate problem (van der Linden, 2018). This reality becomes a demotivator against the desired behaviour for climate actions. Usually people 'feelgood' when they decide to act pro-environmentally because of the intrinsic motivator (physical and psychological reward), but this behaviour may not sustain (van der Linden, 2015a). If the behaviour is socially accepted (e.g. long-haul holidays, consumerism), the understandings of the necessity of pro-environmental behaviour for climate actions may be changed over time (Gunster, 2017; Higham, Reis, & Cohen, 2015; van der Linden et al., 2017). Moser (2010, p. 13) addresses the challenges that even having the greatest understanding, "the most passionate motivation to act on climate change will need to overcome a wide range of structural hurdles that can undermine people's desires and attempts to 'act green'".

Climate change understanding depends on several socio-demographic factors such as family income, level of education, access to communication technology, governance systems and political situation (Filho, 2009; Mycoo, 2015). More than 90% people of the developed world like North America, Europe and Japan, are aware of climate change; in contrast, few people are aware of current climate issue in the context of developing countries, despite many of them have noticed changes in the local weather patterns (Lee et al., 2015). The prime reason for different understanding level regarding climate change between developed and developing countries are dissimilar socio-demographic characteristics (Hopkins, 2015c; Whitmarsh et al., 2012). Worldwide, climate change awareness is highly associated with education level of the people of a society; in case of USA, civic engagement, communication access, and education are the most important factors; whereas, in case of China, firstly education level, then proximity to urban areas, and household income are the most influential predictors of climate change awareness (Lee et al., 2015).

In some developed countries, political ideology is a strong determinant of climate change understanding – people believe what their supported political parties' position about climate change (Marlon et al., 2018; van der Linden et al., 2018). Government and people of many countries show very little concern about climate change and its consequences (Weber, 2006) because of the high focus on national economic development goal (Pidgeon, 2012). The ideology of (neoliberal, extractive) capitalism is the key influencer of climate change; however, despite climate change being the

immediate and existential risk to humanity, the political tendency is negative in terms of reducing emissions from industrialisation and consumerism (Gunster, 2017). The political fear is that carbon offsetting actions may affect economic growth and development and stability of political government (Pidgeon, 2012). Understanding the climate change as a risk by the politicians, indeed, has great implications for preparing for this serious challenges facing the planet and its inhabitants (van der Linden et al., 2015a).

In spite of being highly vulnerable, climate change literacy in many rural coastal communities in developing countries is considerably low (Mycoo, 2015). As a result, their understandings are different. In some societies, belief regarding the rapid changes in weather system is culturally or religiously inclined (Wolf & Moser, 2011). If the changes in the environment threaten the local livelihoods or lifestyle, people perceive more risk (Hopkins, 2015b). But they think that the changes are occurring because of natural cause – ‘there is nothing one can do but cope’ (Wolf & Moser, 2011, p. 14). Lack of climate change information is one of the reasons for this (mis)understanding. Even, having proper information about climate change, people may not perceive it as a great threat in some places. Wolf and Moser (2011) have noted an example that managers found illegal poaching more challenging than the threats of climate change impacts. The climate understandings are place-specific; most of the research works regarding climate understanding are conducted in the developed world context, therefore, it is not wise to generalise those research findings in developing country contexts.

Social understandings of climate change primarily influence the political, economic and public support to national climate change policies (Dal et al., 2015; Leiserowitz, 2005). Zakaria (2015, p. 59) argue that public understanding about “the potential consequences of climate change lead them to exert pressure on their leadership to be more cooperative in efforts to create a global climate change regime”. If people of a society feel climate change as a risk, the political government takes apposite climate actions in terms of adaptation and mitigation (Hopkins, Campbell-Hunt, Carter, Higham, & Rosin, 2015; Lee et al., 2015). National level climate actions require capital investment and immediate sacrifice (e.g. limited public facilities, higher tax) which is very tough without proper public support, particularly for mitigation in the context of the nations which are not highly vulnerable at current timescale (Kuntzman & Drake,

2016; McNaught et al., 2014). People will allow the government to spend money to resolve climate change unless they do perceive it as a threat (Lee et al., 2015). The situation may be different for the adaptation of nations which are already facing climate vulnerabilities (McNaught et al., 2014; Van Pelt et al., 2015). Considering only the current vulnerabilities without understanding the future risks, however, may be a threat to the resilience of a society (Kuntzman & Drake, 2016; McNaught et al., 2014).

2.2.3 Sources of climate understandings

Communication works as a bridge for transferring the scientific understandings of climate change into social understandings (Yale Project on Climate Change Communication, 2015). Communication of the scientific information regarding the effects of climate change creates understandings among the public which ensures their effective and meaningful engagement that leads to action (Dal et al., 2015; Moser & Dilling, 2011; Spence & Pidgeon, 2010). The findings of scientific research of climate change are necessary to be communicated in order to create understandings in different scales of a society from policymakers to local communities (Bernabo, 1995; McNaught et al., 2014). Communication is the way of public understanding and those understandings drive a society to take actions for achieving viable solutions against climate change (Lee et al., 2015). Furthermore, ongoing communication between scientists and policymakers is recommended for not only creating social understandings but also developing effective climate policy (Bernabo, 1995; Webster, 2003).

Media is the most prominent means of communicating the scientific findings of climate change (Painter & Cartner, 2014; Retzbach & Maier, 2015). It becomes increasingly difficult to ignore the role of media for science communication. Over recent decades, the media has expanded public understandings of climate change science (Antilla, 2014). Different media including television, newspaper, the Internet often present the anthropogenic cause of climate change and impacts including sea level rise, salinity ingress, increased temperature, which creates understandings among the public. The degree of media coverage of climate change can stimulate the risk perceptions of nations (Painter & Cartner, 2014). The visual and print media such as BBC, the Guardian (UK), internationally portray the impacts of climate change which create understanding, particularly by highlighting on climate mitigation for managing risks

(Antilla, 2014). However, some media publish climate denial items to establish political agenda in the society (Alison, 2009). News media often create stories containing inaccuracies which reduce the authenticity of the climate change messages regarding risks and uncertainties (Allan, 1994; Boykoff, 2011). To resolve this problem, Painter and Cartner (2014) have recommended that media and scientists need to work together to better inform the public about climate change.

The scientific understanding of climate change is conveyed to the society through different communication ways, besides media. The other modes of communicating climate change in society vary in consideration of context (Sterman, 2011). In some places, planned communication such as awareness campaigns, and educational programmes are the sources of climate change understanding. Climate understanding may develop through informal social interaction with friends and acquaintances (Hopkins, 2013a). Political groups which accept climate change as a threat also assist to create climate understandings among the supporters (Marlon et al., 2018). People who have interest (or concern) about climate change may study from different available and accessible sources of climate science. Incorporation of climate change in the syllabus of regular national education system can be a good way of climate understandings. However, teachers' misunderstanding (e.g. ozone depletion, acid rain, and pollution are conducive to climate change, or relating greenhouse effect with ozone depletion) can disrupt students' understandings of climate change (Papadimitriou, 2004).

Personal experience of changes in the weather system is the most effective source of climate change understanding (Abbott & Wilson, 2015; Berkhout, Hertin, & Gann, 2006; Marlon et al., 2018). It is easy to understand climate change by relating it to visual experience rather than statistical facts and figures (Shao & Goidel, 2016). People feel more risk of climate change when they see the effects on their lives and livelihoods (Hopkins, 2015b). But people of many nations do not have personal experience of climate change, even they have - the experience does not contain any vulnerability which is one of the reasons for denial (Weber, 2006). Whitmarsh (2008a) argues that the people who have experience of flooding have higher climate understanding. Connecting the local experience (observed impacts) with the consequences of climate change is a prominent determinant of climate understanding (Safi et al., 2012). Unfortunately, daily lived experiences of climate change are crucially missing from the

scientific understandings of this wicked problem. Abbott and Wilson (2015) note that while scholars of physical and social science seek to explain climate change effects, millions of people all over the world experience it personally in their day-to-day lives.

2.2.4 Obstacles to communicating climate understandings

Climate change is 'abstract' in nature, which is the most challenging issue against climate understandings (Filho, 2009). That is why "people often falsely attribute unique events to climate change and also fail to detect changes in climate" (Weber, 2010, p. 333). For example, cyclones do not occur because of climate change but increased intensity of cyclones have been attributed to climate change. It is complicated to make understand people the difference between natural variability and anthropogenic climate change (Van Pelt et al., 2015). The challenge further arises when need to communicate the technical issues related to climate change, for example - how CO₂ and other heat-trapping GHGs generate greenhouse effects (Moser & Dilling, 2011). Knowledge about the risks and uncertainties of climate change from statistical description make the scenario more complex to the general people (Webster, 2003). Quantifying the impacts and related losses are not possible to calculate, as past data is unobtainable in many cases, is a reason for low climate change understanding (Webster, 2003). The denial of climate change by few scholars like Hulme (2009), Shani and Arad (2014) also have a negative influence on social understandings of climate change (Hall et al., 2015).

The challenges of science communication are also applicable when creating social understandings of climate change (Schneider, 2016). For instance, scientific research findings are sometimes inconsistent (or mismatching) among different scholars, deceptive (false information), and puzzling (complex) to the general public (LaFollette, 1998). The 'uncertainty' characteristics of scientific findings is an obstacle for filtering climate change as a social threat, particularly for the developed society where the education level is high (Retzbach & Maier, 2015; Schneider, 2016; Weber, 2010). The scientific findings and risk predictions regarding climate change have not received necessary media attention (Painter & Cartner, 2014). Compared to other problems like oil crisis, climate change receives little and delayed media concentration (Becken & Hay, 2007), which contributes to the gap between scientific understandings and social understandings of climate change. The erroneous way of communicating the impacts,

effects, and risks, and occasional coverage (e.g. weather event based reporting) also are the reasons of low understandings of climate change (Painter & Cartner, 2014; Shanahan, 2017).

There are several socio-psychological issues which are accountable for not gaining required social understandings of climate change. Firstly, the intangibility of climate change is the key impediment to social understanding – people do not believe what they do not see (Shao & Goidel, 2016; Whitmarsh, 2008a). Lack of personal experience of impacts in some developed countries is one of the reasons for climate change denial (Safi et al., 2012). Secondly, consumer culture and corporate globalisation often indirectly inspire people to ignore climate change and its risks (Gunster, 2017). Thirdly, poor socio-economic conditions like extreme poverty, lack of education are the cause of lack of social understandings of climate change in the context of many developing countries (Spittlehouse & Stewart, 2004). Despite being vulnerable, for example, the people of Bangladesh who cannot provide reasonable attention to climate change as they have so many poverty-related current problems. Last but not least, lack of political support and willingness even from global to local scale makes the further challenge to create climate change understanding (Barrett, 2013; Sachs, 2014). Political parties of many developed and developing countries do not want to raise climate change as a risk, which is a challenge against social understandings of climate change (Gunster, 2017).

2.2.5 Building climate change understandings through communication

Climate change understanding currently remains low in many parts of the world. Mounting evidence from across the science communication and social science literature has found that many people regard climate change as a nonurgent issue which has led to deferred social decision making about mitigation and adaptation responses (van der Linden et al., 2015a). The other reason for non-response is lack of information regarding climate change in terms of mitigation options, adaptation skills, disasters and risks management (Lee et al., 2015; McNaught et al., 2014; Moser, 2017; Weber & Stern, 2011). In a large sample experiment, van der Linden et al. (2017) suggest that communicating the scientific consensus on anthropogenic climate change significantly increases public understanding (by approximately 20%). Scholars, particularly Fischhoff and Davis (2014), Leiserowitz and Smith (2017), Moser and Dilling (2011),

Spence and Pidgeon (2010), Spence et al. (2012), van der Linden et al. (2015a), Whitmarsh (2008a), Wolf and Moser (2011) have indicated a range of communication approaches to improve climate change understandings for effective public engagement.

Communication efforts need to simplify the complex issues related to climate science (e.g. is climate change responsible for the storm? or, how anthropogenic behaviour is responsible for sea level rise, erratic rainfall or drought?) for a better understanding by people (Fischhoff & Davis, 2014). In the aspect of risk communication, the potential source of confusion – for example, the unrelated application of knowledge about the ozone hole – needs to be resolved (Leiserowitz & Smith, 2017). Since individuals cannot be expected to comprehend the complex linkages between the long-term changes in the climate patterns and extreme events, the research results of Marlon et al. (2018) that climate change experts' interpretations is consequential for public understanding. Attention-catching and emotionally engaging (e.g. applying fear appeal) communication interventions are recommended to engender the public understanding for individual or collective climate action (Weber, 2010). Emphasising on the health impacts of climate change through communication efforts, for instance, can ensure prolific public engagement with climate change (Leiserowitz & Smith, 2017).

Communicating risks with reference to experience (e.g. current impacts such as flooding, high temperature) is more likely to be effective where audiences do not believe in climate change as a threat (Hansen et al., 2012; Safi et al., 2012; Spence, Poortinga, Butler, & Pidgeon, 2011; van der Linden, 2014; Whitmarsh, 2008a). Individuals' limitation related to lack of the first-hand experience can be overcome by visualising the potential consequences of climate change (Shaw et al., 2009; Sheppard, 2012). To deal with the distant risk perceptions (van der Linden et al., 2015a), communicators need to articulate and seek to strengthen the 'here and now' association in the public mind based on the observed and visualised impacts of climate change (Leiserowitz & Smith, 2017). At the same time, highlighting the potentially very serious distant risk of climate change is also very useful in promoting sustainable behaviour, even among the most conscious people (Spence et al., 2012). Continuous media attention is required - usually, when there is an extreme event like a severe

cyclone or tidal flooding, media cover the issue of climate change, then after the event, the media coverage to communicate climate change reduces significantly (Shanahan, 2017).

A few misunderstandings regarding climate change (e.g. not my risk – other people’s risk, individual’s action contribute nothing, large and unmanageable risk) need to carefully consider for improving social engagement for mitigation (Fresco & Timm, 2016; Hopkins & Maclean, 2014). Humans are highly unlikely to respond to climate change unless they consider it as immediate and tangible risk (Whitmarsh, 2008a). Since ‘risk’ is a mental construct which cannot be sensed - it is only perceived, the communication interventions need to be designed such a way so that people can perceive the threat (van der Linden, 2014). Weber (2006, p. 103) notes that “when people fail to be alarmed about a risk or hazard, they do not take precautions”. Presenting climate change as a concern for personal welfare (Whitmarsh, 2008a) and threat to livelihoods (Hopkins, 2015b), and attaching the high likelihood of occurrence (Weber, 2006) and the relevance to individuals’ social group, locality, and lifetime (Spence et al., 2012) in the communication interventions is helpful to promote public understandings of climate change. However, Weber (2006) has alerted that climate change communication needs to be conducted with full consciousness about unintended side-effects (e.g. ignorance of other important risks) and in ways designed to help people overcome cognitive and emotional capacity limitations.

To improve social understandings, information requirements of climate change need to be defined for individuals and societies (Hine, Phillips, Driver, & Morrison, 2017). Communicating climate information which is irrelevant to a society may create overwhelming condition and may be waste of efforts (Weber, 2006). Information requirements of society about adaptation and mitigation can be identified based on the degree of vulnerabilities and level of emissions (**Figure 2.1**). If the climate vulnerability of a society is high, information related to adaptation needs to be the focus in communications (Moser, 2017); and if emissions by a society are high, information related to mitigation needs to be the focus in communications (Hansen et al., 2012; van der Linden et al., 2015b). Type of information requirements may vary in developed and developing countries. Usually, the developed nations which are not highly vulnerable to climate change but responsible for large emissions need to be communicated more

about mitigation and less about adaptation, and the developing nations which are highly vulnerable to climate change but not engaged in huge emissions need to be communicated more about adaptation and less about mitigation (McNaught et al., 2014).

Figure 2.1: Information requirements for creating climate change understanding

		<i>Emission level</i>	
		High	Low
<i>Vulnerability</i>	High	Adaptation - very important Mitigation - very important	Adaptation - very important Mitigation - less important
	Low	Adaptation - less important Mitigation - very important	Adaptation - less important Mitigation - less important

Source: Synthesis of literature

There is no common approach that is applicable to all over the world for climate change communication. The use of messages and type of technology deployed should be customised in consideration of economic and cultural characteristics of target audiences (Mycoo, 2015). Local socio-demographic factors – education, experience, values, context – should be considered while developing climate change communication plan (Filho, 2009; Lee et al., 2015). Communication style needs to be different according to different segments of the audience, here ‘one size fits all’ approach is certainly not applicable (Moser & Dilling, 2011). Hine et al. (2017) suggest that different content and framing of messages are required for different segment of audiences such as deniers and believers in climate change. Communicating tangible local benefits for responding to climate change (Whitmarsh, 2008a), integrating climate information for individual and institutional disaster capacity building (Ziervogel & Taylor, 2012) and placed-based social movements (Gunster, 2017) can promote better understandings among people.

Communication of climate change can foster collective understandings to build resilience (Fresco & Timm, 2016). Customised messages based on social capacity and response requirement in terms of adaptation, mitigation or resilience building need to

be communicated for improving public engagement with climate change (Erickson & Lazarus, 2013; Shi et al., 2016). Different tactics need to be utilised for communicating climate change. For example, verbal communication is a powerful means of transmitting messages to rural (coastal) communities for climate literacy (Mycoo, 2015). The appearance of celebrities in climate awareness documentaries can provide meaning to and communicate climate change risks to a wider audience, but the appeal needs to be emotional beyond scientific data (Doyle, Farrell, & Goodman, 2017). Improving basic education (Lee et al., 2015), educating environmental science (Weber, 2006), empowering rural communities (Higham, Cohen, Cavaliere, Reis, & Finkler, 2016a; McNaught et al., 2014), working on politicians' beliefs (van der Linden et al., 2018), social understandings of climate change is likely to be enhanced. Even after careful communication, however, the social understandings of climate change may be different from scientists' conceptions because of 'learning pathways' (Niebert & Gropengiesser, 2013).

In spite of accelerating growth of academic research, most of the academic literature revealing understandings of climate change are based on the developed world context, focusing on the aspect of mitigation (McNaught et al., 2014). Scholars including Marlon et al. (2018), Spence et al. (2012), van der Linden et al. (2015b), and Whitmarsh (2008a) highlight about how to enhance social risk perceptions for improving public engagement with climate change, which are mostly applicable to encourage mitigation policy and behaviour in the context of highly carbon-emitting nations. Climate change understanding is also necessary for involving people for adaptation and resilience building in climate vulnerable developing countries. However, very few scholars have worked on rural understandings of climate change in developing world context (Mycoo, 2015). Since the problem frameworks regarding climate change of developing and developed countries are different, utilising developed nation climate understanding model may not be applicable to developing world context. Even generalising climate change understanding for two nations with similar economic status is not wise, as the socio-demographic, cultural, and political factors are different (Filho, 2009). Spence et al. (2012) suggest that investigation of the current understandings can be helpful to develop proper understandings, which is critical to engaging the public with the major societal transformations required to combat climate change.

2.3 Strategic responses to climate change

The United Nations addresses climate action as an obligation to ensure of sustainable development goals (SDGs). The 13th SDG remarks that responding to climate change is mandatory for ensuring sustainable development (UNDP, 2015). Two approaches have been utilised commonly in response to the worldwide climate change. Firstly, mitigation - efforts to reduce the flow of GHGs into the atmosphere; and secondly, adaptation - efforts to cope with the effects of climate change. In order to address the future unavoidable risks of climate change, another strategy is to build resilience (IPCC, 2014). Building resilience in response to climate change addresses the adaptation requirements for current vulnerabilities and precautionary actions for future risks of climate change. As the vulnerabilities and risks of climate change vary by context/settings, thus, customised response strategies are not worthwhile in all cases (Bulkeley & Tuts, 2013). For effective and efficient climate change management, the response strategies need to be context-specific (IPCC, 2007).

2.3.1 Mitigation

In simple terms, mitigation refers to any efforts to alter human behaviour that contributes to reducing climate change. Generally, mitigation is the action to decrease GHG emissions by examining different approaches and their suitability, for instance, using environment-friendly technologies or changing human behaviours. In case of climate change, “mitigation is a human intervention to reduce the sources or enhance the sinks of greenhouse gases” (IPCC, 2014, p. 4). There are two paths to mitigation: firstly, reducing the sources of GHGs by using renewable energy sources (such as solar or tidal power) and utilising green technologies (such as fuel-efficient vehicles, inventing recycling, reducing pollution, and waste management); secondly, tree plantation (and reducing deforestation) to absorb CO₂ from the atmosphere. Most mitigation efforts are designed to reduce the emissions of fossil fuel. For example, switching coal to gas fuel (natural gas emits far fewer GHGs than coal) for electricity production to reduce the overall emissions.

Mitigation can be achieved through developing older equipment more power efficient, changing management policy and practices, and altering users’ behaviour (UNEP, 2018). Avoidance of forest destruction and exploitation, for instance, can contribute to mitigation. Mitigation is the most appropriate and cost-effective approach to climate

change in the long-term. But since the benefits of climate change mitigation are beyond the common people threshold, that means people do not perceive any direct or immediate benefit from mitigation (Lee et al., 2015), they usually do not feel interested in mitigation initiatives (Tart, 2015). Mitigation would reduce the adaptation cost (IPCC, 2007), but require an immediate investment. Mitigation costs and efforts vary between countries even between places of a particular country, and depend on the distribution of costs and actions (IPCC, 2014). There is a misconception of people that individual efforts (say, for mitigation) will not contribute much to lessen the climate effects (Filho, 2009). Thus, people do not want to compromise their personal energy consumption, particularly who live in the developed countries, in spite of having proper understandings of climate change (Whitmarsh & O'Neill, 2012).

Mitigation should be every nation's obligation, it is not only the developed nations' responsibility to step forward to mitigation efforts (Paris Agreement, 2015). However, the scope of mitigation is more for developed nations than developing nations, because the developed world leads high energy intensive lifestyle. The industrialised nations are very ahead in terms of climate-friendly technological innovations. For example, an OECD report reveals that from 1990 to 2010 for technological advancement Europe has decreased the GHG emissions by 23%, whereas Asia has increased the emissions by 95% (Tart, 2015). The developed nations which are advanced in carbon-cutting technologies can exchange their technological know-how to the developing nations for maximising mutual goal of mitigation (Bulkeley & Newell, 2015). It is certainly unlikely that mitigation efforts only will clean up the additional GHGs from the atmosphere and stop climate change completely. In order to adjust to the effects of climate change, adaptation measures are essential as well. A combination of both mitigation and adaptation can optimise climate governance all over the world (Ostrom, 2014).

2.3.2 Adaptation

Adaptation, in general, means to cope with a situation, where very limited or no option exists to stop it. In the aspect of climate change, the IPCC defines that adaptation is any adjustment in natural or social system in response to existing impacts of climate change, which reduces harm or exploits favourable opportunities (IPCC, 2007). Becken and Hay (2007, p. 223) expand the definition of adaptation by indicating to those

“actions or activities that people undertake, individually or collectively, to accommodate, cope with, or benefit from, the effects of climate change, including changes in climate variability and extremes”. Adaptation measures can be taken in different scales and by different entities like individuals, organisations, societies or governments (Eriksen & Kelly, 2007). Adaptation efforts provide space for people to either reduce the vulnerabilities of climate change or gain benefits from the changes. To get benefit from sea level rise, for instance, farmers can convert their farmland into the fish pond.

Deeper insights into adaptation can be gained by examining climate vulnerabilities²⁵ (Hopkins, 2015a). Vulnerabilities are the present effects and miseries developed because of climate change impacts. For example, intense cyclones and tidal waves push sea saline water into the cultivable land and destroy crops which is a reason for malnutrition in the affected locality (Bhuiyan & Dutta, 2011). Therefore, vulnerabilities have multifaced effects on society and one kind of vulnerability can create a few further vulnerabilities like climate vulnerabilities into socio-economic vulnerabilities (Sovacool, 2018). Adaptation interventions cannot avoid vulnerabilities but can provide partial relief from vulnerabilities, for example, the early warning system can reduce vulnerabilities of disasters like cyclones. Adaptation policy needs to acknowledge the indicators of vulnerability (e.g. food security, pollution, water and sanitation, physical risk, ecosystems sensitivity, environmental capacity) in order to confirm socio-economic growth (Eriksen & Kelly, 2007). However, vulnerability is descriptive, not easy to measure in any objective fashion, which often creates complexity to include it in adaptation policy.

Adaptation is very important for those nations which are vulnerable to non-recoverable losses due to climate change (IPCC, 2014). Nonetheless, it is desperately cost intensive (e.g. costs of planning, developing and executing adaptation measures); and very often the developing nations cannot deploy exactly what they need for adaptation. Taking appropriate adaptation measures is challenging for developed nations as well, but they often can arrange robust adaptation interventions for having

²⁵ “Vulnerability is the degree to which a system is susceptible to, and unable to cope with, adverse effects of climate change, including climate variability and extremes” (IPCC, 2007, p. 27).

strong ‘adaptive capacity²⁶’ in terms of ‘hard adaptation’ and ‘soft adaptation’ measures (Sovacool, 2011). Hard adaptation involves using particular technologies and capital goods like dykes, levees, seawalls to cope with climate change and soft adaptation measures concentrate on knowledge and information sharing, capacity building, policy and strategy development, and institutional supports (Hassan, 2018; OECD, 2015). Soft and hard adaptation interventions are often used in a combined manner (**Table 2.1**). The poor nations, very often, suffer from ‘adaptation deficit’ and their most common adaptation strategy is ‘doing nothing’ (bear losses). Sometimes the climate vulnerable people develop their own ways to live with the effects. Bear losses or ‘no adaptation’ can be a strategy when the cost of adaptation is higher than anticipated losses of climate change.

Table 2.1: Types of adaptation interventions in response to climate change

Type	Description
Soft adaptation	Managerial, legal and policy approaches that aim at altering human behaviour or styles of governance. Examples: early warning systems, knowledge sharing
Hard adaptation	‘Grey’ interventions that aim to reduce vulnerability to climate change through structural changes. Examples: building flood defences, beach restoration to prevent coastal erosion ‘Green’ interventions that make use of climate impacts. Examples: Introducing new crop and tree varieties, allowing room for rivers to naturally flood onto floodplains, restoring wetlands
Combined adaptation	Approaches that use both soft and hard adaptation interventions. In fact, the best results are often achieved by combining actions. Examples: Flood risk in an area can be addressed by a combination of ‘green’ and ‘soft’ interventions, ‘grey’ and ‘soft’ interventions, or ‘green’, ‘grey’ and ‘soft’ interventions.

Source: Adapted from OECD (2015, p. 90)

Adaptation is more than designing a list of measures to reduce climate change vulnerabilities. Adaptation requirements should be, not reactive, incorporated in the national policy as an integrated framework for economic growth, sustainable development, and poverty reduction (Lagos & Wirth, 2009; Schmidt-Thomé, 2017). Reconfiguring national development policies and strategies to fulfil the requirement of adaptation is essential to meeting the needs of present generation without ignoring future generations’ capacity to meet their needs (Wilkinson et al., 2014; Xiao, Li, & Wang, 2011). For integrating adaptation into the wider policy-making process,

²⁶ Adaptive capacity to climate change depends on economic, social, institutional, and technological conditions of a nation (Kelly & Adger, 2000).

legislative conflicts and limitations need to be resolved to reduce the human and social costs of climate change (Urwin & Jordan, 2008). Adaptation planning for different sectors (e.g. vulnerable and nonvulnerable sectors) needs to follow a common policy thread to sustainable growth and development (Ford & Berrang-Ford, 2011; Xiao et al., 2011). In case of most of the developing nations, adaptation planning focuses on building infrastructure (e.g. embankments, shelters) for the protection against climate events (Lagos & Wirth, 2009). But strategies need to be incorporated in terms of vulnerability management and long-term impacts while developing infrastructure for adaptation, particularly in an environmentally critical area like forest area.

The solution can be a problem in some cases. The adaptation measure or procedure which increases the vulnerability to and risk of climate change is commonly defined as maladaptation (Schmidt-Thomé, 2017). Barnett and O'Neill (2010) define maladaptation as the actions taken to avoid or reduce vulnerability to climate change that effects adversely on or increases the vulnerability of other systems and sectors. In other words, maladaptation occurs when climate change funding measures are doing harm to the social-ecological system. Typically maladaptation arises from planned development action which usually provides a short-term solution for the negative impacts of climate change but make an intensified vulnerability in the aspect of medium to long-term (World Bank, 2013). Barnett and O'Neill (2010) indicate five pathways of maladaptation as actions - i) increase GHG emissions, ii) disproportionately create burden to the most vulnerable groups, iii) have high opportunity costs, iv) decrease benefits of adapt, and v) build a path dependency. Barnett and O'Neill (2010) further argue, maladaptation actions as 'more harmful than helpful'. Establishing those measures (maladaptation) requires capital; and then further investment requires for getting rid of those initiatives, that means those initiatives bring twofold loss.

Research works related to adaptation in the developed counties are quite available, such as: Ford and Berrang-Ford (2011), Ford, Berrang-Ford, and Paterson (2011), Game, Lipsett-Moore, Saxon, Peterson, and Sheppard (2011), Brown, Proust, Spickett, and Capon (2011), Hopkins (2014), Kettle and Dow (2016), Rosenzweig and Solecki (2010), Rosenzweig, Solecki, and Degaetano (2011), Stone, Vargo, Liu, Hu, and Russell (2013), but in the context of developing countries, adaptation research is truly scarce.

Adaptation strategies may be different in terms of characteristics of geographic location, level of social capacity (Tegart et al., 1990), access to technology (Tessa & Kurukulasuriya, 2010) and type of industry like agriculture, tourism (WTO & UNEP, 2009) in order to minimise the effects at best possible level. Understanding stakeholders' awareness, knowledge, perceptions and attitudes towards climate change is an important stage of climate adaptation (Boyer, 2013; Weber & Stern, 2011). Exploring those understandings offers enormous scope to address the adaptation-related research gap (OECD & UNEP, 2011), particularly in the context of coastal communities in developing countries.

2.3.3 Resilience building: Approach to managing risks and vulnerabilities

A significant approach to adapt to the upcoming climate change risks by addressing current vulnerabilities is resilience building. The term 'resilience' comes from a Latin root 'resi-lire' which means 'spring back', and describes the stability or capacity of a system and its resistance to external shocks (Davoudi et al., 2012, p. 300). Holling (1973) has introduced the notion of 'resilience' in the field of ecology with the belief that natural systems have a capacity to come back to an optimal state of equilibrium following a shock, which has later acquired a noteworthy traction in the social science (Martin et al., 2015). Resilience is commonly defined as the capability of a system on to achieve 'equilibrium' or a new (different) 'steady state' after any kind of disruption (Holling, 1973, 1986; Martin et al., 2015). Putting a 'resilience lens' over existing policies and strategies in different scales – from local to global, sustainability of a system can be ensured by managing risks and vulnerabilities through interventions such as policy formulation, conservation, and development action (Walker, Abel, O'Connell, & Grigg, 2016).

Resilience is examined for different forms of systems such as ecological, engineering, or evolutionary (account for the social and ecological system). However, it is bit complex to quantify the resilience of a system and how much resilience increased or decreased of a system because of a change such as an input or a shock (Haider, Quinlan, & Peterson, 2012) The resilience of two systems can be interrelated, such as social resilience depends on ecological resilience and vice versa (Adger & Tompkins, 2004). Because of changing a subsystem within a system, resilience may or may not change, depending on how important the subsystem is for the main system (Fünfgeld &

McEvoy, 2012). A resilient system should have the ability to return to an equilibrium after having a massive catastrophe. The stated equilibrium may be different before and after the shock; but the system still can be capable to withstand (Bulkeley & Tuts, 2013). After encountering shocks, resilient systems have the capacity to keep functioning or to transform part or all the system into a different system when the current one is in an irreversibly undesirable condition (Walker et al., 2016).

Social-ecological resilience²⁷ - captures two interdisciplinary concepts of natural and social sciences - provides insights into the complex dynamic interplay between systems and informs high-level strategic agendas (Davoudi et al., 2012). Applying the framework of ecological resilience to social systems (e.g. organisations and governance process) can provide a better understanding for strategy development, but generalising the ecological rooted concept to the social setting may create further complexity (Swanstrom, 2008). The interconnection between social and ecological systems, which is highly context-dependent, needs to be understood to develop strategies for resilience building (Walker, Holling, Carpenter, & Kinzig, 2004). Building resilience of one system by applying an intervention has implications on the resilience of another system – there are often trade-offs in managing social and ecological resilience (Walker et al., 2016). For example, logging that creates some employment for the people of a society may decrease ecological resilience or even social resilience by ignoring other uses of the forest. Focusing only on ecology or society may lead to too narrow conclusions when society and ecosystem are highly interdependent. To build social-ecological resilience, the interdependence between people and nature need to be considered while developing policies and strategies (Resilience Alliance, 2015).

To enhance resilience, a social-ecological system should have the ability to build and increase the capacity (or scope) for learning and adaptation so that the system can self-organise for continue functionality (Carpenter et al., 2001; Resilience Alliance, 2015). Another essential condition of building social-ecological resilience is adding capacity for tackling shocks to humans (user groups like communities and management patronisers) to anticipate change and influence pathways (Folke, 2006; Joerin, Shaw, & Krishnamurthy, 2014). The focus of and responses to systems are slightly different

²⁷ Also known as evolutionary resilience (Davoudi et al., 2012) or socio-ecological resilience (Carpenter, Walker, Anderies, & Abel, 2001).

when considering social resilience and ecological resilience independently (**Table 2.2**). For a social-ecological system, enhancing social resilience may decrease ecological resilience or increasing ecological resilience may decrease social resilience (Joerin et al., 2014). Ignorance of the dynamic interplay between the two (sub)systems - social system and ecological system (systems within a system) - while applying any strategy or intervention may be a threat to overall social-ecological resilience (Walker et al., 2016). Resilience building efforts for one part of the system need to incorporate the strategies which contribute to building the resilience of other related system or ensuring the overall resilience of the two subsystems by balancing dynamic interactions between social system and ecosystem.

Table 2.2: Social-ecological resilience: focus and strategic responses

Resilience concepts	Characteristics	Focus	Strategic responses
Ecological resilience	Buffer capacity Withstand shock	Robustness	Conservation Regeneration
Social resilience	Maintain functions (e.g. economic) after shock	Adaptive capacity	Capacity building
Social-ecological resilience	Interplay disturbance and reorganisation Sustaining and developing	Transforming Learning Innovation	Balancing dynamic interactions between society and ecosystem

Source: Adapted from Folke (2006)

Climate change study acknowledges the general properties of resilience and argues that resilience of a social, ecological, or social-ecological system can be enhanced (Davoudi et al., 2012; Fresco & Timm, 2016; Nelson, 2011). In the field of climate change, the Arctic Council (2013) defines resilience as: “the capacity of social, economic, and environmental systems to cope with a hazardous event or trend or disturbance, responding or reorganising in ways that maintain their essential function, identity, and structure, while also maintaining the capacity for adaptation, learning, and transformation” (IPCC, 2014, p. 1270). Before adopting the Arctic Council’s definition, the IPCC report 2007 states resilience as: “the ability of a social or ecological system to absorb disturbances while retaining the same basic structure and ways of functioning, the capacity for self-organisation, and the capacity to adapt naturally to stress and change” (IPCC, 2007, p. 37). The definition of IPCC (2007) ignores the

'equilibrium' property of resilience which was indicated in the definition of IPCC (2014) by mentioning 'transformability' capacity of systems. Climate change resilience not only resolves around the existing and visible vulnerabilities like in the discipline of disaster planning but also deals with the potential future risks (Martin et al., 2015).

After having turbulent shocks such as strong cyclones, a social or ecological system can be disrupted, it is important how fast the system bounces back to its functional condition (Davoudi et al., 2012). The sooner the system comes back, the more resilient it is. A resilient system can tolerate shocks and reconstruct itself when necessary. The reduced resilience of a system increases its vulnerability, even to minor disturbances that the system could handle effortlessly earlier can put it under great threat. The gradual alterations from climate change, even in the absence of any significant disturbance, can trigger a tremendous response of the system. The response can vary system to system, a small-scale change can amplify and lead to a major shift, and vice versa (Fünfgeld & McEvoy, 2012). Even the past reaction of a particular system is no longer a dependable predictor of its future reaction when circumstances (disturbance and change) are alike (Duit, Galaz, Eckerberg, & Ebbesson, 2010). Proper assessment of the characteristics of a system can partially resolve the problem of measuring its reactions to climate disturbance (Haider et al., 2012).

Presently 'resilience' often deals with the impact of climate change in terms of adaptation planning, policy development, and implementation, at different administrative scales (Fünfgeld & McEvoy, 2012; Porter & Davoudi, 2012). Assessment of resilience (adaptive capacity assessment) can support to prepare a comprehensive plan for a social-ecological system which is vulnerable and has complex interactions between scales (Haider et al., 2012). The assessment criteria should be measurable or understandable in relation to their relative contribution to resilience. Resilience building strategies should be developed based on the strength or weakness of those criteria. This approach becomes very important for preparing disaster management strategies to work on the critical criteria (Fünfgeld & McEvoy, 2012), where addressing higher protection level, flexibility, robustness, and future risks are the major features of resilience building (OECD, 2015).

Fünfgeld and McEvoy (2012) describe climate change adaptation can be explained by the term resilience and define resilience building as the adaptation measures those are designed to handle the impacts of climate variability (change). This is the general thought to many people that resilience building is nothing but adaptation. Adaptation is a reactive approach where interventions are taken after having a shock to adjust to the effects of the shock, whereas resilience building is enhancing the ability to handle a shock (proactive approach). Of course, both resilience and adaptation deal with vulnerabilities, but the extent is different (Adger & Tompkins, 2004). Resilience building efforts mitigate vulnerabilities (fully or partially) by considering the future risks, but the core focus of adaptation is to reduce or remove current vulnerabilities (Davoudi et al., 2012). Resilience (building) complies with all the qualities of adaptation and addresses long-term risks – by avoiding the drawbacks of (mal)adaptation.

Davoudi et al. (2012, p. 299) argue that the concept of ‘resilience’ in some ways increasingly supplements the classic concept of ‘sustainability’ in the academic literature. IPCC also addresses the relationships between the concepts and states that “sustainability is closely related to resilience” (IPCC, 2014, p. 292). However, the concepts – resilience and sustainability – are slightly different in terms of practice, “while sustainability evokes restoring a lasting equilibrium to a world thrown out of balance; resilience emphasizes adapting to changes and shocks in a perpetually unbalanced world” (Martin et al., 2015, p. 17). In the aspect of nature-based tourist destinations, Espiner, Orchiston, and Higham (2017, p. 11) argue, “resilience and sustainability have features that are conceptually similar, but are distinct and, largely (but not necessarily) complementary”. The most common feature of resilience and sustainability is both deal with long-term social, economic, and ecological benefits (Adger, 2003a; Adger & Tompkins, 2004; Davoudi et al., 2012).

Scholars including Bulkeley and Tuts (2013) and Martin et al. (2015) consider resilience as the opposite of vulnerability – the more resilient, the less vulnerable and the less resilient, the more vulnerable. The opposite relationship between resilience and vulnerability is mostly examined for vulnerable developing world context. However, Espiner and Becken (2014, p. 646) argue that “high levels of vulnerability do not necessarily determine low levels of resilience, nor vice versa” for a protected area

tourism system in the context of the developed world. Here, two things need to be considered: one - the terms 'high level', 'low level', 'more', and 'less' are abstract (may vary place to place), two - if the system is already resilient, even if it is vulnerable it will bounce back. Many scholars including Adger and Tompkins (2004), Bulkeley and Tuts (2013), Davoudi et al. (2012), Espiner and Becken (2014), and Martin et al. (2015) agree in one point that if the adaptive capacity or resilience can be enhanced, the vulnerabilities can be managed through reduction or elimination of the effects.

In consideration of climate change vulnerabilities and risks, the resilience of a social-ecological system can be increased by capacity building through education, policy and planning, information sharing, skill development, and institutional development (OECD, 2015). For example, capacity can be enhanced by maintaining ecological functions through conservation and sustainable use, diversity in economic livelihood portfolio, and legitimate and inclusive governance structures (Adger, Hughes, Folke, Carpenter, & Rockström, 2005b). For building a resilient social-ecological systems, therefore, policymakers and managers need to incorporate balanced capacity (or strength) enhancement features in management decisions and actions (Adger, 2003a; Duit et al., 2010). However, policies and strategies which are academically established as means of resilience building may not contribute to developing desired strength of a social or ecological system unless the local attributes (e.g. geographic location, nature of vulnerabilities, social learning and experience, governance structure) of the context are not considered (Folke, 2006; Walker et al., 2004). In this research, the concept 'resilience building' indicates to deploying any efforts which can enhance 'adaptive capacity' of the social, ecological, or social-ecological system for tackling current vulnerabilities and future risks of climate change.

2.3.4 Sustainable adaptation through resilience building

The notion of 'sustainable adaptation' refers to the interventions in response to climate change which reduce existing vulnerabilities and enhance long-term resilience (O'Brien & Leichenko, 2007). Sustainable adaptation considers the economic, social and environmental aspects while addressing the vulnerabilities and risks of climate change (Eakin, Lemos, & Nelson, 2014; Eriksen & Brown, 2011). It is an advanced form of

'sustainable development'²⁸, which address not only climate change but also address poverty in the development programme (Adger, 2003a). The adaptation interventions which bring further vulnerabilities - often referred to as maladaptation (Brown, 2011), and the interventions which enhance carbon emissions are not sustainable adaptation (Wilkinson et al., 2014). Eriksen and O'Brien (2007) suggest that sustainable adaptation interventions must reduce current vulnerabilities, strengthen adaptive capacity of the poor people, and address the cause of vulnerability (e.g. climate change) in the society.

The more an adaptation measure can contribute to the resilience of a system, the more it is sustainable. Nelson (2011) states that a resilience perspective provides a framework for evaluating adaptation actions and managing capacity for long-term sustainability. The degree of resilience is one of the scales of sustainability of that action (e.g. adaptation intervention). If an adaptation intervention develops the resilience of the social or ecological system, that intervention is a sustainable adaptation. By identifying the contribution to resilience, it is possible to define the relative sustainability of the adaptation intervention. Espiner et al. (2017, p. 6) support this argument for ecology-based tourism system by arguing, "without resilience, sustainability cannot be realised". Applying resilience building strategies such as utilisation of social resources, ensuring collective social actions, community involvement in management, local autonomous management structure, choosing no (or low) carbon emitting solutions, in adaptation intervention can enhance sustainability (Adger, 2003a; Brown, 2011; Bulkeley & Tuts, 2013; Nelson, 2011; O'Brien & Leichenko, 2007).

Adaptation interventions which just address current vulnerabilities, do not address long-term risks, contribute to building short-term resilience (Adger, Arnell, & Tompkins, 2005a). Providing relief aids to cope with the immediate vulnerabilities is less resilient solutions to climate change (Barnett, 2008) because every time there is a disaster, the affected society needs relief aids. Resolving problem developed by the hazards - for example, dykes against sea level rise - can be helpful in short-term adaptation but can develop further vulnerability (Fünfgeld & McEvoy, 2011, 2013). Whereas, creating social independence through climate education or capacity building

²⁸ The policy of sustainable development indirectly assists to mitigate climate change crisis (Lawn, 2016).

and strengthening social institutions enhances resilience and can contribute to sustainability of a system (O'Brien & Leichenko, 2007). For instance, creating a market for locally produced products offers self-dependency of a society, which increases resilience and lead to sustainability (Adger, 2003a; Stringer et al., 2009). By applying resilience building strategies in the adaptation interventions, the sustainability of adaptation can be enhanced.

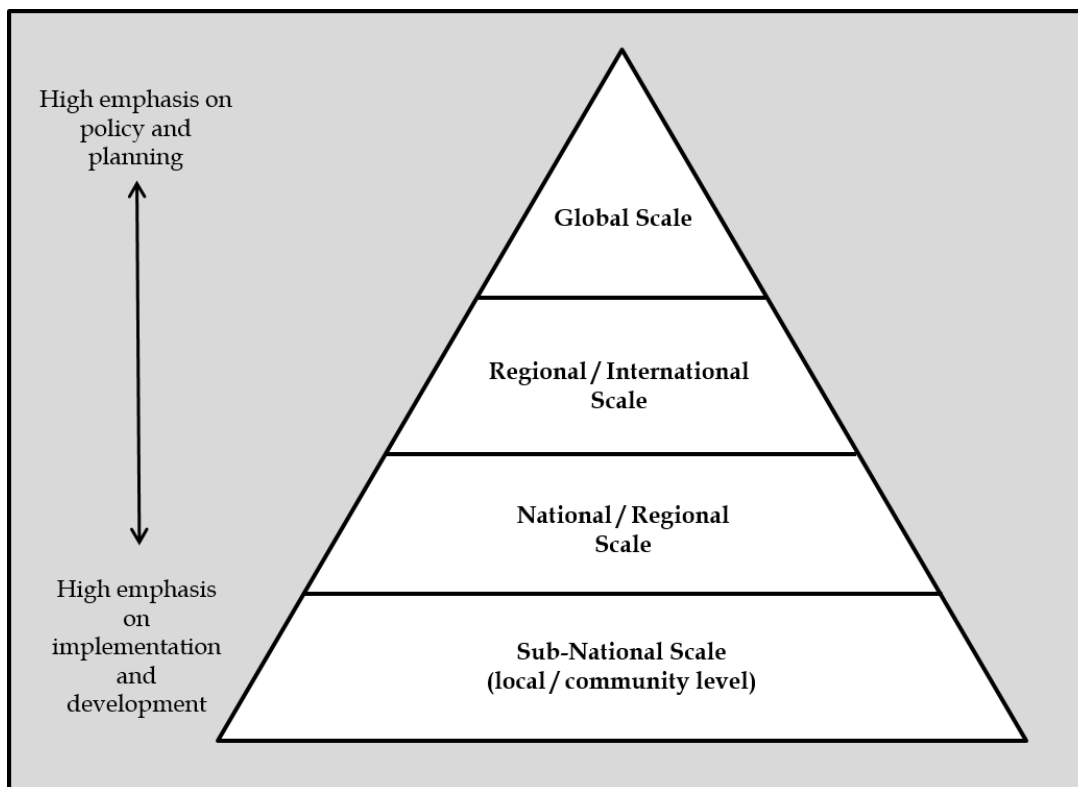
2.4 Governing and managing climate change

Climate change governance strategies and management efforts range from the global scale to regional-international, national-regional and even local/community level (Hopkins & Higham, 2012). At the global scale, the United Nations and the international leaders develop comprehensive climate change policies based on 'shared scientific understanding' (Zakaria, 2015). The global scale of climate governance mostly highlights the policy and planning issues which are followed by the regional-international, national-regional and to sub-national scale (local/community level); whereas, the sub-national, national and international scale of climate change management emphasis implementation and development in terms of mitigation and adaptation (**Figure 2.2**). The global scale management receives limited (or no) feedback from national or local level as climate action is voluntary - no international authorities usually create pressure on sovereign nations. Transnational or regional-international scale governance regimes partially involved in information sharing, capacity building, and policy and regulation development (Bulkeley & Newell, 2015). Governing climate change is complex because: "the multiple scales of political decision making involved; the fragmented and blurred roles of state and non-state actors; and the deeply embedded nature of many of the processes that lead to emissions of GHG in everyday processes of production and consumption" (Bulkeley & Newell, 2015, p. 2).

The IPCC has been established by two prominent associate organisations of the United Nations: the World Meteorological Organisation (WMO) and the United Nations Environment Programme (UNEP) in 1988 for producing reports which contain scientific, technical and socio-economic information applicable to understanding the risks of anthropogenic climate change, its impacts and dealing strategies like mitigation and adaptation. The IPCC mainly supports the UNFCCC, which is considered the foremost international accord on climate change. The ultimate objective

of the UNFCCC is “stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system”(UNFCCC, 1992, p. 4). Up to mid-2018, the IPCC has published five comprehensive assessment reports²⁹ and various special reports on different topics associated with climate change.

Figure 2.2: Climate governance pyramid



Source: Synthesis of literature

One of the major steps of global climate change governance, adopted at COP 7 (Conferences of the Parties) by the UNFCCC is the Kyoto Protocol, proposed in 1997 and entered into force from 2005, an international agreement which recognised the developed countries are directly responsible for the huge GHG emissions in the atmosphere by their industrial production (Pattberg & Widerberg, 2017). This protocol has introduced a scheme known as ‘emission trading’ which is a method of compensation by highly carbon-emitting countries to the countries those are

²⁹ The First Assessment Report of IPCC has published in 1990 (and in 1992, a supplemental report that highlighted the negotiations on the UNFCCC at the Rio Earth Summit), a Second Assessment Report (SAR) in 1995, a Third Assessment Report (TAR) in 2001, a Fourth Assessment Report (AR4) in 2007 and a Fifth Assessment Report (AR5) in 2014. Each assessment report is in three volumes, corresponding to Working Groups I, II, and III. The Working Group I report of IPCC highlights the basic science of climate change, whereas the Working Groups II and III reports typically highlight impacts, vulnerabilities, adaptation, mitigation, policy-planning and/or socio-economic aspects of climate change.

responsible for low emission but highly vulnerable. The other significant post-Kyoto regimes of UNFCCC conferences of parties are the Bali Action Plan (2007), the Copenhagen Accord (2009), the Durban Platform for Enhanced Action (2012), and Paris Agreements (2015). In the Copenhagen Accord, without selecting the baseline of temperature target, specified to limit the global temperature rise below 2.0 °C. At the Paris climate conference (COP 21) in 2015 (also called Paris Agreement) representatives of 190 countries, UN leaders, public bodies, and major business entrepreneurs were participated and agreed to achieve an overarching goal to reduce GHG emissions to limit the global temperature increase to 2 °C above pre-industrial levels.

The global scale of climate governance has implications on transnational (e.g. the European Climate Foundation), national and local levels of climate change management (Lagos & Wirth, 2009). In the UNFCCC, countries make voluntarily promises to act on climate actions, particularly for mitigation. In the next UNFCCC, those countries (voluntarily) reported the progress they have made between the period of two conferences. This effort creates a global to local scale understanding to reduce climate change. Even the climate change denier countries are softly handled at this stage. The United Nations suggests comprehensive policy towards climate change mitigation to assist the countries for being climate-resilient and move towards low emissions techniques. Of course, global mitigation efforts contribute to reducing local level vulnerabilities. The climate compensation commitments³⁰ mostly take place at the platform of global scale by which the low emitting vulnerable countries like Bangladesh, Nepal and Maldives receive funds for adaptation from developed countries. This platform also suggests how to utilise the received funds in terms of managing vulnerabilities, contributing to mitigation, and building resilience.

2.4.1 Managing global emissions

Wherever the emissions occur, the impacts are dispersed globally, therefore, the global scale climate governance focuses on the reduction of nationwide emissions. All nations in the world, more specifically, the developed countries (for example, countries in Europe and North America) those consumed extensive energy for luxurious lifestyle, and the rapidly developing countries (for example, China, Brazil or India) those are

³⁰ For example, \$100 billion a year that high emitting developed countries would deliver by 2020 to help developing countries cope with the rising impacts of climate change (Westphal, Canfin, Ballesteros, & Morgan, 2015)

continuously increasing industrial production are asked to respond immediately to attain the global common goal of limiting climate change. National and international level efforts are required to mitigate emissions in response to climate change (IPCC, 2014). At the present level, the core emission reduction approaches are: a) increasing forest cover, and b) inventing and utilising green technologies. Consumption (or commercial production) reduction is yet not a popular way of mitigation because of poor social understandings of climate change. For example, people do not want to sacrifice their discretionary travel behaviour in response to climate change (Higham et al., 2016a). Some giant corporates, however, are participating in tree plantation as a social responsibility as a partial companion of their emissions (Sobhani, Amran, & Zainuddin, 2009).

Innovative technologies that can produce products and services without emissions are the other approach, besides tree plantation, for climate change mitigation. The developed world is gradually replacing carbon-emitting technologies with carbon-free green technologies, whereas the developing nations are staying far behind in this regard. Some developed countries such as Germany, England, Ukraine, France, Poland, are trying to reduce dependency on fossil fuel by utilising new sources of renewable energy like solar power (Tart, 2015). Leading scientists expect that due to the scientific innovations in energy sources and technological equipment, the world will reach in a point of zero carbon emission level by the middle of twentieth-first century (Diesendorf, 2014; Harvey, 2013; Rotilio, Berardinis, & Cucchiella, 2015; Tart, 2015). At the same time, they are warning the world for existing and future carbon emissions before achieving the zero carbon emission level (IEA, 2014). For managing climate change, therefore, waiting for upcoming carbon-free technologies is not a wise decision – immediate mitigative actions are required.

2.4.2 Managing local vulnerabilities and risks

Adaptation is a local scale intervention in response to climate change impacts and related vulnerabilities. Adaptation requirements - vary from place to place - are mostly taken based on types of impacts and vulnerabilities (Schmidt-Thomé, 2017). Some adaptations are taken on the personal level and some are on the social level. Installing air conditioning at home to remain comfortable in high temperatures is a personal level adaptation, whereas, building seawalls to protect from tidal waves or erosion is

usually social level adaptation. Social adaptation interventions are usually taken by the government by using public tax money (IPCC, 2014). Policy for adaptation significantly depends on the government's attitude towards vulnerabilities and capacity in terms of finance and technical skill (Eriksen & Kelly, 2007). Since adaptation interventions are taken for reducing existing vulnerabilities such as coastal flooding, therefore, the public normally support adaptation interventions. Sometimes public pushes government to take adaptive interventions when the government is ignorant. The type of adaptation interventions, of course, is different for the same type of effects in developed and developing countries (Ford & Berrang-Ford, 2011; Schmidt-Thomé, 2017).

When the government of a country is not (financially/logistically/politically) capable of taking the required adaptation, international agencies (also known as international NGOs) often help the government of the vulnerable nation to take required adaptations (Lim, Spanger-Siegfried, Burton, Malone, & Huq, 2005). Some international agencies are working for vulnerability reduction in developing countries where governments cannot always allocate sufficient money in the national budget for vulnerable communities to cope with the climate change. The main involvement of international agencies in developing countries is funding (e.g. donation, or low-interest loan) for adaptation interventions to provide relief from existing vulnerabilities. Besides, those agencies are also involved in policy formulation with governments (Gough & Shackley, 2001). In this regard, international agencies closely work together with civil society, public bodies, and government at local to national scale (Adger et al., 2005a; Korten & Quizon, 1995). Sometimes international agencies help in adaptation through government channels (e.g. national disaster management authority) and sometimes through NGOs. International agencies hire NGOs to overcome manpower limitation and lack of local knowledge (Gough & Shackley, 2001).

With rich and diversified experience, NGOs have played an extensive role in socio-economic transformation including climate change management for last few decades. NGOs are mostly working as partner organisations of national or international donor agencies in third world countries (Lim et al., 2005). Non-government organisations are usually recruited by donor agencies. NGOs use the funds of donor agencies and accomplish donors' adaptation goals (Forsyth, 2017). They are effective and efficient for

working in remote area where it is difficult to reach for donor agencies and help the vulnerable people (Lim et al., 2005). NGOs work to build public awareness of climate change and help people to cope with climate change impacts to manage local vulnerabilities and livelihoods (Gough & Shackley, 2001). NGOs also assist local development programme by engaging with relevant stakeholders of the community (Forsyth, 2017; Korten, 1987). Korten (1990) identifies four strategic orientations in development action of NGOs: a) relief and welfare b) community development c) sustainable systems development d) people's movement (**Table 2.3**). He further argues that all the four strategic orientations co-exist within the larger NGO system - and sometimes even within a single NGO.

Table 2.3: Generation strategies concept for NGOs

	First generation NGO (Relief and welfare)	Second generation NGO (Community development)	Third generation NGO (Sustainable system development)	Fourth generation NGO (People's movement)
Problem definition	Shortage	Local inertia	Institutional and policy constraints	Inadequate mobilising vision
Timeframe	Immediate	Project life	10-20 years	Indefinite future
Scope	Individual or family	Neighbourhood or village	Region or nation	National or global
Chief actor	NGO	NGO and community	All relevant public and private institutions	Loosely defined networks of people or organisation
NGO role	Doer	Mobilizer	Catalyst	Activist/advocate
Management orientation	Logistics management	Project management	Strategic management	Coalescing and energizing self- managing networks
Development education	Starving children	Community self-help	Constraining policies and institutions	Spacious earth

Source: Korten (1990)

In Table 2.3, Korten (1990) has reported the roles and functions of NGOs in Asia, including Bangladesh. At the initial stage (the 'first generation' in the language of Korten), NGOs help vulnerable people by providing relief aid. Providing relief is essential and appropriate response to emergency situations that demand immediate and effective solution to vulnerabilities, but as a development strategy, "relief and welfare approaches offer little more than temporary alleviation of the symptoms of underdevelopment" (Korten, 1987, p. 148). Addressing the limitation of first generation

approaches, in the second generation approaches stress on local self-reliance with the intention that benefits would be continued beyond the period of NGO aids. By re-examining the dysfunctional aspects in terms of sustainability, in the third generation, NGOs work to build networks between public and private institutions that control resources and local policies. Instead of favouring a few localities, NGOs work on building the capacity of the whole social system - not by controlling them - but by helping them to learn to manage their necessity in vulnerable situations. The fourth generation NGOs efforts are quite visionary where NGOs lead the society to self-sufficiency (Korten, 1990).

In case of adapting to climate change, management agencies including government, international agencies, and NGOs often work together toward the similar goal of the social capacity building (Korten & Quizon, 1995). The more a society (or nation) is capable of solving their own problem, the more it is resilient to climate change impacts and risks (Adger et al., 2005a; Eakin et al., 2014). Considering this argument, each succeeding generation of NGOs proposed by Korten (1990) can better contribute to the resilience of a society than the previous generation. That means - the fourth generation NGOs strategies are contributing to building more resilience than the third generation NGOs' strategies, and the third generation strategies are assisting to build more resilience than the second generation strategies. The first generation NGO strategies - designed to solve immediate vulnerabilities - hardly contribute to the resilience of society. Addressing the existing impacts and vulnerabilities along with future risks while climate change adaptation can better contribute to building resilience (Eriksen & Brown, 2011; O'Brien & Leichenko, 2007). In the context of developing nations, the integrated effort of all the relevant management agencies is one of the core determinants of the success of adaptation interventions.

2.5 Climate change: Bangladesh perspective

Bangladesh is a South-Asian developing country (per capita income UD \$1524 in 2017)³¹ with a large population (163 million, 2016 estimate)³² and high population

³¹ IMF. World Economic Outlook Database.

<https://www.imf.org/external/pubs/ft/weo/2017/01/weodata/weorept.aspx?pr.x=52&pr.y=9&sy=2016&ey=2020&scsm=1&ssd=1&sort=country&ds=.&br=1&cc=513&s=NGDPD%2CNGDPDPC%2CPPPDP%2CPPPDC&grp=0&a=>

³² World Population Prospects: The 2017 Revision". ESA.UN.org (custom data acquired via website). United Nations Department of Economic and Social Affairs, Population Division. Retrieved 10 September 2017.

density (about 1106/km²)³³, situated in the Himalayan mountain originated Ganges, Brahmaputra and Meghna rivers basin. The transboundary Ganges-Meghna-Brahmaputra rivers with their hundreds of branches have created, at their way into the Bay of Bengal, a greatest deltaic plain distributed among India (64%), China (18%), Bangladesh (7%) and some other neighbouring countries (Joint Rivers Commission Bangladesh, 2011). Approximately 80 percent of Bangladesh consists of flat lowland with fertile sediment coming from the Ganges-Meghna-Brahmaputra rivers flow (FAO, 2016). The Ganges-Meghna-Brahmaputra rivers, which have created the Greater Bengal Plain by substantial deposit of sediment in the Ganges delta, are discharging about 6% of the global total silt input into the sea (Rajasuriya et al., 2002). Weather events such as tropical storms, mud floods are the common characteristic of the landscapes in the Ganges delta.

At the present level of climate change, the coastal region in the Ganges delta is experiencing extensive impacts like extreme temperature, sea level rise, frequent and strong cyclones, and salinity ingress. The water flow in the rivers of the delta depends on the water flow from Himalaya mountain range. The scientific forecast suggests that the glaciers of the Himalaya is melting faster than the glacier in other mountain region of the world, and could disappear by the year 2035 if the global temperature increases at this present rate (IPCC, 2007; WWF, 2005). This could put up to 100,000 km² of coastal land area permanently under water (WWF, 2005). However, most of the people of the delta are not informed about the future predictions of climate threats (Lee et al., 2015; Nanlohy, Bambang, Ambariyanto, & Hutabarat, 2015). Even they are hardly informed about climate change (e.g. the cause of vulnerabilities) and are not capable of responding to the existing climate change impacts. The future risks of climate change are ignored by the management regimes of the Ganges delta (Danda et al., 2011; World Bank, 2014a; WWF, 2005).

2.5.1 Impacts and risks of climate change in Bangladesh

Due to geographic location, and hydro-meteorological and topographical characteristics of the basin, about twenty to seventy percent of Bangladesh is

³³ <https://web.archive.org/web/20110904045106/http://www.bbs.gov.bd/Home.aspx>

inundated by flood water every year during the monsoon³⁴ (Agrawala et al., 2003; Mirza, 2002). Besides severe flooding, the country is vulnerable to other types of natural disasters like tropical storms and cyclones. Climate change accelerates the vulnerabilities of those disasters in greater scale (World Bank, 2016). At present, Bangladesh is considered one of the most climate vulnerable countries in the world in terms of range and severity of effects (IPCC, 2014, p. 295). The physical climate impacts further bring social-injustice by changing the social-economic system - rich people become more wealthy and poor people become more helpless (Rahman, 2013; Sovacool, 2018). Among all the Asian countries, and in consideration of the number of people living in the coastal zone, Bangladesh is one of the most climate vulnerable countries with high future risks (Brodwin & Johnston, 2015; Pender, 2008a). In **Table 2.4**, this study summarises the current impacts of climate change in Bangladesh.

Table 2.4: Impacts of climate change in Bangladesh

Climate change impact	Related effects	Socio-economic implications
Increased temperature	Heatwave (Northern part) More humidity	Prevalence of disease
Retreating Himalayan glaciers	Imbalanced flow of rivers followed by salinity intrusion	Threatening food security
Sea level rise	Salinity intrusion Submergence of the coastal area	Reducing fresh water supply Destroying coastal forest
Frequent and severe cyclones and tropical storms	Damaging the coastal region	Loss of lives Increased migration Increase water-borne disease Infrastructural loss
Heavier and erratic rainfall (during monsoon)	Higher river flow (flooding) Riverbank erosion Increased sedimentation	Loss of property and agricultural land Drainage congestion and waterlogging
Lower and erratic rainfall	Increasing droughts (North-West of the country)	Loss of crops followed by malnutrition
Ocean acidification	Losing marine biodiversity	Reduced fishing

Source: Government of Bangladesh and UNDP (2009), Hossain, Reza, Rahman, and Kayes (2012), Huq, Hugé, Boon, and Gain (2015), Ministry of Environment and Forests (2009), NCC (2017), and Shaw, Mallick, and Islam (2013)

³⁴ The Monsoon is seasonal wind coming from the Bay of Bengal which is associated with high temperature, heavy rainfall, extreme humidity and noticeable seasonal variabilities in the Indian subcontinent. Disturbance of the usual trend of monsoon by climate change can affect the flora and fauna of the region.

The coastal zone is the 'front line' of encountering climate change disasters. The coastal region of Bangladesh is recognised as a geographical 'death trap' (Karim & Mimura, 2008). About 32% of land area belongs to the coastal region in Bangladesh where about 28% of its population resides (Shamsuddoha & Chowdhury, 2007). Sea level rise and escalation of sea surface temperature, intensity and frequency of tropical cyclones may increase in Bangladesh (Ali, 1999; Doyle & Chaturvedi, 2011; Khan, Singh, & Rahman, 2000). The sea level rise will accelerate the salinity intrusion and coastal flooding (Ye, Gu, Gao, & Lu, 2010). At a higher sea level, the gradient of rivers will be reduced, resulting in slower drainage to the sea. This will be compounded by higher rainfall in the Ganges-Meghna-Brahmaputra river basins and greater Himalayan glaciers melt in the monsoon, resulting in more devastating floods (Ministry of Environment and Forests, 2009).

Climate predictions for Bangladesh suggests that tropical storms are replaced by intense cyclones, sea level rise changes the flooding patterns (Al-Farouq & Huq, 1996). Sea level rise has the potential to intensify cyclones and coastal inundation (Thomalla, Cannon, Huq, Klein, & Schaerer, 2005). Pender (2008a, p. 54) notes that "a higher sea level means that storm surges that accompany cyclones will drive sea water even further inland" which will further increase the level of salinity in water. Due to sea level rise, Bangladesh – as an extremely low-lying country with high density and a large number of population, situated in flood-prone deltas – might lose territorial boundaries (Gilman, Randall, & Schwartz, 2011; Warrick & Ahmad, 2012). A one-metre rise of sea level forecast for the end of the 21st century could affect about 70 million people of the country due to the prevailing geographic and socio-economic conditions (Government of Bangladesh & UNDP, 2009).

The other climate change impacts in Bangladesh, besides sea level rise and severe floods, are coastal erosion, salinity intrusion, the backwater effect³⁵, alteration of the characteristics of coastal region, increase drainage congestion, extreme temperature and drought (Ali, 1999; Bhuiyan & Dutta, 2012; Government of Bangladesh & UNDP, 2009; Jamieson, 2011; Rawlani & Sovacool, 2011; Shahreen & Rana, 2014; Shamsuddoha & Chowdhury, 2007). These climate effects already are disrupting the livelihood of

³⁵ A hydrological effect in rivers occurs due to any type of obstruction, in which there is very little or no current.

inhabitants of Bangladesh, particularly the southern part of Bangladesh (Kabir et al., 2016b; World Bank, 2010b). The physical impacts of climate change have threatened the food security of Bangladesh (Huq et al., 2015; Islam, Sallu, Hubacek, & Paavola, 2014a). The country highly depends on rain-fed agriculture, but flood (during monsoon) and drought in summer (particularly in the North of Bangladesh) hamper food production which leads to malnutrition (Rahman, 2011; Ruane et al., 2013; Warrick & Ahmad, 2012).

Salinity intrusion reduces the area of cultivable land and creates insufficiency of fresh water supply for irrigation, household necessity, and even for drinking (Jamieson, 2011; Pender, 2008a). Climate change and upstream withdrawal of freshwater for irrigation decrease the availability of freshwater in the downstream of Bangladesh (Dasgupta, Kamal, Khan, Choudhury, & Nishat, 2015). Increased salinity in water has already reduced freshwater fish and enhanced vulnerabilities of fishery-based livelihoods in the coastal area of Bangladesh (Islam et al., 2014a). Rasheed et al. (2016) explain that salinity in drinking water and foods because of climate-induced saline intrusion in the coast of Bangladesh may have already surpassed permissible levels that might be a great concern of health issue. The salinity transmitted from water to soil which creates obstacles to grow the plants in the locality of the coastal region in Bangladesh (Khan et al., 2011). Sea level rise has a direct influence on salinity ingress in the low-lying coastal area in Bangladesh (Yu et al., 2010). Researchers including Mondal et al. (2013) have reported that the 5 ppt (parts per thousand) isohaline may intrude about 9 km further inland (in the soil) during the dry season because of a sea level rise of 32 cm.

The effects of climate change are accelerating the social vulnerability and the cycle of poverty (Brouwer, Akter, Brander, & Haque, 2007; Pouliotte, Smit, & Westerhoff, 2009; Sovacool, 2018) and threatening the poverty alleviation strategies of Bangladesh (Planning Commission of Bangladesh, 2010). Frequent and strong extreme events are threatening the livelihoods and minimising the effectiveness of the traditional adaptive strategies (Doyle & Chaturvedi, 2011). The crop choice is affected by climate change – farmers cannot grow many of the traditional crops in Bangladesh (Moniruzzaman, 2015; Yu et al., 2010). Due to the change of precipitation pattern, the rain-fed agriculture is about to disappear; for increased salinity, rice (the staple crop) cannot be

grown; lack of fresh-water for irrigation disrupts the whole agricultural system. In addition, intense cyclones impose further pressure on food security by destroying crops, livestock and property (Government of Bangladesh & UNDP, 2011). Fishermen are at higher risk of death than earlier because of adverse climate disasters in the sea (Mozumder & Mollah, 2015). People are dying because of not only cyclones but also many diseases exacerbated by floods and other climate effects (Shahid, 2010).

2.5.2 Climate change understanding in Bangladesh

Despite Bangladesh being a highly climate vulnerable country, the level of climate change understanding of the people of the country is very low (Lee et al., 2015). A significant portion of the population of Bangladesh has neither proper knowledge of adaptation and mitigation nor even aware of climate change (Kabir et al., 2016a). In the context of northeastern Bangladesh, Anik and Khan (2012) have found that only 10% of people can describe climate change in terms of adaptation requirements. Most of the people of Bangladesh have personal experience regarding changes in the environment and weather system (The Asia Foundation, 2012). The people of the south west of Bangladesh (the study context of this research project) are experiencing climate change effects such as cyclones, rapidly increasing salinity intrusion, and temperature rise (Al-Farouq & Huq, 1996; Huq et al., 2015). Rural people of Bangladesh are concerned about the increasing environmental changes as their livelihood status are affected due to climatic hazards (Anik & Khan, 2012; Midtgaard, 2015). Often they blame the government for their vulnerabilities arising from the climate change impacts (The Asia Foundation, 2012) as the infrastructure is not sufficient for managing the vulnerabilities.

In a study of the human health of climate vulnerable people in Bangladesh, Kabir et al. (2016a) have found that climate change understanding depends on several sociodemographic variables such as age, educational qualification, monthly income, and occupation. They have also found that about 46% of the respondents from the coastal region of Bangladesh never heard about climate change [another research conducted by Lee et al. (2015) have found 65% of the people in Bangladesh never heard about climate change]. Kabir et al. (2016a) have also reported that television, newspaper, and informal communication (e.g. neighbours) are major sources of climate change information. People with higher education level are more knowledgeable about

climate change, but about 98% people of the coastal region perceive that healthcare expenditure has increased due to extreme weather events (Kabir et al., 2016a). The people of Bangladesh hardly think that human-induced GHG emissions is the cause of climate change, rather they have some misconceptions such as climate change is natural – nobody has control on it (The Asia Foundation, 2012).

Knowledge of climate change in terms of adaptation and mitigation is insufficient among the vulnerable people of Bangladesh (Ahmed, Alam, & Rahman, 1999; Pender, 2008b). Knowledge of adaptation and mitigation is limited in not only individual and household level but also management level (e.g. government, local agencies). Research-based information such as effects of sea level rise on salinity intrusion in the coastal area, which is important for adaptation plan is unavailable in Bangladesh (Bhuiyan & Dutta, 2012). The Asia Foundation (2012) has suggested that educating adaptation knowledge for the capacity building of the vulnerable people of Bangladesh. Scientific research work is needed for knowledge production, particularly around flood forecasting, climate-tolerant crops innovation, adaptation technologies, and monitoring the current impacts and future risks (Haque, Bremer, Aziz, & van der Sluijs, 2017). Haque et al. (2017) also have emphasised on the necessity of knowledge sharing between government and non-government agencies and communicating traditional adaptation knowledge throughout vulnerable society for capacity building.

Many vulnerable individuals and households of Bangladesh are unaware whether their present knowledge (and capacity) is sufficient to cope with climate change impacts and a large number of them are uncertain about the adaptation ways to manage the vulnerabilities they are already experiencing (The Asia Foundation, 2012). Usually, individuals try to adapt themselves to the changing climate through changing behaviour (e.g. drinking rainwater) and applying experienced-based local knowledge for managing livelihoods (Anik & Khan, 2012; Midtgaard, 2015). Due to lack of public knowledge of livelihood adaptation, there is huge internal migration takes place across Bangladesh from the drought-prone western districts and areas vulnerable to cyclones and floods in the south towards the centre (northern and eastern districts) of the country (Hassani-Mahmoei & Parris, 2012). The climate vulnerable people do not have the knowledge to deal with the upcoming risks of climate change (Kabir et al., 2016a). NGO initiatives to communicate climate knowledge are quite helpful for the

individuals and households in terms of adaptation and capacity building (Haque et al., 2017).

Risk perceptions of people living in Bangladesh are highly connected with the tangible factors like local temperature change (Lee et al., 2015; Nanlohy et al., 2015). If the effects are visible and vulnerabilities are understandable, then the people of the country perceive the impacts of climate change as a risk. For example, flood risk perceptions of the people of Bangladesh is high (Rawlani & Sovacool, 2011) and the perception of climate change related events on health is high (Kabir et al., 2016a). When the people find weather events as a threat to livelihoods and survival, they perceive climate change as a risk. But risk perceptions regarding scientific predictions of climate change are yet to be revealed. It is also unknown how the people of Bangladesh perceive the (tangible and intangible) risks of climate change, the degree of uncertainties they perceive in relation to other socio-economic problems like poverty, and the implications of risk perceptions on fostering adaptation and mitigation.

2.5.3 Climate change responses in Bangladesh

Adaptation is the main focus of Bangladesh in response to climate change. The country is facing climate change impacts in many ways (Pender, 2008a) but it is one of the low GHGs emitting countries in the world. In consideration of impacts and emissions, Bangladesh is a climate change victim. The per capita carbon dioxide emission of Bangladesh is less than one-twentieth of the global average (IPCC, 2014; Jamieson, 2011) and 85% of the GHG emissions of Bangladesh comes from the energy production to meet the fundamental needs (Government of Bangladesh & UNDP, 2011). Some initiatives within Bangladesh to reduce carbon emissions would not contribute significantly to reducing vulnerabilities of the country as the emissions of the country is low compared to global emissions (BCAS, BUET, BIDS, & BUP, 1998), therefore, adaptation is the core response to climate change in Bangladesh (Ahmed et al., 1999). Yet, management agencies often incorporate mitigation measures with adaptation plan in vulnerable Bangladesh (Bangladesh Climate Change Trust, 2016; World Bank, 2016).

Mainstreaming adaptation is urgent for Bangladesh in consideration of the climate impacts, vulnerabilities, and risks (Hossain, Hein, Rip, & Dearing, 2015; Thomalla et al., 2005). The existing infrastructure developed for adaptation by the government,

such as cyclone shelter and embankments are not sufficient to face even the present climate threats (Huq, 2001; World Bank, 2014b). In order to adapt to the effects of climate change, the fund Bangladesh needs is nearly two-fifths of the country's national budget (Jamieson, 2011) which is a big challenge for this developing country. In order to address climate change, the Government of Bangladesh has developed climate change action plan with six overarching pillars: food security, social protection and health services to most vulnerable communities; comprehensive disaster management; infrastructure (e.g. coastal and river embankments, cyclone shelters) development and maintenance; research and knowledge management in relation to impacts and strategies; mitigation and low carbon development; institutional and social capacity building (Ministry of Environment and Forests, 2009).

In 2010, the government of the country has established the 'Bangladesh Climate Change Resilience Fund' (BCCRF) to provide support for the implementation of "Bangladesh's Climate Change Strategy and Action Plan 2009 - 2018" which has focused on adaptation and mitigation particularly for vulnerable communities (IPCC, 2014, p. 1231). The BCCRF is established to appeals funds from UNFCCC finance mechanisms and direct donor support. Few ministries including the Ministry of Environment and Forest and government departments of Bangladesh are governing the BCCRF (Bangladesh Climate Change Trust, 2016). The Government of Bangladesh also deploys domestic finance to manage vulnerabilities of climate change. To manage the vulnerabilities, the most popular adaptation measures in Bangladesh are crop diversification, floating garden, cage aquaculture, constructing and reconstructing the embankments, wave protection walls, canals (Anik & Khan, 2012). Most of the adaptation interventions are supported by the government and non-government management agencies.

Soft adaptation interventions are more common than hard adaptations in Bangladesh (Minar, Hossain, & Shamsuddin, 2013) as soft adaptations can be taken even in individual or household levels. Management agencies, particularly donors, provide humanitarian relief aids to address some of the immediate concerns of cyclones (Kartiki, 2011). In the post-disaster period, NGOs help the vulnerable communities to manage livelihoods through goat rearing, poultry farming, crab fattening, handicrafts (Pouliotte et al., 2009). Likewise, people have their own way to adapt with natural

calamities like building home at higher elevations to protect the house from floods, cultivating vegetables and other small plants on floating bed to avoid the effects of sea level rise and waterlogging (Ministry of Environment and Forests, 2009). However, local adaptation knowledge which has merits is barely considered by the management agencies (Anik & Khan, 2012) and knowledge sharing for coping with the climate impacts are not well focused (Kabir et al., 2016a; Pender, 2008b). Most of the adaptation interventions do not have long-term solution towards sustainability (Kartiki, 2011).

Withdrawing people from climate vulnerable areas is not possible because of high population density all over in Bangladesh (Minar et al., 2013). Adaptation is essential for Bangladesh, but the sustainability of the adaptation interventions needs to be assured. By mainstreaming climate change through 'integrating adaptation into development', the country can reduce the vulnerabilities and ensure sustainability (Ayers et al., 2014, p. 295). Creating climate change understanding in terms of adaptation and mitigation (Hossain et al., 2015; Kabir et al., 2016a), improving access to and diversifying livelihood options (Huq et al., 2015), introducing climate resilient crop species (Rahman, 2011) and dry-land farming techniques (Pender, 2008a), defining sector-wise (e.g. agriculture, fisheries, or tourism) adaptation requirements (Al-Farouq & Huq, 1996), and choosing community driven coping mechanisms – rather than outsider-led, highly technical and expensive measures (Pender, 2008a; Rawlani & Sovacool, 2011) can reduce vulnerability by ensuring sustainability of adaptations. Both current vulnerabilities and future risks need to be considered while applying adaptation, because utilisation of embankments for prevailing flood adaptation measures suggested by Bhuiyan and Dutta (2011) may not be a sustainable adaptation solution in the long-term timeframe (Roy et al., 2016).

With the assistance of government and NGOs, the vulnerable people Bangladesh are utilising some adaptation techniques including cultivating salt-tolerant crops, rainwater harvesting, strengthening houses; and they are taking some mitigation measures like using solar power, improved cooking stove (ICS), and natural compost (Ministry of Environment and Forests, 2016). The Bangladesh Climate Change Trust (2016) and World Bank (2016), and few other researchers such as Anik and Khan (2012), Hossain et al. (2015), and Huq et al. (2015) inform the core interventions of adaptation for managing community vulnerabilities in Bangladesh. Very little is

known from available literature about the kind of adaptation interventions applied to avoid specific impacts or vulnerabilities. It is also unknown how those interventions are implemented and what is the management integration status in terms of implementing adaptation interventions to reduce community vulnerability. The existing literature also ignores that how the current adaptation interventions for managing community vulnerabilities are effective in terms of building resilience.

2.5.4 The Sundarbans context

The Sundarbans mangrove forest area, situated in the low-lying delta of the Bay of Bengal, consists of around 200 small islands shared by two South-Asian countries Bangladesh and India, is one of the most climate vulnerable regions in the developing world (Barua, Chowdhury, & Sarker, 2010; Dash & Hunt, 2007; Ellison, 2014; Mahadevia & Vikas, 2012; O'Donnell & Wodon, 2015; Raha, Das, Banerjee, & Mitra, 2012). Scholars have warned that the effects of climate change can alter the characteristics of mangrove ecosystems (EPA, 2015) which might vanish totally from the global map in future (DasGupta & Shaw, 2013). The most significant climate change impacts which disrupt the ecological and economic functions of the Sundarbans are sea level rise (Jayalakshmi, 2015b), more intense of extreme events such as cyclones and tidal waves (Mahadevia & Vikas, 2012), salinity intrusion (Seetharaman, 2015), and ocean acidification (Jana, Zaman, Pramanick, Mukhopadhyay, & Bose, 2014). Disturbance of ecological growth due to climate change is decreasing the availability of forest resources which is directly impacting on local livelihoods.

The current adaptation measures are not sufficient to protect coastal communities living at the fringe of the Sundarbans from existing vulnerabilities. In case of future risks confrontation, their resilience is very low. To protect the communities from sea level rise and coastal flooding, embankments (dykes) are made which are very often overflowed or broken due to water pressure (Bhattacharyya, Pethick, & Sarma, 2013; Ghosh, 2012). The dykes, which are the solution to protect cultivable land and communities from flooding, create a further problem when saline water enter into it and cannot get way out after heavy cyclones (Seetharaman, 2015). Without considering the local geographic features and dynamics, the blind efforts to build embankments in the coast of the Sundarbans endanger the topography and biodiversity (Ghosh, 2012;

Roy et al., 2016). Because the dykes, dams and dunes should allow the water to come in and deposit silt in order to settle and build the land strong and higher, but the embankments in the Sundarbans are only to keep the water out for cultivation (Seetharaman, 2015).

To escape from increasing natural catastrophes like cyclones and storms, many people (e.g. farmers, fishermen) of the Sundarbans migrate and resettle to nearest islands or to faraway cities and work as daily wage earners because they do not know anything except their traditional occupations (Ghosh, 2015; Ortolano et al., 2016). This migration of the people of the Sundarbans can be permanent or seasonal³⁶ (Mahadevia & Vikas, 2012). Kartiki (2011) suggests to the fragile livelihoods, lack of social protection, and infrastructural deficiencies are the reasons for migration due to climate shocks from the coastal area of Bangladesh, including Sundarbans area. A large number of people of Indian Sundarbans depend on the remittances sent by their relatives who migrated permanently as environmental refugees for the effect of climate change or because of unavailability of the mangrove resources like fish, and honey (Ghosh, 2012). For ensuring sustainable livelihoods at the face of climate change, the management agencies of Indian Sundarbans have taken several initiatives such as encouraging cultivation of salt-tolerant and indigenous varieties of crops, rainwater harvesting for irrigation, constructing cyclone shelters, reducing forest dependency by creating village-based employments such as sewing, and poultry farming (Raha et al., 2013).

Both in the context of Bangladesh and India, the communities of the coastal Sundarbans have very limited capacity to cope with the effects of climate change (Sujana, 2011) because of socio-economic limitations and infrastructural deficits (DasGupta & Shaw, 2015). Scientists are further predicting a range of future climate change risks which might lead to permanent resettlement of people from the Sundarbans area. However, the people of the Sundarbans are neither prepared for combating the risks nor they are aware of climate change (O'Donnell & Wodon, 2015). A few management agencies are assisting the communities by communicating climate change and helping to cope with the impacts. Under this contextual circumstance, this research attempts to fill the research gaps: understandings of and responses to climate change in the Sundarbans.

³⁶ Migrating temporarily from the disaster areas and come back again when disaster likelihood is low.

2.6 Chapter summary

This chapter has reviewed relevant literature regarding understandings of and responses to climate change. It conceptualises the theoretical aspect of climate change understanding with the argument that climate change understanding consists of general awareness, knowledge of adaptation and mitigation, and perceiving climate change as a risk. The chapter also critically explores the significance of public understanding for climate action by society. Climate change understanding develops from various sources including science communication, media, social interactions, and personal experience regarding changes in the weather system. The chapter further has identified the obstacles to and implications of climate change understanding between vulnerable developing countries and high emitting developed countries.

This chapter has outlined the response strategies to climate change based on available literature. The common ways to manage climate change are mitigation and adaptation. Mitigation is the functions of humans to reduce or absorb GHGs and adaptation is the interventions or behaviour change to reduce or stop climate impacts. Since adaptation literature largely overlooks the necessity of addressing future risks, this chapter highlights the need for resilience building to manage present impacts and future risks. Adaptation interventions need to be sustainable for vulnerability management in the long-term timeframe and should not create further vulnerability because of interventions. Drawing on the available literature, this chapter has argued that the interventions or treatments which can enhance the resilience of a system can contribute to sustainability.

Climate change responses are highly contextual – it depends on public understanding, climate impacts and vulnerabilities, and economic condition of society. The general response strategies in terms of adaptation and mitigation are quite well researched, but their effectiveness, particularly in the context of vulnerable coastal developing society is largely avoided by the research community. Available literature also informs very little about understandings of and responses to climate change in the context of the Sundarbans in Bangladesh. To address this research gap, this chapter examines the available academic and non-academic findings regarding understandings of and responses to climate change of Bangladesh for framing the contribution to the knowledge of this thesis.

Since the first objective (research question 1) of the thesis intends to examine critically the understandings of climate change and sources of constructing those understandings among different groups of stakeholders, this chapter has discussed not only the components of climate change understanding - awareness, knowledge, and risk perceptions - but also public understandings of climate change as they differ between developed and developing nations, the complexities of communicating climate change, and ways of build climate change understandings. In order to examine the understandings of climate change of multiple stakeholders of the Sundarbans in Bangladesh, this chapter has identified different attributes of climate change understanding (e.g. aware or not aware of climate change, level of knowledge for adaptation and mitigation, different state of risk perceptions) that need to be critically examined to address research question 1. In addition, this chapter has reviewed the literature regarding different approaches to constructing climate change understanding to provide insights into how climate change understanding varies different groups of people.

The second objective (research questions 2 and 3) intends to critically examine the management response strategies to climate change in the specific context of the Bangladesh Sundarbans. The response strategies to climate change including mitigation, adaptation, resilience building, and sustainable adaptation. These strategies are discussed in different parts of this chapter to clarify the second objective of this research. Responses strategies are discussed under different levels of management (global scale to local scale) to consider the governance and management of climate change. In order to address research question 2 which examines the climate change management functions that support community adaptation in the Sundarbans, the roles of management agencies including NGOs for managing local vulnerabilities and risks of climate change have been discussed. The literature that underpins research question 3 is discussed in Chapter 3.

Chapter 3

Climate Change: Tourism and Forest Management

3.1 Introduction

In Chapter 2, climate change understanding, response strategies to climate change, climate change governance and management frameworks and climate change in Bangladesh have been discussed to address the theoretical and contextual background of this research. Following on Chapter 2, this chapter focuses on the issues of climate change enclosed with tourism and forest management. The previous chapter has identified and discussed the theoretical concepts from the general literature viewpoint and moved towards context-specific information. Following that structure, this chapter highlights the global and general issues between climate change, tourism, and forest management, and later looks at the context-specific perspectives. The chapter presents an in-depth discussion regarding tourism functions in forest ecosystems under climate change.

At the beginning of the chapter, the cross-relationships between climate change and tourism, including tourism management strategies under climate change are examined. The chapter reveals the tourism stakeholders' understandings of and responses to climate change. Later it addresses impacts of climate change on forest ecosystem, adaptation options, socio-economic aspects of forest, and importance of forests to mitigate climate change. The chapter also examines issues of integrated forest ecosystem management (e.g. community-based forest management, transboundary forest management) and natural World Heritage management policy in relation to climate change, community involvement, forest biodiversity, and tourism. The chapter finishes with the discussion of contextual scenario in the Sundarbans in terms of tourism, community, and threat to the tourism for climate change.

3.2 Climate change and tourism

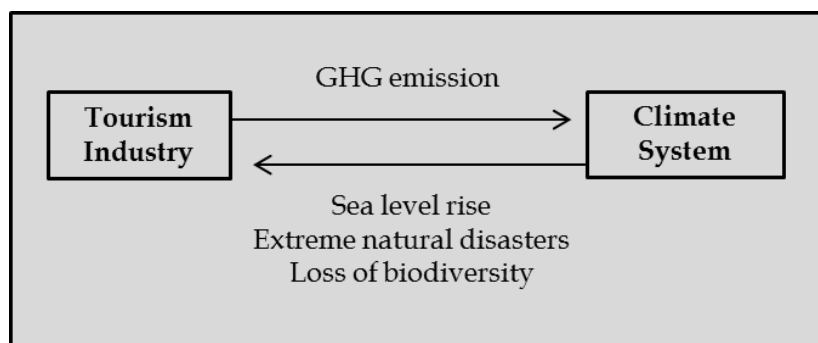
Climate is a tourism resource³⁷ and a major consideration when selecting a travel destination (UNWTO-UNEP-WMO, 2008). Tourists like to travel to both comfortable and different climatic regions and to enjoy the aesthetic beauty of landscapes developed by its distinctive climatic characteristics (Hall et al., 2013). However, climate change is changing the attractiveness of destinations by not only altering the beauty of

³⁷ De Freitas (2005) selects three attributes of climate which attract visitors: one, thermal attributes (e.g. functional elements of environment like air temperature, humidity, wind flow); two, physical attributes (e.g. presence of specific meteorological elements like snow, rain); three, aesthetic attributes (e.g. overall natural setting like sunshine, visibility).

usual landscape but also bringing different types of natural catastrophes which threaten human health and lives (Becken & Hay, 2007). As a result, a major modification is taking place in tourism demand-supply system all over the world (Higham & Miller, 2017; Rosselló-Nadal, 2014). Again, tourism as a sector is accountable for 5% of global CO₂ emissions, and the emissions of this sector are predicted to be more than double by the year 2035 (UNWTO-UNEP-WMO, 2008). Every year the sector is growing at a significant growth rate which is further accelerating GHG emissions from tourism (Gössling, 2013).

There is a 'bi-directional relationship' between tourism and climate change (**Figure 3.1**). It means that the tourism industry is being affected by climate change impacts like sea level rise, extreme events, and tourism itself is partially responsible for global climate change by loading additional carbon in the atmosphere. Tourism activities and facilities like transportation, accommodation, recreations services are directly accountable to significant carbon emissions which are the main cause of climate change; alternatively, the effects of climate change have implications on the tourism industry which is a very important economic sector for many countries (Reddy & Wilkes, 2012). It is predicted that the effects will increase on tourism sector more with the increase of climate change (UNWTO-UNEP-WMO, 2008).

Figure 3.1: Interlinkage between tourism and climate



Source: adapted from- Kwame (2014)

From the beginning of the last decade, scholars consider climate change as the biggest challenge confronting the global tourism industry (UNWTO-UNEP-WMO, 2008). As a response to this issue, in 2003, United Nations World Tourism Organisation (UNWTO) sponsored the First International Conference on Climate Change and Tourism in Djerba (Tunisia) to achieve the overarching goal of sustainable tourism and

development under climate change. The outcome of this conference is known as 'Djerba Declaration' on tourism and climate change. Then in October 2007, the Second International Conference on Climate Change and Tourism took place in Davos (Switzerland) and acknowledged anthropogenic climate change as a reality and its significant interlinkage with tourism. Later the 'Davos Declaration' addressed the necessity of adapting enduring strategy for the tourism sector in order to reduce the GHGs and to cope with climate change (Davos Declaration, 2007). In the same year, the concerns regarding climate change and tourism raised at Davos were presented at a Ministerial Meeting (London), UNWTO General Assembly (Cartagena de Indias, Colombia); and later on December 2007, the core ideas were conveyed from UNWTO to the United Nations Climate Summit in Bali.

The fourth assessment report of the IPCC (2007) introduced the cross-relationships between tourism and climate change, and the vulnerabilities and threats of tourism resources in different national and regional scales (Hopkins, 2013b). IPCC (2007) attention was the turning point from the research community concentrated on these issues with an increasing focus (Scott & Becken, 2010). Since climate change and tourism have a complex two-way relationship, the industry needs to maintain a balance between both aspects. Extensive emissions from tourism will directly impact on the survival of the industry; again, minimisation of emissions will increase the operational costs and investment requirements of tourism. This interlinkage and their adjustment is the greatest challenge for the industry. By realising this multifaceted relationship between climate and tourism, research communities increasingly continue to give attention to this subject.

In the mid-1980s for the first time, scientific scholars publish papers on the impacts of climate change on tourism (Scott, Hall, & Gössling, 2012b). Wall, Harrison, Kinnaird, McBoyle, and Quinlan (1986) were the first to ever research climate change and tourism. The more focus on this aspect has been gained by the research community in the last decade (Kaján, 2014). The research on climate change with tourism is highly focused on the West (mostly conducted by the Western universities). This reality leaves geographic scope to fulfil knowledge gap in the context of developing world (Scott & Becken, 2010). Especially, destinations in the Indian subcontinent deserve special attention in climate research as tourism is an emerging industry in the region (Mayor &

Tol, 2008). The South-Asian tourism industry is growing rapidly (WTTC, 2017). Providing attention to tourism research at this stage is significant in terms of dealing with climate change in the South-Asian developing countries like Bangladesh and India.

3.2.1 Effects of climate change on tourism

Globally, travel and tourism as a sector is contributing about 10.2% to GDP, about 9.6% to employment (directly and indirectly) and about 4.5% to total investment (WTTC, 2017). This sector is highly vulnerable due to climate change in terms of current effects and future risks. As tourism is considered a 'climate-sensitive economic sector', the changes of climate impose a 'great risk' to survival and growth of the industry and those whose livelihoods depend on it (UNWTO-UNEP-WMO, 2008). Climate change is reconfiguring the tourism industry all over the world in terms of the season of travelling, mode of transport selection, income generation, tourist flows, destination development, tourists' involvement level and quality of experience (Lisa, 2012). Climate change is also threatening the competitiveness and sustainability of many tourist destinations (Higham & Miller, 2017; Scott et al., 2012b). Scott (2011) notes that many scholars consider the tourism as one of the least prepared industries for facing climate change challenge in large part of the world.

UNWTO-UNEP-WMO (2008) has acknowledged four major classifications of climate change impacts on tourism businesses globally. Firstly, climate as a primary resource, there are some direct visible impacts on tourism like changes of length and quality of tourism seasons. The changing climate is not only altering the length of the season of tourist destinations but also increasing the operational expenditures of tourism sector including cooling-heating (for extreme temperature), snowmaking (for ski resorts), backup water, power system, and insurance charges. The effects of climate change like sea level rise, extreme weather events will demand more capital disbursements in the tourism sector, for example building strong infrastructure and tourism superstructure or keeping extra emergency preparation arrangements.

Secondly, climate change further affects the tourism business by degrading the environmental quality of destinations because of lack of fresh water availability, damaged ecosystems, and decreased aesthetic values of natural landscape. Thirdly,

mitigation policy like reducing GHG emissions from transportation increases the cost of travelling can impact on tourist flows particularly in long-haul destinations. Fourthly, climate change may slow down the tourism sector in some nations which are highly dependent on this sector. As tourism is highly discretionary in nature, therefore due to climate change, people will provide more priority to meet their fundamental needs rather than expending money for travelling, which would lower the growth of this sector (Luigi, 2010).

Climate change impacts in a destination initially can be understood by tourists' climate preference according to their key thresholds, for example, some destinations like Australia may be too hot for a beach holiday (Lisa, 2012). Specific category of climate impact is accountable for particular implications on tourism. Almost all the implications are already taking place in different destinations, and the implications may affect with greater severity in future (UNWTO-UNEP-WMO, 2008). Since climate change disturbs the natural environment mostly, many nature-based tourism destinations are under threat. Further climate change stimulates destinations to drive for some tourism operational aspects like air conditioning, more freshwater for watering golf course greens. As climate variability and change affects tourism destinations, UNWTO-UNEP-WMO (2008) lists the impacts of climate change introduced by IPCC along with implications for tourism sector (**Table 3.1**). Since this project is dealing with a coastal World Heritage area as a study context, therefore, only the direct impacts related to islands and coastal tourism zone are addressed for meeting the purpose of the current study.

Due to climate change, the physical tourism resources are redistributed in many regions (Amelung & Moreno, 2011; Buzinde, Manuel-Navarrete, Kerstetter, & Redclift, 2010; Hall, Scott, & Gössling, 2014), that means some regions lose attractiveness to the target markets. For this reason, tourism demand in particular destinations like Europe, and North America may decline (Kwame, 2014). Countries which are greatly dependent on the income from tourism industry are more vulnerable due to climate change (Lisa, 2012; Reddy & Wilkes, 2012). The vulnerability becomes severe for the coastal regions and small inland destinations (UNWTO-UNEP-WMO, 2008). Because of changing the climate, many coastal and island destinations, particularly in developing countries, are losing tourism potentials before receiving optimum

economic benefit. The vulnerable destinations in developed countries can adjust with the changing pattern of climate by using available adaptation technology and strategies (Hall et al., 2014), whereas the destinations in developing countries need to close the tourism business in many cases. Alternatively, the shift of climate also may provide new tourism expansion opportunities for many destinations (Lisa, 2012), for example, the Arctic Region³⁸. Due to climate change, therefore, the world may experience a rapid modification in the pattern of tourism business in future (Becken & Hay, 2007; Hall et al., 2014).

Table 3.1: Impacts of climate change on tourists' destination

Impacts	Implications for tourism
Warmer temperatures	Altered seasonality, heat stress for tourists, cooling costs, changes in flora and fauna distribution, infectious disease ranges
Increasing frequency and intensity of extreme events	Risk for tourism facilities, increased operating costs, business interruption costs, degradation of forest aesthetics
Reduced precipitation and increased evaporation	Water shortages, desertification, deforestation
Increased frequency of heavy precipitation	Flooding damage to tourism infrastructure, altered seasonality
Sea level rise	Coastal erosion, loss of beach area, higher costs to protect and maintain waterfronts
Sea surface temperatures rise/ More acidic ocean	Degradation of marine environment and biodiversity
Changes in terrestrial and marine biodiversity	Loss of natural attractions and species from destinations, higher risk of diseases in tropical-subtropical countries
Soil changes (Moisture levels, erosion, acidity, etc.)	Loss of natural resources, with impacts on destination attractions

Source: Adapted from UNWTO-UNEP-WOM (2008)

Climate change has some impacts which seem to be beneficial for tourism in different geographic locations. The Euronews (2018) has reported that long summers in some destinations in Europe (among other places) provide new or extended tourism business opportunities. Canada and some north European countries are getting more green land due to decreased snow and ice cover (Becken, 2010). These changes in the landscape have created new and emerging tourism opportunities. The Arctic region is receiving more tourists than ever because of sea ice melting that allows cruise ships to move more extensively throughout the northern polar region (D'Aprile, 2018). The number of polar bears is reducing due to climate change (WWF, 2019). A segment of

³⁸ Arctic region is receiving record tourists than ever before, because of having easy access to the North Pole for ice sheet loses (Dawson, Johnston, & Stewart, 2014).

tourists is rushing to the North Pole to see polar bears, motivated by their looming extinction – a phenomenon that has become known as ‘last-chance-tourism’. While some may see positives in climate change, ignoring climate change by considering limited short-term tourism benefits is an exercise in wilful neglect. Scientific predictions of a one-metre sea level rise at the end of this century, presents a threat that makes such short-term perspectives pale into insignificance (IPCC, 2014).

3.2.2 Tourism as a driver of climate change

Tourism is one of the major contributors to climate change (Becken, 2007; Hall et al., 2013; Scott, Gössling, & Hall, 2012a), and is responsible for 5% of global GHG emissions (UNWTO-UNEP-WMO, 2008). The report UNWTO-UNEP-WMO (2008) further specifies that transportation is responsible for about 75% of carbon emissions produced by tourism, with aviation’s 40% share in it. Generally, all modes of transportation discharge 10.6% of total GHG emissions (IPCC, 2014); and aviation has a significant contribution to the emission which undoubtedly harming climate system (Peeters & Bongaerts, 2015). The continuous growing aviation and increased frequency of ‘discretionary air travel’ particularly by the people of developed countries have been increasing the emissions (Higham & Cohen, 2011). Long haul return travel has maximum GHG emissions record (Douglas & Christian, 2010; Gössling, 2015b).

Travellers, especially from developed countries, usually do not want to compromise their ‘freedom to travel’ (Becken, 2007). Excessive travelling habit - ‘flying addiction’ in the language of Cohen, Higham, and Cavaliere (2011) and ‘frequent-flyer loyalty programme’ offered by airlines companies (Higham et al., 2016a) further increase global passenger kilometres. Behavioural change by creating ‘sense of personal responsibility’ to mitigation is needed to reduce unnecessary travelling (Becken, 2007; Higham et al., 2015). Other than transportation, accommodation for tourists produces about 20% of carbon emission in the tourism sector (UNWTO-UNEP-WMO, 2008). UNWTO-UNEP-WMO (2008) further states that 30-40% of emissions from accommodation can be reduced even by using existing available technologies.

In addition to transportation and accommodation, other components of the tourism system need to contribute to lessening GHG emissions (Scott et al., 2012b). By creating an influence on the entire tourism supply chain and modifying the pattern of supply,

tourism operators can play a significant role in mitigation (UNWTO-UNEP-WMO, 2008). Launching alternative technologies to become more environmentally sustainable, especially for transportation sector can reduce emissions (Becken & Hay, 2007; Hopkins & Higham, 2016). Introducing changes (e.g. technological) for lowering carbon emission may have costs, but in long-term, they are energy efficient and cost effective (UNWTO-UNEP-WMO, 2008). Knowing the volume of carbon emission by tourism activities can help to reduce it, but the emission calculation is bit complex procedure - because many countries do not consider tourism as an economic sector (Perch-Nielsen, Sesartic, & Stucki, 2010); again identifying the domestic tourism emission is often ignored by national governance (Gössling, 2013). By establishing 'carbon neutral' destination, tourism planners can contribute to mitigation and build better image to the target market (Gössling, 2009). In addition, mitigation efforts ensure to meet the goals of sustainable development framework (Simpson, Gössling, Scott, Hall, & Gladin, 2008).

3.2.3 Managing tourism under climate change

3.2.3.1 Tourism for sustainability

Climate change "must be considered the greatest challenge to the sustainability of tourism in the 21st century" (UNWTO-UNEP-WMO, 2008, p. 180). At the face of climate change, tourism scholars advocate strongly to maintain the pillars of sustainability (economic, environmental, social) in case of tourism planning, development, and management (UNWTO-UNEP-WMO, 2008). Sustainability confirms to meet the current needs without compromising the long-term wellbeing. The notion of 'sustainability' has been coined in the early 1990s in tourism to ensure long-term economic, ecological and social benefits (Moscardo, 2012). Though climate change directly threatening the 'sustainable development'³⁹ practices (IPCC, 2007), therefore the 'sustainability' paradigm is a necessary but not sufficient for tourism development, without considering climate change (Hall & Higham, 2005a; Moscardo, 2012; Spector, Higham, & Doering, 2017; Weaver, 2011). In spite of climate threats, the present tourism business systems have not sufficient attention to the future risks during planning and development (Tervo-Kankare & Saarinen, 2012). Scott (2011) notes that addressing climate issue is a prerequisite to sustainable tourism development.

³⁹ "Sustainable development which meets the needs of the present without compromising the ability of future generations to meet their own needs" (WCED, 1987, p. 43).

Unlike many industries, tourism can maintain both successful economic operations and conserve natural ecosystem (Naidoo & Adamowicz, 2005). Even agriculture or fishing in or around the forest area reduces the area of vegetation which degrades natural environment and later threatens forest community (Roy et al., 2016). Tourism encourages enriching natural beauty by tree plantation and discourages polluting the environment. For instance, one of the increasing popular forms to mitigate climate change is 'green tourism'⁴⁰, which ensures carbon (emission) free practices by using accommodation with the natural cooling system, emissions producing transportation. This type of environment-friendly tourism practice is gradually turning into a high demand segment, and some awareness building programme among tourists and tourism suppliers can increase these practices to a greater extent. By developing environmentally sustainable tourism offers, it is possible to mitigate climate effects while having economic benefits (Gössling, Hall, & Scott, 2009).

Tourism can contribute to sustainability by reducing the opportunity-cost of using environmental resources like forest ecosystems (Enger, 2010). It can create jobs for the local people and contribute to local infrastructure development, the overall growth of this sector enhances economic development and standard of living of the destination communities (Brida & Risso, 2010). Because of these reasons, tourism is an important sector for many developed countries (Hall et al., 2013). Many destinations belong to economically weak nations which have huge tourism potential, but very little has been used, can develop tourism for strengthening their economic backbone (Sharpley, 2014). With the other socio-economic challenges like poverty, food security, resource availability, pollution, climate change becomes a big problem to develop tourism in those developing nations. In an ecologically fragile area like a forest, tourism is one of the best alternatives for poverty alleviation (Chok, Macbeth, & Warren, 2007; Hall et al., 2013; Zeng, Ryan, Cui, & Chen, 2015) and environmental conservation (Gössling et al., 2009). Consideration of environmental sustainability in tourism also contributes to climate change mitigation.

In consideration of socio-economic sustainability, community-based tourism (CBT) is a widely accepted avenue for ensuring local benefits in terms of local employment and

⁴⁰ Green tourism is a form of environment friendly tourism activity by which tour business operators offer tourists to use such type products and services those are not producing any harm to the environment in terms of pollution or degradation; and safeguarding ecological balance by maintaining sustainability.

local development (Blackstock, 2005). Utilising CBT in forest destination, community people (often rural, poor and economically marginalised) can earn income as land managers, entrepreneurs, service and product providers, and employees (Goodwin & Santilli, 2009). Beside ensuring local benefits, one of the core issues that CBT addresses is the importance of preserving social assets (e.g. natural forest). Direct local benefits from CBT also motivate local people to involve in maintaining the environmental quality. It is augured by many scholars including Okazaki (2008), Zapata, Hall, Lindo, and Vanderschaeghe (2011) that CBT offers some advantages over mass tourism as CBT may prevent environmental degradation and provides diversification in the local economy, equitable social benefits and educational opportunity to local people through interaction with the people beyond the locality. However, many local communities, particularly from the third world countries, are mostly unaware of the advantages of CBT (Anuar & Sood, 2017). Due to lack of community involvement and proper knowledge of tourism business, CBT often faces challenges in terms of long-term sustainability (Okazaki, 2008).

3.2.3.2 Tourism strategies under climate change

In the stage of planning and development, tourism should address climate change impacts and risks (Gössling et al., 2009; Hall & Higham, 2005a; Hall et al., 2014). Considering the 'bi-directional relationship' presented in Figure 3.1, tourism planners should take initiatives to mitigate carbon loading in the atmosphere due to tourism activities, side by side, they also need to cope with the current climate impacts and to build climate resilient tourism products and facilities (UNWTO-UNEP-WMO, 2008). Several global bodies including the UNEP have recommended that climate change adaptation and mitigation is very urgent in tourism for long-term sustainability (Simpson et al., 2008). For ensuring sustainability, one aspect needs to be considered that adaptation measures should not be the cause of further emissions which might enhance vulnerabilities in medium to long-term timeframe (Xiao et al., 2011). The integrated effort of all tourism stakeholders (e.g. tour operators, tourists) is necessary for climate actions in terms of adaptation and mitigation (Becken & Hay, 2007).

Since tourism is experiencing rapid and substantial growth over the years, mitigation measures are immediately needed to be taken to confirm sustainability (Gössling, Scott, & Hall, 2013). Emissions from all the related sub-sectors of tourism such as

accommodation, transportation, recreation should be addressed to avoid the danger of climate change (Peeters & Dubois, 2010). Reduction of CO₂ and other GHG emissions is the responsibility of every stakeholder of tourism (Gössling, 2015a). Tourism supply-side stakeholders should take the lead in investment for mitigation, similarly, the tourism demand-side stakeholders need to change consumption patterns (Dickinson, Robbins, Filimonau, Hares, & Mika, 2013). Inventing new technologies, incorporating structural modifications, altering travellers' behaviour can contribute to reducing the carbon-intensity in the air by the current travel and tourism system (Cohen et al., 2011; Hopkins & Higham, 2016). Mitigation initiatives from tourism are necessary not only to reduce hazards of climate change but also to ensure sustainability of tourism business (Gössling et al., 2013; Peeters & Dubois, 2010).

For reducing total emissions, tourism planners and policymakers have to be strategic to target tourist market segments for a particular destination. Tourism destination targeting long-haul tourist market can make the climate change scenario much worse and increase poverty rather than ensuring sustainability (Peeters, 2015). Tourists mobility, especially by air transportation, is account for significant GHG emissions (Higham et al., 2016a) thus, sustainable tourism cannot be established with an increasing share of air transportation (Peeters & Bongaerts, 2015). In a long haul air trip, the per-head energy use by a passenger is more than a person uses for a whole year (Peeters & Bongaerts, 2015). Awareness about aviation impacts on climate is required to address the emissions of aviation-based tourism (Hall et al., 2014). Developing nations may improve tourism by targeting short and medium-haul market. Contemporary researchers including Becken and Hay (2007), Holden and Linnerud (2015) address the necessity of environment-friendly transportation by reducing per capita transportation energy consumption and/or using renewable energy sources for reducing the vulnerabilities of climate change.

Adaptation in tourism means adjusting with the effects of climate change in order to lessen the damage or to find new opportunities for recreations. IPCC (2007) provides three coastal adaptation techniques: a) protecting the existing resources by creating robust flood protection structures like dykes; b) coping with the effects; and c) reducing the vulnerabilities by increasing awareness and preparedness. These techniques can be applied to meet the requirements of coastal tourism adaptation, for

example - in case of sea level rise. Hall and Higham (2005b) indicate to a range of adaptation techniques for tourism business in coastal tourists' destinations such as introducing new attractions like spa for replacing the demand of natural resources, building tourism infrastructure (e.g. resorts) further back from the seashore, replanting mangrove swamps to enhance and preserve the natural resources, or applying strategic marketing techniques for revitalising destroyed demand and seasonality due to climate change. To cope with the changing climate, tourism operators can build climate resilient tourism infrastructures (Lisa, 2012) and modify the existing infrastructure so that those can cope with the climate events like strong cyclones.

UNWTO-UNEP-WMO (2008) has acknowledged tourism as an industry with high adaptive capacity - by considering the rapid recovery from SARS, terrorism, and the Asian tsunami. By building climate resilient tourism infrastructure and superstructure, the industry can achieve the highest climate resistance and can come back within the shortest period after having a climate shock than any other industries. Side by side, the chance of tourism of being affected is relatively higher than other industries. Since, tourism is a discretionary need (Higham & Cohen, 2011; Luigi, 2010), the demand of tourism may reach at nil immediately after encountering a climate event. By considering the climate impacts and their consequences on tourism, planners should design the adaptation interventions such a way so that a destination can bounce back within the shortest period of time. In doing so, the effects of current impacts and potential future risks on tourism need to be assessed before deploying an adaptation intervention (Njoroge, 2015).

National climate change policy for tourism is required for climate action, which is largely absent in national legislation in many countries (Gössling, 2013). Non-tourism sector related climate change policy is adequate but addressing tourism in climate change policy is highly ignored even in the developed world (Becken & Hay, 2012). Becken and Hay (2007, p. 223) suggest that "adaptation should be 'mainstreamed' and implemented as an integral part of national and tourism development planning, environmental management" in order to ensure sustainability in tourism. Some developed countries address carrying capacity, limits of acceptable change (LAC), visitor management programme, recreation opportunity spectrum (ROS) in their national tourism policy, however, climate change has not yet got required attention in

national policy framework (Higham et al., 2016b). Since, policy framework in terms of acts and legislation, rules, strategies and plans, determines how tourism management actions will be operated (Higham & Maher, 2007), thus climate issues (e.g. adaptation requirements, mitigation options, destination resilience) need to be incorporated in the national policy of every country.

For incorporating climate change in the policy framework, research related to climate change and tourism is indispensable, however, researchers leave a big 'knowledge gap' in case of tourism adaptation and mitigation (UNWTO-UNEP-WMO, 2008). Despite having the acceleration of tourism adaptation research after 2010, developing countries are greatly ignored by research communities (Njoroge, 2015). Even in the context of developed countries, researchers find that tourism businesses have insufficient instruments to adapt to climate effects (Csete & Szécsi, 2015). Destination adaptation researchers mainly highlight the technical and marketing aspects of mountain and snow-based tourism in the developed world context (Wyss, Abegg, & Luthe, 2014), for example, researching on the implications of artificial 'snow making' in the winter ski-resorts when natural snowfall is not sufficient for skiing (Hopkins, 2013b). In another point, Njoroge (2015) indicates researchers focus on five areas of adaptation research: tourism business adaptation, destination adaptation, tourist adaptations, adaptation policies, and frameworks for adaptation. Both developing country context and sustainability of tourism at the face of climate change receive less research attention.

3.2.3.3 Scope of climate education through tourism

Many nations around the world, including some developing countries, are highly depending on the tourism industry (UNWTO, 2003) and many developing countries are increasingly depending on the contribution of the industry (WTTC, 2017). But climate change creates a challenge for the policymakers to maintain a balance between climate effects and tourism management, particularly in developing countries (Hall et al., 2013). Very often the developing nations neither aware of climate change nor have the knowledge to cope with climate change (Lee et al., 2015). Dickinson et al. (2013) report that tourism stakeholders, particularly tourists, are generally unaware of climate change while making travel decisions. Climate change understanding (e.g. awareness and knowledge) is the prerequisite of climate change action in tourism. Education is required to create climate change understanding for adaptation and mitigation. By

educating tourism stakeholders (e.g. tourists and tourism business), it might be possible to adapt to climate change impacts and contribute to mitigation (UNWTO-UNEP-WMO, 2008).

Tourism can be a robust avenue of communicating climate change; it means - educating and awareness building through tourism practices may lead to climate action (Hassan, Higham, Wooliscroft, & Hopkins, 2017; Higham, Cohen, & Cavaliere, 2014). In comparison to many other industries, tourism can offer economic benefits with least environmental damage in the natural area (Naidoo & Adamowicz, 2005). Sustainable tourism encourages people not to degrade the natural environment, which directly contributes to mitigation by safeguarding ecological balance. Another emerging tourism philosophy, responsible tourism - rebuilding and enriching natural destinations which are already degraded for some reasons - directly contribute to carbon mitigation by increasing coverage of vegetation (Gössling, 2009; Spenceley, 2012). Tourism is not hungry for destroying nature like most of the factory-based industries; rather nature is an asset for tourism. The environment-friendly tourism practices teach people the importance of forest which can be a motivator of conservation and climate action. Some guided and conscious efforts can increase the learning opportunity about climate change by tourism.

3.2.4 Tourism stakeholders' climate understandings and responses

Tourism stakeholders' understandings of climate change have implication on climate responses by the tourism sector. Lack of awareness of climate change is a threat to the sustainability of tourist destinations (Cohen et al., 2014; Hall & Higham, 2005a; Miller et al., 2010). Behavioural change, particularly by tourists, is indispensable for mitigation (Christian, Andy, & Taciano, 2010). Some researchers including Cohen and Higham (2012), Moscardo (2012) have found that tourists consume energy more when they are on holiday than at home because of lack of climate change awareness. Tourists' positive attitude towards mitigation is also vital to increase suppliers' motivation to contribute to reducing climate change (Higham et al., 2015). By educating and applying strategies like social marketing techniques, consumer behaviour of tourists can alter (Hall et al., 2013). Johannesburg Declaration has addressed the obligation to responsible tourism practices to the environment by all group of stakeholders including tourists (Ivanovic & Wassung, 2009).

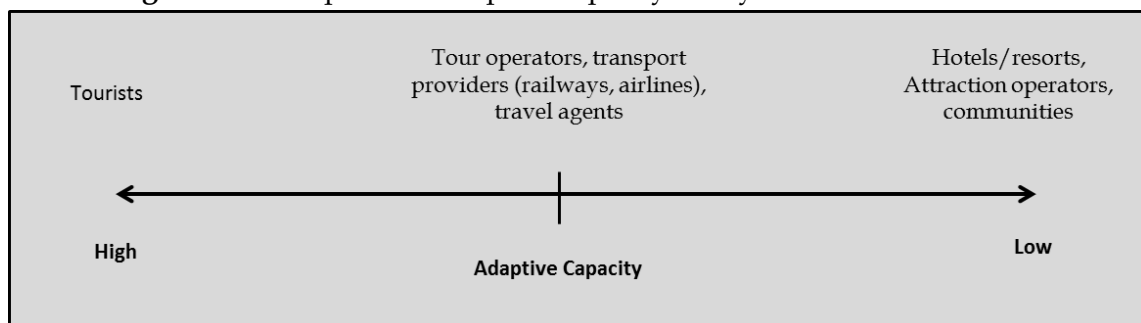
Some research works indicate neither tourists nor the tourism business operators are ready to consider the aspect of climate change (Scott et al., 2012a). Climate-friendly tourism practice becomes a paradox (Gössling et al., 2013) because of reluctance to present sacrifice (e.g. money, consumption, or profit) for unseen and uncertain future benefits. 'Willingness to pay' is the main challenge for climate-friendly behaviour (Csete & Szécsi, 2015; Lisa, 2012). Most of the cases, the tourism suppliers are not ready to spend money on using stuff (e.g. technologies) which can mitigate climate effects (Hall, 2006b). One of the reasons for that is spending money for mitigation increases the price of tourism products which may push out those suppliers from market competition. This is because customers usually prefer cheaper products without considering the climatic and environmental issues (Scott et al., 2012a). In relation to the relative emissions by the tourism industry, tourism stakeholders' understandings of climate change are not adequate for responding to climate change.

The majority of the tourism business stakeholders in the developed countries know about climate change, but still many of them think that their knowledge is insufficient in terms of taking appropriate adaptation and mitigation actions (Csete & Szécsi, 2015). Media, particularly Internet, inform the tourism business stakeholders about climate change which are mostly general, not tourism business-specific information (Csete & Szécsi, 2015). Willingness to act is another concern against environment-friendly actions (Miller et al., 2010). For example, most of the time tourism suppliers are interested in expense for adapting to climate change rather than spending for mitigation (Hall, 2006b). Because, they do not get any immediate benefit from the expenditure on mitigation, but adaptation in response to climate change impacts is obvious to continue tourism business. Cambridge Institute for Sustainability Leadership (CISL) and the Cambridge Judge Business School (CJBS) have found a similar type of result from their research that most tourism business operators only want to add costs to get short-term relief from climate effects rather than investing for resilient infrastructure (European Climate Foundation, 2013).

Risk perceptions in the aspect of climate change depend on the adaptive capacity of humans (Lo & Chow, 2015; Safi et al., 2012). Scott and Jones (2006) describe the comparative adaptive capacity of different key tourism stakeholders (**Figure 3.2**). Destination communities who are highly dependent on tourism and investors in

tourism business like hotels and resort complex have very low adaptive capacity to climate change since they have direct involvement and investment, whereas tour business operators who mostly outsource their business infrastructure and use mobile capital assets have moderate level of adaptive capacity (Marshall, Tobin, Marshall, Gooch, & Hobday, 2013). Tourists have most adaptive capacity against the climate change as they can switch to another option (Hopkins & Maclean, 2014). Tourists adaptive capacity depends on their flexibility to alter the destination and availability of resources like money, information, time (Gössling, Scott, Hall, Ceron, & Dubois, 2012). By considering the relationship between 'adaptation capacity' and 'risk perceptions' proposed by Safi et al. (2012) and Lo and Chow (2015), it can further be argued that community people and direct investors (e.g. hotel, resorts) perceive higher risks of climate change than tour operators and agents. And, tourists perceive low risk compared to tour operators or communities, as tourists have the highest adaptive capacity to climate change. Here, the more the adaptive capacity of stakeholders, the less they perceive the risk of climate change.

Figure 3.2: Comparative adaptive capacity of key tourism stakeholders



Source: UNWTO-UNEP-WMO (2008); reproduced from Scott and Jones (2006)

For assuring long-lasting benefits from tourism, all the stakeholders (e.g. operators, community, and government) need to understand and respond to the climate change (Scott, 2011). Cooperation between local and regional level management (Wyss et al., 2014) and collaboration among researchers and tourism industry stakeholders (Scott, 2011; Tervo-Kankare & Saarinen, 2012) provide scope to reach for a viable climate solution. Supply-side stakeholders of tourism need to the access to the knowledge taking apposite adaptation and mitigation interventions (Hopkins, 2013b). Since efforts to limit consumption from individual-level contribute to the collective success of mitigation, tourists' climate awareness is important for desired behavioural change to reduce the danger of climate change (Higham & Cohen, 2011). Understandings of

climate change by regulatory bodies such as government and other management agencies have a significant implication on the climate change responses by tourism industry (Wyss et al., 2014). The responses to climate change by tourism based on stakeholders' understanding specify the resilience of a destination.

3.3 Forest management under climate change

Species ranges and ecological dynamics are already responding to recent climate shifts (Heller & Zavaleta, 2009), and coastal mangrove forest is rapidly decreasing worldwide (Osti, Tanaka, & Tokioka, 2009). The effects of climate change pose extensive challenges to attain sustainable forest management in terms of protecting natural resources, conserving biodiversity, collecting forest resources (Milada, Schaicha, Bürgib, & Konolda, 2010; Ogden & Innes, 2007). Sea level rise, for example, increases land erosion and decrease forests area; the extreme events like cyclones destroy the trees and kill the animals of the coastal forests. As forestry is very much climate sensitive (Nelson, Williamson, Macaulay, & Mahony, 2016), climate effects like temperature variability, erratic rainfall, heatwaves, floods disturb the balance of forest biodiversity which triggers an imbalance in ecosystem and reduces forests density; eventually many species of flora and fauna become extinct (Milada et al., 2010).

Temperature rise directly disrupts or eliminates the pollination procedures which may reduce the availability of floral pollinator species up to fifty percent (Memmott, Craze, Waser, & Price, 2007). Increased salinity in the water can decrease the area and density of mangroves (Ball, 2002). Climate effects including increased erratic precipitation influence in the growth and quality of water ecosystem by degrading not only the water yield but also the forest ecosystem (Fan, Shibata, & Wang, 2016). Insect outbreaks, for example, due to heatwaves can indirectly disturb forest ecology; but extreme events like cyclone create multiple impacts which might amplify each other to destroy the whole forest ecosystem all in a sudden rather than gradually (Lindner et al., 2010; Milada et al., 2010).

Climate change affects the socio-economic functions which further create trouble for forest management. By reducing the availability of forest resources, climate change cuts the income coming from forest products collection such as timber, and honey. An article published in the scientific journal *Nature* states that bee populations in the

forest are declining due to temperature rise (Cressey, 2015) which will reduce the quantity of honey collection from the forests. In case of developing countries, unavailability of sufficient forest resources for economic benefits pushes the dependents of the forest particularly community people to severe poverty (Naughton-Treves, Alix-Garcia, & Chapman, 2011; Rahut, Behera, & Ali, 2016). Because of poverty, sometimes they illegally overexploit the forest resources which put the management further pressure to conserve forests. Overall, consideration of climate change and its direct and indirect implications on ecology, species, and forest productivity become mandatory for sustainable forest management (Milada et al., 2010).

In order to manage the forests under climate change, awareness regarding the impacts and knowledge regarding adaptation measures can assist to conserve forest ecosystem (Keenan, 2015). "In light of partially antagonistic ways to adapt forest ecosystems to climate change, implementation of conservation measures will require awareness raising and a high level of information on part of all stakeholders" (Milada et al., 2010, p. 840). Forest managers need to know and incorporate apposite adaptation strategies and practices for preserving forestry (Lindner et al., 2010). Adaptation policies and measures highly depend on the perceptions of forest managers about vulnerabilities and risks (Nelson et al., 2016), thus it is significant to know the understandings of forest managers regarding climate change. Nelson et al. (2016) note that knowledge is the main barriers to forest adaptation; the other barriers are mandates, resources, and institutions. The first IPCC (1990) report states that the survival of forest ecosystem under climate change mostly depends on social capacity, that means how a society understands and responses against the effects (Tegart et al., 1990).

Climate change adaptation deserves context-specific independent research to optimise the adaptation benefits; because adaptation requirements and procedures vary according to the geographic and vegetation characteristics of a forest. A wide range of forest management research regarding climate impacts and adaptation has been done by the research communities in the Western context, mostly in central Europe (Bright, 2014; Milada et al., 2010; Nelson et al., 2016; Ogden & Innes, 2007; Peterson, Vose, & Patel-Weynand, 2014). But still, scholars feel existing research efforts are not sufficient to address the climate issue on those forests like the Boreal forest (Lindner et al., 2010). Available research findings show that most of the forest researchers, in the context of

developed countries, address the necessity of adaptation whereas a small number of them like to follow the traditional practices (Nelson et al., 2016). Attitudes towards adaptation and climate actions by the stakeholders of conservation and management agencies working for forest management in developing countries are mostly unknown.

Adaptation for a forest ecosystem is a long-term and continuous procedure where multi-stakeholder groups including planning, management, policymakers, are involved; and their psychological aspects, knowledge base, access to capital resources, information availability, ecology management capacity, governance and institutional climate orientation reflect on adaptation decision (McMahon, 2014; Nelson et al., 2016). Interdisciplinary and comprehensive research efforts are necessary in order to support policy development and managerial decision making (Lindner et al., 2010). Conflict of interests in terms of economic, ecological, and social functions of forest further complicated the climate management (Milada et al., 2010). Though climate impacts influence in different ways in consideration of nature and topography⁴¹ of forests, like mangrove forest or rainforest, thus the research findings of available literature may be helpful, but each forest region demands individual research (Milada et al., 2010). If it is not possible to conduct independent forest research for any developing country, adaptation policies which are successful in a number of similar forests can be reproduced for environmental protection and sustainable development (WTO & UNEP, 2009).

Climate change and forest ecosystems are inherently linked (McClanahan et al., 2008). Forests act as carbon banks by storing carbon dioxide and thereby play a major role in mitigating climate change (Parks & Bernier, 2010). However, forests become sources of carbon dioxide when forest vegetations are removed through degradation or land use change because the plants discharge all their reserve carbon into the air. Forests are the carbon banks of the Planet Earth. As forests absorb the carbon from the air, losses of forests due to climate effects again accelerate climate change; therefore, conservation of forest from the changing effects is a major way of mitigation (Parks & Bernier, 2010). Carbon sequestration efforts like reducing deforestation or increasing afforestation accelerate mitigation; at the same time, those efforts improve the adaptive capacity of

⁴¹ Climate change is shifting the mangrove colonisation in higher latitudes, for example in recent years Northern New Zealand has rapid expansion of mangroves (Lundquist, Morrisey, Gladstone-Gallagher, & Swales, 2014).

forests by conserving plants, soil and water, that means the adaptive capacity of biodiversity of forests is enhanced (Ravindranath, 2007). IPCC (2014) states, by incorporating mitigation and adaptation in forest management policies and practices, a synergic output can be received which make the forestry more resilient.

In order to maintain a sustainable forest under climate risks, forest management authority has to have a comprehensive adaptation plan (Spittlehouse, 2005). Meaningful participation of management bodies including NGOs, international agencies need to be ensured for forest conservation (Hein & Garrelts, 2014). Management authorities have to help forest to cope with the current climate impacts and keep ready to adjust to the predicted climate risks (Lindner et al., 2010; Seidl & Lexer, 2013). The management needs to integrate into higher level strategic plans and lower level operational plan (Ogden & Innes, 2007). The plan must incorporate appropriate local interests - because forest management without community participation often becomes unsuccessful (Bulkeley & Newell, 2015).

Socio-economic, political and legal aspects have a considerable influence on and to the management of the forest at the face of climate change (Ellis & Porter-Bolland, 2008). Socio-economic characteristics determine how the forest resources would be utilised for the community (Moscardo, 2012). Regional economic condition (e.g. poverty or wealth), level of education, or employment opportunity are important predators of biodiversity management under climate change (Spittlehouse & Stewart, 2004). The legal and political environment of a nation decides the strength of the forest management system (Dalby, 2017; Muhammed, Koike, & Haque, 2008). The 'land-use decisions' next to a forest taken by the political government has a direct implication on the biodiversity of the forest, for instance, building carbon emitting industry next to forests may damage forests (IPCC, 2014). In addition, the management capacity of adaptation and mitigation relies on the access to technology (Tessa & Kurukulasuriya, 2010). Overall, the macro-environmental forces can influence the micro-management efforts of climate change (Hassan, 2017; IPCC, 2014).

Tourism can contribute to the conservation of forest and increase the quality of ecosystem in protected areas by retaining revenue generation (Lopes, Pacheco, Clauzet, Silvano, & Begossi, 2015; Naidoo & Adamowicz, 2005). Forest management authority

may consider CBT as an avenue of rural poverty alleviation (Chettiparamb & Kokkranikal, 2012; Zeng et al., 2015) and ecology conservation (Lopes et al., 2015). By launching innovative tourism products, for example, 'mangrove planting tours' integrating 'bamboo bikes tours', inspire tourists and tour business operators to go for mitigation and to practice sustainability (UNWTO, 2014). Tourism needs to be utilised in the forest such a way so that it does not disturb the ecological system particularly wildlife breeding and movement. The sustainability of tourism in the forest environment, however, largely depends on the 'political ecology'⁴² of a society - how they utilise the available natural resources (Douglas, 2014). Geopolitical interests also affect significantly the tourism and sustainability of the environmentally fragile areas (Zelenskaya, 2018). Politicising environmental issues often lead to unsustainable use of the forest ecosystem.

3.4 Integration in management: forest and tourism

3.4.1 Managing forest and forest dependent community

Community residents who are depending on forest resource collection for their livelihoods can contribute to forest management functions (Ellis & Porter-Bolland, 2008; Nath, Jashimuddin, & Inoue, 2016; Noe & Kangalawe, 2015). Managing forest lands and resources in terms of conservation and resources extractions by or with local people, individually or in groups, can be defined as community-based forest management (Ellis & Porter-Bolland, 2008). Community-based forest management addresses the forest centric community needs and forest biodiversity management under the same management system (Brosius, Tsing, & Zerner, 1998). Under community-based forest management, in most countries, community people are required to accept prescribed policy framework (e.g. laws, regulations and rules) in exchange for the authority to manage forest and collect forest resources (FAO, 2015). Often this management scheme highlights local empowerment through ensuring community participation in preparing forest management plans.

Community-based forest management not only ensures local economic benefits but also contribute to climate change management in terms of mitigation and adaptation.

⁴² Political ecology which describes the relationship between political, social, and economic factors with environmental issues and changes, determines the sustainability of tourism (Higham et al., 2016b).

Lasco, Evangelista, and Pulhin (2010) report that community-based forest management leads to enhance carbon storage and sequestration because of the incorporation of tree plantation in local landscapes. Community participation in forest management offers more access to information about climate change and increases capacity of local people which help them to adapt to climate change (Spittlehouse, 2005). As a way of reducing vulnerability to climate change, often, NGOs and international agencies suggest participatory and deliberative forest management with the assistance of community people (Forsyth, 2017). Forsyth (2017) further notes that community participation may not provide the desired result if a society contains many inequalities and social exclusions. Even so, pointing to the climate change impacts and risks, Adger (2003b) and Nelson et al. (2016) argue that community participation in forest management enhance the resilience of the social and ecological system.

“... adaptive and community-based resource management suggest that building resilience into both human and ecological systems is an effective way to cope with environmental change ... Societies and communities dependent on natural resources need to enhance their capacity to adapt to the impacts of future climate change, particularly when such impacts could lie outside their experienced coping range” (Adger & Tompkins, 2004, p. 1).

Forest vegetation and wildlife are highly interdependent in terms of maintaining ecological balance and food chains (Rajpar & Zakaria, 2014; Rashvand & Sadeghi, 2014). The more effectively the food chain works, the better the forest health. For instance, if the density of the forest becomes thin for any reason (e.g. climate change), the animals which need shade will be affected. In the relationship between community, forest, and wildlife – community receives a range of advantages from forest ecosystem including protection from disaster (Osti et al., 2009) and forest resource collection (Garcia, Malabrigo, & Gevaña, 2014; Redmond et al., 2016; Sparling, 2014). But, if the forest- community is poor, the forest dependents may involve in exploitation (Parida, Tiwari, & Jha, 2014) and poaching and killing (Hoq, 2014). Again, the community people can be involved in forest and wildlife conservation (Chowdhury, Koike, & Izumiyama, 2014; Jalais, 2014), and regeneration of forest (Chowdhury, 2014).

To conserve a forest under climate change, forest management agencies usually take a range of actions including harvesting control (Alongi, 2014), patrolling (Hoq, 2014), assisted regeneration (Mohti, Parlan, & Omar, 2014), tourism management (Latiff &

Faridah-Hanum, 2014), management capacity building in terms of logistic support and training (Islam, Rahman, & Chakma, 2014b), pollution control (Pumijumnong, 2014), and forest research (Suratman, 2014). Forest management agencies can support the endangered animals, organise adaptation aid and captive breeding, secure reproductive season (Lunney & Hutchings, 2012), and rescue for treatment (Streicher, 2016) to protect the wildlife for maintaining ecological balance. Management agencies have scope to involve the community in these forest management functions as integrated management of community and forest biodiversity can enhance the effectiveness of conservation efforts (Brosius et al., 1998; McClanahan et al., 2008).

3.4.2 Scope of transboundary forest management

Integrated management for transboundary forest offers a promising response to different challenges of forest management including natural resource shortage, water distribution, decision-making process, both within and across country borders (Macknick & Enders, 2012). Integration between countries also offers effective and efficient management of forest which has identical geological characteristics, and flora and fauna. For example, integrated transboundary management saves research costs - often the two parts of a forest can conduct joint research to solve a specific problem. Knowledge-sharing regarding forestry also uplifts mutual benefits (Johnson & Becker, 2015). Integration in forest management across the border is useful not only to enhance monetary benefits but also to retain own survival (Macknick & Enders, 2012). Any threats to one side of the forest have indirect (or direct) impact to the other side, thus helping the management agencies of the same forest in other country has strong implications on forest conservation (IPCC, 2014).

Integrated management is applicable where there is at least a common interest between parties. Since climate change is a global common problem, policy linkage between international frontiers offers synergy in the case of mitigation and adaptation (IPCC, 2014). International collaboration with clear understandings of climate change can increase the socio-ecological adaptive capacity and resilience of a common transboundary ecosystem (Heller & Zavaleta, 2009; Johnson & Becker, 2015). Integration of different climate change policies and strategies can confirm further effective solution (IPCC, 2014). Climate strategies for forest management should

incorporate both mitigation and adaptation connectedly rather than separately (Kongsager & Corbera, 2015).

For preserving long-term sustainability of forest ecosystems, an international integration for management practices in terms of utilisation of economic benefits (e.g. development, employment), land use policy (e.g. tourism or resource collection), and climate change is required (Hall, 2009; Prato & Paveglio, 2014; Zapata & Hall, 2012). Management integration for climate change, tourism, or forestry also requires across the regional border of different districts, even among different departments (e.g. the ministries) in the same country. Integration initiative is much easier and less political inside a sovereignty than international levels. And there are some ethical issues like 'equitable effort-sharing' arise while considering cooperation for climate change management across international borders (IPCC, 2014). The investment and operating costs of joint forest management functions between nations should be spent according to relative benefits.

3.4.3 Managing tourism across the international border

Cross-border tourism destinations are the functional areas (adjacent territories on international borderlines) where tourism movements take place within a certain cross-border catchment territory regardless of administrative boundaries (Blasco, Guia, & Prats, 2014). Destinations situated on international borders are generally attractive to particular segments of visitors as boundaries themselves become attractions for tourists (Timothy, 1995). Despite being separated by different jurisdictional boundaries, cross-border destinations might share some cultural markers such as language, a common history, and the landscape that might provide additional value to tourists. It is also argued that dissimilarity between cross-border destinations might be attractive to tourists (Blasco et al., 2014). Providing easy mobility to and from cross-border neighbouring destinations adds value in the cross-border experience for visitors (Weidenfeld, 2013). However, while partnership in tourism management across borders is popular between some developed countries such as USA and Canada, France and Spain, and many European countries, cross-border integration for tourism is quite rare in developing countries.

Initiatives to develop tourism across international borders in the destinations of border areas have received significant interest during the last decades. The attractiveness of cross-border resources contributes to increasing tourism business in the border area and enhances the mutual benefits of nations. Tourism has gained considerable attention for enhancing cross-border regional cooperation as cross-border tourism generates income, employment and some local economic linkages (Prokkola, 2007; Studzieniecki, Palmowski, & Korneevets, 2016). Weidenfeld (2013) suggests that tourism facilitates knowledge transfer because tourist mobilities can help to foster cross-border innovation systems. Tourism management beyond international borders provides leverage in upgrading management frameworks, infrastructure, human resources, conservation practices, and fostering tourism promotion that play a part in the sustainable management of trans-frontier resources (Timothy, 1999; Tosun, Timothy, Parpairis, & MacDonald, 2005). A range of decisions including the support area, allocation of funds, relationships, priorities, serendipity, leadership, and institutional structures is involved in order to engage in and manage cross-border tourism (Blasco et al., 2014; Studzieniecki et al., 2016).

Despite cross-border tourism governance being potentially beneficial, there are challenges involved in managing tourism functions across international borders. Firstly, cross-border tourism can lead to uneven economic development in the destination regions as economic growth differs in extent between nations (Weidenfeld, 2013). Secondly, there might be negative socio-cultural impacts in borderland communities, particularly if they do not share a common culture and values (Hampton, 2010; Sofield, 2006). Thirdly, lack of multi-scalar institutional alignment (e.g. mismatching of roles, goals and authorities of organisations between countries) often creates obstacles to achieving cross-border tourism management (Stoffelen, Ioannides, & Vanneste, 2017). It is challenging to align the dissimilarities between the functions of tourism management institutes of the cross-border nations. Fourthly, low levels of mutual trust between management stakeholders of cross-border nations may hinder the normal development of governance collaborative mechanisms in cross-border settings (Weidenfeld, 2013). Last but not least, crucial factors such as social, economic, environmental, and political conditions can be causes of disjuncture in cross-border tourism governance (Hampton, 2010; Prokkola, 2007; Studzieniecki et al., 2016).

The degree of cross-border cooperation determines the development of tourism in the borderland of the two countries (Studzieniecki et al., 2016). Timothy (1999) argues that the more integrated the two sides of an international destination are in relation to the border, the higher the level of cooperation is likely to be. The USA (northern Montana) and Canada (Alberta) have been gaining scholarly attention in this regard by developing a successful model of transboundary tourism management (Pétre, Rivera, & Lefebvre, 2015). For example, Glacier National Park, a transnational park covers over 4000 km², was enlisted as a UNESCO World Heritage Site in 1995. Situated on the border of USA (in the state of Montana) and Canada (in the provinces of Alberta and British Columbia), it is managed by the both nations as a single national park (Encyclopaedia Britannica, 2016). Integration is also important to the domestic level of management agencies. For example, Mount Aspiring National Park (New Zealand) is located on the boundary line of the Otago and West Coast Department of Conservation conservancies, therefore both the domestic and regional management agencies work together to manage tourism in this UNESCO World Heritage, across jurisdictional boundaries (New Zealand Department of Conservation, 2011).

3.5 World Heritage management

The primary purpose of the UNESCO to select WHS is to “encourage the identification, protection and preservation of cultural and natural heritage around the world considered to be of outstanding value to humanity” (World Heritage Centre, 2008, p. 3). A natural or cultural site which has been declared as world heritage receives a label that plays a very important role to construct a brand image of the place, create tourist awareness, and promote the site worldwide (Brown & Hay-Edie, 2014; Hassan & Rahman, 2015). By realising the benefits particularly from tourism, Government of a country apply for WHS nomination (Leask, 2006). After assigning World Heritage designation, UNESCO provides operational guidelines⁴³ and recommendations (for the endangered sites) to the National Government of the State which is responsible for implementing the convention (World Heritage Centre, 2012). The UNESCO assists to maintain an interactive relationship among different scales of management from local,

⁴³ “A wide range of elements that serve as indicators of whether the site is being managed in such a way as to ensure that the values that are the reason for being inscribed on the World Heritage List are being maintained, e.g. management plan and strategies, appropriate regulation and funding regimes, development of management and reporting structures; as well as individual indicators relating to the quality of the site, e.g. visitor numbers, maintenance of heritage values” (Hall, 2006a, p. 23).

national, regional to international for conserving the aesthetics of the world heritage (Millar, 2006; World Heritage Centre, 2012).

Tourism is one of the most promising economic functions in terms of conservation and protection scope in the natural forest (Naidoo & Adamowicz, 2005). Significant academic literature including Colavitti and Usai (2015), Hassan and Rahman (2015), Marcotte and Bourdeau (2012), Wang and Zan (2011), and Yasuda (2010) claim that tourism contributes to conserve and manage World Heritage Sites. The local government also get the motivation to preserve the World Heritage because of its tourism potential (Hall, 2006a). Cochrane and Tapper (2006) state that tourism operators can use WHS to add value to their tour packages and local tourism businesses contribute greater to national revenue and raise awareness of preserving conservation challenges, which encourages the Government to preserve the dynamics of the site. Proactive tourism development and operational plan by considering stakeholders interests (especially local communities), and integrity between community residents and tourists are necessary for conservation and long-lasting benefits from World heritage (Eagles, McCool, & Haynes, 2002; Higham & Maher, 2007; Liburd & Becken, 2017; Woosnam, Aleshinloye, & Maruyama, 2015).

WHS status of a natural forest can be meaningless to the community people, particularly in the context of developing countries, if they do not receive any significant benefit from the World Heritage (Sharpley, 2012; von Droste, 2012). Benefits like employment, local development, or environmental restoration can create a sense of ownership to the local community which assists them to conserve the aesthetic of World Heritage (Deegan, 2012; Okware & Cave, 2012). If local people of WHA receive significant benefits from tourism, it is highly likely that they will conserve and become custodians of the resources rather than exploiting those for immediate benefits (Cochrane & Tapper, 2006). A significant tourism industry with insufficient local benefits increases social costs (e.g. increased congestion, littering, destruction and crime; disturbance of community activities; compete for recreational places, transports, and other services) in the protected areas (Eagles et al., 2002). Ignoring the tolerance of community people may be a threat to the sustainability of tourism and WHS (Negussie & Wondimu, 2012). Enhancing the quality of life of the host community in the natural

forest destination through tourism can help to develop a better appreciation of the value of conservation (Liburd & Becken, 2017).

The behaviour of the surrounding communities of a WHS has a strong influence on the resilience of the natural heritage (Perry & Falzon, 2014). Recent UNESCO policy strongly recommends that engaging local community throughout the life of a WHS for conservation and sustainable development. The purpose of community involvement in planning and adaptive management and governance system are ensuring broad participation and capacity building of local people for stewardship (Brown & Hay-Edie, 2014). Exclusion of local people in management is a reason for miscarrying to address local needs, which is a great threat to the sustainability of WHS (Viñals & Morant, 2012). Mainstreaming meaningful community participation in the WHS management involves a range of decisions. Brown and Hay-Edie (2014) suggest that engaging people in the daily WHS management process involve: nominating appropriate community members, providing training for skill development (e.g. forest conservation, livelihood management, tourism, project development, financial management, monitoring and control). The responsibility for drawing up and implementing the community inclusion in the management belongs to existing management of WHS.

Tourism, however, can increase the financial and economic cost of managing WHSs, because the sector requires investments in infrastructure development and management of fragile and sensitive ecosystems for tourists' presence (Cochrane & Tapper, 2006). Cochrane and Tapper (2006) further add that when national government play insignificant or no role to conserve the WHS, the stakeholders including local people, tour business has to follow the 'user pays' principle, that means the tourists who use the site have to recompense for its conservation. The key challenge here is to reach a 'consensus of opinion' among different stakeholder groups since they have conflicting interests and priorities (Leask, 2006). For example, the UNESCO emphasises on the total conservation of a World Heritage, the national government wants to maximise revenue earnings, and tour business operators might want high profit by avoiding environmental compensation like carbon tax.

Improved interest in and awareness of WHS status of a destination, motivates tourists to visit and significantly influence to enlarge the tourism in the site (Hall & Piggin, 2001; Lopes et al., 2015; VanBlarcom & Kayahan, 2011). It is indeed a reality that WHS receives quick promotion of tourism, which is bit challenging for the economically weak nations those are not prepared properly for handling the demand in terms of capacity of local human resource and infrastructure (Millar, 2006), and sometimes those nations degrade their natural ecosystem by offering unplanned mass tourism. This unplanned demand handling approach to tourism diminishes the value of the destination. Local pollution due to unplanned economic activities in WHS further creates dissatisfaction in the mind of tourists, particularly coming from a long way (Di Giovine, 2009). Since WHSs are considered as part of global heritage rather than only national tourism asset (Cochrane & Tapper, 2006), thus preserving the local natural value is not only significant for increasing inbound tourism but also for the uplifting national flagship to the rest of the world. The host nation should maintain the 'spirit of place' by taking appropriate visitor management programme in the aspect of demand control, safety & security, cultural sensitivity (Shackley, 2006).

External undue influence may create a conflict of interests between Government of the state party and the UNESCO. Due to the representatives from few influential countries, the UNESCO World Heritage decisions have been disrupted with severe biases. International Council on Monuments and Sites (ICOMOS) - a prime advisory organisation of UNESCO - finds that some issues were overrepresented and some were ignored on the World Heritage list (Stillman, 2015), and very often the UNESCO decisions suffer from 'politicisation' because of the undue influence of some emerging countries like China, South Africa, Russia, India (Bertacchini, Liuzza, & Meskell, 2015). Conflicts arise when the international authority of WHS impose decisions without consulting local management and try to establish those. Loss of local autonomy in the governance of WHS will create dissatisfaction among the local people and local government, which might act against sustainability (van der Aa, Groote, & Huigen, 2004). An impartial partnership in terms of managing and conserving the WHS between State Government and the authority of UNESCO can be supportive (Millar, 2006).

UNESCO supports state parties having WHSs by protecting the heritage, establishing management plan and reporting system, offering immediate assistance in a crisis, arranging technical support and professional training, inspiring community participation, developing public awareness for heritage conservation, reassuring international cooperation (World Heritage Centre, 2008). This UN body addresses climate change in their key agenda (Rodwell, 2012) and the agency has also introduced policy how to deal with the climate change to enhance nature-based WHS (Perry & Falzon, 2014). Ishwaran (2012) states that due to climate change impacts like sea level rise, UNESCO biosphere reserves can target short and medium-term tourism to balance between climate effects and socio-economic benefits. A few research works which are partially relevant including Phillips (2014b), Howard (2013), inform about the managing approach to WHS under climate change; but UNESCO roles in climate change management are quite ignored by the research community. At the same time, UNESCO faces a different type of challenges, while assisting state party of WHS, which should be addressed in academic research (Perry & Falzon, 2014).

3.6 Contextual scenario of the Sundarbans

3.6.1 Tourism in the Sundarbans

The Sundarbans is one of the most popular destinations for the domestic tourists in Bangladesh (Islam, Rahman, Iftekhara, & Rakkibu, 2013). In 2010, around 1,17,000 tourists visited the Sundarbans mangroves with official permission (Bangladesh Forest Department, 2010). Many domestic tourists visit the Sundarbans without the permission from the government authority. Khanom and Buckley (2015) have found in their research that about 98% of visitors of the Sundarbans are domestic tourists. The mangrove forest has become more famous internationally after being enlisted as a Ramsar Wetland Site in 1992 and as a World Heritage Site in 1997. International tourist arrival is increasing by 5% in every decade (Khanom & Buckley, 2015). The WHA has enormous potential for domestic and inbound tourism for its distinctive natural characteristics (Islam et al., 2013). At present, tourism is a less important economic sector in relation to forest resource collection (e.g. fishing, shrimp fry collection, mud crab catching) in the Sundarbans of Bangladesh.

Tourism of the Sundarbans is river cruise based - mostly operated by private tour operators (Hassan, 2012). Because of unavailability of public transportation facilities

from the nearest city Khulna to the Sundarbans, independent tour is not feasible; the tourists usually buy tour packages to visit the mangrove forest. The day-trips (same day tours) offer tourists to visit the closest part of the Sundarbans, but the typical tour packages last for approximately three days in the forest. There are few exclusive tour packages offered by some professional tour operators such as dolphin/whale watching⁴⁴, honey hunting tour⁴⁵. Though there is no commercial accommodation inside the protected reserve forest of Bangladesh Sundarbans, so tourists sleep at night on board of vessels by which they explore the forest. In a typical tour package, tourists have a 150 kilometre trip throughout the mangroves (Khanom & Buckley, 2015). During the tour, the operators allow tourists to disembark from the ship to visit some specific points in the Sundarbans of Bangladesh and tourists get opportunity to enjoy walking in the trails, bathing in beaches, and watching natural beauty including wildlife.

The quality of vegetation and diversification of wildlife in this unique ecosystem are main attractions to the tourists (Iftekhar & Saenger, 2008). Lack of tourism facilities (e.g. transportation, entertainments, and catering) is the reason why the forest does not get significant tourism exposure both domestically and internationally (Molla, 2017). As tourism is not considered as a significant economic contributor in Bangladesh, it always receives very little attention from the Government in terms of patronisation and development. With very few initiatives by the Government, the private sector is leading the existing tourism business of the Sundarbans in Bangladesh. For managing tourism in the Sundarbans, scholars such as Chakraborty and Eagle (2017), Islam et al. (2013), Khanom and Buckley (2015), and Uddin et al. (2013a) have suggested to improve infrastructures, tourists services, safety and security, guiding skills, local benefits, and forest rangers capacity. However, the scholars have largely ignored climate change issue in relation to tourism in the Sundarbans despite the forest being a vulnerable destination.

Any expansion of economic activities based on natural resources collection will be a threat towards the sustainability of the Sundarbans (World Bank, 2014a). By realising this, the Government of Bangladesh has taken the policy to allow eco-tourism in

⁴⁴ Tour which take tourists in the Bay of Bengal (about 50km south of the Sundarbans) to show Gangetic dolphins.

⁴⁵ Talking tourist in the deep forest to show how honey is collected by honey hunters. It is form of adventure tour in a forest where tiger lives.

Sundarbans, which can provide revenue from the forest without collecting the forest resources (Kanopy, 2015). One of the prime goals of 'Integrated resources management plans for the Sundarbans (2010–2020)' is to "provide for and enhance eco-tourism and visitor recreation opportunities" with expected outcome of "eco-tourism revenues are sufficient to provide enhanced alternative incomes as well as provide for increased emphases on biodiversity conservation" (Bangladesh Forest Department, 2010, p. 19). The management agencies of the Sundarbans have the enormous scope of environment-friendly tourism, such as offering tiger watching tours (Khanom & Buckley, 2015).

3.6.2 Tourism management in the Bangladesh and Indian Sundarbans

The tourism operations in the Eastern part of the Sundarbans in Bangladesh and the Western part of the Sundarbans in India are independent – it is not possible to visit both parts of the ecosystem in the same trip. Tourism functions quite differently in the two parts of the mangrove forest. In recent time, every year around two hundred and fifty thousand with two percent international tourists visit the Sundarbans in Bangladesh (Islam et al., 2013; Molla, 2017). Whereas, with the two-fifth share of the forest, tourism market size of the Indian Sundarbans is larger than Bangladesh Sundarbans because of the bigger domestic tourism market in India. The West Bengal (India) Government provides well emphasis on tourism promotion and convenient transportation system to the forest. In Bangladesh Sundarbans, there are a few walking trails and a couple of watchtowers available as tourist facilities. On the other hand, there are a significant number of accommodations including some luxurious resorts, quality catering services, safe tiger watching trails, recreation points and information centres in the Indian Sundarbans, which make this part of the forest more attractive to the visitors, following a high growth rate of tourist arrival (Bhutia, 2014).

There is a similarity in tourism management in both parts of the Sundarbans in Bangladesh and India; tourists need to collect on-spot permits by paying fees from the government management authorities to visit the mangrove forest (Tisdell, 1997). The Bangladesh part of Sundarbans is mainly managed by the 'Ministry of Environment and Forests' and this authority also controls the tourism activities in the Bangladesh Sundarbans; there is almost no role of national tourism organisation like Bangladesh Parjatan Corporation (BPC) or Bangladesh Tourism Board (BTB). The tourism in

Bangladesh Sundarbans is in the jurisdiction of the Forest Department of Bangladesh. This authority has developed a few tourism facilities (e.g. visitors centre, walking trails) in a few spots inside the forest. Forest Department of the Sundarbans (Bangladesh) provides gunmen (security guard) with every tour group to protect tourists from tiger attacks during tours.

On the Indian side, the Ministry of Forest has involved in the governance of tourism in the Sundarbans, and the West Bengal Tourism has a very limited role in this regard. Over decades, the Indian part of the Sundarbans is performing well in terms of revenue generation from tourism (Danda et al., 2011; Tisdell, 1997). Both Bangladesh and India have knowledge sharing scope in the aspect of tourism management in the Sundarbans. In order to optimise the mutual benefits, the World Bank (2014a) highlights the necessity of collaboration between Bangladesh and India for tourism development and regional promotion. Some agreements have already been signed, but it is unknown to what extent those agreements are functioning. International agencies including UNESCO, World Bank, IUCN, WWF-India (World Wildlife Fund) and some other national and international NGOs are working for the socio-economic development including tourism, climate education and climate action in the forest region. However, to what extent those agencies are engaging and collaborating with local governments for managing the forest in terms of sustainability and resilience is yet to be examined.

3.6.3 Tourism and local communities

Tourism is one of the most important economic functions of the Sundarbans Mangroves in Bangladesh. The most significant local economic function is forest resource collection including fish, honey, and nipa palms. Around four and a half million people of both Bangladesh and India depend directly on the forest resource collection (Mahadevia & Vikas, 2012). The existing tourism offers little employment opportunity to the local people of the Sundarbans (Islam et al., 2013; Tisdell, 1997). Most of the community people do not understand the value of Sundarbans by being World Heritage (Jalais, 2007). Because of high poverty and very few economic options to earn livelihood other than selling forest resources, the people of the region overexploit the forest resources (World Bank, 2014a). The climate impacts further destroying the forest biodiversity and reduce forest resources (Danda et al., 2011;

Ortolano et al., 2016). Due to the regional poverty, the community people of the Sundarbans themselves rarely can manage the vulnerability of climate change (Ahsan & Warner, 2014).

Opportunity to earn from tourism can assist to alleviate regional poverty and reduce forest depletion (Islam et al., 2013). The development opportunities in terms of income and employment for the people who live on the fringe of the Sundarbans mangrove forest are insufficient (World Bank, 2014a). Local people living beside the forest receive almost no benefit from tourism (Guha & Ghosh, 2008b; Tisdell, 1997) because most of the tourism businesses are operated by investors from outside and they usually do not use any local commodities in their tour offers. At present, around 50 % of the staffs working in tourism in the Sundarbans are from the local community, but most of them earn very low (Khanom & Buckley, 2015). To conserve the forest from extreme human utilisation, it is essential to develop other industries that can create employment for local people. In these circumstances, tourism is considered a sustainable way of development in the Sundarbans, as tourism can contribute to reducing forest dependency and mitigation by conserving carbon bank of the forest (Reddy & Wilkes, 2012).

Tourism in the forest of Bangladesh creates less pressure and threat on forest biodiversity compared to hunting, logging, fuelwood collection, encroachment, refuges, and land use change (Department of Environment, 2015). It is not like that tourism is not harming the ecosystem but developing new industry other than tourism can demand different types of land use and may accelerate pollution⁴⁶. Some industries⁴⁷ that create huge environmental pollution can further destroy the forest and act against the sustainability of the forest. The planned development of tourism is likely to conserve the forest ecosystem and maintain the environmental balance to show the panorama of the mangroves to the visitors. Of course, local needs in terms of employment and development have to be addressed by tourism to avoid forest depletion and to confirm sustainability (Islam et al., 2013).

⁴⁶ For instance, establishing heavy industry like the proposed Rampal coal-fired power plant near the Sundarbans will degrade the ecology of the forest.

⁴⁷ There are 150 legal factories approved by the government around the Sundarbans in Bangladesh (The Daily Star, 2017).

Tourist-community interactions are limited in Bangladesh Sundarbans. Local people are reluctant to be involved in tourism because of discontinuity of income due to seasonality (Guha & Ghosh, 2008b). CBT can resolve this problem to some extent (Islam et al., 2013) - the local people can produce tourism products like souvenir items during the off-peak season and sell those during tourism season when tourists arrivals are highest. Developing CBT by involving community people in the tourism business in terms of benefit sharing (e.g. employment) and participation in decision making can be a prime way of sustainable forest management (Islam, 2011). Enhancing tourism in the Sundarbans can reduce the poverty of the region and conserve the mangrove by reducing dependency on the forest (Guha & Ghosh, 2008b). Islam et al. (2013) suggest that employment of community people in terms of reasonable economic benefits and use of local products in tourism need to be ensured for sustainability. The available literature does not inform whether tourism has any implication for locals' climate change understandings.

3.6.4 Climate impacts on tourism in the Sundarbans

Tourism in the Sundarbans has been fluctuated by seasonality⁴⁸ (Tisdell, 1997). Winter season is the popular time to visit the forest because of safety from weather-related disasters. Tourists do not want to visit the Sundarbans during summer for not being comfortable due to high temperature. The most visible impact of climate change on tourism in the Sundarbans is decreased length of the winter season (Shamsuddoha & Chowdhury, 2007). In recent years, Bangladesh has been experiencing a very short winter season, which might be threatening the internal (inbound plus domestic) tourism of the country as domestic tourism in Bangladesh is winter season based. The available research works including Guha and Ghosh (2008a) and Islam et al. (2013) that focus on climate change and tourism in the context of Bangladesh hardly inform about the influence of temperature rise on tourism movement.

Since tourism in the Sundarbans depends on the quality of the mangrove ecosystem, the future climate risks that have been predicted by the scientists can be a great threat to tourism in the region. The mangroves may sustain and cope with slow impacts of

⁴⁸ The tourism season lasts generally eight months from September to April but the peak period is only four months (November to February); May to August is not popular time for tourism in Sundarbans because of natural calamities like tropical storms, cyclones.

climate change, but any kind of rapid impacts can abolish the whole ecosystem (Kanopy, 2015) and destroy the attractiveness of the forest. After having super cyclone *Sidr* in 2007, the forest took about five years to get back its natural beauty. This type of extreme events decreases tourists flow in the mangrove forest. Increased salinity also alters the vegetation quality and decrease the wildlife population, which may reduce the attractiveness of the Sundarbans (Uddin et al., 2013b). Sea level rise may destroy the tiger population and a significant part of the mangrove forest, which will also affect tourism in the Sundarbans. In Bangladesh, tourists often cancel trips and change destinations by perceiving climate events as a risk (Wu, Zhang, Lu, & Rahman, 2017). Despite all the impacts and vulnerabilities in the Sundarbans, tourism demand-supply side stakeholders' understandings of and responses to climate change are quite unknown.

3.7 Chapter summary

To clarify why climate change research is important in the discipline of tourism, this chapter has outlined the cross-relationship of climate change and tourism. Tourism is affected by climate change, and in turn, tourism is increasing the threat of climate change. This chapter also demonstrates that tourism can be a means of sustainable forest management and can be a way of climate change education if appropriate climate strategies can be applied. Based on the available literature, this chapter depicts that that tourism stakeholders' understandings of and responses to climate change are not adequate even in the developed countries (Becken & Hay, 2007; Gössling, 2015a; Miller et al., 2010; Scott, 2011). The research community has left a knowledge gap about the understandings of and responses to climate change by the tourism stakeholders of developing countries. The perceptions of climate change risk by tourism stakeholders largely depend on the relative adaptive capacity of the stakeholders; more adaptive capacity leads to the low perception of risk and vice versa.

This chapter describes impacts of climate change on forest biodiversity and the common strategies of forest management in response to climate change, particularly for adaptation. It also outlines the macro-environmental factors (e.g. political, legal, social) which directly influence the forest management functions. Reviewing forest management literature, this chapter identifies typical forest management functions, the potentials of community-based forest management in vulnerable developing countries,

and scope of cross-border forest management. In considering climate change, world heritage policy literature is reviewed in terms of benefits of world heritage, community participation and tourism management in world heritage. Finally, the chapter outlines the scenario of tourism in the Sundarbans (Bangladesh and India), community benefits potentials from tourism, and current impacts of climate change on tourism for framing the contribution of this research to fill the knowledge gap.

Since the research objectives (research question 1, 2 and 3) of this thesis attempt to reveal understandings of and responses to climate change by different tourism industry stakeholders and conservation and management agencies' stakeholders, this chapter has included related and relevant literature in that regard. For research question 3, specifically, this chapter has discussed multiple aspects including forest management strategies under climate change, significance of integrated management, cross-border tourism management, and World Heritage management practices and challenges. The purpose of reviewing a range of aspects is to examine the research question 3 that attempts to conduct a comparative analysis of the climate management regimes across the international border of Bangladesh and India in relation to forest biodiversity, forest communities, World Heritage, and tourism. Following this chapter, Chapter 4 turns attention to important aspects of methodology and methods applied in the empirical phase of this research.

Chapter 4

Research Methodology and Methods

4.1 Introduction

This research explores the understandings of climate change held by multiple stakeholders (local communities, tourism demand-supply stakeholders, and conservation and management agencies), and investigates how the conservation and management agencies are responding to climate change in the context of the Sundarbans. The aim extends to an international comparative analysis of how the Sundarbans World Heritage is managed by Bangladesh and India in response to climate change. The aim of the study further classified into two objectives and three research questions (**Table 4.1**). The first objective reveals issues regarding climate awareness, knowledge, attitude and perceptions; and the second objective investigates issues regarding climate change responses, actions, and management functions. The focus of this chapter is to describe the research methodology and methods employed to meet the aim and objectives of this research project.

Since the broad aim of this study is to examine the understandings of and responses to climate change, this research project has followed the methodological principle that allows investigating deeper insights into climate change discourses. This chapter provides a reflective account of the process of conducting this research. It introduces and examines the basic philosophical principles which underpin this study, outlining the ontological, epistemological, methodological and axiological assumptions that justify the study's grounding in the constructivism research paradigm. Aligning with the research philosophy, this study selects semi-structured in-depth interview as a method of data collection. Besides the interviews, a range of published and non-published documents and websites has been analysed for cross-validation and enriching the empirical materials. Later, this chapter addresses the merits of utilising qualitative study for this research.

The attention of this chapter then turns to the fieldwork in the Sundarbans, which describes the reasons for selecting the study context, researcher's background and fieldwork preparation, and demographics of participants. Consequently, this chapter specifies the research method, procedure of interview schedules development, sample selection criteria that include the way of approaching the respondents to participate in the interview and process of the interviews. Later, it describes the procedures utilised for analysing and interpreting the empirical materials. The chapter ends with a

discussion about the transparency of the qualitative research findings, ethical aspects related to research and presentation of the research findings in this thesis.

Table 4.1: Research objectives along with research questions and key attributes

Research objectives	Research questions	Research attributes
<p>First objective To critically examine the understandings (awareness, knowledge, and perception) of climate change held by multiple stakeholders (local communities, tourism demand-supply stakeholders, and conservation and management agencies) of the Sundarbans in Bangladesh.</p>	<p>1) What are the current understandings of key stakeholders of the Sundarbans in Bangladesh regarding climate change and how are those understandings constructed among them?</p>	<ul style="list-style-type: none"> - Awareness of climate change - Knowledge level - Vulnerabilities and effects on life - Coping actions - Capacity to survive - Perception - Attitude to future predictions - Sources of information - Reliability - Information requirement - Experience and observed changes
<p>Second objective To critically examine how the conservation and management agencies of the Sundarbans are responding to climate change in terms of adaptation and resilience building.</p>	<p>2) What are the management functions that support community adaptation in the Sundarbans in Bangladesh?</p>	<ul style="list-style-type: none"> - Extent to address climate change - Management roles - Climate education approaches - Measures to mitigation - Adaptation strategies - Capacity building - Effectiveness of existing practices
	<p>3) What are the areas of convergence and divergence in the management actions of the Sundarbans World Heritage in response to climate change across the international border of Bangladesh and India?</p>	<ul style="list-style-type: none"> - Forest management - Species management - Community involvement - Advocacy - Risk management (information) - Governance policies - Climate management regimes - Forest usage functions - Coordination among management - What to achieve

4.2 Underlying paradigms

Researchers often follow specific and appropriate philosophical principle, known as the research paradigm (Creswell, 2013; Denzin & Lincoln, 2002). A research paradigm is a set of beliefs, values, and practices regarding the world (Goodson & Phillimore, 2004; Jennings, 2005; Kuhn, 1996). The paradigm is defined as the “basic belief system or worldview that guides the investigator” (Guba & Lincoln, 1994, p. 105), it means that the fundamental way of thinking about the world. Research paradigm for particular research project consists of ontological (nature of reality), epistemological

(the relationship between researcher and knowledge) and methodological (data collection method) assumptions that are very much interrelated and work as a system (Guba & Lincoln, 1994; Jennings, 2005). The notion ontology means, in general, the views regarding the form and nature of reality (Denzin & Lincoln, 2005). Epistemology and methodology of a study are determined by ontological beliefs, where epistemology is more theoretical than methodology (Killam, 2013). Epistemology examines the relationship between the knowledge and the researcher during the process of knowledge creation, that means how we come to know what we know about the world (Cooper & White, 2012). The methodology is more specific, systematic and practice-oriented; and the appropriate methodology of a particular research is defined by ontological and epistemological principle (Killam, 2013).

The target of this study is to interpret the social understandings of and nature of responses to climate change. For the purpose of social knowledge accumulation in the aspect of 'understanding' and 'reconstruction', constructivism⁴⁹ is one of the sophisticated ways among other major paradigms in qualitative research (Guba & Lincoln, 2005). Constructivism offers vivid experience in case of describing 'social reality' (Valsiner, 2009). Therefore, the constructivism paradigm fits with this research as this study aims to investigate social understandings of climate change (the first objective) and management responses to climate change (the second objective). "The constructivist paradigm assumes a relativist ontology (there are multiple realities), a subjectivist epistemology (knower and respondent co-create understandings), and a naturalistic (in the natural world) set of methodological procedures" (Denzin & Lincoln, 2005, p. 24) and "users of this paradigm are oriented to the production of reconstructed understandings of the social world" (Guba & Lincoln, 2005, p. 184).

The ontological belief 'relativism' - mostly used for qualitative research - undertakes that all truth or reality is 'constructed' by humans and placed within a social context where multiple meanings can be in the same set of data (Creswell, 2014). Relativists believe that reality depends on context and there are various mental constructions of reality, which are influenced by experiences and social interactions (Killam, 2013). Killam (2013) further argues that 'relativism' is opposite of 'realism' (an ontological perspective mostly for scientific research); and realities are subjective (not fixed-

⁴⁹ Also known as 'constructionism' or 'interpretivism' (Pasian, 2015, p. 62 and 317)

multiple truths that may conflict but still true), dynamic (change over time), and findings of a study cannot be generalised directly for other contexts. The understandings of and responses to climate change by various stakeholders which have constructed the current research study are very much parallel to the ontological assumptions of relativism.

Constructivists deny the notion of objective reality and argue that the researcher and participants jointly create new knowledge (Creswell, 2014; Denzin & Lincoln, 2005). The subjectivists believe that knowledge is not possible to find, it is constructed from social interactions, that means knowledge is transactional (Guba & Lincoln, 2005). According to this epistemological viewpoint, the interaction between researcher and participant co-construct new and multiple realities those all are considered real, which can develop a consensus (Killam, 2013). In order to construct the subjective knowledge from the social environment, the followers of this paradigm usually adopt dialectical methods like interviews to collect data (Denzin & Lincoln, 2005). In the present study, there might be various 'understandings of climate change' held by different stakeholders and multiple ways of 'engagement for responding to climate change', but all findings would be acceptable from individual stakeholder's perspective and might be useful to comprehend the entire research context.

The nation axiology deals with 'basic beliefs', 'ethics', and 'values' associate with qualitative research paradigm (Guba & Lincoln, 2005; Jennings, 2005). In order to address the ethical aspects, the popular quantitative research terms 'validity' and 'reliability' have been adopted in qualitative research (Golafshani, 2003). Guba and Lincoln (2005) argue that the traditional quantitative research criteria of internal and external validity are replaced in qualitative research by new terms 'trustworthiness' and 'authenticity'. By addressing the issue of 'trustworthiness' in a qualitative study, the researchers can extend the rigour of constructive inquiries (Decrop, 2004). Again, since the subjective knowledge construction depends on the effort and ability of the researcher, the authenticity (credibility) of the study should be justified (Golafshani, 2003). Like the concept validity, the term reliability has been increasingly used in the qualitative study for characterising the 'quality of research'. Here, quality represents the extent how a research is able to 'generate understanding' (Stenbacka, 2001, p. 551). Golafshani (2003) mentions that for addressing the reliability and validity in qualitative

research, the researcher should check the essential criteria of quality introduced by Lincoln and Guba (1985), which are: Credibility, Neutrality (Confirmability), Consistency (Dependability) and Applicability (Transferability).

4.3 Qualitative study

Over recent decades, qualitative research techniques have become increasingly popular among researchers who investigate the social problems (Silverman, 2015). Of course, it is research aim and objectives that should determine which method is suitable to conduct a study: qualitative, quantitative or both (Malhotra, 2010). Researchers should select such a method, which can best achieve the aim of the research. This study attempts to investigate the understandings of and responses to climate change in a particular context. Qualitative study offers much scope to contribute to achieving the aim of this research. Qualitative data provides detail description regarding a subject or phenomenon which offers greater understanding regarding an issue (Smith, 2015). Again, the quantitative method only can provide the reasons, but qualitative method can provide comprehensive nature of the reasons (Lederman, 1991). Qualitative investigation can explore better when there is a considerable research gap exist in the literature (Mareeuw, Vaandrager, Klerkx, Naaldenberg, & Koelen, 2015) and where desired attributes are not well established in the literature. In this consideration, it is logical to utilise qualitative techniques for this project. Furthermore, this study best fit with the constructivism research paradigm, which also suggests applying qualitative methods (Guba & Lincoln, 2005).

A qualitative study, indeed, fits with this project to reveal the research objectives. In the first objective, rather than just knowing the level of understanding, this study explores what the respondents know and how (why) they come to know about climate change. Since this objective implies to reveal multiple realities and associated perceptions of climate change, qualitative paradigm is likely to offer the desired research outcomes (Filstead, 1979). A qualitative study can better expose relevant and recognisable in-depth understanding regarding a particular phenomenon (Alvesson & Kärreman, 2011). In the second objective, this study reveals the specific management actions in response to climate change. For exploring rich, deep, nuanced, multi-dimensional issues like management functions, qualitative study is a useful method (Mason, 2002). Qualitative interviewing is desirable when critical stakeholders such as

managers, executives are needed to be included in the sampling framework (Phillips, 2014a) as needed for uncovering the second research objective of this research project.

4.4 Fieldwork: Sundarbans in 2016

4.4.1 Justification of context selection

The coastal region of Bangladesh can be divided into the east-west oriented deltaic coastline and the north-west oriented non-deltaic coastline (Al-Farouq & Huq, 1996). Since the deltaic coastline of Bangladesh where the UNESCO World Heritage Sundarbans mangrove forest situated is more vulnerable to climate change, thus the Sundarbans area was decided to be the study context for this research project. The Sundarbans is highly endangered for sea level rise. Tropical storms are replaced with intense cyclones in the region, which becomes life-threatening for the poor people of the Sundarbans. Super cyclone Sidr (2007) and severe cyclone Aila (2009) hit the mangroves area and destroyed the entire locality of the coastal Sundarbans. Saline water entered the region and created a scarcity of fresh water. The community people of the Sundarbans do not have available fresh water for drinking, household activities, bath, and irrigation. Salinity gradually transfers from water to soil, so that this community cannot grow their traditional crops in their land. Climate change creates obstacle in their livelihoods by hampering in the subsistence farming. Despite the carbon emissions of this community is very low, they are highly vulnerable to the different type of climate change impacts. This situation motivated to conduct this study in the UNESCO WHA Sundarbans.

The Sundarbans mangrove is a single ecosystem, and its eastern part is in Bangladesh and western part is in India (West Bengal). Due to the geographic position of the Sundarbans in the delta of Bay of Bengal, both parts of the mangroves area are affected by the similar type of climate effects. The socio-economic condition of the two parts of mangrove area is quite similar (World Bank, 2014a, 2014b). But the management authorities of both parts of the forest are different as the ecosystem belongs to two different countries. As a significant part of the Sundarbans is in India, therefore, a plan of cross-border analysis was taken to learn about the informative lessons of both management regimes (Baum, 1999; Warwick & Osherson, 1973). It would be interesting to know how the two management regimes of the two vulnerable developing countries are responding to climate change in relation to forest biodiversity, forest communities,

World Heritage and tourism. Having knowledge about the climate management strategies from a similar type of ecosystem may offer effectiveness and efficiency in the management actions (Higham et al., 2016b). By considering the existing knowledge gap, this research assumed that the Indian Sundarbans could be a part of the study context.

4.4.2 Background of the researcher

Bangladesh is a climate vulnerable country, as a citizen of the country I feel the risks of climate change from the deepest part of my heart, which actually motivate me to be sincere to conduct the research project. Ritchie and Ormston (2014) note that the interest of the researcher on the topic of research is a vital factor in the successful progress of a qualitative research project. The language of most of the respondents of this study is Bengali, which is my mother tongue. Therefore, it was very easy for me to understand what the participants want to mean by a particular statement or words, including local slangs. I was born and brought up in a place that is very near the field area, thus I know the social norms and customs of the participants, which assisted me to approach and interact with study participants. As a result, the response rate was very high, and the magnitude of empirical data from the fieldwork was satisfactory.

Researcher's positionality need to address while conducting qualitative study (Hopkins, 2013b). Researcher's own views may affect the outcomes of research when the researcher is from the same culture where the research takes place, as the researcher contains some predefined assumptions in his/her head (mind) because of previous experience about the context. The researcher's personal viewpoints and characteristics may lead to interviewer bias (Chenail, 2011) and may influence the interpretation of the research findings (Goodson & Phillimore, 2004). Many scholars highlighted the issues of interviewer bias when the researcher is from the same society, however, the risk of such bias may occur in all research (Field, 1991). In addition, the previous experience of the researcher regarding the social settings of the fieldwork region offers efficient use of empirical data during analysis (Vail, 2001). By taking reflexivity⁵⁰ in consideration, the researcher of this project tried to outline the

⁵⁰ "A researcher's background and position will affect what they choose to investigate, the angle of investigation, the methods judged most adequate for this purpose, the findings considered most appropriate, and the framing and communication of conclusions" (Malterud, 2001, pp. 483-484).

contextual scenarios regarding understandings of and responses to climate change avoiding the potential sources of bias.

4.4.3 Fieldwork preparation

In line with University of Otago fieldwork policy, this project needed to obtain 'Category A' human ethics approval⁵¹ - applicable when human participants from outside of New Zealand are involved in an empirical study - before leaving for fieldwork to Bangladesh and India. The 'interview schedules' were developed for semi-structured interviewing and key stakeholders were contacted via email regarding their availability during the fieldwork period of this project. As fieldwork training (practices) offers the researcher mental peace and efficiency to collect data (Cramer, 1977), before having the original fieldwork, a couple of simulated interviews were conducted where the respondents were requested to 'role-play' of a specific stakeholder, which helped the researcher to cope with the real world situation. Fieldwork involves health, safety and other types of physical risks (Hammett, Twyman, & Graham, 2015). According to the University of Otago 'Fieldwork Budget and Safety Plan Application Form', the researcher fulfilled all assessment criteria including travel insurance coverage, immunisations, subscribing international security and medical alert advisory service (International SOS) before departing to fieldwork.

4.5 Data collection criteria

4.5.1 Research methods

This study utilised two qualitative research methods, face-to-face semi-structured interviews and document analysis, to gather data to fulfil the demand of research objectives. Interviewing and document analysis are widely used qualitative data collection methods (Chenail, 2011; Gubrium & Holstein, 2002; Herbert & Irene, 2005; Kvale, 2015). Scholars often utilise qualitative methods to conduct similar types of research (**Table 4.2**). In-depth interviews are useful while dealing with the complex phenomena like environmental awareness, knowledge, and perceptions (Robbins, 2000) and information related to functions, activities or actions (Boyce & Neale, 2006). Analysis of documents offers access to more information that has not been asked or answered during interviews. In this study, only interviews were utilised to meet the

⁵¹ Category A Human ethics application form of University of Otago is included in the **Appendix C**.

demand of the first objective; and both interviews and document analysis were utilised for the second objective. Like this research project, Mycoo (2015) has utilised the same type of methods (interview and document analysis) in his research for achieving similar type of objectives and for similar type of research context.

Table 4.2: Qualitative method utilised in the climate change and tourism research^{52,53}

Author/s	Method used	Research area/theme	Context
De Urioste-Stone, Scaccia, and Howe-Poteet (2015)	Interviewing	Impacts, resource management, mitigation strategies	USA
Dillimono and Dickinson (2014)	Interviewing	Climate change awareness	Nigeria
Higham et al. (2015)	Interviewing	Attitude-behaviour towards climate change	Australia
Hopkins (2013b)	Interviewing	Awareness, Risk perception, adaptation	New Zealand and Australia
Kaenzig, Rebetz, and Serquet (2016)	Interviewing	Environmental changes, adaptation	Bolivia
Stroebe (2015)	Document analysis	Green growth discourse	Global
Trawöger (2014)	Interviewing	Risk perception, adaptation, knowledge transfer	Austria
Tang et al. (2013)	Document analysis	Climate actions, risk management	USA
Tapsuwan and Rongrongmuang (2015)	Interviewing	Perception, climate communication	Thailand
Wong, Jiang, Klint, Dominey-Howes, and DeLacy (2013)	Interviewing Document analysis	Vulnerability, environmental policy, adaptation	Fiji, Samoa and Vanuatu

This study followed semi-structured in-depth interviews (Mason, 2002) to explore the research objectives - awareness and knowledge of climate change (first objective) and climate management responses (second objective). Qualitative interviews provide flexibility to deal with multifaceted public understandings regarding environmental discourse (Robbins, 2000) and because of being open-ended, the researcher gets the opportunity to collect a large quantity of data (Boyce & Neale, 2006). Semi-structured interviewing “allows for a degree of comparative analysis and is well suited to

⁵² This table has been developed through electronic library search by using the terms ‘climate change’, ‘tourism’ and ‘qualitative’ together.

⁵³ The purpose of presenting the table is to support the utilisation of methods - interviews and document analysis - for conducting the current research project. The table exhibits a range of studies utilised a similar type of methods for examining similar type of research objectives.

exploring understandings and perceptions” (Hammett et al., 2015, p. 141). Again, this type of interview provides probing opportunity to achieve the depth of answer in terms of ‘penetration, exploration and explanation’ (Legard, Keegan, & Ward, 2014, p. 141). Because of being interactive in nature, the qualitative interviews are described as “a construction site of knowledge” (Kvale, 1996, p. 62). The use of semi-structured interviews aligns with the ‘constructivism’ research paradigms which ontologically address multiple realities, epistemologically subjective in nature and methodologically recommends to use qualitative approach (Jennings, 2005).

In semi-structured interviewing, the interview schedule contains a set of questions to disclose the research objectives. In the interview schedule (also known as interview guide), some of the questions and their sequence are predetermined, while others evolve as the conversation of the interview goes on. In comparison to the structured interviews, “semi-structured interviews can make better use of the knowledge-producing potentials of dialogues” between interviewer and interviewee by avoiding a pre-set questionnaire; and, compared to unstructured interviews, “the interviewer has a greater say in focusing the conversation on issues that he or she deems important in relation to the research project” (Brinkmann, 2014, p. 286). By describing the semi-structured interview, Lewis-Beck (2004, p. 2) explains, “the relatively open, flexible, and interactive approach to interview structure is generally intended to generate interviewees’ accounts of their own perspectives, perceptions, experiences, understandings, interpretations, and interactions”. Due to the flexibility in questioning and the interactive conservation of semi-structured interviewing process, both researcher and participants obtain much scope of co-creation of knowledge.

A non-probability judgemental sampling⁵⁴ technique (Malhotra, 2010) was utilised in order to recruit the participants for interviews in this study. In judgmental sampling, the participants are included in the sample of a study on the basis of the researcher’s own knowledge, experience and assessment to meet the information requirement (Altinay & Paraskevas, 2008; Panacek & Thompson, 2007). As the elements (e.g. participants) of the sample are selected for the purpose of the researcher, the judgemental method is criticised for containing interviewer bias (Curtis, 2011). However, in case of exploring common understandings of something and interviewing

⁵⁴ Judgmental sampling is widely known as purposive sampling (Tongco, 2008, p. 147).

experts, judgemental sampling ensures efficiency despite having the inherent chance of interviewer bias in the method (Tongco, 2008) and often effective to achieve research objectives (Altinay & Paraskevas, 2008) as this method is flexible to include or exclude interviewees during fieldwork. Finally, yet importantly, the intentional selection is effective when critical persons like managers, key person, need to include in the sample for deep, rich and meaningful data (Phillips, 2014a).

To fulfil the demand of the second objective of this study, document analysis - analysing the contents of different published and non-published secondary sources - was utilised. In document analysis, a systematic procedure is applied for reviewing or evaluating collected printed, electronic, and other documents (Bowen, 2009). In order to ensure the validity of the documents, the researcher examined the 'source and authenticity' of the collected materials (Olson, 2012). Analysis of documents was utilised as a supplementary method that supported the other data collection method like qualitative interviews (Altheide, Coyle, DeVriese, & Schneider, 2008). Since triangulation becomes challenging because of limited research budget and short fieldwork timeframe, a combination of data collection methods, e.g. interviews, document analysis, or observation can reduce the errors linked to a particular qualitative method (Patton, 1999). Triangulation was one of the main motives of utilising multiple methods to disclose the second objective of this research.

4.5.2 Preparation of interview schedule

The interview schedules of this study were designed by following the principle of Gill, Stewart, Treasure, and Chadwick (2008), in which the interview questions should be developed to yield much information to address the research objectives. For developing interview schedules, this study accomplished a two-step process for open-ended question development. In the first step, the key attributes were identified based on the research objectives (Table 4.1) and later, core interview questions - with proper clues and prompts - were prepared appropriately to address the identified attributes by targeting a different group of stakeholders to reveal the research objectives (**Appendix A**). In the second step, all the core questions - related to research objectives - for a same group of stakeholders were assembled together with few other relevant questions to maintain the flow of conversation. Five set of interview schedules were

developed in the second step, as outcomes of this procedure, which were taken for the fieldwork for semi-structured interviewing (**Appendix B**).

For identification of the key attributes from the objectives, the researcher depends primarily on the existing literature. The attributes and language of the questions were developed in close consultation with the supervisors of this project. Later, the interview schedules were tested in pilot interviews (Gill et al., 2008) with the role-playing participants. Based on the feedback and outcomes of the pilot interviews, the questions of the interview schedules were adjusted, where necessary. The interview schedules were utilised only for researcher purpose - were not supplied to the participants. The reason for having the interview schedules was the convenience of the researcher to maintain the flow of conversation during interviews. As most of the participants of this study speak in the Bengali language, the researcher identified appropriate Bengali words to communicate the jargons (e.g. adaptation, mitigation, resilience) in the interview questions.

4.5.3 Stakeholder analysis

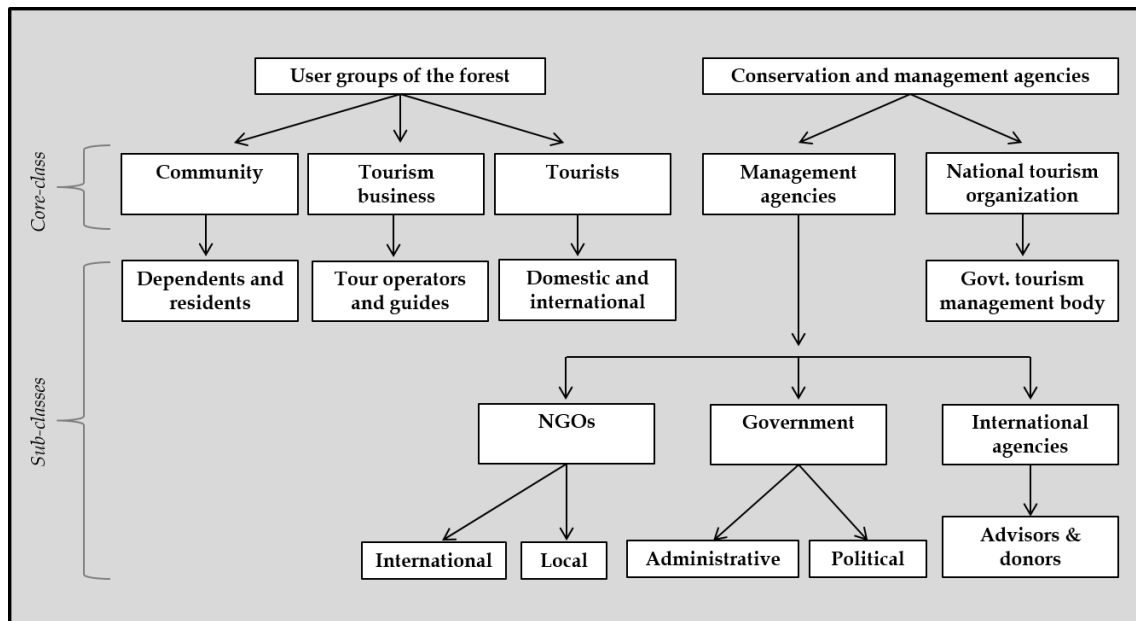
Stakeholder analysis is used to identify the key players and interest groups involved in a research project (Brugha & Varvasovszky, 2000). The objectives of research mainly define which stakeholders would be important to include in a study (Berg, 2016). In order to achieve a wide variety of perspectives to meet the demand of the objectives, this study involved a range of stakeholder classification (**Figure 4.1**). Five groups of stakeholders were identified under two broader categories - user groups of the forest, and conservation and management agencies (facilitators) - to address the objectives of the study. The stakeholders are: 1) community residents, 2) tourism business operators, 3) tourists, 4) management agencies - NGOs, Government, and International agencies, and 5) NTO or tourism management authority.

Community

Community participants are the stakeholders who live at the periphery of the Sundarbans mangrove forest. The community includes the forest dependents (e.g. fisherman, woodsman, honey hunters), local residents (e.g. housewives, other business), community leaders (e.g. volunteers, social workers) who permanently reside in the Sundarbans area. The forest dependents of the Sundarbans mainly change their

profession according to the availability of forest resources in different seasons in a year. Community participants were recruited by considering their demographic characteristics: profession, gender, location, age, and social role and status. The demographic characteristics were self-identified by the participants. The researcher selected the potential community participants from the locality of the Sundarbans and approached them for a face-to-face interview.

Figure 4.1: Stakeholder classification



Tourism business

Tourism business stakeholders include the tour operators, ship owners, tour guides and managers, tour operators’ association leader. There are two types of tour operators in Bangladesh Sundarbans - registered tour operators (tour operator by profession, registered under tour operators’ association) and non-registered tour operators (do passenger transportation business in different water routes, but involve in tourism business during peak tourism season). Tourism business stakeholders were selected by considering business location, operator’s reputation for tourism business in the Sundarbans, and relative role and status. The researcher phoned the potential tourism business stakeholders and asked for an appointment for an interview by informing about the purpose of this research project. The interviews were conducted in the offices of the participants and in restaurants.

Tourists

Tourists were classified between domestic and international for this study. Domestic tourists who come to visit the Sundarbans are usually students or professionals who are generally educated. Travelling inside the Sundarbans is bit expensive for most of the people of Bangladesh. A standard three-day tour takes around US \$100. Unlike many developed countries, travelling for vacation is not culturally established in Bangladesh. But still, many people want to visit places. For this study, both tourists on same day trips and tourists on extended stay (more than one nights) in the Sundarbans were included in the sample. The same day tourists hire boats and visit the nearest part of the Sundarbans and stay in the hotels outside of the protected area. The extended-stay tourists purchase tour packages which cover the government fees, transportation, river cruise, and foods. Tourists were selected for interviewing when they completed their tours. The selection criteria were the region they came from (Southern, Central or Northern Bangladesh, international), gender, and occupation. After making appointments, most of the tourists' interviews took place in restaurants.

Management agencies

The stakeholders who are responsible for managing the Sundarbans in terms of forest management, community services, climate change adaptation were defined as management agencies for this study. The SRF (Bangladesh) and SNP (India) are governed under the jurisdiction of the Forest Department of the countries. Government departments like local administrations, law enforcement agencies, and elected public representative play a significant role to manage the socio-economic affairs in the periphery of the Sundarbans. In addition, a range of national and international NGOs is working, particularly on climate change, in the Sundarbans area (impact zone) of Bangladesh. In comparison, a number of small NGOs are working for the Indian Sundarbans region. A few international agencies are working directly for the Sundarbans in Bangladesh including USAID, UNESCO, IUCN and a few are for India including WWF (India), World Bank. These international agencies play roles as policy patrons or advisors and donors for the mangrove area.

The management agencies were selected to be included in the sample of this study by considering two aspects: the relative importance of the organisation for the Sundarbans, and the extent of involvement in climate change management. The

participants from the conservation and management agencies were interviewed after making appointment with the desired personnel. A few of the participants were approached via email before fieldwork started. Appropriate permission (written or verbal) was taken, where necessary, from the chief of the organisation to take an interview of personnel. All the interviews from the management agencies were conducted at the workplace of the participants.

National Tourism Organisation

National Tourism Organisations (NTO) in Bangladesh and India do not have any direct engagement in the tourism of the Sundarbans. BPC, one of the NTOs of Bangladesh, has a few motels at the edge of Bangladesh Sundarbans; and Department of Tourism (Government of West Bengal, India) has a tourist lodge beside the forest office at Sajnekhali in the Indian Sundarbans. However, the NTO often integrates tourism policy with the top level of management in case of Bangladesh Sundarbans. The Forest Department of Indian Sundarbans has introduced 'registered tourist guides' to manage and control the tourism activities. The participants from tourism management organisations were recruited by considering the associated job responsibility with the Sundarbans and their availability. The interviews were taken place in the office of the participants.

4.5.4 Interview methodology

Five set of interview schedules were taken during fieldwork for interviewing the five groups of interviewees - local community, tourism business, tourists, management agencies and tourism management organisations (**Appendix B**). Since human participants were involved in this research, all the ethical aspects recommended by the University rules were followed accordingly. Before starting an interview, the researcher communicated to the potential interviewees for ensuring the eligibility of being included in this study. At the first step of the interview, the researcher shared the purposes of the research and all other information available in the information sheet (**Appendix D**). The researcher took participants' signature on the consent form (**Appendix E**) and took voice consent - recorded digitally - from the participant who cannot sign on paper. The information sheet and consent form were translated into Bengali language and utilised where necessary.

While conducting the interviews, the researcher followed the 'listen more, talk less' principle (Seidman, 2013, p. 81). The questions, normally, were asked in the order of the interview schedules, but the interviews maintained adequate flexibility to change the order of questions to keep the 'natural flow' of conversation. In the event that the subject of conversation shifted in other direction that was not relevant to the research interest, the participants were provided sufficient scope to finish what he or she intended to say before the interview returned to the next question from the schedule. As climate change is a complex phenomenon for discussion (Hopkins, 2013b), the researcher sometimes talked to the participants regarding their personal interest beyond the research interest to provide them 'comfort' when they were not feeling good to talk about the complex issues; and once they feel good, the research again started asking to gain more information.

During the fieldwork for interviews, the researcher of this study, carefully observed the surrounding environment to get a better contextual view of climate change scenarios and tourism management. Interviewing is typically an effective tool for obtaining personal understandings regarding a social issue and for finding insights into nature of organisational involvement from persons closely involved with those issues (Smith, 2010). When a researcher does a face-to-face interview in the study context (area) that must contain a component observing the study field (Gubrium & Holstein, 2002; Seidman, 2013). Face-to-face interviewing offers opportunity to observe the case study field (area) which provides more clear ideas and insights about respondents interpretation, that is why, interviews are increasingly utilised in climate change and tourism studies (Klint et al., 2012).

This research was transformative while conducting the interview programme (Pernecky & Jamal, 2010). The issues which might be important to achieve the research objectives raised from previous interviews were included in asking in the subsequent interviews, where relevant (Gibson & Brown, 2009). The interview questions were approached to the respondents by maintaining flexibility to raise self-awareness (Higham et al., 2014) regarding the issue of discussion. To do so, this study follows the 'reflection practice' principle of action research (Lewin, 1946) which provides a "viable research strategy enabling a balance between rigour and relevance and that it has great transformative potential" (Levin & Greenwood, 2011, p. 28). Reflections of previous

interviews in the following interviews helps to conduct broad investigation of specific social issues (Denscombe, 2014), which is a kind of profound engagement to understand more insights about the issue of research interest (Vaughn, Parsons, Kologi, & Saul, 2014). In the field of climate change management, reflections can reveal more insights regarding the issue of inquiry - as critical stakeholders are involved in the research framework (Huntjens, Eshuis, Termeer, & Buuren, 2014). Constructivists support that reflection practice manifests “a meaningful and important outcome of inquiry processes” (Lincoln, Lynham, & Guba, 2011, p. 117).

While the semi-structured interview was the main tool to achieve the research objectives, the researcher applied judgement for selecting interview locations and potential participants during the fieldwork to meet the objective of the study. The judgement was developed based on the literature survey, the researcher’s experience, and interaction with the different stakeholder groups. The judgemental criteria were varied for recruiting participants from different classes of stakeholder. In the judgemental sampling method, the researcher is able to identify and select participants due to the qualities the participants possess and can decide what needs to be known and set out to find people who can and are willing to provide relevant insights by the quality of knowledge or experience (Etikan, Musa, & Alkassim, 2016). Despite the abstract characteristics of the judgemental sampling technique, **Table 4.3** exhibits how the participants were included in this research.

Table 4.3: Participant recruitments by utilising judgemental sampling method

Stakeholder classification	Number of participants	Recruitment criteria	Decision rules utilised to participants selection
Community	9	<ul style="list-style-type: none"> - Occupation (e.g. fishermen, woodcutters, honey hunters, not dependent on the Sundarbans) - Gender (e.g. male or female) - Location of living (e.g. different areas of the Sundarbans region) - Age (e.g. young, senior citizens) - Role and status (e.g. volunteers, social workers, community leaders) 	<ul style="list-style-type: none"> - Participants from community people were recruited from different occupations to ensure maximum variation in the sample. - Three participants were selected from female to avoid gender exclusion. - Interview participants were collected from different localities of the Sundarbans such as Burigowalini, Munsigong, Gabura, Koikhali. - Participants were selected from different ages (20s to 60s). - Social roles were considered for some participants while including in the sample.
Tourism Business	5	<ul style="list-style-type: none"> - Types of operators (e.g. physical business office based, internet-based) - Reputations (e.g. well-known in Bangladesh, local operator) - Role and status (e.g. member of operators' association- registered or non-registered, employees, owners) 	<ul style="list-style-type: none"> - Participants from four physical-office-based and one Internet-based tour operation agencies were selected. - Reputed operators that were doing inbound and domestic tourism and operators that were exclusively operated tours in the Sundarbans were included in the sample. - Three registered with the tour operators' association and two non-registered tourism business were included. Among the five – two were owners and three were employees such as guides, managers.
Tourists	6	<ul style="list-style-type: none"> - Origin (e.g. Southern, central or Northern Bangladesh, international) - Gender (e.g. male or female) - Occupation (e.g. students, professional, housewives) 	<ul style="list-style-type: none"> - Tourists were selected based on their origin: domestic and international. The domestic tourists who were from the Southern part or central and Northern part of Bangladesh were selected. - To ensure gender equity, tourists from both gender were included. - Tourist participants were recruited job holders, students, and other professions for ensuring maximum variation.
Management agencies	19 (Bangladesh: 14, India: 5)	<ul style="list-style-type: none"> - Relative attachment (e.g. agencies working only for the Sundarbans, agencies that have a dedicated department/section for the Sundarbans) - The extent of involvement in climate change management (e.g. climate change is a core focus, climate change is less focused in operation) 	<ul style="list-style-type: none"> - Participants were selected from the agencies which were directly involved in the management of the Sundarbans. These include: Government disaster management department, forest management department, agencies for climate change management, Non-government organisations. - Most of the participants were selected from the agencies that were involved in climate change management except one NGO in Bangladesh (to understand its development work in relation to climate change).
National tourism organisation	3 (Bangladesh: 1, India: 2)	<ul style="list-style-type: none"> - Job responsibility (e.g. responsible for tourism development, responsible for inspection) - Availability (e.g. easy accessible, recommended by peer group) 	<ul style="list-style-type: none"> - Participants who were directly related to tourism management in the Sundarbans were selected. - Researcher shared the information requirements to the staff of tourism management organisations and they suggested the participants based on availability.

May to August (in 2016) was selected for fieldwork because from April to September of the year is very vulnerable due to climate events like cyclones in the Sundarbans area (World Bank, 2014a). The assumption behind selecting the fieldwork period was getting in-depth views of and responses to climate change during the high-risk period, particularly from conservation and management stakeholders. The fieldwork took place in four locations of Bangladesh (Sundarbans area in Satkhira and Khulna, and Dhaka - the capital of Bangladesh) and India (Sundarbans region in South 24 Parganas, and Kolkata - the capital of West Bengal, a prominent state of India). **Table 4.4** provides a brief description of the fieldwork along with the rationale of location and participant selection. The core fieldwork locations of Bangladesh and India are indicated in **Map 4.1**.

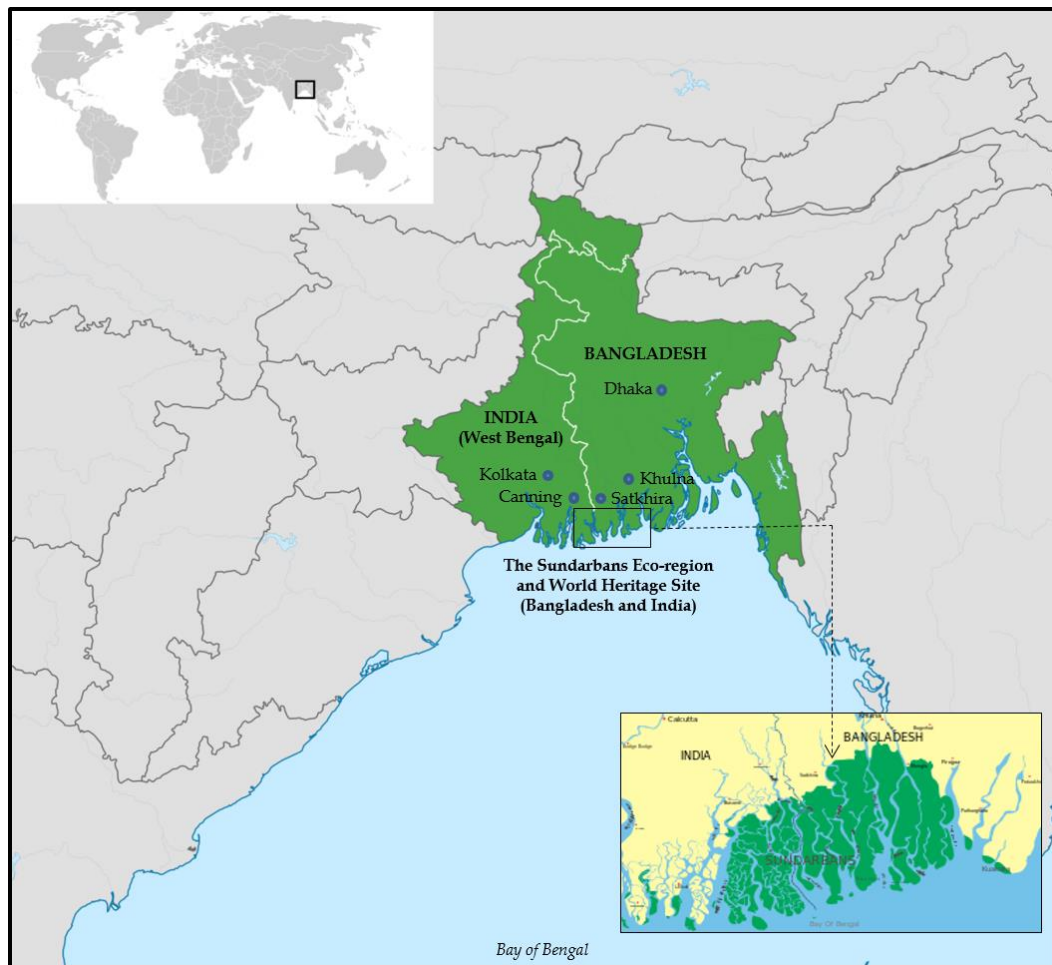
Table 4.4: Fieldwork in the Sundarbans (May to August 2016)

Location	Period (months)	Core interview focus	Rationale for selection
Bangladesh Sundarbans Satkhira District (Shyamnagar Upazila, Burigowalini, Munsigong, Gabura, Koikhali)	May & June	Local community NGOs Local administration	Community people and management agencies working on climate change were interviewed for getting a preliminary assessment regarding climate change understanding and response in the Bangladesh Sundarbans.
West Bengal, Indian Sundarbans Kolkata and South 24 Parganas (Canning, Gosaba, Pakhiralay, Sajnekhali, Bally Island, Jharkhali)	June & July	NGOs Government forest and Tourism management	In the second fieldwork period, the management agencies of Indian Sundarbans were interviewed as the researcher had already a primary idea about the management scenario related to climate change in the Bangladesh Sundarbans.
Bangladesh Sundarbans Khulna Division (Khulna city, Mongla, Karamjal)	July & August	Government forest management Tourists Tour operators	All tourism demand-supply side stakeholders along with government agencies working for tourism were interviewed from Khulna division of the Bangladesh Sundarbans.
Dhaka, Bangladesh (Agargaon, Banani, Mohakhali)	September	International agencies Government forest management	This segment of respondents - executives of international agencies and government high officials - were approached from the beginning of the fieldwork, however, the appointments were possible to arrange at the final stage.

By considering Satkhira district and Khulna division as different clusters, a same group of stakeholders were interviewed from a single geographic region to get a full picture

of a particular segment of stakeholders. The Satkhira was selected, as the most Western part of Bangladesh Sundarbans is located in this district - then Indian Sundarbans starts. This district offered easy access to the community, many NGOs and administration within fifty-kilometres from the boundary of the Sundarbans. Again, Khulna is the prime and dominating start point of tourism operations in the Sundarbans. Therefore, tourists and most of the tour operators were accumulated from this area for interviewing in the third phase of fieldwork. In the second phase of fieldwork, one participant was pre-communicated to have an interview in Kolkata. The others were selected from the Indian Sundarbans region according to their importance to be included in the sample of this research. In the fourth and final phase of fieldwork, the interviews were conducted in Dhaka for the stakeholders related to management who did not have any on-site office in the Bangladesh Sundarbans.

Map 4.1: Fieldwork locations in Bangladesh and India⁵⁵



Note: The circles on the map indicate the fieldwork locations in Bangladesh and India

⁵⁵ The shaded space on the map indicates the land area where people speak in Bengali language in both Bangladesh and West Bengal, India (divided by a white line).

The interviews were digitally recorded with the full consent of the participants. In order to achieve the two objectives of this project, 42 interviews were conducted. The length of the interviews varied between 41 to 110 minutes (average duration 58 minutes approximately). 'Repetition and redundancy' of information regarding key themes of this research was considered as a guide to the closure of taking interview from a specific group of stakeholders (Lincoln & Guba, 1985). Researcher's subjective judgement was applied to determine 'data saturation' which guided the end of the interview programme (Francis et al., 2010). In this research project, the number of interviews from each category of stakeholders were very close to the Guest, Bunce, and Johnson (2006)'s proposed saturation benchmark - six to twelve interviews.

4.5.5 Documents collection and analysis

The documents⁵⁶ utilised for this study include respondents' official website, publications, brochures, fliers, billboards, academic articles, newspaper articles, maps, policy documents, manuals, handbooks, photographs, magazines, books (written in Bengali language), management documents regarding contextual climate change, YouTube videos, and Facebook pages. During the interviews, the respondents (management stakeholders only) were asked to suggest relevant documents, which might be useful for the research; according to their suggestions, the researcher collected the necessary documents. Often the participants shared the printed version of documents to the researcher. Field notes - created by the researcher- were also used as documents during analysis. The research of this project used the documents, of which the source can be identified to ensure authenticity. Information collection is the secondary purpose of document analysis for this study.

4.6 Analysis and interpretation

In the case of judgemental sampling, the sampling procedure, data generation, and data analysis are dynamic and interactive (Mason, 2002). In qualitative research, analysis and interpretation take place throughout each step of the research process (O'Reilly, 2012), as a result, the initial interpretations occur during the fieldwork and transcription processes and the organised interpretation of the empirical materials takes place during data coding, data analysis and writing the results. Qualitative data

⁵⁶ A list of documents is provided in the **Appendix F(1-4)** which were utilised in data analysis process but those were not cited in this thesis.

analysis is an invisible interpretative task and complicated brain-work in terms of discovering the outlines, similarities, differences, patterns, logic, reasons, actions from a large volume of text (data) to explain the results for addressing the research problem. The mental procedure of qualitative analysis for this research highly consider the epistemological principle of constructivists that participants views on an issue should be represented in research findings.

The researcher translated the interviews which are taken in Bengali language and transcribed the audio recordings of the digitally recorded interviews. The researcher did the translation of the recorded interviews - to resolve the 'epistemological dilemma', by understanding the local realities, cultural meaning, and quaint vocabularies of the interview language (Temple & Young, 2004). Verbatim translation was undertaken where the translated sentences fully represent the participants' dialect. The translating process was easy except in some cases when researcher did not find appropriate English words of particular Bengali words. Bengali to English dictionary (publish by the Bangla Academy) has been used to find necessary English words. For making the transcription process handy, a 'PC Transcription Kit' - a foot control pedal that can do the audio recording backwards, play, and forward, was used. By listening to the audio recording repeatedly, the translation (where necessary) and transcription process were conducted simultaneously. The interviews were transcribed partially (only the very unnecessary and irrelevant conversation was avoided) to improve the efficiency of the analytical process with a large volume of texts. This procedure assisted in getting more familiarity with the empirical materials and interview transcripts.

Thematic analysis⁵⁷ was used to analyse the empirical materials from the interviews. It is a hybrid approach, where themes emerge from inductive and deductive reasoning (Fereday & Muir-Cochrane, 2006). The themes utilised to present the findings of this research developed based on both literature survey (deductive reasoning) and reading the interview transcripts (inductive reasoning). The interview transcripts were read multiple times and coded under relevant constructs. A range of constructs was developed before reading the transcripts (deductive reasoning) and a few other developed during the transcripts reading (inductive reasoning). The analysis was the

⁵⁷ "Thematic analysis is a method for identifying, analysing, and interpreting patterns of meaning ('themes') within qualitative data" (Clarke & Braun, 2017, p. 297).

next step of coding; however, the analysis also takes place when transcripts were coded under constructs and sub-constructs (e.g. concepts, attributes). The purpose of coding was to see the all relevant empirical data at once under particular constructs. Coding assisted in identifying similarities, differences, patterns and structure of empirical data (Seidel & Kelle, 1995). Coded empirical materials were analysed for theme development.

Computer-aided coding and analysis assisted the researcher to manage a large volume of empirical data. For qualitative analysis, NVivo is a popular data management software for coding and analysing interview materials (Bazeley, 2013; Patton, 2015). Data management software like NVivo can manage a large volume of data by providing easy and quick access to the empirical materials (e.g. transcripts). For this research project, the interview transcripts were uploaded in the NVivo 11 for coding and analysing⁵⁸. Focusing on the research objectives, the empirical data were coded under predefined constructs (mostly parent nodes) and some constructs were driven from empirical materials (mostly child nodes). This process of coding generated 11 constructs and aligned with 60 sub-constructs⁵⁹, given in **Table 4.5**.

⁵⁸ **Appendix G** exhibits a 'word cloud' of all the interview transcripts where 'people', Sundarbans, 'climate' are the most uttered words during interview programme.

⁵⁹ The detailed Node list of the NVivo project is available at the **Appendix H**.

Table 4.5: Coding of empirical data: constructs and sub-constructs (concepts)

Constructs (parent nodes)	Sub-constructs (child nodes)
Adaptation	Approaches and strategies Challenges Maladaptation Migration Responsibility
Awareness and knowledge	Attitude- climate change Behaviours Believes Causes- climate change Consumption and usages Definition- climate change Environmental Experience- climate change Impacts and vulnerabilities Misconceptions Pollution Weather system
Climate management	Advocacy Challenges Community involvement Disaster management Livelihood support Public education Species management
Communication	Approaches and strategies Challenges Message development Responsibility
Forest management	Conservational practices Governance system Policy and laws Socio-economic aspects
Information sources	Information flows Information sufficiency Media Reliability
Management coordination	Benefits Challenges International liaison Institutional roles Scope
Mitigation	Alternative livelihoods Approaches and strategies Challenges Responsibilities
Perceived risks	Attitude to scientific predictions Current risks Future plans Preparation
Resilience (building)	Approaches and strategies Challenges Infrastructure Planning and development Responsibility
Tourism	Development approaches Effects Monitoring and control Observed vulnerabilities Pollution Risk management

The coded materials were utilised to address the research objectives or research questions of this thesis. **Table 4.6** demonstrated which constructs were utilised for which findings chapter. To address the research question 1, all the 35 interviews (sources) from Bangladesh Sundarbans were utilised. To address the second objective of the research specifically research question 2, 15 interviews (sources) of management stakeholders from Bangladesh Sundarbans were utilised; and for the research question 3, references were taken altogether from 22 management stakeholders (7 from Indian Sundarbans included) of Bangladesh and Indian Sundarbans. To address the quality of this research project, **Appendix J(1-3)** presents three project maps (NVivo outputs) for three findings chapter of this thesis. These maps exhibit the evidence of evolving the constructs from claimed interview sources, which indicates to the quality of the research findings developed from the analysis process.

Table 4.6: Constructs utilised to develop research themes⁶⁰

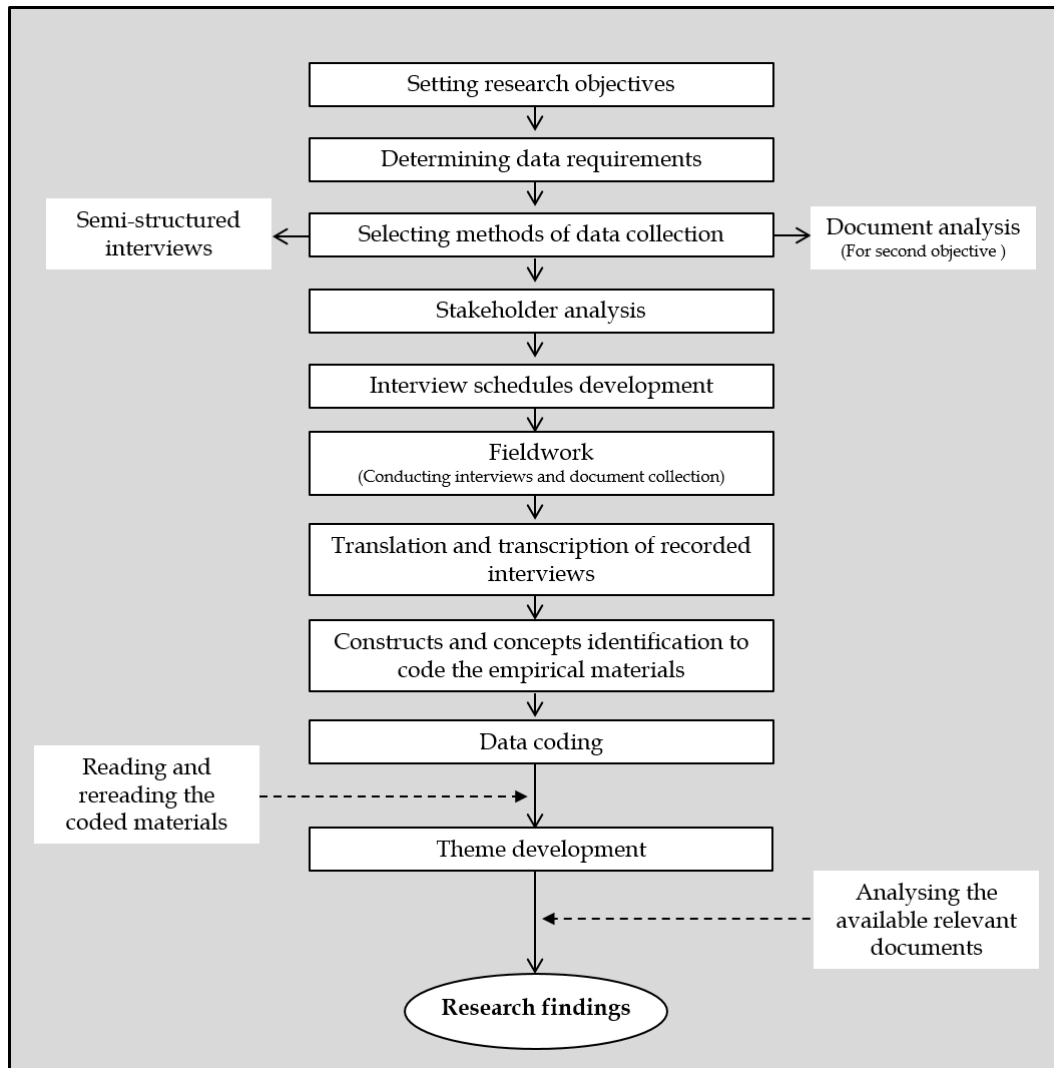
Findings chapter of the thesis	Constructs (Bangladesh Sundarbans)	No. of coded references/sources	Constructs (Indian Sundarbans)	No. of coded references/sources
Ch. 5 Understandings of climate change (first objective - research question 1)	Awareness & knowledge	207/35		
	Information sources	152/35		
	Perceived risks	59/35		
Ch. 6 Climate change management actions (Second objective - research question 2)	Adaptation	35/15		
	Communication	47/15		
	Coordination	73/15		
	Mitigation	24/15		
	Resilience (building)	30/15		
Ch. 7 Climate change management: Cross-border analysis (Second objective - research question 3)	Climate management	128/15	Climate management	44/07
	Forest management	140/15	Forest management	68/07
	Tourism	66/15	Tourism	42/07

⁶⁰ The computer-generated cluster analysis of qualitative coding (NVivo output) also supports the utilisation of constructs in the analytical process, which is given in the **Appendix I**.

The coded empirical materials under the constructs and sub-constructs were used through reading and rereading by the researcher. Multiple reading of the coded interview materials assisted to develop themes for each research question. The emerged themes were elaborated with relevant explanations and participation quotations. All the themes that emerged in this research were developed from the empirical materials. For research objective 2, the outcomes of document analysis were incorporated, where necessary, with the outcomes of the interview programme. Documents were not cited as evidence of claims where empirical materials were available. The empirical materials were the primary focus of the analysis, and findings were corroborated in relation to document analyses.

The gathered documents were manually coded and were used to crosscheck (validation) and interpret the empirical interview data. For manual coding of the collected documents, the constructs and sub-constructs presented in Table 4.5 were utilised. The constructs for document analysis were namely adaptation, communication, coordination, mitigation, resilience (building), climate management, forest management, and tourism (see Table 4.6). The collected documents were read, watched (if videos) for coding the materials. The contents of the hardcopy documents which seemed to be important for this research were marked with pencils under the constructs and sub-constructs. The relevant information obtained from videos was documented by the researcher and the important websites were printed. The same procedure of coding was then applied to hardcopy materials arising from video and website documentation. The findings of data analysis were written for presentation in Chapter 5 to 7. **Figure 4.2** exhibits the overall research process followed in this project from objectives setting to final research findings.

Figure 4.2: Qualitative research process followed in this project



4.7 Transparency of qualitative findings

In a quantitative study, there are some acceptable statistical criteria to check reliability and validity of research which is absent in qualitative research as it is subjective in nature (Atieno, 2009; Leung, 2015). Addressing the quality of qualitative study contributes to more rigour and acceptability to qualitative inquiries (Decrop, 2004). In order to explain the quality of the qualitative study, a researcher needs to make sure the transparency of research process from data collection to interpretation of findings. Lincoln and Guba (1985) introduce four essential criteria to check the quality of qualitative research: credibility (trustworthiness), neutrality (confirmability), consistency (dependability), and applicability (transferability). **Table 4.7** demonstrates the above criteria to the current research project and reflects upon the decisions and actions taken for ensuring the quality of the research findings (Chapter 5 to 7).

Table 4.7: Quality-checking criteria of qualitative research

Quality checking criteria (Lincoln & Guba, 1985)	Delineation for qualitative research	Application to the current research project
Credibility	The researcher's ability to limit bias and error in research design, develop trust, and avoid reactions and selective perceptions (Henderson, 1991)	<ul style="list-style-type: none"> - Sources of data have been identified to ensure clarity - Researcher's background and experience related to the research context reduced interview related biases - Multiple methods (and sources) utilised to check the validity of data (Loh, 2013), where necessary - Findings were connected to the literature
Neutrality	The research being free from researcher bias (Myburgh & Poggenpoel, 2007). Presenting a variety of explanations, disclosing the analysis process are the strategies to maintain neutrality.	<ul style="list-style-type: none"> - The data coding and analysis procedure are presented in Table 4.5 and Table 4.6. - Rigour in the research design from interview schedule development to systematic data analysis indicates to neutrality.
Consistency	There should be uniformity between research data and actual scenario of the study context (Slevin & Sines, 1999).	<ul style="list-style-type: none"> - The interviews were digitally recorded for ensuring a clear understanding regarding participants' motive (Barriball & While, 1994). - The verbatim quotations have been presented to support the major claims of the research.
Applicability	The quality to transfer the research findings to research context and matching research findings with current literature (Decrop, 2004).	<ul style="list-style-type: none"> - In Chapter 2 and 3, previous literature has been reviewed to describe the research phenomena with sufficient detail (Lincoln & Guba, 1985). - Description of the context is given in different parts in the previous three chapters - Description of the extent to which the outcomes of this current research can be transferred to other times, settings, situations, and people - Addressing multiple realities, where applicable

In order to enhance quality and trustworthiness of qualitative findings, triangulation technique was utilised to limit interview-related and methodological biases (Decrop, 2004). Triangulation facilitates validation of data through cross verification from various (at least two) sources (Denzin & Lincoln, 2011). It refers to collecting data from different sources and at a different time and places, due to find the true meanings and to verify the trustworthiness [or validity] of data (Flick, 2004). Triangulation is done by not only changing data sources but also by changing the application and combination of several research methods on the same phenomenon. The present research project incorporated five core stakeholder classes and compared their responses regarding understandings of climate change in terms of awareness, knowledge, risk perceptions in line with 'informant triangulation'⁶¹. Again, data source triangulation (Denzin & Lincoln, 2011) was utilised when examining management response to climate change

⁶¹ Informant triangulation involves considering a broad range of informants and comparing what they say" (Decrop, 2004, p. 163).

by deploying the method of document analysis along with interviews. Entailing dependability (consistency) and conformability (neutrality), as presented in Table 4.7, also can reduce potential research biases and enhance the quality of data (Lietz, Langer, & Furman, 2006).

4.8 Limitations of the research

Since this research has adopted qualitative methodology and methods for obtaining the objectives, it is important to acknowledge the limitations of qualitative research for this current project. Qualitative research is “descriptive in that the researcher is interested in process, meaning, and understanding gained through words or pictures”, and the research process is “inductive in that the researcher builds abstractions, concepts, hypotheses, and theories from details” (Atieno, 2009, p. 14). Since qualitative analysis develops through a nebulous process (as subjectivity leads to procedural ambiguity), despite this thesis covers all the possible aspects for clarity and quality of the qualitative study (see Table 4.7), unintentional and unconscious prejudice might involve in the research process (Decrop, 2004; Tongco, 2008). This study addresses the limitations of utilising the judgemental sampling technique, as the method emphasises on the purpose of research while selecting interview participants. Researcher’s positionality (see section 4.4.2) might unintentionally influence the result of this study despite the researcher was aware of this issue.

This research project addresses several limitations in the interview framework of the current study. Firstly, this research is highly context-dependent (Bangladesh and India). The findings of the research may not be appropriate for other contexts. Secondly, the fieldwork for this study was conducted in mid-2016, the results of this thesis may not be applicable for the long-term timeframe. The contextual climate management functions may change over time. Thirdly, all the interview participants of this research are from conservation and management agencies who are involved in contextual management, not in policymaking. Conducting interviews with policy-makers (e.g. ministers, secretaries and directors of ministries, members of parliament) might provide a deeper understanding regarding climate change management responses. Lastly, mixed methods research (qualitative plus quantitative study with a large sample) for uncovering contextual understandings of climate change might be more helpful. Time and budget were the constraints to do so.

4.9 Research ethics

The major ethical issue arises when interviewing human participants to avoid harm. Usually, ethical concerns revolve around “the topics of ‘informed consent’- receiving consent by the respondent after having carefully and truthfully informed him or her about the research, ‘right to privacy’- protecting the identity of the respondent, and ‘protection from harm’- physical, emotional, or any other kind” (Fontana & Frey, 2005, p. 715). This programme of research strictly maintained the potential ethical concern related to human participants. It preserved the anonymity of human participants from any kind of risks or harassment. Before starting every interview, the participants were informed how the privacy would be maintained during and after the research project.

The information sheet and consent form – which were translated into the Bengali language – outline the specific criteria which the participants agreed to participate in semi-structured interviews. Written consents were taken from all the participants (except one – who is unlettered, gave recorded voice consent) by informing the necessity and conditions of interview programme. This research utilised one-to-one semi-structured interview, which allows more confidentiality of the participants (Brinkmann, 2014). For ensuring the anonymity of research participants, name and organisational designation were not presented in this thesis. Participants of this research are identified only by their stakeholder classification and organisational affiliation.

4.10 Presentation of thesis findings

The findings of this thesis are presented in Chapter 5 to 7 along with relevant theoretical and contextual background. The chapters are reported as independent but interrelated – each findings chapter addresses specific objective (and research question) by following the empirical materials through the analysis and coding process (Table 4.5). Each findings chapter incorporates a critical discussion of related literature and specific research approach followed by research findings following the University of Otago guidelines for thesis that incorporate published papers. The findings are presented through the verbatim quotations from empirical materials, the relevant information accessed by collected documents, and synthesis discussion grounding the research findings within relevant literature. Respondents’ quotations have been directly used to interpret the findings of this project, as “dialogue is a powerful and

evocative metaphor for the transformative engagement that happens in conversation” (Ravitch & Riggan, 2017, p. 118). **Table 4.8** highlights how the findings of the thesis are presented.

Table 4.8: Presentation of the three findings chapters of the thesis

Findings chapter	Objective being addressed	Methods utilised	Stakeholder groups	No. of participants	Interview location
Chapter. 5 Understandings of climate change	First objective (Research question 1)	Semi-structured interview	Community (9) Tourism business (5) Tourists (6) NGOs (7) Government (6) Int. agencies (2)	35	Bangladesh (Satkhira, Khulna, Dhaka)
Chapter. 6 Climate change management actions	Second objective (Research question 2)	Semi-structured interview Document analysis	NGOs (7) Government (6) Int. agencies (2)	15	Bangladesh (Satkhira, Khulna, Dhaka)
Chapter. 7 Climate change management: Cross-border analysis	Second objective (Research question 3)	Semi-structured interview Document analysis	NGOs (10) Government (9) Int. agencies (3)	22	Bangladesh (Satkhira, Khulna, Dhaka) India (West Bengal - Kolkata and Canning)

4.11 Chapter summary

This chapter has provided a discussion of the philosophical principles utilised to design the research presented in this thesis. This research adopted a constructivist paradigm to achieve the research objectives, as this paradigm recognised that there are multiple truths in the environmental discourse of social science investigations. Aligning with the research paradigm, the ontological belief is relativism - rather than realism - as it undertakes all the possible truths or reality surrounding the research phenomena. In order to examine the social understandings of and responses to climate change, it followed subjectivists epistemology - constructing knowledge jointly by the researcher and interview participants. The constructivism paradigm aligns with qualitative research approach which justifies the use of semi-structured interviews and document analysis to conduct the current research project.

Qualitative research allows investigating how and why the world is socially understood and constructed. In case of social science research aspects of climate change discourse, qualitative methods are quite flexible and offer a large volume of data. Face-to-face interviews provide great scope to critically examine human perceptions in terms of awareness, knowledge, beliefs and perceptions (first objective of the thesis). Interviews along with document analysis provide in-depth acquaintance regarding a phenomenon like climate change response and action (second objective of the thesis). To ensure credibility, neutrality, consistency and applicability of the research outcomes, this chapter incorporates the descriptions of the fieldwork, five categories of stakeholders (community people, tourism business, tourists, management agencies, and tourism management authorities), interview participants recruitment criteria, triangulation technique, and data analysis and interpretation process.

In the analysis and interpretation process, this research utilised thematic coding which was undertaken by the qualitative data management software NVivo 11. Table 4.6 has identified how the constructs were derived; and this, in turn, contributes to the neutrality of the research methods utilised to achieve the objectives. This chapter also addresses transparency of the qualitative analysis, a few sampling and non-sampling limitations, participants anonymity memantine criteria, and presentation of qualitative findings. The next three chapters present the research findings. In the context of the Sundarbans, the chapters respectively examine the social understandings of climate change, climate change management actions, and relative climate change management between Bangladesh and India. While they are presented in individual chapters, the overall findings are reviewed and discussed in Chapter 8 to inform how all these three chapters meet the overall research aim of the thesis.

Chapter 5

Understandings of Climate Change

5.1 Introduction

The empirical research presented in this chapter is conducted in the context of high climate vulnerable UNESCO WHA of the Sundarbans mangroves forest in Bangladesh. The forest ecosystem is important for livelihoods including fishing, honey collection, other forest resource collections and tourism (O'Donnell & Wodon, 2015; Ortolano et al., 2016) and for disaster protection as the mangroves works as a bio-shield by reducing the effects of hydro-metrological events like cyclones and tidal waves (Seetharaman, 2015). Because of high regional poverty, the forest is over-exploited by the community people, which reduces the resilience of the ecosystem to protect the community people from extreme climatic events (World Bank, 2014b). Some community people involved in mistreating the environment, such as fishing by using the entangling net with the smallest mesh and by poisoning with certain chemicals, poaching and cutting trees illegally (World Bank, 2014b). Recently, despite protests at the national and international level, the Government of Bangladesh is going to establish coal-based thermal power plants at the edge of the Sundarbans, which might threaten the biodiversity of the ecosystem (Muhammad, 2013).

The forest is one of the popular tourist destinations, particularly to the domestic tourists. As the Sundarbans is a place with high-intensity weather events, its tourism is highly seasonal (November to February peak period and May to August off-peak period). The tourism businesses in the Bangladesh Sundarbans are dominated by external investors (Guha & Ghosh, 2008a; Khanom & Buckley, 2015). Community benefit from tourism is quite insignificant in the Sundarbans of Bangladesh (Islam et al., 2013). Two types of tour operators are controlling the tourism business in the Sundarbans. Firstly, professional tour operators who have tourism vessels, permanent staffs (e.g. guides, managers) and offices; and secondly, seasonal tour operators who are the owners of big ships that are used for regular passenger transportation involved in the tourism during the peak season for high profitability. The involvement of government agencies in monitoring tourism functions in the Sundarbans is quite low, particularly in the case of pollution control.

The fourth assessment report of the IPCC has framed climate change understanding as knowing the information of the science of climate change in terms of mitigation and adaptation (IPCC, 2007). Achieving such climate understanding in the most vulnerable

developing countries is a critical and urgent challenge, and it becomes a necessity for the coastal communities of the UNESCO WHA Sundarbans mangrove forest in Bangladesh. This chapter explores awareness, knowledge, and risk perceptions about climate change of a range of stakeholders in the Sundarbans of Bangladesh focusing on the research question: What are the current understandings of key stakeholders of the Sundarbans in Bangladesh regarding climate change and how are those understandings constructed among them? From the empirical material presented in this chapter, a theoretical framework is proposed to inform future studies examining public awareness, knowledge, and risk perceptions as components of social understandings of climate change. The objective of this chapter is to critically examine the understandings of climate change held by multiple stakeholders (local communities; tourism demand-supply side stakeholders; and conservation & management agencies) of the Sundarbans in Bangladesh.

5.2 Social understandings of climate change

Climate change understanding is not general awareness limited by the theoretical definition, but a comprehensive realisation to mitigate the existing vulnerabilities and the scientific predictions of future risks. General awareness of climate change is required to address the cause, impacts, effects and risks of climate change (Lee et al., 2015). If people do not hear about climate change, they are not capable of engaging in climate actions. Awareness is the primary driver of climate change actions (Hopkins, 2015c). After being aware of climate change, people usually search for more information and try to learn for required action (Leiserowitz & Smith, 2017; van der Linden, 2017). Climate change knowledge is the learnings of what to do for mitigation, adaptation, and/or resilience building (Sterman, 2011; Zakaria, 2015). Appropriate knowledge (e.g. learning through education) is required to resolve and manage the existing vulnerabilities and future risks related to lives and livelihoods (Moser, 2010; Scott & Becken, 2010). Despite having awareness and willingness, lack of knowledge of climate change is an obstacle to climate action. Proper awareness and knowledge regarding vulnerabilities and risks of climate change is the fundamental requirement for being resilient (McNaught et al., 2014)

Risk perceptions of climate change, the subjective realisations (e.g. understandings) of people about the characteristics and severity of the risks, shapes how society would

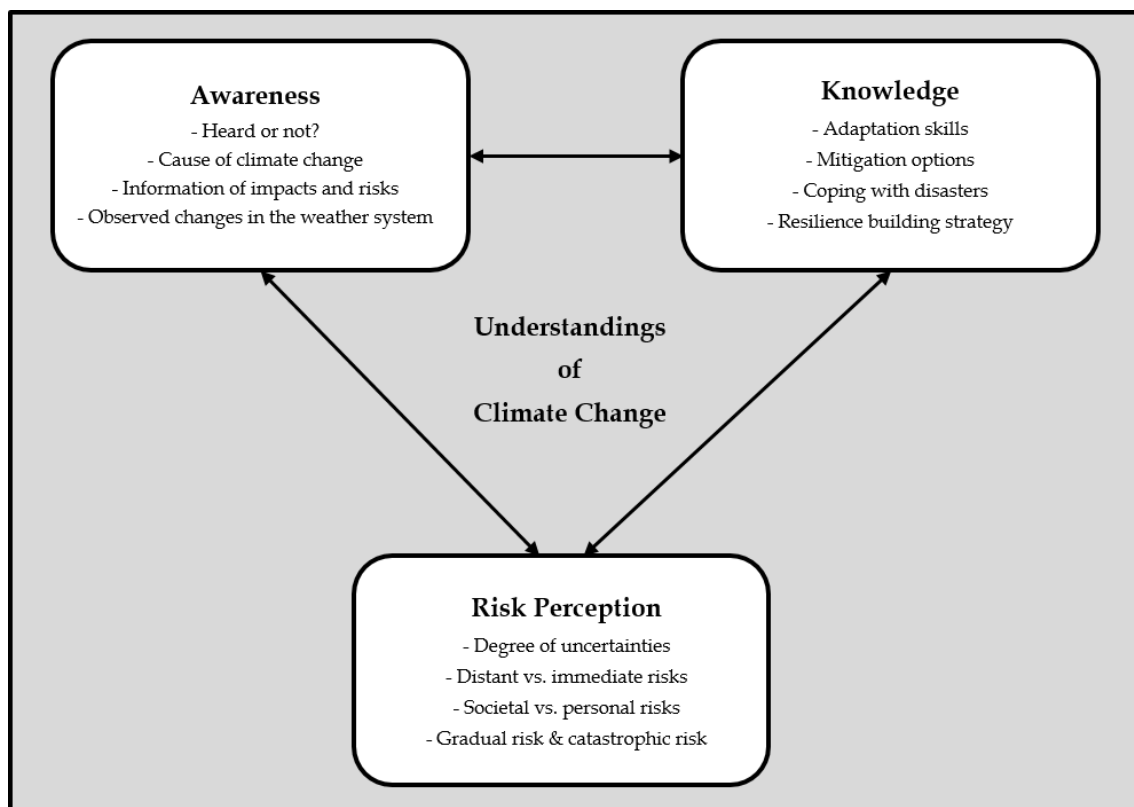
deal with climate change (Zakaria, 2015). Perceiving climate change as a risk by the individuals of society results in climate actions such as mitigation, adaptation, and resilience building (Bulkeley & Tuts, 2013; Filho, 2009). Public perceptions of climate change as a 'distant risk' could affect the government support for climate change actions (Hopkins et al., 2015), and perceiving climate change as a 'social risk' creates dilemma to individuals' climate action (Milinski et al., 2008; Santos et al., 2012). People usually participate in climate action when they perceive climate change as immediate (local), personal (individual) risks (Spence et al., 2012; van der Linden et al., 2015a). Perceiving anthropogenic climate change as 'gradual risk' (considering climate change is controllable) or 'catastrophic risk' (considering climate change is beyond human control) have implications on climate action (Wibeck, 2014). The people of a society who perceive climate change as gradual or catastrophic risks usually focus on the need of adaptation but show unwillingness towards mitigation.

Public perception regarding science is generally positive (Bauer, 2009) but the uncertainty of scientific findings may be the reason for disbelieving in science, particularly in the developed world (Fischhoff & Davis, 2014). For instance, all the scholars worldwide admit the rapid changes in the weather system, but the debate is - whether the changes are human-induced or not. About 97% of the scholars' consensus is humans are responsible for climate change but there a big gap exists between reality (scientific consensus) and public perception regarding anthropogenic climate change (Cook et al., 2013). Believes of a society in the scientific findings of anthropogenic climate change is necessary to mitigate it and taking adaptive measures to build social resilience (Lee et al., 2015). There is a striking contrast witnessed regarding public risk perception of climate change between developed and developing countries. People from developed countries possess more knowledge about the risks of climate change than their counterparts from developing country, but they perceive less risk of climate change than the people of developing countries (Lee et al., 2015). The risk perception is less in the developed world as they have higher capacity in terms of financial power, robust infrastructure and access to technology for facing extreme climate change events (Chinowsky et al., 2011).

Adaptive capacity is one of the key determinants of risk perceptions of climate change (Safi et al., 2012). If a group of people can easily avoid certain vulnerabilities of climate

change, then their risk perception would be lower than those who cannot avoid. The groups who can withstand vulnerabilities have the higher adaptive capacity. In the aspect of the tourism industry, Scott and Jones (2006) indicate that adaptive capacity might vary among stakeholders. They explain that tourists have the very high adaptive capacity, tourism business has the medium type of adaptive capacity and the community people have the low adaptive capacity. By combining the propositions of Lee et al. (2015) and Scott and Jones (2006) it can be stated that if the adaptive capacity of a stakeholder group is high, their perception of risks is low and vice versa. Perceiving climate change as a low risk undermine the sustainability of tourism and climate action (Miller et al., 2010). Based on the literature, specifically Cohen et al. (2014), Hopkins (2013b), Masud et al. (2015), and Wolf and Moser (2011) this research has conceptualised that awareness, knowledge, and risk perceptions are the components of the social understandings of climate change (**Figure 5.1**). [Section 2.2 has examined the Figure 5.1 in detail].

Figure 5.1: Components of social understandings of climate change



Climate change understanding (awareness, knowledge, and risk perceptions) develops from different information sources and daily life experience regarding changing

weather system (Filho, 2009; Hopkins, 2013a). Communication of the scientific understandings of climate change to the public creates social understandings which empower people to take appropriate climate action in terms of mitigation, adaptation, and resilience building (Dal et al., 2015; Goodall, 2008). Social understandings of climate change, therefore, are the reflections of and developed from scientific understandings of climate change (Hopkins, 2013b). Conveying scientific research findings of climate change into public understanding is the initial step to climate action (Bauer, 2009). But the transformation of scientific understandings (e.g. research findings of physical science about climate change) into social understandings is a critical and complex procedure (LaFollette, 1998; Schneider, 2016). It is assumed that climate action largely depends on how the scientific understandings are communicated to the society, as understandings of climate change motivate the stakeholders of society towards climate action (Lyttle, 2014). The gap between social understanding and scientific understanding defines the further communication requirements of a society.

Despite having similar information from different communication sources, climate change understanding varies from person to person based on demographic background (e.g. income, level of education), cognitive engagement and motivation level (Hopkins, 2013a; Kabir et al., 2016a; Lee et al., 2015; Mycoo, 2015; Stern, 2011; Whitmarsh et al., 2012). Understanding of communicated messages of climate change depends on several socio-economic factors including regional poverty, governance systems, political situation, and access to technology (Mycoo, 2015). Climate change understanding may develop by observing external signals (Abbott & Wilson, 2015; Berkhout et al., 2006), for instance – personal experience of the physical impacts and vulnerabilities (Filho, 2009). Climate change awareness develops when observed impacts match with the communicated message of climate change (Hopkins, 2013a). A big reason for not believing climate change by most of the developed world is not observing changes in the weather system in their day-to-day life. Media like Internet, TV, newspapers play important role in communicating climate change information which helps to develop climate understandings (Retzbach & Maier, 2015). Due to 'learning pathways', the social understandings of climate change may vary from scientific understandings (Niebert & Gropengiesser, 2013).

5.3 Research approach

The qualitative materials presented here address the understandings of climate change and the sources of constructing climate change understanding in the context of the coastal Sundarbans in Bangladesh. The chapter examines the understandings of climate change of two broad stakeholder groups: the users of the Sundarbans including community residents, tourism business operators and tourists; and the personnel of management agencies who are working for communication, and adaptation of climate change for the user groups. Since, there is a reflection of management stakeholders' understandings of climate change over the user groups' understandings (Boyer, 2013; Weber & Stern, 2011), this study examines understandings of climate change held by users' groups and reflective discourses from the management stakeholders.

The empirical materials were collected via 35 face-to-face semi-structured interviews conducted from a range of stakeholders of the Bangladesh Sundarbans during May to August 2016. The interviews sought to address participant awareness and knowledge about climate change, later engaged with participants in an in-depth discussion of related risk perceptions and finally identify the sources of information regarding climate change (**Table 5.1**). To examine the knowledge about scientific predictions of climate change, all the participants were asked unprompted questions whether they know about future climate change risks. In the later part of the interviews, two study context related prompts were utilised to examine participants' understandings: one-metre sea level rise by the end of the 21st century (Church & White, 2006) and melting the all Himalayan glaciers by 2035 (IPCC, 2007).

Table 5.1: The semi-structured interview schedule

Part one:	Awareness and knowledge of climate change
	<ul style="list-style-type: none"> a) Observed changes in the regional weather system/environment b) Personal experience about weather system - between past and present c) Identified effects of climate change on society and business d) The cause of climate change, anthropogenic or not. e) Attitude towards scientific predictions f) Relative actions (or reactions) based on awareness
Part two:	Risk perceptions of climate change
	<ul style="list-style-type: none"> a) Perceived risks b) Reflection of the perceptions
Part three:	Sources of information about climate change
	<ul style="list-style-type: none"> a) Flows of climate change information b) Roles of tourism to inform about climate change, in what ways c) Reliable sources of information d) Availability of information to respond in terms of climate actions

The interviews of this research were conducted in Bangladesh (Dhaka, Khulna, and Satkhira) employing judgmental sampling technique (Malhotra, 2010) in which researcher's judgement is the prime criteria to select participants for the interview programme. To achieve the research objective, the researcher set different criteria (e.g. information availability, relative role and importance to achieve objectives) for different groups of stakeholders for including participants in the interview programme. The programme of in-depth interviews included the participants who were the actual representative of the desired stakeholder groups. The minimum age of the selected participants was 18 years. The semi-structured open-ended interviews were conducted at neutral sites, mostly in Bengali language (only three in English). The average interview length was 57 minutes (range: 41-90 minutes), and all the interviews were digitally recorded with participants' permission. **Table 5.2** presents a brief description of the participants of the research.

Table 5.2: Description of the Participants and Interviews

Participant identity	Gender	Age	Occupation / role	Education ⁶²	Interview Length (minutes)	Interview location
Community ₁	M	40s	Forest dependent	No education	49	Satkhira
Community ₂	M	50s	Forest dependent	Primary level	60	Satkhira
Community ₃	M	40s	Forest dependent	Primary level	54	Satkhira
Community ₄	M	50s	Fisherman	Primary level	61	Satkhira
Community ₅	M	30s	Young leader	Graduate	55	Satkhira
Community ₆	F	20s	Housewife	Primary level	44	Satkhira
Community ₇	F	30s	Volunteer & organiser	High school	50	Satkhira
Community ₈	F	20s	Entrepreneur	High school	51	Satkhira
Community ₉	M	50s	Small business	High school	56	Satkhira
Tour operator ₁	M	30s	Guide and owner	High school	66	Satkhira
Tour operator ₂	M	30s	Guide and owner	Masters	57	Khulna
Tour operator ₃	M	30s	Owner	High school	44	Khulna
Tour operator ₄	M	30s	Guide and employee	Masters	70	Khulna
Tour operator ₅	M	40s	Association leader	Graduate	73	Khulna
Tourist ₁	M	30s	Private job	Masters	51	Khulna
Tourist ₂	M	20s	Government job	Masters	49	Khulna
Tourist ₃	M	20s	University student	Undergraduate	42	Khulna
Tourist ₄	M	50s	Foreign consultant	Masters	65	Mongla
Tourist ₅	F	20s	University student	Undergraduate	46	Khulna
Tourist ₆	F	40s	Housewife	Graduate	44	Khulna
NGO worker ₁	M	60s	Project manager	Masters	90	Satkhira
NGO worker ₂	M	40s	Owner and director	Masters	60	Satkhira
NGO worker ₃	M	30s	Project manager	Masters	71	Satkhira
NGO worker ₄	M	40s	Project manager	Graduate	58	Satkhira
NGO worker ₅	M	30s	Project manager	Graduate	48	Satkhira
NGO worker ₆	M	30s	Field worker	High school	51	Satkhira
NGO worker ₇	M	40s	Project manager	Masters	49	Satkhira
Forest employee ₁	M	50s	Forest ranger	Graduate	57	Satkhira
Forest employee ₂	M	40s	Divisional officer	Masters	63	Khulna
Forest employee ₃	M	40s	Forest manager-tourism	Masters	43	Dhaka
Member of local government	M	60s	Politician	Primary level	84	Satkhira
Local administrative officer	M	30s	Government officer	Masters	41	Satkhira
Executive of NTO	M	40s	Govt. tourism manager	Masters	67	Dhaka
Executive of IUCN	M	30s	Employee of Int. agency	Graduate	87	Dhaka
Executive of UNESCO	M	40s	Employee of Int. agency	Masters	55	Dhaka

By applying thematic analysis (a detailed description of the qualitative analysis process is included in Chapter 4) on coded interview materials, climate change understanding of the stakeholders of the Sundarbans are presented under two broad themes: (A) The meaning of climate change, and (B) The sources of constructing climate change understanding. For the theme ‘A’, the sub-themes are: (1) Living with climate change, (2) Climate change causes and accountabilities, (3) Actions as reflections of understandings, and (4) Adaptive capacity driven risk perception. For the theme ‘B’, the sub-themes are: (1) Learning climate change through education and

⁶² The community residents of the Sundarbans are backward in education; the educated community members usually migrate in cities and towns for better livelihoods. The education level of the tourism business stakeholders vary who come from outside of the community. The domestic tourists of Bangladesh Sundarbans are mostly from students and educated groups.

communication, (2) Tourism as a driver of climate awareness, and (3) Information requirements and trustworthiness. After triangulating – through a matching process among the participants’ responses, by considering the consistencies and differences of participants’ response on themes, the researcher identified the context representative results for interpretation.

5.4 Empirical findings

(A) The meaning of climate change

This study has found that the term ‘climate change’ is better explained by the people who have better academic education. Only three of the participants who are from community never heard about the term ‘climate change’. The popular meaning of ‘climate change’ is ‘global warming’ and ‘temperature rise’ specified mostly by academically educated participants. The minimum definition of climate change given by the participants from the community who heard about it is ‘disaster’, by which they mean storms, cyclones, tidal waves, and floods. A significant portion of the participants from the community, tourism business, and tourist failed to relate the sea level rise, salinity ingress, erratic rainfall, heat waves with climate change; but all of them have personal experience with those events.

(1) *Living with climate change*

All the participants in this study, except the tourists, noticed significant changes in the regional weather system of the Sundarbans. The observed changes were: six seasons turn into two seasons - long summer and short winter; tropical storms are converted into depressions to super cyclones; thunderstorms have increased due to depressions; crop cycle has been changed and many traditional crops cannot grow anymore; the increased hailstorms are destroying crops. Every day the people of the Sundarbans are living with the impacts of climate change.

The temperature has increased severely. We understand it from our past experience. Going under the sun is not comfortable; people are now having (heat) stroke. In our early age, the temperature was not as high as present; rain would come time to time. There were no depressions (when the weather is dominated by unstable conditions – forming an area of low pressure at the surface). Now rain comes through depressions. But earlier the monsoon would come at a certain time, in the *Asharh* and *Shrabon*, the Bengali months. Even, in the middle of *Jyoishtho* [name of a Bengali month], our (cultivable) lands were full of water. Now, you will not find any rain without depression. – *NGO Worker₃ (from the Community)*

The tourists have their own experience of environmental changes in their usual surroundings. A domestic tourist (*Tourist₅*) coming from the capital city – about 240 kilometres away from the Sundarbans – explained that, “The climate is really changing, I feel something different in comparison to the past. Flood, drought, temperature, (and) cyclone have increased than the past”. The observed changes in weather system make people understand about climate change. The community people are suffering from fresh water scarcity due to salinity intrusion in the Sundarbans region. The *Community₅* noted that “after Aila, the only source of fresh water is rainwater. If not so, we have to drink salty water. In my pond, the water is salty but in this few rainy days the water is quite fresh [less salty]. Then salt [becomes salty again].

Community people of the Sundarbans identified the high intensity of cyclones. To indicate the intensity, a local resident (*Community₂*) of the Sundarbans said, “People would not go to the cyclone shelter frequently in the past. But now, according to my observation, people need to go to the cyclone shelter two to five times in a year”. Another sign is an excessive water level rise in the rivers of the coastal Sundarbans, which is identified as ‘sea level rise’ by the participants.

If I stand there (on the embankment) during the high-tide, I will see that water level on the embankment is six feet higher than the countryside [the land area inside the polder] where rice was produced in the past. The land (inside the polder) would go under water if the water of high-tide get chance to enter (in the polder). The Gabura Union, Podmopukur Union [two administrative localities next to the Sundarbans] would go six feet under water; in some places, it might be (reach) seven or eight feet. And now the sea level rise (in here) is more than we get from the statistics [research documents]. We quantify (sea level rise) by millimetres, but in reality, the ratio [degree] of sea level rise is much more higher than that. - *NGO worker₁*

The increased sea surface temperature might increase the volume of water, and more water might add due to other climate change effects like melting water reserve from glaciers and sea ice. By considering these reasons, the water level rise in the Sundarbans area cannot be explained at the point of time. A few participants, mostly management stakeholders, identified the reason behind this extreme water level rise. The tributaries throughout the Sundarbans do not receive sufficient water flow because of interventions at upstream for irrigation schemes, mostly in India. Due to the lack of proper water flow, sediment cannot transfer to the sea and sit on the riverbed, which reduces the depth of the rivers and increases the height of the water in the coastal

Sundarbans. As the hydraulic pressure from the upstream reduces, the water pressure from the sea increases. Due to the regional-international interventions in the river system for irrigation schemes, the saline water from the sea is now travelling much further inland than earlier. The stakeholders addressed the issue of salinity but did not want to define this increased salinity in the water as a reason for worldwide carbon emission.

We think salinity have been increased. Mangrove can tolerate a certain level of salinity. If the level of salinity increases more than the required level, then obviously it is a threat. We are observing that the level of salinity is increasing in the Sundarbans, especially the salinity in the soil has been increased. The salinity transfers water to the soil in the southern region. It is a big threat to the Sundarbans. - *Executive of UNESCO*

Due to different type of climate change impacts, tourism business in the Sundarbans is affected. High-temperature rise reduces the tourism season, makes physical discomfort during tours, increases cooling costs, and decreases tour quality in the Sundarbans. Intense depression, storms become life-threatening for tourists, as tourism in the Sundarbans is river cruise based. By considering the weather forecast, operators sometimes do not dare to continue the voyages. Due to high salinity in river water, tour operators cannot use the river water and need to carry huge freshwater from departing point. Climate change is threatening the tourism potentials of the Sundarbans WHA.

Last time [earlier], the cold season used to stay for long time. October to February or end of February. But now it becomes very short. Last time [previously], tourist used to come until March. But now, end of January it becomes very hot. So, tourists do not come. So, I am very badly affected (because of less number of tours). - *Tour operator₂*

In last seven/eight years, we faced huge number of depressions. It was like that the weather was very bad for three, four, five days. Huge storms and wind flow and we were stuck in the Sundarbans with tourists. We could not get down in the land. We were staying in the Ship. This type of depression we face every year. It becomes a common phenomenon. - *Tour operator₄*

The stakeholders of the Sundarbans noticed so many problems associated with the change of weather system, that means climate change. **Table 5.3** includes the summary of the participants' observed climate change scenario.

Table 5.3: Observed effects of climate change in the Sundarbans

Impacts	Effects on community and their livelihood (mostly reported by community people and NGO workers)	Effects on tourism (mostly reported by the tourism business operators and tour guides)	Effects on flora and fauna (mostly reported by the Forest employees and staffs of government agencies)
Intense cyclones	Temporary or permanent migration	Tour cancellation	Uproot trees and animals die
	Destruction of lives and properties	Depression degrade tour quality	
Sea (river) level rise, tidal waves, and flood	High tidal waves affecting embankments	n/a	Scarcity of fresh drinking water for mammals, animals suffers from diseases and eventually die
	Floods damage crops		
Salinity ingress	Diarrhoea breaks out after the flood		Lack of land for the animals during high-tide
	Scarcity of fresh water for drinking and cultivation	Tourists cannot use the river water anymore - need to carry huge fresh water on the boat during a tour	Changing the vegetation pattern from big size freshwater mangrove to small size marine mangrove
	Increase diseases like kidney dysfunctionality, acidity, diarrhoea, dysentery, skin diseases, hair loss		Reducing the density of the forest and eventually decrease shade for the animals
	Death of domestic animals and birds		Top-dying disease of Sundari trees
	Freshwater trees die in contact with salinity		Extinction of freshwater fish
	No trees and grazing land in the locality		
Temperature rise	Reduce the strength of the embankment made of soil in contact with salinity		
	Increase diseases like asthma, sudden fever, cough, headache, heatstroke	Reduced length of the tourism season	Need research
	Heat waves in some parts	Unbearable hot during the tour - need to arrange cooling system	
	Sudden storms		
Erratic rainfall	Difficulty to do rain-fed agriculture	n/a	Need research
Erosion	Embankment breaks and loss of properties	Planning to shift the tourist spots which are close to the sea	Loss of forest area
Drought	Scarcity of drinking water	n/a	n/a
	Crops loss		

Source: Interview programme

(2) Climate change causes and accountabilities

The participants of this study believe that climate change is real as they see physical impacts and feel the changes. All the participants who heard about climate change before participating in the interview think that human activity is the reason for climate change. A woman (*Community₈*) from the locality of the Sundarbans said that, “Humans are responsible for climate change. This is not the fault of trees. This is not the fault of non-living objects”. However, the participants who are from the community hardly blame other developed nations for the changes in the weather system. They think that they themselves are the reason for climate change as they exploit the Sundarbans.

The (developed) countries might have better ways of power supply for their factories. The quantity of fuel-wood we burn, I think, other countries do not burn such huge quantity of wood. Most probably, they have developed technology, perhaps they have gas supply, or they can cook by electric (stove). In one hour..., the stoves that are used in the all [whole] Bangladesh, the heat coming from the fire of the stoves creates hot weather. When the heat spreads, the environment becomes wet [dry]. Again, the heat of the fire mix with the climate [atmosphere] then an unfavourable reaction [situation] is created and many weather events occur. - *Community₉*

Community people come to know that climate change is anthropogenic from different sort of communication. They neither know from the conventional sources nor see on television about the emissions generated by other nations. The existing communication efforts by management agencies (see Chapter 6) only highlight the negative sides of contextual exploitation and related implications on climate change. Thus, most of the community people participated in this study could not relate the observed changes with the original cause of those changes; and they think that climate change is a result of their own exploitation. There is a contrasting view from the participants who know the cause of climate change. With enormous grievance, a visitor who is from the closest city (Khulna) of the Sundarbans articulated:

These (effects of climate change) are not natural. These are the result of human activities. People need to be aware. We as the citizen of third world country emit a very low volume of carbon. But the Western world emits huge carbon. They need to be very conscious. They have to think, they have to understand how difficult our lives are. They live comfortably and build company [factories] and consume huge. But we are suffering. By giving money, it cannot be compensated. They pay us; they give us money through different NGOs. But our loss is not manageable. - *Tourist₁*

The academically educated people from the stakeholders of the Bangladesh Sundarbans know that climate change is anthropogenic. They are concerned about the vulnerabilities and they expect immediate actions from high carbon emitting nations beyond monetary compensations. Whereas uneducated people think that the reason for changes in the weather system is natural, there is no human control over the impacts.

(3) Actions as reflections of understandings

This research tried to extract the climate change understanding from actions, as climate action is the consequence of awareness. In order to protect houses from climate events, the community residents of the Sundarbans plant trees in the backyard and front yard. Their primary motivation of tree plantation is not mitigation but adaptation. A forest-dependent (*Community*₂) explained, “Those (trees) provide us fruits. The most important reason (for having trees in the yard) is to protect (the house) from storms and tidal waves”. They also plant trees beside the river banks to increase the strength of embankments.

From management communication efforts, mostly by NGOs, community people come to know that the forest can reduce the wind and water force of disasters. As a result of those communications, people perceive that forest protection is good for coping with natural disasters. The *Community*₉ explained that, “In the last five years, we would become very aware of protecting the Sundarbans. We feel that if the Sundarbans survive, we will survive. For this reason, we have taken care of the Sundarbans. If we would become aware of this twenty years back, then we would not face the problem [severe cyclones]”. Again, their intention of forest conservation is not to contribute to worldwide mitigation but to adapt to local climate events – as the forest can buffer the wind force and tidal waves.

Community residents come to know some techniques from the management agencies as to how to survive during disaster and post-disaster period. The *Community*₅ said that “the NGOs invited the women in meeting and said that you should do this and that. When you see a dark cloud, keep some foods. All-time keep necessary clothing, *Chira* [local dry food made by rice], *Muri* [puffed rice] in the polybags. Keep alert all the time so that you can grab them and go to the cyclone centre”. Management

agencies often take actions including creating awareness so that people do not abuse the mangroves. An *NGO Worker*₂ who has been working on climate change in the Sundarbans for more than 15 years stated that “the people of the area collect the mangrove fruits [seeds] and burn (as firewood for cooking). We wanted to stop this fruit collection so that those fruits [seeds] can grow (as plants). If trees do not grow properly, the effect of climate (change) will be increased gradually”.

In the Bangladesh Sundarbans, tourism stakeholders’ understandings are yet shallow in terms of environment friendly behaviour which is a requirement in response to climate change. The professional tour operators are more responsive to the environmental value of the Sundarbans than the seasonal tour operators. Tourism operators often dispose of garbage in the rivers of the Sundarbans. The tourism operators mostly received training and instructions from the government regarding environmental conservation of the Sundarbans. The government monitoring system for tourism activities in Bangladesh Sundarbans is not strong enough in terms of vessels’ engine sound control and garbage management. These issues address a lack of comprehensive climate understanding among the management and tourism business stakeholders.

We are changing (our behaviour). But some big sectors are beyond our control. The government can only work on those (pollution control and environmental restoration). Perhaps they can take help from us. We can help the government, but we cannot manage (everything) as tourism companies. A country and an organisation are not same. The organisation is small, but the country is very big (in authority and control). - *Tour operator*₃ (a leader of a tourism operators’ association from *Khulna*)

During tours, some domestic tourists are littering by throwing plastic bottles and packets inside the Sundarbans; sometimes they use louder sound system that is not good for animals. These activities affect the ecological balance which is a reason for enhancing climate change and its vulnerability. Tour operators reported that domestic tourists are less environmentally responsible than international tourists. The potential reason for this may be the environmental education of the people of Bangladesh is relatively lower than the developed world. An American tourist described the reason for being environment-friendly.

We are taught from a very early age that you should not throw things on the ground. You know, you should always look for a wastebasket or trashcan or something like that. And this is drilled into us from the very beginning, you know, the time when we are small children. - *Tourist₄*

No action does not necessarily mean that lack of climate change understanding. Almost all the management stakeholders of this study including the government employees were concerned about the thermal power plants at the edge of the Sundarbans. Due to the socio-political situation of Bangladesh, government staffs cannot tell anything to the political government about the decision of establishing thermal power plant. The tour operators do not do any strong movement against the power plants, as they need approval from the government to operate tours in the Sundarbans. The community people are not concern about the decision of the thermal power plant establishment as they can hardly relate the effects of the power plant on the mangroves and climate change.

(4) Adaptive capacity driven risk perception

Perception of risk depends on the participants' adaptive capacity – if people have high adaptive capacity to a certain threat, they perceive low risk. The community people of the Sundarbans are frightened for the extreme weather events. They consider the climate events that they have experienced early years as 'immediate risk'. A woman (*Community₆*) explained that, "We always get scared. If any big storm [cyclone] occurs, the road [embankment] will be broken and water will enter inside. Where will we go then? This (event) can occur at any time". The high intensity of natural disasters not only destroys their property and crops but also threaten their lives. A forest-dependent man who lives at the periphery of the Sundarbans described the risks associated with a cyclone:

It is difficult to reach in the cyclone (shelter) with the children. It is very much fearful that the signal [early warning] can be declared anytime (during the season of weather events). I am a strong man, but what would be happened to my children. The most problem is to save the children (during the cyclones)". - *Community₂*

The community people of the Sundarbans feel 'life risk' because of the increased intensity of cyclones. The people who have financial ability build a 'second home' far away from the periphery of the Sundarbans. Relatively poor people try to replace old roof made of straw by asbestos or tins and use concrete pillars to strengthen their

house. A woman from the community described a quite different tactic for saving the family from tidal waves and flooding caused by the cyclone.

We have a trawler [engine boat]. By having the trawler, we feel a kind of safety from disaster. Once we were about to drown. Our whole region was gone under water..., at that time we did not have the trawler. In order to save ourselves from this kind problem, we made [purchased] the trawler. At least we could save our family and relatives. – *Community₈*

Due to the poverty, the community people of the Sundarbans consider 'migration' as a defence mechanism in response to the future uncertainties related to climate change. They consider the scientific predictions of climate change as 'distant risk', and they were not proactive rather they showed reactive attitude in terms of future risk management. The community people consider the intense weather events as social (or collective) risk rather than a personal (or individual) risk. A forest-dependent (*Community₁*) who migrated from the Sundarbans after severe cyclone Aila for few years said that, "We are afraid of disasters, but we do not have anything to do. If I could not survive here, I might leave this place again... or I will do what the other five people do. If the natural calamities increase in future, the people of this area could not survive (here)".

The tourism operators of the Sundarbans consider climate change as a threat to the business. Extreme weather events destroy trees and kill animals of the Sundarbans which temporarily abolish tourism business as a result of the destruction of the forest beauty. By considering uncertainties, the *Tour operator₅* concurred that: "There is a risk for this (climate) change. I am really terrified that my business could be stopped. My business will be closed at some points. It will certainly be closed at some points". By indicating to the similar type of concern because of climate change, other tour business operators expressed:

We want to show the big trees - but if the vegetation (trees) turn into thicket, if there are no big trees then the tourism industry (of the Sundarbans) will be finished. People come to visit big trees, tigers, and deer - if we cannot show those. Why do they (tourists) come? - *Tour Operator₁*

The tourism business in Bangladesh Sundarbans is dark [hopeless]. I just see very darkness in (tourism of) the Sundarbans. I saw the scenario of seven/eight years back and I know the present scenario. When I compare both scenarios I just feel frustrated. In near future, the tourism business in the Sundarbans is [will be] very bad. - *Tour operator₄*

The tourists who do not live far away from the Sundarbans feel the contextual risks of climate change. A visitor (*Tourist₅*) from the capital Dhaka stated, "I do not think people are serious about climate change. Even a common people are fearful of cancer or Aids. But I do not think everybody understands about climate change or thinks of it". Tourists coming from the places very near to the Sundarbans have more association with the contextual climate change risks as the effects of climate events often reach to the near cities. The tourists who live in Khulna, the nearest city of the Sundarbans believed that: 'if the Sundarbans is saved, the Khulna is saved'. A young male tourist from Khulna City explained:

I do not want the Sundarbans to be destroyed. I have heard if that Rampal Power Plant would start, our forest will be spoiled. So, I think it should certainly be stopped for the sake of the forest and for the country. We are saved from the cyclones because of the Sundarbans. We are saved from tidal waves. So, if the Sundarbans has been destroyed, we will not survive. The Sundarbans is a (natural) barrier like a wall of a fort. It works as a barrier to protect us from all type of disasters coming from the sea. It saves us. We do not want the forest to be destroyed - for the sake of the country, environment, and human. Certainly, the Rampal power plant should be stopped. - *Tourist₁*

Previous experience of climate change events develops the risks perceptions. Perception of risk is higher for the stakeholders who have direct interest in the Sundarbans. The stakeholders who perceive the climate events as risk try to enhance adaptive capacity according to their own ability. The stakeholders who do not have the ability, because of poverty, do not do anything despite having a high perception of climate change risk.

(B) The sources of constructing climate change understanding

(1) Learning climate change through education and communication

The community people of the Sundarbans mostly come to know about climate change from NGO-operated awareness campaign, e.g. training and workshop after the severe cyclone Aila in 2009. The staff of NGOs also receive training to teach climate change to the local community. The *NGO worker₁* explained that, “We provide training to our staff so that they can make understand the people about the environment, climate (change) ... If I do not know myself..., how could I conduct training among our beneficiaries at village level?” The government of Bangladesh also run programme to train up the NGO workers. The NGOs run a range of awareness campaign including workshops, training, public meeting and discussion, and exhibiting promotional materials to inform about climate change.

The participants who were academically educated, at first, they come to know about climate change from the textbooks. The textbooks of the regular education system in Bangladesh contains essays on global warming, greenhouse gas, which is a source of climate education in primary and high school level. A *Tourist₃* said that “I come to know (about climate change) in the school at first. But we just read (the topics) which were potential [important] for the exam and memorize those. I read about it [climate change] but I did not feel it properly. First I feel it (a problem) from the newspaper”.

At first, we come to know about climate change in the school. We studied climate change, wrote essay (on climate change), particularly on environmental pollution. Because of climate change, sea level is rising, the storms and cyclones (are occurring). Day by day, we even can notice ourselves that temperature is rising. This is all because of climate change. We come to know when we studied by article and passage reading. - *Tourist₁*

Due to the professional and personal interest, a few participants reported that they study about climate change from different sources like journal articles, newspaper articles, websites, and policy documents. The *Community₉* said that “there are many websites on climate change. Those websites contain that it is not a misguided or wrong concept. Many educated people are involved there. We are villagers and our knowledge is very low, but they [scientists] are working on climate change”. Media plays a significant role to create public understandings – for example, communicating

how the thermal power plant at the edge of the Sundarbans can be an emerging threat to the biodiversity and accelerator of climate change.

I watch on television that people are doing movement (against the Rampal power plants), they are not lying. Sheikh Hasina [the Prime Minister of Bangladesh] says it would not be harmful, but she never says anything that their [activists'] claim is totally false. I understand that government usually say like this (to justify their decisions). There may be some benefits (of the power plants) but Bangladesh has a high risk of climate change. Perhaps there may be some benefits, but the risks will be increased. - *Tourist₆*

A large group of civilians from different parts of Bangladesh was involved in the movement against the decision of Rampal power plants, that was communicated by different media (mostly television, newspaper, social media like Facebook) in Bangladesh. The activists of the movement attach the value of the Sundarbans in relation to climate change, which created awareness among the general people of Bangladesh who follow the media.

(2) Tourism as a driver of climate awareness

Tourism stakeholders (e.g. tourists, community, operators) informal interaction is a source of climate change awareness in the Sundarbans. As the Sundarbans is a climate vulnerable area, the tourists often want to know about the effects of intense cyclones on the local people or tourism business operators. This sort of conversation creates knowledge sharing scope – community people or tourism business operators share their contextual experience of climate change, and tourists also share their knowledge about climate science. A few registered tour operators do brief about environmental aspects while beginning a tour. The *Tour operator₂* explained, “When we start the journey (tour), at first, we brief our guests (tourists) about the Sundarbans, about (not to involve in doing) pollution, what should they do and what should not they do (to protect the biodiversity)”. Community-tourists interaction also create climate awareness among these stakeholders.

When visitors come to our locality, we (like to) spend time with them ... Often, they ask about the destruction of Sidr and Aila. We speak about the damages occurred and show them the area of land erosions, forest (area) destruction and how miserable life we are leading because of these disasters [cyclones]. ... Some visitors tell us that all these happened due to global warming [climate change]”. - *Community₅*

In the locality of the coastal Sundarbans, management agencies are utilising tourism as a means of conservation and climate change awareness. An *NGO Worker₁* addressed, “We give a message to the common people that we can use the forest without hampering [destroying] it, (if) people [tourists] come to visit it”. The context-specific climate change awareness campaigns highlight the necessity of conservation through tourism by avoiding forest depletion. The focus of the communication is to utilise the forest resources without degrading the biodiversity for enhancing the resilience of the mangroves to tackle the extreme climate events like cyclones and tidal waves. Rather than forest resource collection, the management now is encouraging people to do eco-friendly CBT that creating an understanding of conserving the rich carbon bank in the Sundarbans. One NGO worker described the perception of forest dependents who have involved in tourism.

“Now they consider that a tree can be shown thousand times and earn money for their family. ... They do not cut trees and encourage other people - not cutting down trees (illegally)”. - *NGO worker₂*

From the different type of awareness campaign, the community people come to know about eco-tourism and understand the necessity of being eco-friendly for their survival from climate events. The management agencies have built few recreation spots in different parts of the locality of the Sundarbans to make understand the community people about the aesthetic value of the mangroves. The recreation spots have billboards containing information about the value of the forest as tourism resource and the importance of mangroves to combat climate change.

In this region, there is no place like parks for recreation. For this reason, we made Resilience Park in three places of this two Union (Gabura and Ramjan Nagor). In those parks, there are umbrellas for shade and benches for sitting, we built wooden-bridge. We printed some messages on the umbrella regarding disaster and climate (change). So that, visitors can build up their awareness about climate and disaster. -*NGO worker₄*

(3) Information requirements and trustworthiness

Every participant of this study claimed that he or she has not sufficient information for responding to climate change. Everyone thought that they need more information in terms of adaptation and mitigation. The tourism business owner (*Tour operator₁*) from the local community said that, “If the government officials who work on tourism guide us, we can understand what else we would need to do to cope with climate change.

From our position, we think what we are doing is right. But we believe there may be some good practices". This research also found that the knowledge and information requirement regarding climate change is not same for every group of stakeholders of the Sundarbans. For instance, the vulnerable poor community people who are disadvantaged in terms of literacy need not know the complex scientific procedure of climate change; they need information that is useful to them.

How much climate education is required for a policymaker and how much is required for a villager? Strategical thinking is required here. All the stakeholders who are living beside and working for the Sundarbans should have climate awareness, but it should be at varied levels. The decision makers who are making decisions whether a power plant would be in the periphery of the Sundarbans to make it as an industrial zone or the Sundarbans will be there as a coastal green belt. Those decision makers should keep in mind what would happen at the end of 21st century (for the projected one-metre sea level rise). - *Executive of IUCN*

Most of the participants including management stakeholders are not aware of scientific predictions of climate change, but all of them have a strong trust in science. All sources are reliable to the participants when those provide information regarding climate change. One participant (*Tourist₂*) described the reason, "the (climate change) information is reliable because I do not see any scope to make a business from this type of information. There is no chance to earn money by providing unreliable [false] information". Overall, the participants reported local newspaper as the most accessible and reliable information source for climate change.

5.5 Discussion

5.5.1 Understanding climate change

This research has identified that the degree of climate change understanding of people depends on their socio-demographic characteristics (Whitmarsh et al., 2012). Academic education is the most important factor for climate change understanding. Kabir et al. (2016a) address the importance of academic education for climate change understanding in the context of Bangladesh and Lee et al. (2015) address the same way in the worldwide context. Participants from management stakeholders defined climate change properly, because of their demographic background, particularly higher academic education. The management participants also learn about climate change for communicating climate change among vulnerable people. The community people described the climate change poorly despite being vulnerable. All the participants from

Bangladesh Sundarbans believe in climate change because they are experiencing the environmental changes in their day-to-day life, whereas lack of personal experience is the reason for climate change denial in the West (Higham et al., 2016a). For describing climate change, people usually like to explain their personal experience regarding the changes in the weather system they observe in their daily life. Observed physical impacts like temperature rise, salinity ingress or intense cyclones work as external signals which assist people to learn about climate change (Abbott & Wilson, 2015; Berkhout et al., 2006), as they can easily relate the communicated information regarding climate change with the observed physical changes (Lee et al., 2015).

Observed change in the weather system is important source of climate change understandings but if the cause of the changes is not communicated then people think that the changes are natural. The three community participants of the study who never heard about climate change did not accuse humans for the observed changes in the weather pattern. Therefore, observed change (e.g. personal experience) is helpful but cannot solely create climate change understandings. Communication is a must for creating anthropogenic climate change understanding. The strength of communication programme determines the rigour of the learnings about climate change (Niebert & Gropengiesser, 2013). From different climate change awareness campaigns, the community people come to know that humans are responsible for climate change, but they hardly blame other countries for the vulnerabilities they have. This is happened because of the emissions caused by other develop and rapidly developing countries is quite invisible to them.

The existing climate communication efforts highlight the importance of the forest for combating climate change. Since they have exploited the forest, they think that their exploitation is the main reason for climate change which to some extent motivates them to conserve the forest. Niebert and Gropengiesser (2013) address that the climate change understanding of a society may not match with the communicated messages because of 'learning pathways' to target audiences. The difference between the scientific information and the actual social understandings is the cause of misconceptions about climate change. It also needs to think that what are the implications for the local community of the Sundarbans by blaming carbon emitting countries for their vulnerabilities, movement for compensation? If so, how that

movement reach to the global community? In contrast, the (academically) educated participants (mostly, management stakeholders and tourists), predominantly from outside of the community easily identified worldwide carbon emissions as the cause of climate change.

Since understandings may lead to action (Lee et al., 2015), it can be articulated that climate action is a consequence of climate change understanding. The management agencies of the Sundarbans are working on conserving the mangrove forest from community lead depletion, and the community people generally understand the value of the mangroves for their survival from climate events. The primary understandings of forest conservation are not to contribute to the global mitigation but to save the community of the Sundarbans from extreme climate events and ensuring availability of forest-based livelihoods. The knowledge of community people of the Sundarbans for adaptation, mitigation, and resilience building is insufficient, and the people cannot take appropriate climate actions unless management agencies assist them. Educating for adaptation is the main priority in the coastal Sundarbans because of having high vulnerabilities. Most of the climate actions, even supported by management agencies, are reactive – that means the priority is on adaptation not on long-term resilience building. This study also addresses a group of stakeholders from the community, tour operators and tourists do not exhibit environmentally responsible behaviour. It might happen as they did not receive sound environmental education from their early age; or severe poverty, improper governance (e.g. pollution control), lack of democracy (e.g. ignoring the public opinion to establish the Rampal power plant) might be lead to improper action despite having proper climate understandings (Mycoo, 2015).

Risk perceptions depend on the level of vulnerability people encounter, not on the level of knowledge (van der Linden et al., 2015a). For example, management stakeholders' knowledge is very high, but their contextual perception of risk is low. Again, the perception of risk is associated with adaptive capacity (Safi et al., 2012) - the stakeholders who have high adaptive capacity perceive relatively low risk of climate change. By using a continuum of climate change response, Scott and Jones (2006) argue that tourists have the higher adaptive capacity, community people have the lowest adaptive capacity, and the other stakeholders like tour operators have the moderate type of adaptive capacity. This research finds similar results as Scott and Jones (2006)

find in the context of the developed world. Here, tourists have the high adaptive capacity as they can cancel trips if they heard about natural calamities, tour operators can think of diversifying to other business in the medium to long-term, but community people have the low adaptive capacity as they need to combat the vulnerabilities (Scott & Jones, 2006). The stakeholders (e.g. tourists) who can easily escape the contextual vulnerability feel the very low risk of climate change and the stakeholders (e.g. community people) who cannot ignore contextual vulnerability feel the very high risk of climate change. To reduce the perceived risk, the community people of the Sundarbans try to increase their adaptive capacity in the ways they afford. Like the research conducted by Hopkins (2015b), Milinski et al. (2008), Santos et al. (2012) on other parts of the world, this study has found that risk perceptions have a strong influence on climate action.

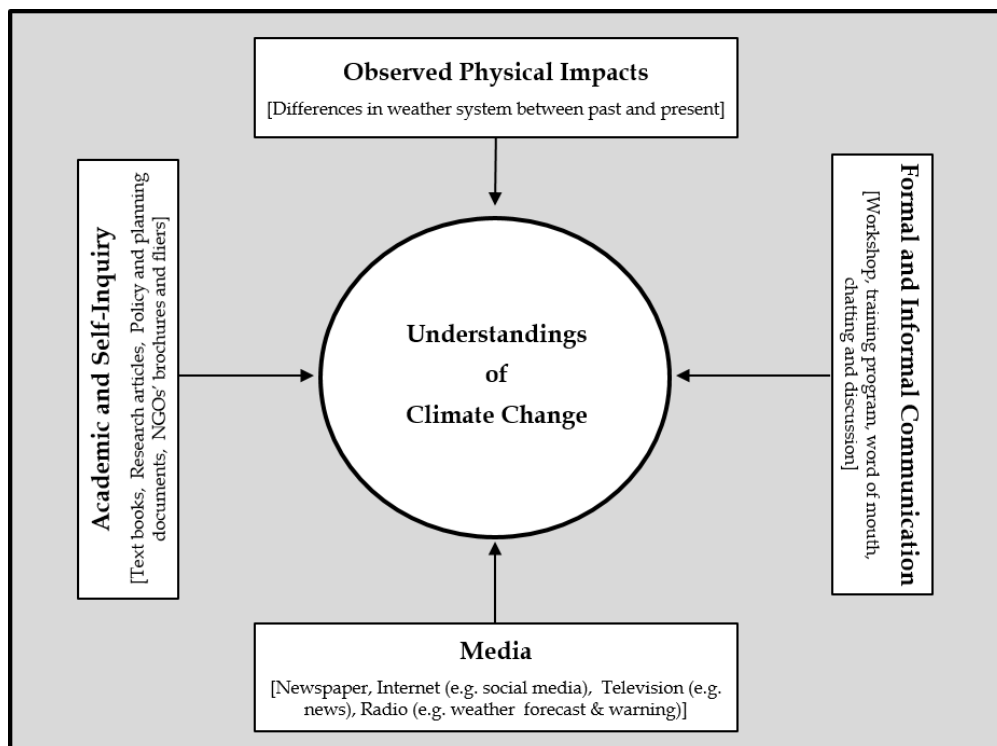
5.5.2 Learning about climate change

The clear result of this research is the observed physical impacts – not only through their eyes but also through their bodies and through their minds – develop the climate change understanding of community residents of Sundarbans. However, many people in this world come to know about climate change from media and other information sources (Retzbach & Maier, 2015). The participants of the research have first-hand experience of climate change, most particularly the community residents of the Sundarbans are living with climate change impacts in their day-to-day life in terms of physical vulnerability and potential life threat. These observed physical impacts contribute hugely to their understandings of climate change (Filho, 2009; Hopkins, 2013a). Since the stakeholders are observing the changes in the weather system and they are vulnerable to several impacts, there is no denial of climate change in the study context.

The climate change understanding of the stakeholders of the Sundarbans starts from observed physical impacts with the connection of available information sources – formal and informal communication, media, and academic texts and self-inquiry (**Figure 5.2**). Of course, the sources of gaining climate change information vary among stakeholders according to their demographic profile (Whitmarsh et al., 2012). The participants from the community have personal experience of contextual climate change, that means they have noticed changes in the weather system. The main

communication source of climate change information for the community residents is awareness campaign in the Sundarbans area. The learnings from the campaigns spread over the society because of informal social interaction – people share with other people of the community what they come to know about climate change. Informal interaction between community residents and outsiders such as tourists also develop climate change understandings.

Figure 5.2: Sources of constructing climate change understanding



Formal communication to a target group and their informal interaction in the social environment produce effective outcomes in terms of climate change understanding. The stakeholders from management agencies who work to manage climate change in terms of vulnerability reduction and communication receive formal training and workshop for upgrading their knowledge. The tourism demand-supply side stakeholders' understandings of climate change developed by the different climate science communication efforts in education system, media, scientific papers (Hopkins, 2013a). Media plays a significant role to gain climate change understanding (Retzbach & Maier, 2015) if the information relates to the context of the readers' interest. Climate change knowledge may come from academic learning throughout years or self-inquiry for personal interest or occupation. Climate change understanding develops and

improves gradually with more information access along with observed changes in the weather system (Filho, 2009; Hopkins, 2013a).

The understandings of climate change of the user-groups of the Sundarbans (community, tourists, and tourism business stakeholders) come from the impacts experienced by them. It is easy to understand about climate change when the participants find similarities between the communicated message of climate change and observed impacts. Information from at least one of the three communication sources – formal and informal communication, media, and academic texts and self-inquiry about science – and personal experience (observed changes) are required for strong climate change understanding (see Figure 5.2). Having only personal experience of changes in the weather system cannot teach people about anthropogenic climate change without communication (Filho, 2009). Communication is also required for learning about the techniques of adaptation, mitigation and resilience building (Lyttle, 2014). This study also addresses that tourism can be a source of climate change understanding (Higham et al., 2014) and climate action.

5.6 Conclusion

This chapter explores the understandings of a range of stakeholders in the Sundarbans in Bangladesh regarding climate change as well as the sources of constructing those understandings. This research finds multiple understandings of climate change of the stakeholders of the vulnerable coastal developing society in the Sundarbans in Bangladesh. It also finds that climate understanding can be different from stakeholder to stakeholder because of different degree of access to information. Demographic characteristics and social background play an important role to transform climate information into understanding. The current understandings of climate change held by the stakeholders of the Sundarbans emphasis adaptation to reduce vulnerabilities; future risks of climate change what scientists are predicting are widely unknown to them. A very few of them who heard about the future scientific predictions of climate change risks, do not have any specific arrangement to deal with those risks, as the community people of the Sundarbans even do not have the capacity to mitigate the current vulnerabilities.

This research expands the theoretical framing of climate change understanding developed by scholars such as Hopkins (2013b), Masud et al. (2015), and Wolf and Moser (2011), where they indicate that awareness, knowledge, and risk perceptions are the components of climate change understanding. Based on the available literature, in Figure 5.1, this research draws attention to the three components and points out the attributes of the three components which collectively develop climate change understanding and argues that social understandings of climate change can be framed with these attributes of the three components. Of course, all the attributes may not always be applicable to examine the understandings of climate change in every society. Pointing to the Figure 5.1, a person may not hear about anthropogenic climate change, for example, but he or she may perceive the observed changes in the weather system as risks.

The research of this chapter finds no climate change denial among the stakeholders of Bangladesh Sundarbans. The potential reasons are: they observe physical changes in the weather system, they are highly vulnerable at the current state, their trust in science is strong (as they think that there is no reason to provide false information), and they do not have any fear to lose anything for believing anthropogenic climate change. It also finds that the prime implication of climate change understanding in the Sundarbans (Bangladesh) is adaptation, whereas the most focus of climate change understanding in the developed world is mitigation. The four sources of constructing climate change understanding (presented in Figure 5.2) is found to be similar by Hopkins (2013a) and a few other researchers in the developed world context. The key difference is: the stakeholders of the Sundarbans have huge personal experience of environmental change, but they have limited access to information about climate change compared to the people of many developed nations.

Several main points emerge from the research presented in this chapter. Firstly, the understandings of climate change are different among key stakeholders. But the understandings of climate change are quite similar among homogenous stakeholder groups. For example, community people of the Sundarbans have shared understandings of climate change – almost all the community participants have confusion about the cause of climate change. Secondly, climate action is limited among the user group stakeholders (particularly, community residents, tourism operators)

despite experiencing high vulnerability. For example, tour operators are concerned about climate change impacts but some of them are not exhibiting the desired behaviour for climate action. Thirdly, management stakeholders want to utilise tourism to save the Sundarbans mangroves by communicating the value of the mangroves for lives and livelihoods at the face of climate change. Finally, tourists of the Sundarbans are much aware of climate change. The tourists who are living in the cities nearby the Sundarbans can understand the value of the mangroves against climate change.

This research suggests considering socio-demographic characteristics of target stakeholders and attaching observed impacts with potential future consequences of climate change while developing a communication programme for creating climate change understanding. Communicating personal, social, and immediate benefits, rather than global benefits, might motivate to climate action in the context of the developing society. For example, local communication should encourage forest conservation and tree plantation for being saved from tidal surges and wind force, not for contributing to global carbon mitigation. Since information requirements of climate change vary between stakeholders' groups, the communication should be different for different segments of stakeholders (e.g. policymakers, vulnerable people, tourists, tourism managers) for creating relevant and better understandings of climate change. The government and other management stakeholders, for example, need to be communicated the future climate change risks like one-metre sea level rise at the end of the century, as the community people have limited capacity to manage the future risks. Adequate climate change understanding is a critically urgent criterion for responding to climate change, which is particularly important for the resilience of vulnerable coastal societies in the developing world.

Chapter 6

Climate Change Management Actions

6.1 Introduction

Anthropogenic climate change is altering patterns of living and livelihoods (IPCC, 2014). Achieving sustainability becomes more challenging at the face of climate change, so 'climate action' becomes one of the focus of SDGs of United Nations (UNDP, 2015). Climate action is required everywhere from the global to local scale. To manage local scale climate change impacts, context-specific research is a key requirement as a one-size-fits-all strategy does not work for vulnerabilities and risks management in terms of adaptation and resilience building (Bulkeley & Tuts, 2013). Conflict of interests among economic, ecological, and social functions further complicates climate actions (Milada et al., 2010). To ensure sustainability, therefore, effective and efficient adaptation interventions need to be utilised by addressing climate vulnerabilities and risks (Adger et al., 2005a). If adaptation interventions can manage the vulnerabilities and risks of climate change, those can develop resilience in a social or ecological system, eventually, can contribute to achieving sustainability. The existing literature informs us very little about sustainability in adaptation interventions. Assessment of the climate adaptation functions in a specific context can begin to address the current knowledge gap and assist to achieve SDGs by 2030.

The research presented in this chapter is conducted in the context of the climate vulnerable Sundarbans WHA in Bangladesh^{63,64,65}. The common approach to manage climate vulnerabilities in Bangladesh is to address hazards, which often are not sustainable solution (Brouwer et al., 2007). For example, the Government of Bangladesh built embankments to protect the agricultural land from saline water entrance in the Sundarbans area. These embankments disrupt the sedimentation dynamic of building the delta as the river beds are filled up with silt that should be contributed to building the islands (Roy et al., 2016). During high tide, at present, the river water reaches about six feet to eight feet high from the level of the land where people live. Thus, the embankments become a life-threat for the community residents of the Sundarbans. Intense climate events such as cyclones push saline water in the

⁶³ A version of this chapter is being prepared for submission to publication: Hassan, M. K., Higham, J., Wooliscroft, B., & Hopkins, D. Resilience building for sustainable adaptation to climate change, *Climate and Development*

⁶⁴ A part of this chapter has been published in conference proceedings: Hassan, M. K., Higham, J., Wooliscroft, B., & Hopkins, D. (2017) Managing tourism at the coalface of anthropogenic climate change, *CAUTHE 2017*, 7-10 February, Dunedin, New Zealand

⁶⁵ A theme of this chapter has been published in conference proceedings: M. K. Hassan (2018) Managing climate change: Vulnerability reduction or resilience building, *ICCCGW 2018*, 1st-2nd February, Melbourne, Australia

area surrounded by the embankments. The salinity of the water gradually transfers into the soil, which destroys the local vegetation, and the community of the Sundarbans cannot grow their staple crop rice and vegetables in their field. The people of the Sundarbans area suffer from the scarcity of freshwater for drinking, cooking, bathing, and for irrigation. Due to the freshwater crisis, these people are in hardship to maintain the regional food security. To cope with the salinity intrusion in the Sundarbans area, shrimp farming was introduced; however, those farming are creating conflicts with ecological priorities such as natural resource maintenance, pollution control (Martin et al., 2015).

Realising the contextual vulnerabilities of climate change, a range of management agencies including government, NGOs, and international agencies steps ahead to help this vulnerable community to cope with the environmental changes. In order to examine the contextual climate change management in terms of socioeconomic vulnerability reduction, this research highlights four distinct and contemporary research areas identified by Thomalla et al. (2006). Those are: environmental management, disaster risk mitigation, climate change adaptation, and poverty alleviation. Focusing on the research question 2 (what are the management functions that support community adaptation in the Sundarbans in Bangladesh?), the objective of the chapter is to critically examine how the conservation and management agencies of the Sundarbans are responding to climate change in terms of adaptation and resilience building. To critique the climate change management functions, this research identified the contextual climate actions and then proposed a framework to evaluate the sustainability of adaptation functions based on resilience. Resilience is very important for a country like Bangladesh which is highly vulnerable to climate change. This chapter also presents the relative role of tourism in the WHA of the developing country in response to climate change.

6.2 Sustainable climate change adaptation

This research draws upon the conceptual framework of 'sustainable adaptation' to climate change (O'Brien & Leichenko, 2007). The purpose of being sustainable is to ensure persistent and equitable well-being in the long run as well as effective and efficient utilisation of available resources (Adger, 2003a). Sustainable adaptation must address the vulnerabilities of a system without disregarding the economic, social and

environmental aspects when dealing with climate change (Eakin et al., 2014; Eriksen & Brown, 2011). Sustainable adaptation interventions are relatively robust to uncertainties and risks of climate change (Adger et al., 2005a), and feature less carbon-emitting solutions (Wilkinson et al., 2014). The degree of sustainability of an adaptation measure depends on how properly it minimises the vulnerabilities of climate change in terms of present impacts and future risks (Eakin et al., 2014). According to the IPCC: “adaptation is 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” and “vulnerability is a function of the character, magnitude and rate of climate change and the variation to which a system is exposed, its sensitivity and its adaptive capacity” (IPCC, 2007, p. 27). For being sustainable, the adaptation interventions will reduce the vulnerabilities, risks, poverty, and offer long-lasting benefits (Adger, 2003a). Since sustainable adaptation addresses climate change vulnerability with development goals, it promotes more equitable social, economic and environmental practices (O'Brien & Leichenko, 2007).

The necessity of introducing ‘sustainable adaptation’, as a term and a concept, is to overcome the limitations of ‘sustainable development’, particularly for the context of climate vulnerable poor countries (Brown, 2011). “Combining aspects of both sustainability and adaptation, the notion of sustainable adaptation entails measures that reduce vulnerability and promote long-term resilience in a changing climate” (O'Brien & Leichenko, 2007, p. 31). Sustainable adaptation is an advanced form of sustainable development when climate vulnerabilities and poverty need to be addressed in development programmes (Eriksen & Brown, 2011; Eriksen & O'Brien, 2007). Vulnerability-poverty linkage needs to be understood to ensure sustainability in adaptation measures - as the vulnerability is a reason for poverty and poverty enhances further vulnerability, because of having low adaptive capacity (Adger, 2003a). By providing a thorough analysis of the relationship between vulnerability and poverty, Eriksen and O'Brien (2007) argue that sustainable adaptation interventions must focus on - a) reduction of current vulnerabilities b) strengthening adaptive capacity of the poor people and c) addressing the cause of vulnerability (e.g. climate change) of a society. A more strategic balance of generic capacity (e.g. human development) and specific capacity (e.g. early warning systems, adoption of technologies) regarding context-specific climate change impacts (and threats) is needed

for achieving sustainability in climate change adaptation; if these capacities are low in a society, the community might fall into 'poverty trap' (Eakin et al., 2014).

Adaptation interventions should enhance the resilience of a system (Bulkeley & Tuts, 2013; Roberts, 2010), but for creating a resilient system, potential malfunctions should be considered. Interventions that result in 'maladaptation' undermines long-term resilience (Brown, 2011). Barnett and O'Neill (2010, p. 211) define maladaptation as: "action taken ostensibly to avoid or reduce vulnerability to climate change that impacts adversely on, or increases the vulnerability of other systems, sectors or social groups". Their research identifies five ways to maladaptation as actions which: a) increase GHG emissions, b) disproportionately burden the poor community, c) have high opportunity costs, d) reduce initiatives to adapt, and e) enforce path dependency through large infrastructural investments. Thus, adaptation measures that create further vulnerability, e.g. maladaptation, threatens both resilience (Brown, 2011) and sustainability (Adger, 2003a) of a system. Davoudi et al. (2012, p. 299) argue that the notion 'resilience' increasingly supplement the classic concept 'sustainability', since "both sustainability and resilience recognise the need for precautionary action on resource use and on emerging risks, the avoidance of vulnerability, and the promotion of ecological integrity into the future" (Adger, 2003a, p. 1). Also, Nelson (2011, p. 113) argues that, "a resilience perspective provides a framework for evaluating actions and managing capacity for long-term sustainability".

The two concepts, adaptation and resilience, are developed in dissimilar problem contexts, are important to describe the response strategies to climate change (Davoudi et al., 2012). Resilience - a progressive concept to describe climate change adaptation, is the ability of a social or ecological system and its resistance to external shocks. In the discipline of disaster planning, "resilience is often a measure of the degree to which a community can withstand the impact of a sudden, turbulent shock" (Martin et al., 2015: p.17-18). Bulkeley and Tuts (2013) argue, the term 'resilience' is opposite of the term 'vulnerability' - the more resilient, the less vulnerable; and the less resilient, the more vulnerable. More specifically, adaptation intervention is short-term solution mostly to address the current vulnerabilities (Adger, 2003a), whereas a resilience response is a long-term solution to climate change to addresses present vulnerabilities and future risks (IPCC, 2014). Again, "adaptation can also have positive impacts on

resilience and is necessary to manage system resilience and sustainability” (Nelson, 2011, p. 115), however malfunctions derived from adaptation interventions decrease resilience (IPCC, 2014). “Resilience is not a normative concept” as “it is not always possible to maintain system resilience” when the magnitude of changes (e.g. effects) go beyond the adaptive capacity of a system (Nelson, 2011, p. 113). To maintain sustainability in adaptation interventions in response to climate change, resilience should be enhanced within the capacity and available resources of a society.

By enhancing resilience, sustainability can be increased (Espiner et al., 2017). Human capabilities, young people, good education are important factors to improve the resilience of society as the availability of these resources indicates local independence (O'Brien & Leichenko, 2007). “Local autonomous responses to climate change can scale-up and influence the overall resilience and sustainability of a social-ecological system” (Nelson, 2011, p. 115). Utilisation of social capital (the resources available to the public and private institutes in society) and collective action for coping with extreme weather events build resilience against climate change (Adger, 2003b). Preparedness for disaster risk reduction in responding to the potential, onset and aftermath of disaster increase resilience of a society (Brown, 2011). Incorporating mitigation strategies along with adaptation interventions ensure resilience (Bulkeley & Tuts, 2013). In the context of coastal resource management, Adger (2003b) argues, community involvement in the management enhance resilience. In case of agricultural-adaptation and livelihood management for vulnerable communities, local demand-centric market functions (e.g. selling locally produced goods into local markets) are more resilient than selling into regional and international markets (O'Brien & Leichenko, 2007). On the other hand, adaptation interventions are not/less resilient which create vulnerability in long-term (Adger, 2003a), increase overall adaptation related investment cost than adaptation benefits (Barnett & O'Neill, 2010), do not use local capital and resources (O'Brien & Leichenko, 2007), and degrade the forest ecosystem (Adger & Tompkins, 2004).

Permanent dependency on external institutes (e.g. NGOs) and external funding (e.g. climate compensation, donations) for coping with the climate change impacts are neither sustainable approach nor contribute to building resilience to climate change (Bulkeley & Tuts, 2013). Local capacity building in terms of human resource and social institute development can reduce climate vulnerabilities in a sustainable way (Brown,

2011; Eriksen & Brown, 2011). In the context of vulnerable Asian countries including Bangladesh, Korten (1990) argues that external institutes particularly NGOs start work for vulnerable society by distributing relief aids and gradually work on community development and sustainable social system development. Management agency dependent adaptation interventions for coping with climate change impacts are not equally resilient (Korten & Quizon, 1995; Nelson, 2011). For instance, relief aid is a reactive approach popular in third world countries that may reduce the short-term vulnerability of a disaster but cannot develop long-term resilience of a society (Bohensky, 2015). Relief aid acts against the autonomous social anticipatory action, create relief dependency, and decrease adaptive capacity by undermining the legitimacy of government action, which are not sustainable solutions of the vulnerabilities and risks (Barnett, 2008). Donations need to be used for capacity building so that vulnerable society can enhance their resilience to combat future risks (Brown, 2011).

Another adaptation intervention is hazard-based approach which addresses the hazards and vulnerabilities developed from different climate change impacts like sea level rise, salinity intrusion (Fünfgeld & McEvoy, 2011, 2013). The hazard-based approach stems from disaster and risk management literature, builds short-term (up to 5 years) coping capacity of a community (Fünfgeld & McEvoy, 2011). Hazard approach is not a true development, but maintaining the status quo (Martin et al., 2015). For example, building a dam to protect agricultural-field from sea level rise is not a development but maintaining previous agricultural productivity. In the medium to long-term, hazard approach may be malfunction and could be creating further vulnerabilities. A growing adaptation strategy is to support the community by creating a market for locally produced products (or services) to reduce poverty and manage livelihoods in climate vulnerable regions (Stringer et al., 2009). Marketing support approach is more resilient than hazard-based approach as it develops the local economy and enhances self-dependency (O'Brien & Leichenko, 2007). Management agencies need to select a suitable combination of soft adaptation interventions (e.g. changing policy, knowledge sharing) and hard adaptation interventions (e.g. introducing saline tolerant plants) for adapting to the current vulnerabilities and addressing to future climate risks (OECD, 2015).

Sustainable adaptation interventions build the resilience of system(s) in response to climate change (Adger, 2003a). The degree of sustainability in adaptation interventions depends on the quality and features of the applied adaptation technique (Eakin et al., 2014; Eriksen & Brown, 2011). Some adaptation interventions only address current vulnerabilities and hazards, but some adaptation interventions address future risks along with current vulnerabilities arising from climate change (Adger et al., 2005a). The adaptation interventions that only resolve the immediate vulnerabilities contribute less in the resilience of a system – that means sustainability in those adaptation interventions is low. The adaptation interventions that address not only the current vulnerabilities but also future risks of climate change contribute more in the resilience of a system – that means sustainability in those adaptation interventions is high. Of course, there are some other adaptation interventions that contribute partially to build the resilience of a system. Sustainability in adaptation increases when the interventions in response to climate change can increase the resilience of the system(s). Overall, the adaptation interventions that create relatively more social independence (e.g. through education or capacity building) are more likely to foster long term resilience and sustainable interests.

6.3 Research approach

The purpose of this research presented in this chapter is to identify the functions of the management agencies assisting the community people of the Bangladesh Sundarbans in adapting to climate change. To address the goal of this research, it is important to know how effectively the management agencies are deploying those adaptation functions. Qualitative research is more appropriate for this current research as it can describe not only the realities going on but also the reasons and comprehensive nature of those reasons behind a particular phenomenon (Lederman, 1991). To collect empirical data, this research utilised two methods of qualitative research: semi-structured interviews and document analysis. The interview programme sought to identify organisational structure relevant to climate management actions and then engaged with the interview participants in an in-depth discussion of climate change management strategies in terms of vulnerabilities and risks management (**Table 6.1**).

Table 6.1: Synthesis of the semi-structured interview schedule

Part one:	Management structure for combating climate change
	a) Extent of climate management functions
	b) Climate management - coordinated or isolated
	c) Addressing climate change in forest and species management
	d) The way of community involvement in the management
Part two:	Response strategies for climate change
	a) Awareness communication- approaches to inform
	b) Disaster management and risk mitigation
	c) Adaptation or resilience building

Qualitative interviews can accumulate more in-depth insights than quantitative study when collecting data from critical persons including managers, social leaders (Phillips, 2014a). In order to get individual voices to fulfil the research demand (Patton, 2015) and flexibility in exploring issues in detail (Jennings, 2005), this study conducted 15 one-to-one semi-structured interviews of management stakeholders in neutral sites (Table 6.2). The interview participants were selected by applying non-probability judgemental sampling method (Malhotra, 2010) to ensure a true representation of the management stakeholders of the Sundarbans in Bangladesh. All the participants were male because of male-dominated management system in Bangladesh. The average interview length was about 62 minutes (41-90 minutes); the interviews were conducted mostly in Bengali language (only one in English) and digitally recorded with participants' consent.

Table 6.2: Description of the participants and interviews

Participant identity	Age	Occupation / role	Education	Interview length	Interview location
Forest employee ₁	50s	Forest Ranger (Govt.)	Graduate	57 minutes	Satkhira
Forest employee ₂	40s	Divisional officer (Govt.)	Masters	63 minutes	Khulna
Forest employee ₃	40s	Forest manager- tourism (Govt.)	Masters	43 minutes	Dhaka
Member of local government	60s	Politician	Primary level	84 minutes	Satkhira
Local administrative officer	30s	Government officer	Masters	41 minutes	Satkhira
Executive of NTO	40s	Govt. tourism manager	Masters	67 minutes	Dhaka
Executive of IUCN	30s	Employee of Int. agency	Graduate	87 minutes	Dhaka
Executive of UNESCO	40s	Employee of Int. agency	Masters	55 minutes	Dhaka
NGO worker ₁	60s	Project manager	Masters	90 minutes	Satkhira
NGO worker ₂	40s	Owner and director	Masters	60 minutes	Satkhira
NGO worker ₃	30s	Project manager	Masters	71 minutes	Satkhira
NGO worker ₄	40s	Project manager	Graduate	58 minutes	Satkhira
NGO worker ₅	30s	Project manager	Graduate	48 minutes	Satkhira
NGO worker ₆	30s	Field worker	High school	51 minutes	Satkhira
NGO worker ₇	40s	Project manager	Masters	49 minutes	Satkhira

The interview programme provided rich volumes of qualitative empirical materials (Alvesson & Kärreman, 2011) that provided deep insights into the contextual climate change management scenario. The researcher's subjective judgement was applied to decide about 'data saturation' which guided to close interview programme (Francis et al., 2010). The digitally recorded empirical materials were translated into English language and transcribed, later the transcripts were interpreted using a thematic analysis – a hybrid approach of inductive and deductive coding - where the interview materials were coded under pre-selected constructs and emerging new constructs (Fereday & Muir-Cochrane, 2006). Repeated reading of the coded materials and researcher's fieldwork experience facilitated the research process of qualitative analysis.

This research analyses contents of different published and non-published documents including respondents' official websites, publications, brochures, fliers, billboards, newspaper articles, policy documents, manuals, handbooks, photographs, magazines, books (written in the Bengali language) regarding contextual climate change management (**Appendix F**). The key purpose of document analysis was to triangulate the empirical materials by using different data source (Denzin & Lincoln, 2011) and incorporating the changes in contextual management functions following the fieldwork period. The researcher examined the 'source and authenticity' of the collected documents before taking those in the analysis process (Olson, 2012). Patton (1999) suggests that combining interviews and document analysis can provide deep-insights on research interest by reducing the limitation of a particular qualitative method.

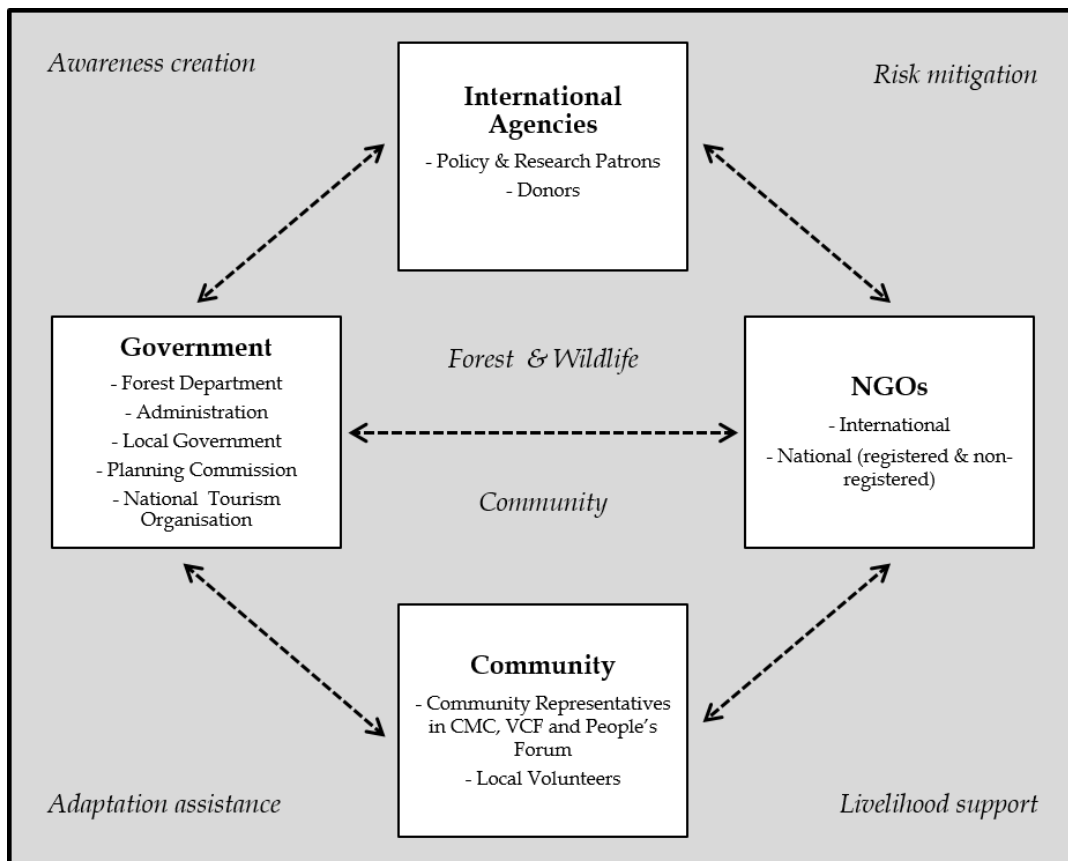
To examine the contextual climate change responses for managing vulnerabilities and risks, two broad themes were revealed by applying thematic analysis on the coded empirical materials. They are: (A) Rearranging management structures to combat climate change, and (B) Conserving the Sundarbans for building resilience. The second theme contains four sub-themes - (1) Enhancing public education for climate action, (2) Mitigating disaster risk by using community resources, (3) Management assisted climate change adaptation, and (4) Arranging alternative livelihood to reduce forest dependency. All these emerged themes and sub-themes collectively describes the climate change management functions and their relative effectiveness to combat climate change of the Sundarbans area in Bangladesh.

6.4 Findings

(A) Rearranging management structures to combat climate change

Severe cyclone Aila (May 25, 2009) was the ‘turning point’ for structuring climate change management in the Bangladesh Sundarbans. Contextual climate change management consists of four groups of stakeholders – the Government, International agencies (e.g. USAID, UNESCO, IUCN), NGOs, and communities (e.g. CMC: Co-Management Committee). The typical communication network for managing climate change involves all four parties, but the combination can be different in the case of Government funding for a climate change project. These agencies mainly work for managing climate change for the community, the forest and its wildlife by creating public awareness, mitigating disaster risks, assisting for adaptation, and providing livelihood support (**Figure 6.1**).

Figure 6.1: Stakeholder linkage to manage climate change in the Sundarbans



Among all the Departments of the Government, the most influential authority working for climate change management in the Sundarbans is the Forest Department. The Government Departments usually do the highly capital-intensive and community-level

adaptation measures including building cyclone shelters and maintaining embankments. The international agencies working through the Government or NGOs for climate change management mainly provide three types of assistance - a) policy and consultation b) donation c) research (see Figure 6.1). The international donor agencies usually recruit local NGOs as their 'implementing partners' to execute climate change projects. By following the donors' guidelines, NGOs mainly work at the household level and try to create successful examples in the society so that other people can get motivated and learn to adapt to climate change. Because of self-promotion, NGOs are quite visible with their climate management functions such as delivering rainwater harvesting plants, organic composts, and relief items.

In the post-disaster scenario, a disaster-affected region receives huge aid from the government and different International sources. As a result, a market (for NGOs) has been developed in that region. It is like the business of development. NGOs take the money and do work. It is assumed that the actual implementation [development work] is for the well-being of people. However, a market (NGO business) grows there. - *Executive of IUCN (Bangladesh)*

International agencies have experts on conservation and climate change, and very often those organisations contribute to the drafting and development of policy when governments request them to do so. In doing so, international agencies will make recommendations to government on forest management. International agencies provide donations for different projects. At present, a significant number of climate change management projects in the Bangladesh Sundarbans are funded by international donors. However, the donor agencies do not have field office to execute projects in the Sundarbans. Therefore, they accomplish their projects by recruiting domestic NGOs. The donor international agencies often ask the related Government body to monitor the work that the donors have assigned to the NGOs. Sometimes, international agencies conduct research to understand and interpret climate change scenarios and projections. An *Executive of IUCN* mentioned: "when we go anywhere (for conducting a project) we analyse resilience. What was the past, what is the present, what trends are emerging, what will be the future ... a Participatory Research Process through PR [Public Relation] or public consultation".

When any NGO is involved in any climate change management project, a donor agency either international or domestic including the Government will be funding the

project. According to the laws in Bangladesh, international donor agencies cannot deliver money directly to their implementing partners (e.g. NGOs). The international agencies have to go through the Bangladesh Planning Commission to donate money for a project. As it is a matter of money inflow, the Government body always assists the donors by all means. Side by side, NGOs also require permission and assistance from local Government and administration to implement the proposed projects in the impact zone of the Sundarbans. A *Forest Employee*₃ said that “if any NGO wants to work inside the Sundarbans, it must need Forest Department’s permission.” And most often, Government authorities maintain a very friendly relationship with NGOs. One *NGO Worker*₄ has noted: “we have very good coordination with the Government. ... The Government authorities invite NGOs in all the national and international programs like day observation. Even, the logos of participating NGOs’ are put on the banner of the program”.

The NGOs working for climate change management usually operate in an alliance called a ‘coordination council’, which generally sit for meeting at least once a month. They share their knowledge, ideas and activities with the other NGOs for evaluation. The Government encourages them to conduct meetings, for example, by offering meeting venues. An *NGO Worker*₄ acknowledged that “we are doing coordination meetings every month in DC [District Council] office or the Disaster Management Office”. Side by side, the Government also takes assistance from NGOs when required particularly during the disaster. A *Forest Employee*₃ said that “we involve NGOs in our different projects. Especially when people are required to be involved, we take support from NGOs”. For climate change management, the NGOs and Government often work beyond the formal official relationship.

The forest department planted trees on an island but still there was some empty land. So, we requested them that we wanted to do afforestation there. They replied that we could not give you written permission, but (please) do the plantation. We will take care of them. – *NGO Worker*₁

Community people are involved in the management structure of the Sundarbans through a participatory forest conservation programme, called the CMC, which ensures involvement of representatives from the community, local administration, and local government. There is a society of all forest dependents, called the Village Conservation Forum (VCF) which runs under the CMC. The VCF – a form of

Community Based Organisation (CBO) consists of the user groups of the Sundarbans like fishermen, and honey collectors. There is another commission called People's Forum, in which a male and a female representative of each VCF are included as members. The People's Forum formed according to the Gazette of the Government, and the CMC is accountable to this People's Forum. Local people run Community Patrol Group (CPG) and work as volunteers for disaster management, forest and wildlife conservation and building awareness of climate change. Few NGOs with the assistance of International agencies are working to strengthen the community participation and to take over the forest management to the CMC.

If we get dedicated leadership and if the associated staffs of the Forest Department guide properly, then CMC will be a very good tool not only for conservation (of the Sundarbans) but also for promotion of ecotourism, for promotion of other AIG (Alternative Income Generation) activates to reduce the dependency on the forest. ... We are providing training so that they (community people) can earn livelihood, if there is any large impact of the climate change. - *Forest Employee₃*

The purpose of community involvement in the Sundarbans is to strengthen the capacity of the existing management structure in response to climate change. Community involvement in the management is an effort to solve problem of the community including climate change by utilising the community people.

(B) Conserving the Sundarbans for building resilience

To address climate change, the Forest Department of the Sundarbans follows 'conservation' as a strategy by discontinuing most of its tree harvesting options like *Sundari (Heritiera fomes)*, *Goran (Ceriops decandra)*, *Gewa (Excoecaria agallocha)* and *Bain (Avicennia officinalis)*. Currently, the Forest Department does not provide permission to collect forest resources except *Golpata* (Nipa Palm), honey, crab and fish. The logic behind the harvesting control is to protect the ecosystem from community depletion so that the mangrove forest can grow naturally and develop its own resilience that can help the community people for better adaptation by reducing wind force and sea waves developed due to climate disasters.

In order to protect the forest from climate change, our government policy has been changed. We are now concentrating on conservation. We stop all type of harvesting for conserving the forest. Only honey, fish and *Golpata* can be harvested with permission. There is no tree harvesting at present. In future, we will reduce (harvesting) more. (Tree) Harvesting will not happen in future. - *Forest Employee₁*

The management agencies are introducing projects for targeted major species conservation including tiger, deer, crocodile, dolphin, river terrapin (*Batagur baska*) to maintain the biodiversity of the mangrove ecosystem. The Forest Department with the help of an international agency (USAID) introduced GPS and GoPro Camera-based patrolling project, known as 'SMART (Spatial Monitoring and Reporting Tool) Patrol Management', to stop forest exploitation. The agencies do 'assisted regeneration' in the newly appeared islands to enhance the resilience of the mangrove and do 'community-based afforestation' to reduce forest dependency by satisfying the local needs of fruits, cooking fuel, and timber.

We have distributed domestic species of plants to households such as Nim, Sofedea, Coconuts etc. and later Mahogany. However, mahogany (tree) has not survived here. Three types of plants survive here: (which are) loathful [*Koshi*], bitter, and sour (in taste). In the saline zone of coastal belt,...the trees which have these three qualities, those can only survive here. - *NGO Worker₁*

(1) Enhancing public education for climate action

To inform the general public about the climate change and adaptations, the management agencies, particularly NGOs are taking different type of measures like *Uthan Boithok* (courtyard meeting), *Gram Shobha* (village meeting), Interactive Popular Theatre (IPT), day observation, and discussion session with school teachers and students. There are many billboards set by the NGOs and the Government in the public locations such as bus stand, shopping places in the periphery of the Sundarbans containing information for informing about different issues of climate change like agricultural adaptation, disaster risk reduction, alternative livelihood, forest and tiger conservation, mitigation, and the scientific procedure of climate change. Those billboards create interest among the local people, and they come to know about different aspects of climate change.

Courtyard meetings [*Uthan Boithok*] are one of the most effective means of educating climate change to the coastal communities of the Sundarbans. NGO workers and local experts including Government Administrators are the facilitators of courtyard meeting in which generally most of the participants are women. The courtyard meeting is a 'two-way communication' approach where both the facilitators and participants share their knowledge and experience about climate change which helps to create understandings. An *NGO Worker₂* said "We meet there together. We share our opinion

and experience. We discuss what we need to do in response to climate change. They [participants] identify the symptoms of climate change. (They say) we experienced this and that. Experience sharing is the major part (of *Uthan Boithok*)". The courtyard meeting is one to two hour-long sessions, consists of 20 to 30 participants with a group leader who organise the participants. The participants are most often the beneficiaries of NGOs under particular climate change project.

We have some target beneficiaries. We do meeting with them to inform about climate change, its adaptation, adaptation strategy and what is happening in nature. What is the cause and what is the effect? We discuss these issues with them. Only the beneficiary people (member) listen to this (discussion). – *NGO Worker₁*

To overcome the limitation of courtyard meeting - as it only informs the beneficiaries, the NGOs conduct village meetings [*Gram Shobha*] where all the people of a community including the social leaders participate. The reason for organising village meeting is to inform the whole community about climate change. The village meeting is a self-conducted meeting by the villagers where NGOs play a role as moderator and let the community people discuss about few identified climate change issues. This meeting creates 'synergic effect' by opening a big platform of discussion for the whole community and helping to carry out the message throughout the society.

In the *Gram Shobha*, we present there as monitor, they (the community people) conduct the meeting. For example, they find out two or three problems like lack of drinking water. At first, they identify the problem [reason] of drinking water; then they find out how they can solve the problem. – *NGO Workers₅*

Another way of creating awareness is Interactive Popular Theatre (IPT) by which people simultaneously get entertainment and learn about climate change. IPT is a cultural show combined with *Pot Gan* (village musical mode like the folk song), *Gono Natok* (public drama). NGOs hire different cultural groups and ask them to incorporate specific climate change messages in the manuscripts what the agencies want to convey to the people; according to the instruction, the groups develop enjoyable dramas and songs to show before the public. By admitting the enthusiastic participation and effective outcomes of awareness from this type of shows, an *NGO Worker₁* shared, "Normally, people do not like to listen to the talk about the environment. But if we

convey the message of environment, (climate) awareness through the cultural show like *Pot Gan, Gono Natok*; people take it nicely”.

For enhancing the local awareness about climate change, the Government and NGOs observe different days like International Day for Disaster Reduction, and Environment Day by organising different programmes including rally, public meeting. The day observation creates an outstanding awareness outcome because of ‘word of mouth’ communication throughout the communities. To inform about climate change to the young children, NGOs have developed educational materials like posters, playing cards, games on different topics including the Sundarbans, climate change, environment. One NGO with the assistance of international donor has developed eco-library for creating knowledge about the Sundarbans and climate change. The users of the library are called ‘Mangrove Children’ who gather knowledge about the Sundarbans and speak about its risks and vulnerabilities in different meeting in the local level, national level, and international level.

We have established eco-library in a school near here. At this point, we have provided laptop, multimedia (projector), TV, so that they (students) can see the multimedia show. We have provided books on the Sundarbans. We provided solar (panel) so that it could run without electricity. As it is eco-library, we have used eco-friendly materials. – *NGO Worker₂*

Along with those efforts, NGOs organise different type of climate change awareness programmes including drama exhibition on road and field, school campaign-informing the school going students so that they can further discuss in their families, quiz and essay writing competition, discussion with the school teachers to share information of climate change with the students. A *Local Administrative Officer* explained, “Now everybody is aware. Every public has received training or participated in the meeting (to know about climate change) after cyclone Aila. And it (awareness building) is still going on by the NGOs”. Besides all these large ‘group communication’ for informing about climate change, there are some efforts of ‘one-to-one communication’. To reduce ‘human-animal conflict’, the NGO workers even sit with individuals who have tendency to kill tigers.

We have found a lot of people (who have a tendency to kill tigers). We sit with and talk to them individually. They did not know about the importance of wild animals; they had no knowledge about the importance of wild animals. We target this type of people to make them understand. We would take them away from human-tiger conflict. We get them back, and now they are helping us. And they are very much encouraged. They do not have any tendency to kill tigers. – NGO Worker₆

Climate education is not limited to adaptation support, but a range of mitigation efforts may be taken by management agencies in order to communicate to the community about climate change. The management agencies, mostly NGOs help and encourage the community people to use solar energy, to plant trees, to use improved cooking stove (ICS) and most importantly to reduce dependency on forest resource collection to mitigate global climate change.

Many people living next to the Sundarbans have been using solar energy to generate light at night instead of kerosene-oil lamps. A *Member of local Government* quantified solar using families in his area (Gabura Union): “Almost every family has solar (panels). Around 70-75% of households use solar (power). 25% of families do not have it yet”. As the power consumption per family is very limited in the region, the households which do not have electricity connections mostly use small solar panel to light one or two electric bulbs. Solar energy is more efficient than kerosene lamps which produce black smoke, but it needs investment. NGOs will often distribute the solar panels among the households in easy payback instalments.

The NGOs encourage and provide assistance for the development of ‘household-based tree plantations’. NGOs provide different types of domestic species of plants including flower plants to households to plant in the courtyards and backyards of houses. However, as the soil of the region contains high salinity, trees can hardly survive and grow on the ground. NGOs distribute plants for free only among their members and the local institutions such as schools; they do ‘community-based afforestation’.

We have done some road-side plantation. We have done plantation beside canals. Many trees are lost from this area and many birds are not nesting here. Where they will come if they don’t have any residence [trees] here? – NGO Worker₄

Again due to salinity, there is little or no grassland for cattle in the villages of the Sundarbans; cows and goats tend to graze instead on plants. Fencing around planted

trees is necessary to solve this problem. NGOs very often do fencing in community mangrove forest beside the embankments. A *Forest Employee₁* acknowledged, “only, the plantation is enough to grow trees in the Sundarbans. If you just take care [do fencing]..., for conservation, it is enough; those will grow naturally”. In addition to planting trees beside embankments, the Forest Department has created ‘island forest’ with the assistance of NGOs and donor agencies.

(Climate Change) Trust Fund provides money for tree plantation where it is needed, to cool the climate [environment]. Mainly we plant our domestic species, and sometimes foreign plants. ... Furthermore, we have done a lot more work here; in here we have established ‘*Chor Bagan*’ [Island Forest] where new islands have appeared. - *Forest Employee₁*

To mitigate the climate change impact, community residents are encouraged to use environment-friendly Improved Cooking Stoves (ICS), which are popular among local people as *Bondhu Chula*. The households along the Sundarbans mangrove forest have little fuelwood in their community, because of salinity in the soil which prevents healthy tree growth; and cyclone Aila and Sidr wiped out many trees from this locality. In most cases, local people depend on the fuelwood from the forest which has been identified as a reason for mangrove destruction. The management addresses this issue and finds two ways to solve it- firstly, controlling fuel requirements and secondly, assisting the community by arranging alternative fuels. For executing the first solution, the NGOs and Government have introduced ICS. An *NGO Worker₁* said that “we are replacing traditional cook stove by ICS. And we are very much successful. About 60 to 70% household is using improved cook stove.” In comparison to the traditional cook stove, one *Executive of IUCN* has acknowledged the efficiency of ICS. “The advantage of the improved cooking stove is low fuel usage; it can reduce fuel use up to 30 to 60%.” Since the fuelwood comes from the forest, so ICS has contributed to mitigation in two ways- i) it has reduced the deforestation partially; ii) it has reduced emission as the fuel consumption is low. For executing the second solution- arranging fuel for cooking, management has encouraged community residents to plant non-mangrove species besides the embankment and roads so that they can collect firewood from those trees.

While household-level emissions are very low in comparison to industrial emissions; both NGOs and the government communicate the importance of using Improved

Cooking Stove (ICS) to communities. In most cases, ICSs have been distributed to communities through co-finance- a part of the cost of ICS has been bearer by the users so that they could understand its ownership. Again, the Government agencies have trained the local people about how to make this energy efficient stove. Besides, one NGO is doing further research with the collaboration with the Science Laboratory under the Ministry of Science and Technology and BUET [*Bangladesh University of Engineering and Technology*] to ensure more efficiency of the ICS.

(2) Mitigating disaster risk by using community resources

To mitigate cyclone risks, a voluntary team from the community works under the Cyclone Preparedness Programme (CPP) for communicating early cyclone warning signals. This team receives training from the Bangladesh Meteorological Department and assists the community in sheltering, rescuing and in post-disaster recuperation and extensive rehabilitation operations. Under this CPP, thousands of male and female local volunteers work outside of their home despite having life-risk to assist disaster-affected people while the cyclone appears in the coastal Sundarbans. A *Local Administrative Officer* said, “We have volunteers in every Union [administrative territory]. When disaster looms, we bring people to the cyclone centre with the help of them. So, the damage becomes lesser. We provide food there (in the cyclone shelters)”. The volunteer team teaches the community about the meaning of different cyclone warning signals and communicates the warning by using megaphone before cyclone hits.

The interview programme provided insights in the dissemination of disaster information to the coastal communities of the Sundarbans is satisfactory - every household comes to know about the signals of cyclone at least few hours before it happens. To communicate disaster information, they usually use their available social instruments such as the sound systems of religious centres and personal mobile phones. To a small degree, some NGOs provide mobile phones to the community volunteers for communicating during the disaster period. Since cyclones are a life-risk event, information tends to spread very quickly through communities immediately after having the news.

We phone to every mosque to share the information (of the cyclone) by mike. Suppose, in Kalibari, where Hindu people live, there is no mosque in that place. We phone some of them to inform rest of the people in the locality that the disaster (cyclone) could hit anytime, be careful. ... The *Imam* (religious leader) of the mosques communicates the news (by using Mike) to the community. - *Member of Local Government*

The Government of Bangladesh has developed multi-purpose cyclone shelters (MPCS) in the coastal zone of the Sundarbans. Upazila Council (Sub-district Council) builds high schools cum three-storied cyclone shelters, and LGED (Local Government Engineering Department) builds primary schools cum two-storied cyclone shelters. However, the number of cyclone shelters is not sufficient for the people of the Sundarbans. Again, the Government (sub-district Council) and NGOs also provide training to the community regarding the necessity of going to the cyclone shelter and keeping dry foods. An *NGO Worker*₄ confirmed, "We trained up volunteers to work in the disaster. We provided training for search and rescue, first aid". In the post-cyclone period, NGOs and civil society distribute relief such as food, water, saline, water-treatment tablet, and tins for reconstruction of damaged houses.

(3) Management assisted climate change adaptation

The management functions for adaptation in the Sundarbans are taken to resolve around three major climate change impacts: i) salinity intrusion ii) sea level rise and tidal waves iii) intense cyclones. **Table 6.3** lists the impacts of climate change and consequent adaptation measures taken by management agencies in the Sundarbans. Most of the adaptation functions are related to agriculture and community. The management agencies have introduced salt tolerant crops and fish, less water requiring crops, flood tolerant paddy species. Due to saving vegetables from soil salinity, they have introduced sack bag (cultivating in plastic bags to avoid soil-salinity), tower (putting soil in a high platform), and wall gardening methods. The agencies demonstrate and communicate the success of those crops and methods to the community so that they feel encouraged to practice those methods.

We are helping them to cultivate some salt-tolerant vegetables – some by using technologies and some by providing varieties (of seeds). The paddy, BIRI 47 is salt-tolerant (species). And BIRI 52 can sustain underwater up to 15 days with insignificant production loss. If water gets out from the field, this species will provide all most same quantity of crops even it drowns for fifteen days. – NGO Worker₃

In some area, we establish, home-state gardening. Some new species like Brinjal, tomatoes, which are not found here, are cultivating in demonstration plots and in some educational institute and shown them the potentials of growing those vegetables. The members who have planted those get good results. These are our efforts for adaptation. – NGO Worker₄

‘Composite agriculture’ – robust method to do multiple crops and fishes by making high dyke around a land, becomes popular to save crops from salinity ingress and cyclone. NGOs provide money and training to the poor beneficiaries for practising composite agriculture.

The land used to provide one crop (in a year). I help to build dykes around the land. On the dyke, there are beds where vegetables are grown. There is a canal inside the dyke. Freshwater fish and *Golda* shrimp are cultured there. ... From the middle of the land, I get paddy. I have three crops in a land at a time. Earlier this land can produce one crop but now three crops. The dyke is built by using the soil from the canal. The canal contains fresh water. Water can be irrigated from the canal for paddy production. – NGO Worker₇

The management agencies excavate ponds and build Pond Sand Filters (PSFs) in the locality of the Sundarbans for free to reduce the scarcity of freshwater for drinking, household usage and small-scale irrigation. For maintaining these facilities, few NGOs form committees from the users of PSFs so that this authority can raise fund to maintain and repair those facilities. To solve the problem of household fresh water inadequacy, NGOs and other agencies also excavate ponds, establish desalination plants and rainwater harvesting plants. Nonetheless, those facilities are neither adequate nor easily accessible to the local people.

Table 6.3: Climate change adaptation techniques in the Sundarbans

Climate change impacts	Emerging crisis	Area of adaptation	Adaptation techniques	Implementing organisations
Salinity intrusion	Freshwater scarcity	Drinking water	- Building PSFs and repair old PSFs - Rainwater harvesting plants - Big pond excavation and re-excavation - Desalination Plants	NGOs
		Domestic gardening & sanitation	- Small pond excavation and re-excavation	NGOs
		Agriculture, livestock & fisheries	- Introducing salt-tolerant crops and fishes - Introducing non-traditional crops like wheat, sunflower which requires less water - Cultivating vegetables on high platform or in sack bags - Wall gardening - cultivation of the jute fabric pockets on the wall - Excavating and re-excavating canals to hold rainwater for irrigation	NGOs
Sea level rise and Tidal waves	House sink	House structure	- Plinth rise up	NGOs
	Crop and livestock damage	Agriculture	- Introducing fast-growing crop species - Introducing flood-tolerant crops rice species which can survive few weeks underwater	NGOs & Government
		Livestock	- Improving (farming) livestock in cases on higher platform	NGOs
	Surface flooding and waterlogging	Human habitat	- Embankments	Government
	Embankment security	Strengthening embankment	- Mangrove plantation out of the embankments	NGOs
Intense cyclones	House breakdown	House structure	- <i>Tana</i> , a process of strengthening houses by using rope and pillars - Planting trees beside the house to get protection from strong wind force	NGOs
	Life risks	Disaster management	- Building cyclone shelters - Constructing and elevating roads to cyclone shelter - Confirming early warning	Government & NGOs

Source: Interview programme

The most common way to collect drinking and cooking water is from pond sand filters (PSFs). A PSF is a surface water-based filtering system installed near a pond to collect water for the slow sand filter. The water from the pond is pumped manually to feed the filter and the treated water is collected by taps for use. NGOs establish this type of PSF on the bank of the ponds which does not dry up during the summer. However, PSFs cannot make the pond water salt-free and cannot eradicate 100% of the pathogens including bacteria. As PSF is not available in every village and men are busy with earnings; an *NGO worker*₃ said: “a woman needs to go 2 to 3 kilometres away from home for bringing (drinking) water. It is very troublesome for these women. By bringing 30 litres [of] water a family can use [drink] for two days.” The *NGO worker*₃ further noted that PSFs cannot make the water salt-free if the pond water contains salinity.

Sometimes the NGOs excavate new ponds to establish PSF beside the ponds; sometimes they re-excavate existing ponds for holding rainwater to irrigate the small-scale vegetable gardens. After excavating a pond, the NGOs put up sign-boards which say not to bathe or to wash legs in the water of the ponds; the water should be used for drinking purpose. All the banks are fenced where PSFs are set. For establishing PSFs, generally, big ponds (about 150 by 120 feet) are excavated; mini ponds (about 85 by 65 feet) are excavated for small-scale farming. Most often ponds are excavated on public land with the permission of the relevant Government authority; if any ponds are excavated on private land, NGOs make agreements with the land owners concerned, so that they allow use of the water for other people for a certain time period. It becomes urgent to re-excavate ponds in which saline water builds up through tidal waves during cyclones. In some cases of high salinity ingress, even re-excavation cannot ensure drinkable water. During the summer when the water level of the ponds goes down, the salinity of the water increases, and people cannot use that water.

Participants in this research reported that the water quality of the desalination plants [convert the ground saline water into fresh water] is excellent. These plants are operated in two ways. One, the NGOs provide the water supply to its members for free and two, the people need to purchase water from the plants. While the price of the water is very cheap [close to the production cost], very few people purchase from there- as most are very poor. A *Member of Local Government* confirmed that “there is a

desalination project here. You have to buy water. But the people of this area are not capable to buy water to drink. So, they don't buy from there". Again, there is a transportation problem, though there are only a few desalination plants which are away from many villages.

Another way of arranging fresh water for households is rainwater harvesting - a big tank is used for holding rainwater from the roof. A part of the tank is set under the ground so that the water keeps cool during hot temperatures in the summer. The NGOs bring small tanks (i.e., 1000 litres) for individual households and a large tank (e.g., 40000 litres) for a group of households. Those people drink this reserved water for the four-five months when there is a scarcity of water. However, an *NGO worker*₁ has questioned the quality of this water. "We have debate [confusion] about this rain-water, whether rainwater is drinkable. It (rainwater) does not contain any minerals. And rain-water contains more nitrogen. But it is better to drink rainwater than to drink river water or pond water."

The embankment is the core of all adaptation functions in the locality of the Sundarbans to protect the agricultural and other livelihood adaptation functions. The water entrance inside the embankment causes financial losses to the community by destroying crops and houses. To reduce this economic risk, the management agencies have developed 'self-sustaining social institution' so that the community can have a resilient embankment. The agencies have planted mangrove plants up to 60 metres from the embankment to the river. This mangrove would protect the embankment from the cyclone, tidal waves, and erosion. To arrange the expenditure of managing the mangrove plants, they have planted a different type of non-mangrove species on the embankment and inside the embankment area. The Forest Department has made embankment management committee from the community for managing the mangroves.

We formed a committee of local people to manage those plants. The committee is nicely managing those. They employ a guard to take care of the plants by selling the grasses that grow on the embankment. We do not need to do any nursing. The river-side plants create a barrier against the river current and enhance the endurance of the embankment. We have developed this type of concept there. It becomes a model. If it is possible to establish everywhere, then the risk will be reduced. If embankment breaks, they fall in risk. - *Forest Employee*₃

The NGOs usually select the poorest and most vulnerable families to provide financial support for adaptation since the poor people hardly able to cope with the climate impacts. As a result, the poor become relief-dependent after having continuous financial aid. An *NGO Worker*₃ described the consequence, “They do not try to become self-dependent. They do not think that ‘I need to be wealthy or I should survive without other people’s help’”. Rather than providing financial aid, few NGOs provide marketing support to sell locally produced products to reduce forest dependency and adapt to the effects of climate change. Because of the lack of fresh water for irrigation, for instance, NGOs encourage local farmers to cultivate crops like sunflowers and wheat that require less water. The agencies sell high-quality seeds to the local farmers and buy the crops from them to sell outside of the community. The agencies also help, because of soil salinity, to create home-based gardening by which the families can meet their vegetable needs and can sell the leftover.

(4) Arranging alternative livelihood to reduce forest dependency

To decrease forest dependency for livelihoods, the Government of Bangladesh introduced AIG (Alternative Income Generation) through *Kormo Srijon* (Employment Creation), VGF (Vulnerable Group Feeding), VGD (Vulnerable Group Development), and RMP (Rural Maintenance Programme) – for employing destitute women as workers for road construction, in the coastal belt of the Sundarbans. A *Forest Employee*₁ said, “If we can manage local people so that they will not go to the Sundarbans (for livelihoods), we could protect the forest”. Alternative livelihood generation for reducing forest dependency is a core management strategy for conservation.

In our management strategy, at first, we need to incorporate that how the livelihood would be arranged for the people who are living on the periphery (of Sundarbans). We cannot stop pass-permit (of harvesting), even if we want. We cannot stop it [harvesting] in spite of having damage to the Sundarbans. If we stop providing pass-permit, what those people will do (to earn money). We need to think about this issue at first. - *Forest Employee*₂

Alternative livelihoods are important to the people of the Sundarbans for not only reducing forest dependency but also adapting to climate change as they cannot do subsistence farming. To arrange alternative livelihood, the management agencies provide training for entrepreneurship development and provide cash to the forest dependent people for sheep rearing, poultry farming, livestock, fish culturing, small

business, mud crab fattening, tourism, and shrimp fry collection from the river. Beyond training and financial aid, few agencies provide backward and forward marketing linkage to produce and sell a product. For instance, NGOs provide handicraft training to the local women for preparing export quality toys such as dolls, Panda, Elephant, and arrange the raw material supply like rattle, foam and thread through maintaining liaison with the suppliers. The women prepare the toys and take a certain amount of money as wage for per piece of finished product.

We targeted that we would bring back people from the Sundarbans by providing them alternative livelihood opportunities. In this case, we achieved success at a satisfactory level, not 100%. - *NGO Worker₃*

The management agencies of the Sundarbans are considering CBT as a tool for 'conservation' in response to climate change. A *Forest Employee₁* addressed, "Tourism can be a mean of alternative livelihood. ... Tourism can open a new scope of business here. The local people will earn their livelihood by involving those businesses. Eventually, the dependency (to collect forest resources) will be reduced". To execute this idea, under a pilot project, the agencies have built environment-friendly tourist cottages at the home of few forest dependents (beneficiaries) and provided boats for carrying tourists to the Sundarbans. Now, these beneficiaries feel a strong 'sense of ownership' of the forest as they earn satisfactory amount of money from tourism. As a result, they are no longer depleting the mangroves. An *NGO Worker₂* noted, "They used to cut-up trees (from the Sundarbans), but now they show the same tree again and again to the tourists and earn livelihoods". The *NGO Worker₂* further reported that by understanding the value of the forest, the beneficiaries communicate with the other residents about the importance of forest conservation.

Developing community tourism facilities in the periphery of the Sundarbans is supported by all major management stakeholders participated in this study. However, most of the tourism initiatives to ensure community benefits are under planning stage. To ensure community benefit (e.g. income, employment) from community asset (e.g. mangroves), the Government wants to encourage small-scale local entrepreneurship by involving people in tourism.

The major share or benefit receives by the (external) tour operators. We want to divert this benefit to the community. At present they (community people) are working as employees. But they are not entrepreneurs. Their entrepreneurship is very low. ... If they (community) take initiatives (of tourism business), the Government will assist. Our conservation partners could assist them as well. By developing native tourism structure, they can attract the tourists. – *Forest Employee₃*

The management agencies have identified a range of community employment scopes from tourism including handicrafts, local food, local cultural show, tour guides. Community based eco-tourism is considered as a resilient livelihood option in the Sundarbans as it can be a replacement for forest resource collection which will reduce forest dependency and enhance ecological resilience. An *Executive of UNESCO* said that, “We have hope here. If you give them (community people) motivation, we would be successful. We could be able to maintain the sensitive ecosystem of the Sundarbans creating awareness by tourism”. Mainstreaming the local people of the Sundarbans through tourism can make them custodians of the forest rather than exploiters.

6.5 Evaluating the sustainability of adaptation

The disaster of severe cyclone Aila (2009) triggered a range of management functions to build resilience in the coastal Sundarbans. This section will evaluate whether those actions can be contemplated as sustainable adaptation. All the management actions in the Bangladesh Sundarbans are integrated and adaptive (climate change management does not operate in isolation). The contextual climate management actions are focused on four areas: forest management, disaster risk mitigation, adaptation, and poverty alleviation through alternative livelihood creation (Thomalla et al., 2006). Controlling the forest resource usages and protecting the mangroves from human exploitation helps to grow the natural forest that enhances resilience and eventually ensures sustainability of social-ecological system (Davoudi et al., 2012). Involving the local community (through CMC, VCF, CPG) in the climate change management structure and empowering the institutes (through coordination, consultation, donation) to achieve a comprehensive goal is an indication of resilience (Adger, 2003b). Here, the degree of resilience, of course, depends on how actively the community people are involved and how properly the organisations coordinate. NGOs - working mostly to execute foreign-funded projects - are assisting social transformation process in response to climate change in the coastal Sundarbans. Rather than project-based

approach, ongoing action and coordination among the agencies for climate change management can offer more resilience.

For conserving the mangrove ecosystem, the management agencies are creating climate change awareness among the community people to stop forest depletion. The climate education is valuable to those people as they come to know the importance of the forest for their survival from climate impacts, the significance of wildlife to the forest, the doings for disaster risk reductions, and the adaptation techniques. The findings of this research indicate that all these knowledge about climate change is creating positive outcomes in terms of community engagement to conserve the ecosystem. O'Brien and Leichenko (2007) argue that community-networks and access to information support creating the desired changes, which leads to building a resilient society in the face of climate change. An example of successful resilience building is community-based mangrove plantation to protect embankments. Similarly, collective social efforts and utilisation of the available facilities and resources enhance resilience to cope with the extreme weather events (Adger, 2003b). Aligning with this thought, community residents themselves do volunteer to fight the disaster like cyclones, and they use their available social resources like schools as cyclone shelters, the sound systems of prayer centres to announce the early cyclone warnings.

Adaptation is the main priority in response to climate change for the coastal community of the Sundarbans as they are highly vulnerable. Disaster risk reduction, food security (e.g. agricultural-adaptation, livelihoods management), and drinkable water arrangements are the focus of the contextual adaptation. Generally, the contextual adaptation interventions are reactive – actions taken in response to impacts, which indicates to less resilient actions (Martin et al., 2015). Lack of addressing medium and long-term risks in adaptation interventions (e.g. improper embankment technology) lead often to maladaptation by bringing further vulnerabilities (Fünfgeld & McEvoy, 2011). Relief aid dependency (short-term adaptation) in the disaster following years reduce the resilience of the socio-economic system, thus the community cannot withstand the further disaster. After confronting a climate event, they need to start from the beginning and to carry over the effects for long-time, eventually, fall into the poverty trap. This study has introduced and utilised four approaches to adaptation to access the sustainability of management interventions in

response to climate change vulnerabilities in the Sundarbans. **Table 6.4** demonstrates the concepts and proposed definitions of a few climate adaptation management approach with contextual examples.

Table 6.4: Adaptation approaches to climate change vulnerabilities

Concepts	Definitions	Examples
Relief approach	Management agencies provide financial or material support to the vulnerable groups after having disasters.	- Providing Rain Water Harvesting System or PSF to the community for free - Providing building materials for houses for free
Hazard approach	Management agencies work for the vulnerable groups to develop their short-term coping capacity.	- Financing for building embankments - Excavating canals for irrigation
Market approach	Management agencies assist the vulnerable groups to produce and sell locally made products for providing livelihood support.	- Supplying the seeds of sunflower to the community and buying the crops from them. - Supplying raw materials of handicraft to the women and buying the finish products for reselling. - Encouraging shrimp farming or mad crab fattening
Resilience approach	Management agencies work to make the vulnerable groups self-dependent through capacity building for managing present vulnerabilities and future risks.	- Offering training for composite agriculture - Encouraging community to engage with CBT

The relief approach is not reliable for the community of the Sundarbans in terms of sustainable adaptation (or development). That does not mean the community people do not need financial aid. The aid should be used in such way so that they can combat the future climate events without external funding (Barnett, 2008). For instance, management giving PSFs to the community for drinkable water as relief aid. If the PSFs are out of order for any reason like damaged due to disaster or need to repair, the community people drink the saline water of the pond until the management agencies fix up the PSFs. Due to late funding for project-based climate change management, often the PSFs are fully damaged and need to be replaced with a new one. This type of adaptation is not sustainable. To enhance resilience, management agencies form a committee from the community who raise fund from the users of PSFs for maintaining and repairing the facilities. For building more resilience, the management agencies can develop a community income source so that they can buy their PSFs when those PSFs needed to be replaced. Co-financing (by beneficiaries and donors) is better than relief

aid to enhance resilience as it reduces relief dependency and creates a sense of ownership to the adaptation interventions.

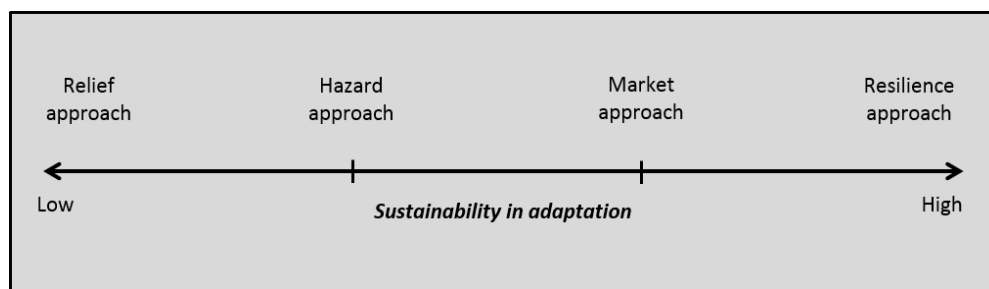
The hazard approach addresses climate vulnerabilities, which contributes to short-term resilience (Fünfgeld & McEvoy, 2013). This approach is a more resilient approach to adaptation than relief approach as it eradicates the vulnerability for short-term by ensuring the continuation of local productivity. For example, canal excavation can ensure water supply for irrigation for the short-term timeframe, but after having a disaster when the canals are filled with saline water and sediments, those canals need to be re-excavated. Most often the users of the canals do not get financial utility as much as the cost of excavating the canals, and sometimes canals are no longer usable for irrigation because of entering the saline water, but the government is still paying back the instalments of the loans taking for canals excavation. The adaptation intervention, which does not consider future risks of climate change and the medium to long-term effects of the intervention itself is categorised as hazard approach. Hazard-based solution is counterproductive in long-term and often lead to maladaptation (e.g. embankments in the dynamic delta of the Sundarbans area) as it only addresses current vulnerabilities (Martin et al., 2015).

Under the market approach to adaptation, management agencies provide the vulnerable community marketing supports to sell locally produced products (Stringer et al., 2009). The market approach is quite resilient in terms of solving the limitation of relief and hazard approaches, in which the local production system is diverted in response to climate change impacts for maintaining the income generation flow of the community. Dependency on NGOs for marketing the produced items like sunflowers and handicrafts decreases the resilience of this approach. If the diverted production system can create opportunity to produce locally, process locally, sells in the local market, then that approach contributes to developing more resilience (O'Brien & Leichenko, 2007). The market approach to adaptation can be a resilient approach if it can ignore the dependency on external agencies for selling local products (e.g. crops, handicrafts) and services (e.g. tourists accommodations).

The resilience approach considers the economic sustainability, social capacity and long-term environmental aspects while taking adaptation interventions for climate

change (Brown, 2011). For example, composite agriculture technique that can ensure productivity of rice, fish and vegetables, despite having disaster and salinity intrusions, without causing environmental damage. The vulnerable people can practice composite agriculture without external assistance. Again, CBT is a resilience approach to arrange livelihoods as it is a way of using the forest (local asset) without degrading the ecosystem. If CBT can be utilised as a replacement for forest resource collection, then it can be a resilient approach to manage climate change. By targeting domestic tourists (local market), CBT can further contribute to resilience (O'Brien & Leichenko, 2007). CBT also enhance resilience by educating the necessity of natural resource conservation (Adger & Tompkins, 2004). Overall, this research theoretically and empirically examines how the adaptation interventions of the Sundarbans are contributing to resilience for ensuring sustainability. **Figure 6.2** exhibits the typical adaptation approaches and their relative sustainability.

Figure 6.2: Climate adaptation continuum



In Figure 6.2, sustainability is low for relief approach to adaptation and sustainability is high for resilience approach to adaptation. Here, it is argued that hazard approach is more sustainable than relief approach, market approach is more sustainable than hazard approach, and resilience approach is more sustainable than market approach. The approaches are relatively proactive from relief approach to resilience approach and they are relatively reactive from resilience approach to relief approach. The sustainability of adaptation intervention can be increased by enhancing the resilience of each of the proposed approach. By adding external support (e.g. financing, capacity building) to the adaptation approaches, resilience can be enhanced (Bulkeley & Tuts, 2013). Gradual interventions by agencies like NGOs for creating social self-dependency (Korten, 1990) can enhance resilience to climate change in the long-term timeframe. An intervention which leads to maladaptation contributes to neither building resilience nor ensuring sustainability. The adaptation interventions which help to build the

capacity of the people of a society, mostly soft interventions (OECD, 2015), are more resilient to climate change, eventually more sustainable.

6.6 Conclusion

This research aims to examine the climate change management functions, specifically adaptation, in the Sundarbans area in Bangladesh. By taking sustainable adaptation as the framework for examining the effectiveness of climate actions (Adger et al., 2005a), this study examines the climate change management functions in the coastal Sundarbans and argues that building resilience contributes to sustainability in adaptation. This study identifies several key empirical issues related to contextual climate change management which are important to ensure sustainable adaptation. Firstly, project-based management may not be effective and efficient in response to the continuous challenge of climate change. Project based management is likely to be useful if the projects can build social resilience, that means the people of a society can solve their own problems after getting assistance from projects. Secondly, community involvement in conservation management and community networking for disaster risk reduction lead to building resilience. People of a society can easily adapt to climate impacts if the management agencies gradually take over the climate management functions to the community people.

Thirdly, educating about climate change in terms of (general) awareness, knowledge (e.g. how to make adaptation) and early disaster warning can reduce vulnerability. Climate education and access to information regarding climate change make people capable of combatting climate change. Fourthly, not all the adaptation interventions (e.g. maladaptation) to climate change are equally effective, the effectiveness of an adaptation approach depends on its contribution to resilience. Nothing is perfectly resilient; management agencies can work for enhancing resilience. By applying robust resilience building strategies, sustainability in adaptation interventions can be increased. Finally, CBT can be a tool for sustainable climate change adaptation in terms of livelihood management. CBT can enhance the resilience of WHA of developing countries where large number of people are depending on forest resource collection. As CBT arranges employment for the community people, it creates social resilience; again, CBT is building natural resilience by replacing the forest resource collection,

thus it creates ecological resilience. The present research shows that CBT is useful for awareness building among the community people.

The research presented in this chapter has several implications for the management agencies which are involved in managing climate change vulnerabilities. This chapter addresses the management actions for climate change in the Sundarbans of Bangladesh, which might provide a comprehensive idea about the climate actions to the contextual management agencies. The existing management agencies of the Sundarbans will be able to compare the effectiveness of the different types of climate management actions. Few management strengths like educating people about climate change, community involvement in management, tourism as an alternative livelihood option, and management weaknesses like disadvantages of relief aid, project-based management structure, might motivate those agencies to redesign the future actions. From this research, the policymakers, researchers, and donors may find ways to ensure sustainability in adaptation interventions. Aligning with the previous researches conducted in different contexts, this research identifies a few resilience-building strategies that might give the policymakers more confidence to follow those strategies. This research highlights key contextual challenges related to sustainable adaptation to climate change in a region that contributes least to the problem but is highly vulnerable to the consequences of anthropogenic climate change.

Chapter 7

Climate Change Management: Cross-border Analysis

7.1 Introduction

Climate change represents a considerable and growing threat to the resilience of coastal forest biodiversity and community viability, particularly in the context of developing countries^{66,67}. To enhance social-ecological resilience in response to climate change, policies regarding forest-centric economic functions including tourism need to be critically examined. The purpose of enhancing resilience is to build the capacity of a social-ecological system to withstand climate change impacts (Adger & Tompkins, 2004). National policy structures regarding environment, conservation, climate change and tourism directly influences the level of social-ecological resilience of natural World Heritage areas (Higham et al., 2016b). Policies for conserving forest biodiversity have direct implications for the livelihoods of people living in and adjacent to World Heritage areas in developing country (Eagles et al., 2002). The Ganges delta is recognised as one of the most climate vulnerable regions in the world (IPCC, 2014). To enhance social-ecological resilience at the coalface of climate change, forest conservation policy is indispensable but not sufficient on its own without management action to close the policy-action gap to build resilience.

Reviewing the management actions of transboundary ecosystems offers learning opportunities (Hall, 2009; Macknick & Enders, 2012). This chapter presents a comparative analysis of both parts of the Sundarbans spanning the international border of Bangladesh and India, with the specific purpose of achieving insights into how the respective management regimes contribute to building social-ecological climate change resilience. In performing this analysis, this chapter set out to critically explore the areas of convergence and divergence in the management actions of the Sundarbans World Heritage in response to climate change across the international border of Bangladesh and India (research question 3). More specifically, the chapter examines the comparative climate change management regimes of the Sundarbans in relation to forest biodiversity, forest communities, World Heritage and tourism. The reason for the comparative study is to learn lessons from both management regimes (Higham et al., 2016b; Rose, 1991). In doing so, this study engaged with the

⁶⁶ A version of this chapter is accepted for publication: Hassan, M. K., Higham, J., Wooliscroft, B., & Hopkins, D. Climate change and World Heritage: A cross-border analysis of the Sundarbans (Bangladesh-India), *Journal of Policy Research in Tourism, Leisure & Events (Special issue)*

⁶⁷ A part of this chapter has been published in conference proceedings: Hassan, M. K. (2017) Relative approaches in response to climate change, *Macromarketing Conference 2017*, 19th-22nd June, Queenstown, New Zealand

management stakeholders including government, NGOs, and international agencies on the current conservation actions and analysed relevant documents reaching across the trans-boundary context.

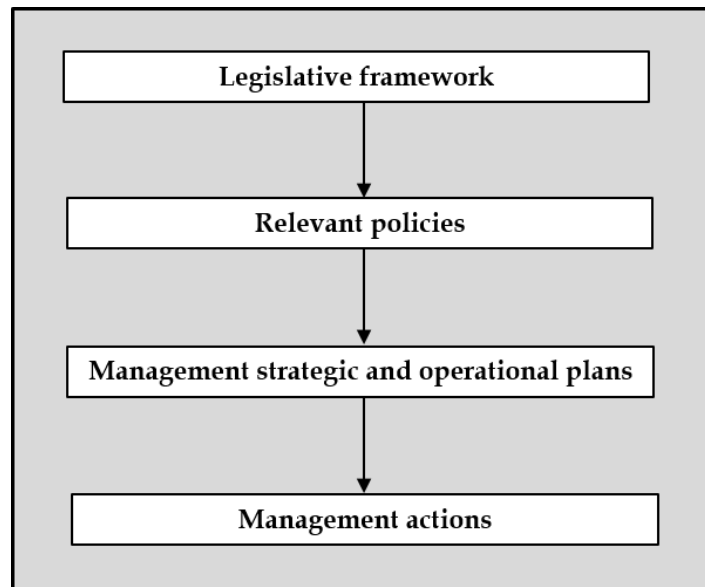
7.2 Theoretical background

Management responses for building resilience to climate change in World Heritage settings largely depend on national policy structures. Higham et al. (2016b) articulate four critical phases of managing protected area such as natural World Heritage. They argue that World Heritage management actions exist in a hierarchical structure which includes national acts of legislation, relevant policy formulation, management strategies and plans, and management actions (**Figure 7.1**). First and foremost, the management structure of World Heritage is built upon national legislative frameworks that are defined in environmental legislation, conservation acts, climate change legislation, and tourism laws (Eagles et al., 2002). Aligning with relevant acts and legislation, secondly, policies are formulated to ensure the resilience of natural heritage. Thirdly, strategic and operational plans are developed by the management agencies of World Heritage Sites based on relevant policies (Higham & Maher, 2007). Finally, management actions are required to achieve the goals of strategic and operational plans (Higham et al., 2016b). Examining management actions in response to climate change, therefore, must be anchored in a critical analysis of the legislative and relevant policy contexts, which form the foundation upon which the management regimes (strategies, plans and action) of World Heritage agencies may build social-ecological resilience.

The consequence of biodiversity management actions in response to climate change depends on a range of policies regarding adaptation and resilience building (Heller & Zavaleta, 2009). Adaptation within an ecosystem is not always possible as it is a long-term procedure, complex in nature and if often capital-intensive (McMahon, 2014). Lack of knowledge, resource, and institutional capacity may also act as barriers to integrate resilience in forest management (Nelson et al., 2016). Incorporating policies to reduce deforestation and increase afforestation helps to improve the resilience of forest ecosystem (Ravindranath, 2007). Robust managerial integration - top-level strategic plans with bottom-level operational plans (Zapata & Hall, 2012), trans-boundary coordination (Bulkeley & Newell, 2015), and policy for community involvement in

management can increase the social-ecological resilience of WHAs (Adger & Tompkins, 2004; Brown & Hay-Edie, 2014).

Figure 7.1: Protected area management policy and action hierarchy



Source: Adapted from Higham et al. (2016b)

Communities are considered as an important component in UNESCO World Heritage management. However, community needs are often neglected in conservation management and tourism policy, particularly in developing world contexts (Viñals & Morant, 2012). To conserve protected areas, community needs should be substantially addressed in terms of livelihoods and local resilience development (Brida & Risso, 2010; Okware & Cave, 2012). The critical point is balancing between requirements for conservation and community needs (Viñals & Morant, 2012). The most common economic function of natural protected areas in developing countries is forest resource extractions (e.g. logging, fishing) by community residents. UNESCO does not discourage the use of natural WHS, but strongly recommends considering sustainability and resilience in forest resource utilisation. Communicating the value of WHS status to the community through tourism can be a motivator for the local community to conserve protected areas in developing countries (Sharpley, 2012).

Planned and controlled tourism in WHS provides economic benefits as well as can contribute to conserving and restoring ecosystems through tourism income (Brown & Hay-Edie, 2014). Policy aimed at replacing conventional forest resource extraction with nature-based tourism can contribute to biodiversity conservation (Reddy & Wilkes,

2012). As tourism is an avenue of poverty alleviation (Chettiparamb & Kokkranikal, 2012) and climate change education (Higham et al., 2014), it can also enhance community resilience by raising awareness and preparedness for climate change. World Heritage status gives an extra impetus to foster tourism in the forest ecosystem. However, uncontrolled tourism may be a threat to a forest ecosystem, and weak policy action might be a threat to the WHS status and tourism (Cochrane & Tapper, 2006; Shackley, 2006). CBT is considered a way of maximising the local economic benefit and conserving the ecological value of forest ecosystem (Chettiparamb & Kokkranikal, 2012), which can contribute to enhancing the resilience of natural WHSs and adjacent communities.

Community-based forest management - involving local people to manage natural resources for local benefits - is a longstanding and widespread conservation policy approach (Brosius et al., 1998). It is critically important to consider the community in forest management and wildlife protection in cases in which communities are highly dependent on forest resource collection (Noe & Kangalawe, 2015). Forest vegetation and wildlife are very much interdependent in terms of the nutrient cycle and ecological recycling (Rajpar & Zakaria, 2014). The more effectively the nutrient cycle works, the better the forest health. In terms of the relationship between community, forest, and wildlife in developing world countries - the community must benefit directly from forest conservation and be actively involved in management for forest conservation and wildlife protection. The available literature informs the inter-relationships between community, forest, and wildlife in relation to management scope (**Table 7.1**).

Table 7.1: Relationships between community, forest, and wildlife

Relationships	Relative benefits	Emerging threats	Management scope
Community to forest		Exploitation (Parida et al., 2014)	Forest conservation (Chowdhury et al., 2014)
Community to wildlife		Poaching and killing (Hoq, 2014)	Protection, rescue, and release (Streicher, 2016)
Forest to community	Protection from disaster (Osti et al., 2009); Resource utilisation (Redmond et al., 2016)		Livelihood support (Nath et al., 2016)
Forest to wildlife	Shelter and food (Rashvand & Sadeghi, 2014)		Afforestation and assisted regeneration (Chowdhury, 2014)
Wildlife to community	Resource collection (Sparling, 2014)		Livelihood support (Garcia et al., 2014)
Wildlife to forest	Maintenance of ecological balance (Rajpar & Zakaria, 2014)		Wildlife protection (Jalais, 2014; Noe & Kangalawe, 2015)

Source: Academic literature survey

Socio-economic, environmental and legal policies have a considerable and direct influence on macro-level management actions for building climate change resilience in protected natural areas (IPCC, 2014). Social background (e.g. education, employment) and economic condition (e.g. poverty or wealth) are important factors for conserving biodiversity under climate change (Spittlehouse & Stewart, 2004). Political ecology (Higham et al., 2016b), geopolitical interest (Zelenskaya, 2018), 'land-use policy' taken by the political government has direct implications for social-ecological resilience (IPCC, 2014). This research is framed to examine how the policy context and macro-environmental factors inform management actions (the fourth phase of Figure 7.1) that contribute to building climate resilience of the Sundarbans. The line of argument that underpins this study is that assessing policy, planning and management actions in relation to forest biodiversity (vegetation and wildlife), forest community, World Heritage and tourism can reveal the contribution of management regimes to climate change resilience in a cross-border context.

7.3 Policy context: The Sundarbans (Bangladesh and India)

In Bangladesh and India, the Sundarbans has strategic importance as the mangroves buffer hydro-metrological climate events (e.g. cyclones, tidal surges) and providing livelihoods for adjacent communities. National Forest Policy (1994) and Indian National Forest Policy (1988) permits to harvest and collect forest resources (e.g., fish,

honey, nipa-palm thatching materials) and conduct tourism in the forest for economic benefits. At present scale, the role of tourism is low for economic benefits in relation to forest resource collection in the Sundarbans (Islam, 2011). However, the existing policies are largely unable to ensure sufficient community benefits from tourism activities in both contexts. In response to emerging needs like addressing climate change and tourism, both countries have introduced policies. **Table 7.2** outlines the major acts of legislation and policies applicable to the Sundarbans in Bangladesh and India.

Table 7.2: Acts of legislation and policies regarding conservation, climate change, and tourism in the Bangladesh and Indian Sundarbans

	Bangladesh	India
Environmental legislations	Bangladesh Environment Conservation Act, 1995 The Environment Court Act, 2000	Environmental Protection Act, 1986 National Environmental Tribunal Act, 1995 National Environmental Policy, 2006
Conservation acts and policies	Forest Act, 1927 Bangladesh Wild Life (Preservation) Order, 1973 National Forest Policy, 1994 Marine Environment Conservation Act, 2004 Biological Diversity Act 2012 Wildlife (Conservation and Security) Act, 2012 ECA Rules 2016 [Regulations for Ecologically Critical Areas]	Indian Forest Act, 1927 Wildlife Protection Act, 1972 Forest Conservation Act, 1980 National Forest Policy, 1988 Coastal Regulation Zone Notifications, 1991 Recycled Plastics Manufacture and Usage Rules, 1999 Biological Diversity Act, 2002 Biodiversity Protection Act, 2003
Climate change regulations	Climate Change Trust Law, 2010 Ozone Depleting Substances (Control) Rules, 2014	Air (Prevention and control of pollution) Act, 1981 Ozone Depleting Substances (Regulation and Control) Rules, 2000 Energy Conservation Act of 2001 National Green Tribunal Act, 2010
Tourism laws and policies	Bangladesh Tourist Reserve Area and Special Tourist Zone Act, 2010 National Tourism Policy, 2010 Bangladesh Tourist Reserve Area and Special Tourist Zone Policy, 2010	National Tourism Policy, 2002

Sources: Ministry of Environment and Forests (2016); Ministry of Civil Aviation and Tourism (2016); Ministry of Tourism (2016); Government of India (2014); Ministry of Environment Forest and Climate Change (2016) and Saini (2014)

The basis of the forest laws and policies which are practised in Bangladesh and India is the Forest Act 1927 developed by British colonial authorities. In post-partition of the Indian Subcontinent, the laws have been changed and amended several times according to the need of the respective countries. The acts of legislation available in Bangladesh and India have implications for conservation. Wild-animal hunting is illegal in both parts of the Sundarbans. In both contexts, the management of the forest is under the jurisdiction of Forest Department of the country. From the 1990s, the forest

conservation practices in Bangladesh started based on a few key acts of legislation such as the Bangladesh Environment Conservation Act 1995 and its Rules 1997 and the Environment Court, 2000 (Mohammad, 2013). However, the major acts of protecting forest and wildlife of India are the Forest Conservation Act 1980, Wildlife Protection Act 1972, Environmental Protection Act 1986, and Biodiversity Protection Act 2003 (Singh, 2016).

The climate actions in the Bangladesh Sundarbans are mostly conducted by the Bangladesh Climate Change Trust under the Ministry of Environment and Forests. In India, by contrast, the Ministry of Environment Forest and Climate Change is responsible for climate actions. India's National Action Plan on Climate Change (2008) emphasises afforestation in the degraded land by expanding forest cover to 33% of Indian territory. The National Forest Policy (1994) of Bangladesh also highlights the necessity of afforestation and the country is working on a 25% forest cover policy. According to the conservation policy of Bangladesh, the locality at the edge of the SRF is defined as the 'Sundarbans impact zone', and the Ecologically Critical Areas (ECA) Rules (2016) defines 10 kilometres from the boundary of SRF as ecologically critical where environmental management must be monitored. The SNP and its fringe locality are known as the 'Sundarbans region', and the activities of the region including tourism are monitored to minimise environmental disturbance.

In both contexts, the environmental and conservation legislation pay little attention to the policies of tourism management in forest areas. For example, clause 2(5) of the Wildlife Conservation and Security Act (2012) only defines 'ecotourism' - any travel to natural areas without damaging the ecological value and improving socio-economic wellbeing of the local community. Even the National Tourism Policy (2010) of Bangladesh does not clearly identify how the World Heritage status of the Sundarbans and tourism can contribute to community development in relation to climate change. The Indian National Tourism Policy (2002) addresses the critical role of the private sector with the government (as a pro-active facilitator and catalyst) able to manage tourism to preserve Indian heritage. It does not indicate specifically the ways to ensure community benefits from tourism. In both contexts, again, there is no significant clause in the policy documents regarding World Heritage management - how the countries

utilise the UNESCO World Heritage operational guidelines in relation to biodiversity, community benefits, and tourism management.

There is no strategic and operational action plan (the third phase of Figure 7.1) based on policy structures publicly available for any parts of the Sundarbans. It is also unknown how the relevant policies (e.g. environmental, conservation, climate change, tourism) are integrated by management agencies to contribute to enhancing the social-ecological resilience of the WHA. Some policy-action gaps clearly exist, for example, both management regimes have the provision of tourism research but there is no reliable up-to-date statistical data publicly available regarding tourist markets, visitor arrivals, and visitor flows (e.g. the total number of annual tourists, the breakdown of domestic and international tourist arrivals, and visitor patterns) in the Sundarbans. In the context of developed countries, action plans inform management actions in conservation and World Heritage areas (Higham et al., 2016b). Where action plans do not exist or are not clearly implemented, examining management actions regarding conservation, climate change and tourism can only help to understand the extent to which management actions are (or are not) contributing to building social-ecological resilience.

7.4 Research approach

The empirical research presented in this study addresses the management actions of the Sundarbans in Bangladesh and India in relation to relative climate change resilience. To collect data, two qualitative research techniques were utilised: semi-structured in-depth interviews and document analysis. Firstly, 22 interviews were conducted using a judgmental sampling technique (Malhotra, 2010) to recruit management stakeholders of the Sundarbans from Bangladesh and India (West Bengal). Secondly, document analysis was applied to cross-check the claims of participants and to enrich information from secondary sources. The documents include participant recommended published and non-published materials, websites, project prospectuses, and promotional materials like leaflets, flyers, and posters; the lists of documents are given in **Appendix F(1-4)**.

To collect empirical data, a set of predetermined questions were included in the interview schedule regarding climate management actions in relation to forest

biodiversity, forest community, World Heritage and tourism, and external influences on the contextual climate change management (**Table 7.3**). The fieldwork was conducted in four months during May-August 2016, on the basis of availability of the management stakeholders of the Sundarbans. The interview programme was conducted in different locations in Bangladesh (Dhaka, Satkhira and Khulna) and India (Canning and Kolkata), where the management agencies of the Sundarbans are located. Interview participants were selected from three broad categories of management stakeholders - the government, NGOs and international agencies. The interviews were implemented mostly in the office of the participants.

Table 7.3: Synthesis of semi-structured interviewing

Part one:	The extent of climate change action
	a) Community - awareness, involvement and benefit
	b) Forest management
	c) Wildlife species management
Part two:	Macro-environmental influences on contextual management
	a) Government approaches to conservation
	b) Legal enforcement system
	c) National capacity and WHS usage policy
	d) The degree of bilateral cooperation

The potential stakeholders were approached to participate in a face-to-face interview based on pre-selected sampling criteria (e.g. which organisation will be included, what information is needed, and the most appropriate representative of the organisation to be interviewed). Before including any participant in the interview programme, to avoid conflict of interest, the interviewer informed the participant of the purpose of the interview, assurances of anonymity, and that there would be no financial incentive for participating in the interview programme. **Table 7.4** provides a brief description of the interview programme of this research.

Table 7.4: Description of interview participants

Location of interview	Classification of participants	Particulars of participants	Recruitment criteria	Interview length (duration of recordings)
Bangladesh	Government	- Forest employees (3) - Administration (1) - Local government (1) - NTO (1)	Government employees working for the Bangladesh Sundarbans	41-84 minutes (average 62 minutes)
	NGOs	- NGO workers (7)	NGO workers working only for Bangladesh Sundarbans	48-90 minutes (average 61 minutes)
	International Agencies	- UNESCO, IUCN (2)	Executives of international agencies working on the Bangladesh Sundarbans as one of the key responsibilities	55-87 minutes (average 71 minutes)
India	Government	- Forest employee (1) - Registered guides (2)	Government employee or authorised person working in the Indian Sundarbans	42-67 minutes (average 54 minutes)
	NGOs	- NGO workers (3)	NGO workers working only for Indian Sundarbans	50-77 minutes (average 63 minutes)
	International Agencies	- WWF-India (1)	Executive of core international agency working for the Indian Sundarbans	110 minutes

By applying thematic analysis on the empirical materials of the interview programme, the research presented in this chapter has come up with two broad themes to reveal the research question 3 of the thesis. The first theme emerged from the analysis is titled 'Conservation as climate change action' with three sub-themes: (1) Managing the local community for conservation, (2) Managing the forest for conservation, and (3) Managing the wildlife for conservation. The second theme developed from the qualitative analysis is titled as, 'Political ecology and management regimes' with four sub-themes: (1) Law enforcement system, (2) Management structure, (3) Navigation and other economic functions, and (4) Geopolitical regimes. The themes and sub-themes developed by analysing the empirical materials were further confirmed with the information of available documents.

7.5 Findings

(A) Conservation as climate change action

The prime focus of the management of the Sundarbans, in both Bangladesh and India, is to conserve the forest from community-driven exploitation, despite the management agencies observing the impacts of climate change including increasing salinity, and the impacts of super cyclones on the mangrove and its wildlife. This study has identified two reasons behind the present conservation strategy: firstly, at present scale - exploitation of the forest is more visible than climate change effects; secondly, the climate change impacts on the biodiversity are highly uncontrollable, whereas forest and wildlife exploitation can be managed by changing forest policies and practices. The overarching purpose of reducing human-induced exploitation is to ensure a healthy forest ecosystem that is resilient to climate change impacts.

In response to the effects of climate change on the forest and wildlife, the management agencies only take adaptation measures which are feasible to implement, for instance, excavating ponds in the highland of the Sundarbans to hold rainwater for the wild animals - as the availability of fresh water supply has been reduced for increased salinity and sea level rise. Since salinity is degrading the characteristics of mangrove vegetation, in answer to a question regarding the feasibility of intervention in the forest for increased salinity, a *Forest Employee*₂ (Bangladesh) replied, "Very tough, very tough..., human have intervened in different circumstances, in few cases they are successful. But intervention in a natural system is very tough". For instance, many wild animals die because of extreme cyclones and big size freshwater mangroves are gradually converting to small size marine mangroves because of increased salinity, but no action is possible to take for preventing these effects. Side by side, the agencies have addressed that other climate change impacts like increased temperature, erratic rainfall, and ocean acidification might be affecting the mangrove health and consequently the wild animals, however, no measure is possible to take.

(1) *Managing the local community for conservation*

The management of both parts of the Sundarbans considers community residents as a vital component of conservation strategies. One *Executive of WWF-India* said, "The men (community people) are considered most important, as the natural area (is important). The realisation is - by excluding this people conservation is not possible". People

become a part of the (eco)system because of their long-time relationship with and dependency on the forest. A *Forest Employee*₂ (Bangladesh) said, “if the people permanently migrate from here - we directly cannot say, it will be good (for the forest) as natural resource extraction stop. Again, there may be a negative impact if the resource extraction entirely stops. ... It is a matter of research if we stop 100% resource extraction, the forest will get our desired strength”. Thus, the management of the mangrove wants to conserve the ecosystem by maintaining the harmony between the human and the forest and its wildlife.

Awareness building:

The severe cyclone Aila (in 2009) is the ‘turning point’ of creating climate change awareness in the Sundarbans regions of Bangladesh and India. An Indian *NGO Worker*₁ said, “Before Aila, nobody thinks of climate change here seriously”. Considering the loss and damage of cyclone Aila, the management started thinking that climate change needs to be communicated in terms of adaptation, mitigation, and resilience. In India the conservation and climate change message are developed dominantly in ‘national or state level’ which is communicated by the NGOs and social clubs; whereas in Bangladesh, the messages of climate change are developed at ‘local level’ and communicated mostly by the NGOs. The management agencies of both parts of the Sundarbans have reported that the existing communication awareness-building efforts are very effective, but more communication is required for creating awareness about conservation and climate change (as mentioned in Chapter 5).

This study has identified that there are two major objectives of awareness creation among public in Bangladesh and Indian Sundarbans, first, building consciousness to protect the ecosystem, and second, enhancing knowledge about climate change and adaptation. Most often those objectives are conveyed to the public in a ‘single communication scheme’ by describing the inter-relationship of biodiversity and climate change. In both the contexts, the awareness creation functions, dominantly led by the NGOs, have significant similarities. To make people aware, the management agencies organise street drama, display documentary films in schools and in public gathering, day observation, and conduct group meetings.

The goals of public communication programme are to make local people understand the value of the mangrove forest, do and don'ts for forest conservation and how forest exploitation would threaten their survival under climate change. An *NGO Worker₁* of Bangladesh described the achievement of the awareness programme, "The guy who did not study science, he/she also understands what nature is (the importance of the forest to combat climate change). Now awareness is very high among people". The public communication activities are accomplished with an association of government departments and NGOs in both contexts. The degree of communication efforts in Bangladesh Sundarbans may be more advanced than Indian Sundarbans, because of the presence of considerable number of NGOs working on climate change projects.

Besides the public communication efforts, the NGOs conduct 'one to one communication' where necessary. By identifying potential forest misusers, the NGO workers or volunteers meet individually to make them understand the disadvantages of the forest resource exploitation and remind about the punishment. For conservation, the prime messages communicated to the forest dependents by the management agencies of Sundarbans are not to catch fish from prohibited forest area as this place is the breeding station of fishes and sanctuary for animals, stop catching fish and crab during breeding time, not to throw plastics in the rivers, ways of getting preparation for cyclones.

To reduce the 'human-animal conflict,' the NGOs and volunteers make people understand the 'positive relationship' between tiger conservation and availability of forest resources. An Indian *NGO Worker₁* stated the message they convey to the community to protect tigers from the community people: "If the Tigers are saved, the forest and the other wildlife would be protected; overall the ecosystem would be sustained. The more the health of the forest ecosystem will be okay, the more the (economic and environmental) condition of the marginal community of the forest will be okay." And both the countries are quite successful in managing human-animal conflicts.

Conversely, there are a few basic differences, despite having significant similarities, in the approaches to climate change communication between the countries. For enhancing public awareness, there are a considerable number of small and large eye-

catching billboards containing different information including basics of climate change, approaches to adaptation and resilience, mitigation measures, necessity of forest and wildlife conservation with helpline numbers in the public places like bus stations, marketplaces or important junctions of the locality in Bangladesh Sundarbans. That means the Bangladesh Sundarbans directly convey the message of climate change, whereas India has a slightly different strategy. The Indian Sundarbans started to communicate climate change with an emphasis on adaptation by following 'indirect approach' for the marginal community people. The management agencies considered the 'requirement of information' of community people regarding climate change. An *Executive of WWF- India* said, "We have built the climate change awareness, but we did not start with climate change. We started with (salt-tolerant) paddy. We talked about paddy and then climate change; not climate change first and then paddy. So, we build awareness by this way". Later, those agencies changed strategy and started 'mass communication' to all level of people including school going students. According to the strategy, the NGOs display nationally developed 'documentary films' which provide environmental education and climate change knowledge.

By slide show projector [projection], we show the school students about global warming, climate change and saving the tigers. Why and what is the reason for global warming? Why the global warming occurs? What is the reason for climate change? What should be done to prevent it? We show everything through cinema. There are many actors act here, for example, Amitabh Bachchan, Shahrukh Khan, Srilekha Bandyopadhyay, Nachiketa, Soumitra Chatterjee. These actors say: save the tigers, save the Sundarbans, save the West Bengal, save India, save the World. We are continuously running this programme round the year. – *NGO Worker₁* (India)

In many cases even having high awareness does not lead people to act accordingly; by supporting this one *Executive of IUCN*, working in Bangladesh, said, "Knowledge is not enough for actions". This is because of the 'lack of ability' of the forest-dependent community people. Therefore, management agencies further offer different type of supports like assisting in adaptation, arranging alternative livelihood to the community so that they can keep them away from forest exploitation. One of the reasons for supporting the community is to find an 'entry point' to communicate the messages of climate change and importance of conservation. Most often the awareness building and adaptation measures are parallel initiatives.

Adaptation and livelihood support:

In Bangladesh and India, the government builds and maintain river embankment to keep the locality of the Sundarbans free from entering salt water. It is the central adaptation measure as the other adaptation measures depend on the sustainability of the embankment. Both parts of the Sundarbans are searching for 'suitable and financially viable' embankment model. There are successful examples of the embankment in different part of the world, but the two developing countries often are in dilemma between the financial requirements (budget) of improving embankments and the economic value (or utility) of the land. A *Member of Local Government* in Bangladesh, who was elected from the community complained, "The measurement (of the embankment) is 50/60 years old, and then the road was built on the embankment. On that time the climate was different. Now, the depth of the river is decreasing day by day..., the height of the water is increasing. But the road (embankment) has not uplifted".

The embankments are made up of soil, bricks and concrete blocks, however, sometimes overflow and break up during strong cyclones like Aila, Sidr. Increased salinity in the water is a reason for land erosion which decreases the durability of embankments. After rebuilding the embankment, there is a common way practised in both Bangladesh and India to strengthen the embankment by planting trees. An Indian *NGO Worker*³ said, "In Aila, this embankment was broken. There was no embankment here. This embankment was built later. After building the embankment, trees were planted on both sides to protect it".

The embankment failure flooded the locality with saline water, as a result, the agricultural production collapse for at least next four years. The management agencies take many adaptation measures in agriculture, fisheries to ensure local food security. Bangladesh Institute of Nuclear Agriculture (BINA) have invented different type of paddy varieties, suitable for different salinity levels; whereas India has found out traditional varieties of salt-tolerant paddy which used to be produced several decades back. The salt-tolerant paddy can ensure crop during a disaster, but its yield is much lesser than popular hybrid paddy, thus farmers only cultivate those species for a short period after having disasters.

To enhance forest resilience, the Forest Department and NGOs provide a range of ‘individual and household level’ livelihood supports and alternative employment opportunities to the community. To assist cultivation in the Sundarbans, different type of support is provided like tractors for cultivation, quality seeds, powered irrigation machine, paddy thresher, and pesticide sprayer machine for agriculture. Alternative livelihood opportunities are created by providing poultry and dairy training, goat, sheep and pig rearing support, making rice from paddy, making rice porridge locally, assisting in fish culture, training on batik print, sewing machine, capital for business, boat for fishing, smokeless cooking stove, and solar lights to the forest-dependent people in both Bangladesh and Indian Sundarbans. An *Indian Forest Employee* said, “We give this support so that people do not go to the forest and can earn their livelihoods by working with these”.

Nevertheless, very often, it is difficult to ensure the sustainability of the alternative livelihood options because of lack of management skill and effect of the disaster. An *Indian NGO Worker₁* said, “The (alternative livelihood) projects had been successfully running, but because of (cyclone) Aila everything was damaged”. Regional poverty is a threat to the resilience of the social and ecological system of the Sundarbans. An *NGO Worker₃* from Bangladesh said, “After having Aila, no crops were grown in this area for next one to two years”. Crop loss occurs almost every year which makes the community people poor and these poor people often deplete the forest resources.

Those who understand, they care (about climate change). Somebody care, somebody doesn't. Necessity knows no law. Where there are lot of needs, how they'd consider (climate change) seriously. They have to live (first). Their position: I know (about the necessity of forest conservation), but give me food to full my tummy. - *Forest Employee₁*

To reduce community vulnerabilities, the management agencies of both contexts also provide some ‘community level’ adaptation and livelihood support including arranging drinkable water, making roads, setting tube wells, excavating ponds and canals, veterinary doctor training and tools and equipment, tree plantation training, high productive cultivation methods commonly in both Bangladesh and India. In consideration of arranging drinkable water, the Indian government has supplied fresh water to the people by pipes from long away from the Sundarbans communities, and the water quality is very good; whereas the management of Bangladesh Sundarbans

arrange few ways of drinkable water like PSF, rainwater harvesting which cannot always assure quality water. In both contexts, the early warning system is satisfactory and the management agencies including local volunteers work for the community before, during and after cyclone to support them. The number of cyclone shelters is less than the actual need for both the context, but Bangladesh contains better condition in this regard. In India, tourists' lodges are used to provide shelter during the cyclone.

The adaptation efforts sometimes result in malpractices which might add threat to conserving the ecosystem in the long-run. For adapting to the entrance of saline water in the cultivable land, people of the Sundarbans mostly left traditional agriculture (e.g. producing paddy) and started shrimp farming and mud crab fattening with the association of NGOs. However, as the shrimp farming and crab fattening are highly capital intensive (poor cannot invest) but low labour intensive (increase local unemployment); and it is not possible to produce paddy beside those farms as salt water and chemicals are used there. An *NGO Worker*₂ of Bangladesh acknowledged, "For shrimp farming, the people irrigate salt water in the plain land [agricultural land] ..., the powerful people are capturing poor people's land. If they do not want to give, they pump salt water in the land. Then it is no longer possible to do agriculture in the land". By losing agricultural land, the poor people need to further depend on the Sundarbans.

The shrimp fry and baby crab which is used to do farming are collected from the rivers of the Sundarbans which is a threat to the resilience of the forest. The Sundarban Biosphere Reserve (India) identifies that because with collection of each shrimp fry, more than seventy fish seedlings of other species become demolished. Furthermore, as crab plays an important role in the food chain, an *Executive of IUCN* indicated, "Mud-crab fattening cannot be climate change adaptation. Mud-crab normally grows in the Sundarbans and nobody would catch them. This is not like this that mud-crab increases due to climate change". The extent of crab fattening and shrimping farming is much greater in the impact zone of Bangladesh Sundarbans than Sundarbans region in India.

Involvement and empowerment:

For ensuring successful forest conservation, the management agencies of Bangladesh and Indian Sundarbans working for ensuring strong and meaningful community involvement. In Bangladesh the Sundarbans, there are CMC, VCF, and People's Forum (Nath et al., 2016); similarly, in Indian Sundarbans, there are Joint Forest Management (JFM) and Forest Protection Committee (FPC) to include the community people in the forest conservation. All these committees and forums receive around 25% forest revenue coming from the Sundarbans for development budget, work with the government for reducing awareness creation and forest dependency, arranging alternative livelihood, assisting in adaptation and local development. The two countries conduct 'community patrol' effectively with the help of local volunteers who watch not in the forest but in the locality if anybody theft wood from the forest and store at home. In addition, community people work as volunteers with the management agencies for early cyclone warning, rescue, and rehabilitation in both contexts. The management agencies of the Sundarbans take assistance from the community people for rescuing tigers when those entering in the locality.

The NGOs are working to empower the local community by creating a relationship with the local administration in the Bangladesh Sundarbans; therefore, the community people easily get access to the administration and can inform about their wants like repairing roads, veterinary advice, or necessary supports. Whereas the management agencies of the Indian Sundarbans particularly NGOs work to build capacity by organising the good local people so that they can raise voice to stop illegal forest exploitation. An Indian *NGO Worker*₁ said, "The number of bad people is very few - it means, the destroyers are very few in number, but they are aggressive. The good people understand the importance of the forest, but they do not want to involve in any hassle (to stop destroyers). But they are aware." The *NGO Worker*₁ further added that they create a stronger force against forest exploiters by organising those forest friends.

(2) Managing the forest for conservation*Harvesting control:*

Resources harvesting are controlled by government regulation in both parts of the Sundarbans. Only fish, honey (including wax), crab and shrimp fry can be collected subject to having legal permission from the Forest Department of the Country. In

addition, the Forest Department of Indian Sundarbans directly control the resource collection, procurement and do marketing the forest products. All type of tree harvesting is legally prohibited except the nipa palms in the Bangladesh Sundarbans, whereas a limited and controlled tree harvesting is ensured in the Indian Sundarbans. A *Forest Employee*₁ of Bangladesh Sundarbans said, “Stop harvesting means conservation. When you conserve the forest..., as it is a natural forest, nature would decide which plants will survive and which will decline”. The purpose of harvesting control is to let the forest grow naturally and get back its own resilience.

Patrolling:

Patrol to prevent exploitation is one of the core functions of the Forest Department of both parts of the Sundarbans. Navy and community volunteers often assist the Forest Department to find theft of forest resources. To ensure effective patrolling, Bangladesh Sundarbans has introduced GPS and camera-based patrolling management, known as SMART patrol. However, the both Forest Departments reported that their number of patrolling staffs was limited in comparison to requirements. The Forest Department of Bangladesh Sundarbans reported insufficient logistic support such as patrolling boats, telecommunication facilities. Despite the limitation, the objective of patrolling is quite successful in both the contexts. Sometimes illegal tree cutting occurs as the territory of the forest is huge. An Indian *Forest Employee* said, “We save trees to save the humans. But people do not understand it always. Sometimes they cut trees illegally”.

Management capacity building:

Bangladesh Sundarbans is also building cyclone-resilient forest stations to ensure non-stop forest patrolling during disasters. To enhance the capacity of the management staff, different types of training are arranged including techniques of forestry and tree plantation to the Forest Department staffs, waste management and pollution control to the tourism businesses, disaster management to the local volunteers, climate change response techniques to the NGO workers. Management participants from the Forest Department of both parts of the Sundarbans reported inadequate human resource and lack of skilled staff. With limited capacity, both management regimes of the Sundarbans are trying to enhance capacity at the face of climate change.

Assisted regeneration:

There is no plantation inside the SRF area except in newly appeared natural islands. This policy is followed in both Bangladesh and Indian Sundarbans to grow more mangrove vegetation. To create vegetation in the empty islands, the Forest Departments of the two countries do regeneration [aided afforestation] which amplifies the procedure of the growth of the vegetation. Both the countries use their 'self-invented' methods to grow new forest by using seeds and small plants. An *Indian Forest Employee* articulated, "We plant trees in the sturdy soil; we dig holes in every one metre to put seeds there. Say, today we dig the soil, and then the high-tide fills up those holes, and we inseminate the seeds during the low-tide next day". A Forest Employee of Bangladesh also said that a range of technical decisions involved developing forest in newly exposed islands.

Afforestation is easy to say but difficult to do. We need to know which plant will grow in which place. In general, we know about exotic and indigenous species; whether I could plant exotic species. One is local demand, and another is natural demand. I need to identify the natural demand. These are the technical issues. Forest Department needs to do it. If I fail to fulfil the natural demand, then afforested plants might be grown but will not be sustained naturally (in the long-run), will be demolished. - *Forest Employee*₂ (Bangladesh)

Local afforestation:

The Forest Departments of both countries encourage and support tree growth by providing free plants in the locality beside the mangrove forest to maintain the tree loss because of cyclones and salinity. The reason for encouraging local afforestation is to reduce dependency on the Sundarbans by meeting the local demands like cooking fuel, fruits, and timbers. In the case of local afforestation, the management agencies of Bangladesh have created few effective and efficient examples. The management agencies with the association of community people developed and maintain social forest and roadside plantation like the famous '*coastal greenbelt project*' in Bangladesh. In addition, the management agencies of Bangladesh Sundarbans utilised a 'net-fencing method' - making net-fence in the muddy place outside of the embankment to hold the floating mangrove seeds for making greenery - to strengthen the embankment. Furthermore, this study found a significant contribution of NGOs and donor agencies in tree plantation in the islands and locality of Bangladesh Sundarbans.

We do not plant trees in the reserve forest because there is no permission to enter [plant] there. We are planting trees in the islands next to the community. We have done tree plantation around the Gabura [Island beside the Sundarbans]. We did 80% afforestation over there. - *NGO Worker*₃ (Bangladesh)

Forest research:

Bangladesh Forest Research Institute conducts mangrove research, particularly on Sundari tree. Both parts of the mangrove forest are facing top-dying disease of Sundari trees, but the reason for the disease is not clear - there are different opinions among researchers regarding the cause of the disease like increased salinity, end of life cycle, or fungal infection. The Forest Department of Bangladesh tried to solve the top-dying disease according to all the prescribed solution available to them, but they did not find any positive result. The Indian Sundarbans also conducted soil and water quality monitoring with the assist Institute of Environmental Studies & Wetland Management. Both parts of the forest produce mangrove plants by using floating seeds in the nursery for planting.

Pollution control:

As there is a direct impact of pollution on the Sundarbans, the management agencies particularly the NGOs of both parts of the Sundarbans are trying to teach environmentally agricultural practices. By realising the effects of using chemical fertilisers and pesticide for agriculture on the biodiversity of the Sundarbans, the NGOs are introducing organic fertilisers such as vermicomposting, and biopesticide developed from the local 'indigenous knowledge'. An *NGO Worker*₁ of Bangladesh said, "We are trying to reduce the use of chemical fertiliser and encouraging people to use compost fertiliser largely - in order to protect the soil health". Another *NGO Worker*₁ of the Indian Sundarbans expressed, "we are trying to create a bio-village" in the locality of the edge of the Sundarbans.

To reduce soil pollution from plastic items, the Indian Sundarbans has been declared as 'no plastic zone'. To achieve this target, the management agencies provide dustbins in rural villages to avoid throwing plastic in the river and organised 'plastic camp' in the local markets to collect garbage plastic. Even the tourism business operators take out the used plastic items of the tourists and burn those. A *Registered Tour Guide*₁ of Indian Sundarbans said, "The benefit of burning (the plastics) is to prevent those from floating away. Carbon is created, but burning can reduce total pollution". In addition, the

Forest Department (with the assistance of local people) of Indian Sundarbans never let any dead cattle floating from the river; rather those bodies are collected and buried. Conversely, plastic items are often seen floating to the Bangladesh Sundarbans by the rivers of the industrial area of Mongla port.

Tourism management:

Tourism operation in the Sundarbans is controlled by the Forest Department of Bangladesh and the Forest Department of India. In light of National Forest Policy (1994) and Indian Forest Act (1927) and Forest Conservation Act (1980), the forest centric economic functions including tourism operation are managed by the Forest Department and related ministry of the countries. Of course, policies related to tourism management such as Bangladesh National Tourism Policy (2010), and Indian National Tourism Policy (2002) are considered while governing tourism in fragile natural sites. Policy documents of both nations highlight the community benefits from tourism. But in both cases, the degree of community benefit from tourism is low compared to the benefit received by the external investors. In the Bangladesh Sundarbans, tourism functions are not monitored according to the forest conservation policy. Tourists have been suspected of littering in the forest and tourism operators throw garbage and burnt engine oil into the rivers which threaten the status of the WHS.

There is no visitor management programme in the Bangladesh Sundarbans, but the Indian Sundarbans implements a 'visitor management' programme in the most sensitive areas of the mangrove. A *Registered Tour Guide*₁ (India) said, "There is a system - first come first serve basis - only 13 boats are allowed to go to *Netidhopani* per day". The Forest Department of Bangladesh occasionally conducts training for tour operators and guides to teach them the guiding practices for conducting tours in the Sundarbans but follow up is limited. **Table 7.5** outlines the comparative tourism management practices of the Bangladesh and Indian Sundarbans.

Table 7.5: Relative tourism management for conservation in two parts of the Sundarbans

Aspects	Bangladesh Sundarbans	Indian Sundarbans
Accessibility	Tourists can walk on few trails throughout the forest accompanied by gunmen of the Forest Department.	Tourists are not allowed to alight from the boats and walk inside the forest. They can just see the forest from the boat.
Vessel movement	Tourist vessel movement is quite flexible.	The tourists' boats are not allowed to anchor everywhere, except next to the assigned camp of the Forest Department.
Vessel fitness	The fitness of the tourists' vessels are not checked at any stage and no measure is taken to reduce sound pollution	Every tourist boat must use silencer (a device installed with the engine to reduce sound pollution)
Pollution control	The legal obligation of waste management is not strict; therefore, disposable plastic garbage is dumped into the rivers and beside the trails of the Sundarbans.	Due to reducing river pollution, tourists are not allowed to carry any disposable plastic items like packets, bottles, thermos call (e.g. plastic plates). Carrying such type of materials during the tour is illegal. Floating plastic materials are taken out by skimmers.
Monitoring and control	The environmental concerns emerge from tourism are not monitored in a structured way.	Any type of environmental incidents occurred by the tourists or tour operators are highly accountable to the authority with immediate penalties like cancelling operator's licence or financial compensation.

Source: Interview programme

The tourism management practices are quite structured in the Indian Sundarbans. Tourists' movement in the Indian Sundarbans is monitored by registered tour guides (guide-cum-inspector authorised by the Forest Department and recruited from community people) that accompany every tour group. The tourism regulations in the Indian Sundarbans are quite strict, for example, the registered tour guides prohibit the consumption of alcohol while travelling, due to earlier alcohol-related incidents on tourists' boats. Before starting a tour, the registered tour guides brief explain the importance of regulations relating to disposable plastic and alcohol, and they inform the tourists regarding the punishment of any misconduct in the forest. The tour boat operators use skimmers to pick up any plastic items that are disposed of in rivers. By testifying all their works, a *Registered Tour Guide*₂ (India) said, "In order to conserve the forest and wild animals, we are working as agile guards. Side by side, we ask tourists - not to pick any leaves from the trees, not to disturb any wild animals, not to throw any plastic in the water".

The Forest Department along with few agencies is planning to control and monitor tourism activities in terms of carrying capacity, visitor management, pollution control in Bangladesh Sundarbans. By revealing the plan regarding tourism in Bangladesh

Sundarbans, an *Executive of UNESCO* said, “We are thinking about the management and protection of the Sundarbans by considering it as a World Heritage Site. Protection does not mean only the forest protection. To manage the forest according to the guidelines of World Heritage, if Forest (Department) requires any capacity, (we) would think of building those capacities”. The Bangladesh Sundarbans is not following properly the operational guidelines developed by the World Heritage Centre (2012) for WHSs. Thus, there is an urge from the UNESCO to maintain the mangroves ecosystem according to the World Heritage policy.

(3) Managing the wildlife for conservation

Supporting endangered animals:

Since wildlife is important to maintain biodiversity, both management authorities of the Sundarbans work for protecting endangered species. In both cases, tigers receive high priority as it belongs to the top of the food chain and is an indicator species in terms of the to the health of the ecological region. An *Executive of WWF (India)* explained the significance of tiger conservation, “The tiger is like an umbrella species. It provides protection to a lot of other species by simply being there. So, if we can maintain the tigers, many other things get maintained. And therefore, the ecological services we humans use continue to be available”. The main approaches to tiger conservation are ‘awareness communication’ to reduce human-animal conflict and managing the availability of food. As tigers often come to the local villages due to food scarcity in the forest, the Indian Sundarbans creates a ‘psychological barrier’ for the tigers by putting in about 8 feet high nylon-net in the forest boundary close to these localities.

To examine the effectiveness of conservation efforts during a particular period, both parts of the Sundarbans conduct a regular animal census. Both Bangladesh and Indian Sundarbans has jointly conducted tiger census by using camera-trapping method (World Bank, 2014a). The Indian Sundarbans also do dolphin counting whereas the Bangladesh Sundarbans has crocodile census. Due to adapt to the scarcity of fresh water for increased salinity in the Sundarbans, the Forest Department of both countries excavated ponds inside the forest to hold rainwater in those ponds for the wild animals. In both contexts, the Forest Department with the assistance of local volunteers rescues injured animals and provide treatment before releasing into the forest. Wildlife

conservation is so important for tourism as the Sundarbans is attractive to the tourists for the availability of diversified animals including iconic Bengal tigers.

Breeding supports:

Both parts of the Sundarbans have crocodile breeding facilities from where baby crocodiles are released to the forest to increase the crocodile population. However, captive breeding does not work for all animals. A *Forest Employee*₂ of the Bangladesh Sundarbans described the reason, “In a safari park in Bangladesh, tiger bred kittens, but will those tiger kittens sustain in the natural environment? ... In general, no tiger through captive breeding can sustain in nature”. In order to maintain the food chain and the availability of forest resources, the management of Sundarbans stop resource collection like fishing, honey collection, or crab catching during the reproductive season. Policy documents of Bangladesh (e.g. Marine Environment Conservation Act 2004, and Wildlife Conservation and Security Act, 2012) and India (e.g. Wildlife protection Act 1972, and Biodiversity Protection Act 2003) focus on the need to breeding support to increase wildlife population.

(B) Political ecology and management regimes

(1) Law enforcement system

National legal-political aspect has become one of the core determinants of conservation success in the Sundarbans. In Bangladesh Sundarbans, a few top national politicians and local powerful men shelter the pirates who are considered as one of the biggest threats to the wildlife, as they involve in smuggling, wildlife trade, poaching wild animals. Even the law and enforcement agencies are helpless to control these illegal activities because of the mafia backup of pirates. A *Member of Local Government* copied a statement of a top officer of Border Guards Bangladesh (BGB): “Bring the permission from higher authority. In 24 hours, we will wipe the pirates out (from the Sundarbans). If Government permits us, we can see [eradicate] it. We cannot do anything beyond direction”. In addition, politically powerful men recommend for releasing the criminals who are caught with the proof of the crime.

Sometimes MPs [Member of Parliament] or Ministers phone the staff of the Forest Department when they arrest the wood thieves. Theft woods are sometimes caught but need to discharge. A group was caught with tiger skin, and then a (convicted) guy was killed in the crossfire - so that the name of the Godfather would not be disclosed - a poor man does not need a tiger skin. Once, criminals were caught with slaughtered deer; by special force - setting the court on Friday [weekend in Bangladesh] - those (criminals) were released. - *NGO Worker*₃ (Bangladesh)

Illegal offending related to forest and wildlife is less common in India, because of the strong national law enforcement practices for biodiversity conservation. In the Indian Sundarbans, all identified offences are taken seriously into account and offenders are prospected. As result, the illegal wood cutting, and poaching is nearly zero; the number of pirates is few. Even Bollywood film stars are not exempt from the punishment of detention for illegal hunting.

If the criminals are caught, they would be punished by Jail. And, wildlife case means having detained for the whole life. In wildlife case, there is no mercy. You know about Salman Khan, Mansoor Ali Pataudi, Sanjay Dutt. In wildlife case, nobody can get mercy; he might be a great celebrity. - *NGO Worker*₁ (India)

Because of stronger national law and order situation, the biodiversity of Indian Sundarbans is better, as the participants reported the satisfactory quantity of honey collection and events of tiger attacks. In Bangladesh the Sundarbans, there was no tiger attack reported in last five years from the fieldwork period and the honey hunters were unhappy as they got insufficient quantity of honey. Again, the forest staffs of Indian Sundarbans were relatively less corrupted; for example, the number of crocodile release is transparent for Indian Sundarbans (given in the Website) whereas the number crocodile release in the Bangladesh Sundarbans is quite unclear to the public.

(2) Management Structure

The adaptation actions are mostly done by donation-based projects in the Bangladesh Sundarbans; therefore, after completion of the tenure and budget of a project, it is not possible to run the functions. For instance, the Forest Department could not re-excavate the damaged ponds inside the forest because of no funding; again the Forest staffs are quite unsure about the future of SMART patrolling when the project finishes. On the other hand, the management function of the Indian Sundarbans is government programme-based, therefore they do not face funding challenges when nylon nets need to be repaired. For increased salinity, again, the NGOs of the Bangladesh Sundarbans

are struggling to arrange fresh drinkable water for the community through PSF, Rainwater harvesting, desalination plants; whereas Indian Government establishes water supply pipes which transmit high-quality drinkable water far away from the community (Jat, 2015).

The coordination for climate change management in terms of national and regional-international scale is poor in both Bangladesh and India. In national scale, lack of coordination between the authorities often leads to the letdown of the climate actions. In Bangladesh, for example, the Department of Environment develops the climate change management policies, but this authority has no implementing power, and the Forest Department is the implementing authority which is hardly involved in policymaking. Despite having a similar type of management challenges, the management of the two parts of the Sundarbans rarely collaborate. Formal communications started in 2011, but are limited in Memoranda of Understanding (MoU) between the countries; there was no significant joint execution except the tiger census (World Bank, 2014a). However, there are some examples of informal knowledge exchange for climate action.

I have learnt the work about drinkable water from your part, from the Bangladesh Sundarbans. In some regions of your part including Shyamnagar, some projects introduced Pond Sand Filters, process drinking water by collecting water from ponds. I replicated it in here (in Indian Sundarbans). - *Executive of WWF (India)*

(3) Navigation and other economic functions

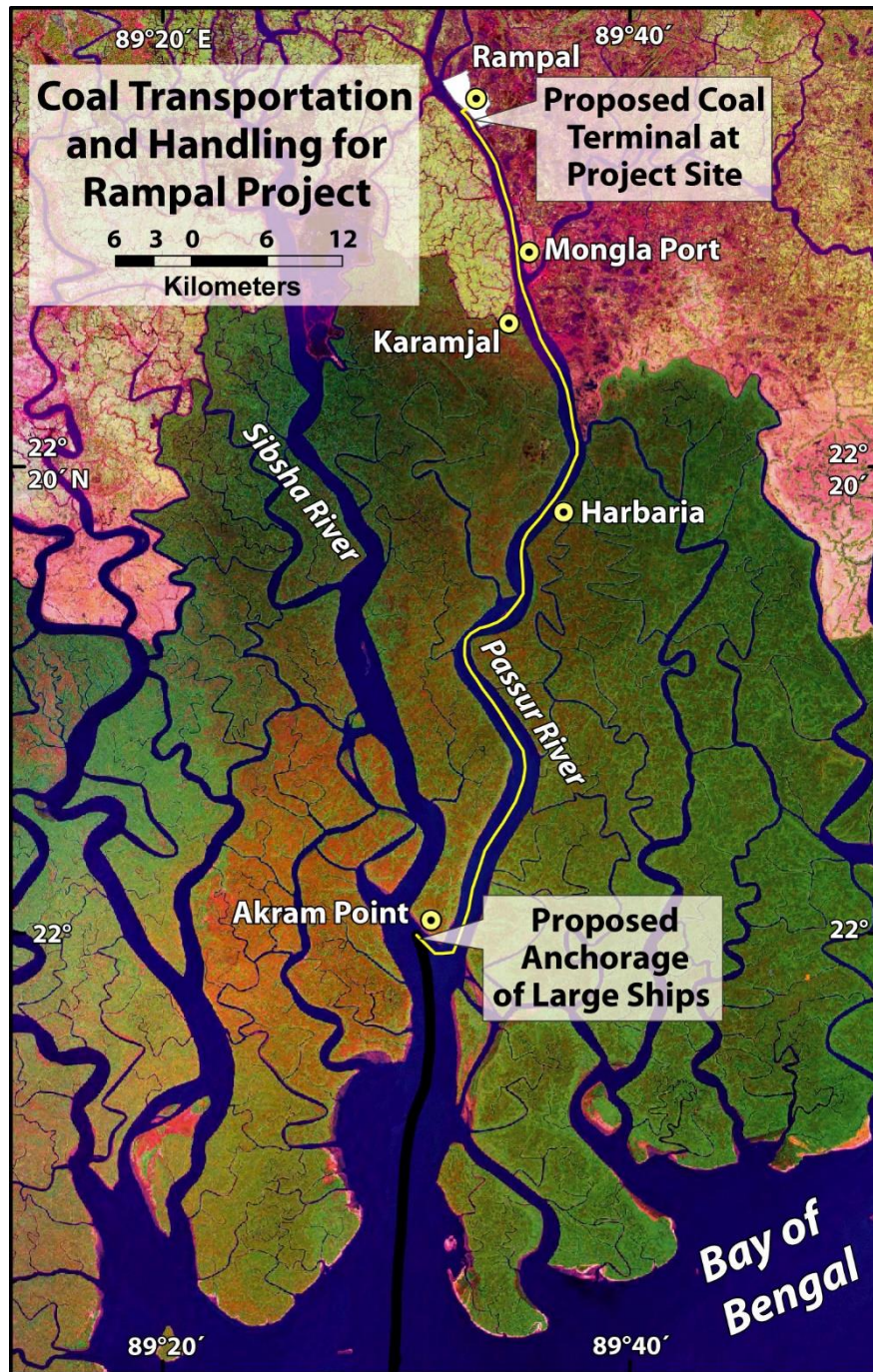
The navigation of cargo vessels through the Sundarbans have considerably increased since 2012, particularly after the implementation of the trade protocol of India-Bangladesh Shipping Pact (Roy, 2015). The Government of Bangladesh is a bit helpless here because the original Mongla- Ghushiakhali route to the Mongla port has silted up for the reduced volume of water pressure from up-stream rivers. Even river dredging is not worthy to make it navigable, because of this reason the vessels have been navigating through the Sundarbans for last few years. Shipping and navigating through the Sundarbans to the Mongla port is polluting the rivers every day, even if there is no accident (Arju, 2016). In addition to the pollution from commercial vessels, there are about 20 cement factories in Mongla at the fringe of the mangrove forest; these factories often dump waste into the rivers to the Sundarbans (Roy, 2015). The Indian Sundarbans have shifted the navigation route, where possible, from inside the

forest to outside (in the rivers between the forest and locality). Nevertheless, both the countries reduce pollution by shifting brickfields from the riverside of the Sundarbans.

(4) Geopolitical regimes

Despite continuous massive protest from a considerable number of national and international bodies, the Government of Bangladesh and Indian government are jointly going to establish a coal-based 1320 MW thermal power plant, known as Rampal Power Plant, in the 14 kilometres radius of the Bangladesh Sundarbans (The Daily Star, 2016). Indian law does not allow establishing a thermal power plant in the 25 kilometres of locality and forest, but the country is an 85% investor in the Bangladesh power plant project (Nazrul, 2016). The power plant was planned to be established beside the Indian Sundarbans, but it failed due to the Indian legal policy obligation. Experts predicted that low-quality coal which produces higher emissions would be imported from India for this plant; and they also said establishing this coal power plant is finding an easy market in Bangladesh for low-quality Indian coal (Mishu, 2016). By investigating the potential and inescapable impacts of the power plant during the construction and production phases, Sattar (2011) and Chowdhuy (2012) have noted in their independent research that the coal-based power plant will threaten the capacity to protect the Sundarbans mangrove system (Muhammad, 2013).

A few more companies want to establish coal-based power plants at Rampal, for example, the proposed 630MW Orion power plant (Harvey, 2016). By addressing the cumulative effect, international agencies are predicting substantial damage of the Sundarbans from rapid 'industrialisation' because of availability of 'electricity and infrastructure', if those power plants start operation. An *Executive of UNESCO*, working in Bangladesh, expressed the reality that the "Rampal (power plant) enhances (additional concern). Few more power stations are going to be established beside the Rampal. Few signboards (of those power plants) were seen. By considering all these issues, UNESCO is very much concerned". Coal transportation throughout the fragile mangroves for the Rampal thermal power plant is a threat to the resilience of the Sundarbans. The proposed anchorage of large ships at the Akram Point in the Sundarbans might be degraded the biodiversity by coal pollution. **Map 7.1** provides a route of coal transportation from the sea to the Rampal area.

Map 7.1: Coal transportation route for Rampal Project throughout the Sundarbans

Source: Simonov (2017)

To assess the situation in the Bangladesh Sundarbans regarding oil spill in the Shela River [December 2014], capsizing coal laden ship [March 2016], and the risks of constructing the Rampal Power Plant, UNESCO World Heritage Centre has conducted a 'Reactive Monitoring Mission' with the association of IUCN in the late March 2016 (Roy, 2016). The report of the mission identified four key concerns regarding the construction of the power plant which include air pollution from coal ash, water

pollution from wastewater and waste ash, increased shipping and dredging, and cumulative effect of the industrial development infrastructure in the forest area (Doak, Murai, & Douvère, 2016). Besides, UNESCO has claimed that the Environmental Impact Assessment (EIA) was not carried out properly. One of the recommendations of UNESCO is:

Taking into account that climate change is a global problem requiring a concerted global solution at the level of the property, it is strongly recommended that the State Party reduce other threats in the property and its surrounding area to secure maximum resilience of the property in the face of climate change impacts. Ecological monitoring for the property should include indicators that measure climate change impacts in view of identifying both short-term and long-term effects on the OUV [Outstanding Universal Value] of the property and the ways and means to effectively address them and the capacity of management staff to plan for impacts from climate change should be further developed (Doak et al., 2016, p. 26).

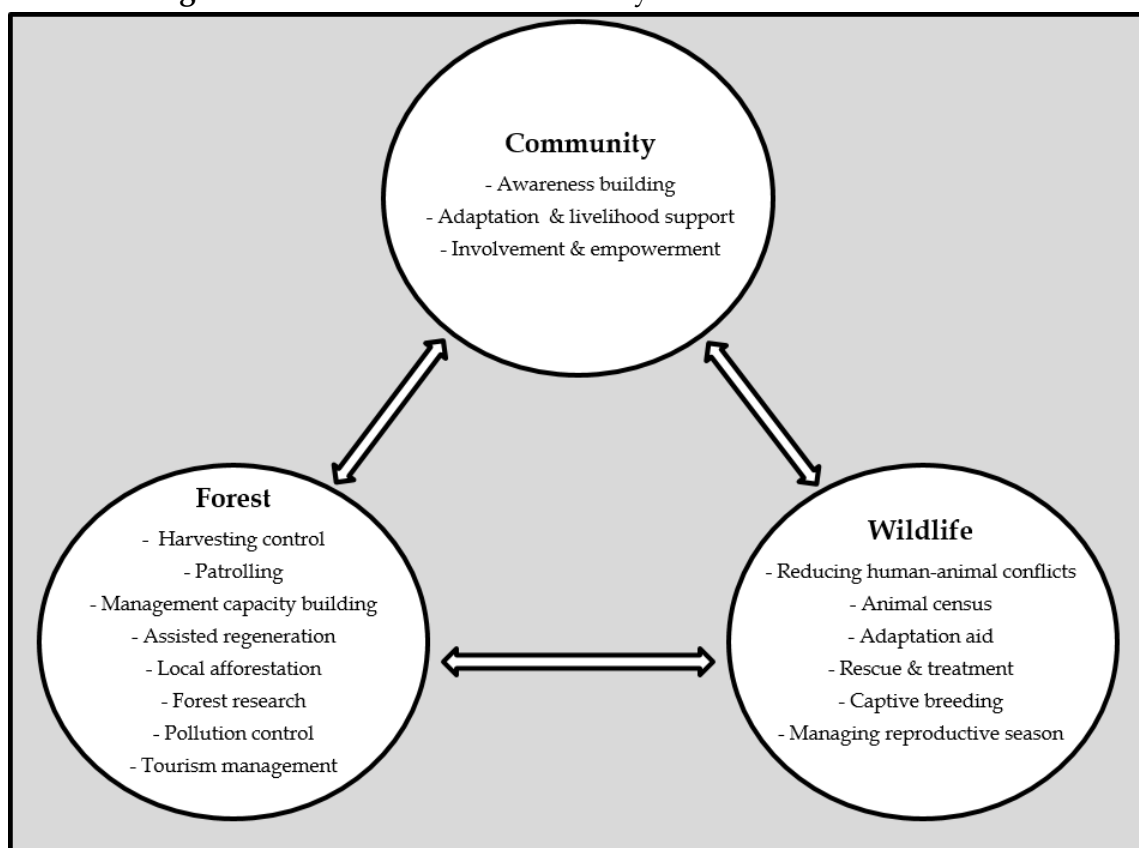
In response to the UNESCO report, the government of Bangladesh replied that the power plant would be established because it would not 'harm' the mangrove forest (The Daily Star, 2016). However, environmentalists noted that the power plant would degrade the ecosystem of the Sundarbans severely (Basu, 2016; Uddin, 2016). An *Executive of NTO* (Bangladesh) predicted the consequence of power plant establishment, "If massive damage, destruction (occurs); we will be out of the UNESCO heritage list". There is a controversial position of both Bangladesh and Indian government in terms of resilience. The Indian Government is serious about conserving the Indian Sundarbans by controlling forest resource collection, emphasising on tourism, and not by establishing the coal-based power plant in their side. However, the Bangladesh Government has ignored the aspect of the social-ecological resilience of the climate vulnerable Sundarbans, and potential threat to the WHS status of Bangladesh Sundarbans while deciding to establish thermal power plant at the edge of the mangroves.

7.6 Comparative climate change management regimes

This research has identified that both parts of the Sundarbans in Bangladesh and India follow a common management regime: conserving the forest and its wildlife for and by local communities. Along with climate education and adaptation assistance, both management regimes support their communities to reduce forest dependency to minimise pressure on forest resources and to enhance forest resilience. To conserve the

flora, the management regimes of both Bangladesh and India apply conventional forestry practices and control forest-centric economic functions like tree harvesting and tourism. To conserve the wildlife, both managements are doing conventional wildlife protection practices and providing a limited scale adaptation support. The management is not taking extensive climate change adaptation actions for the forest and its wildlife, as adaptation is neither feasible (McMahon, 2014) nor efficient (Nelson et al., 2016). **Figure 7.2** provides a framework addressing contextual socio-ecological management actions for climate change resilience.

Figure 7.2: Dimensions of biodiversity conservation for resilience



To conserve the biodiversity of the Sundarbans, communities have become an integral element to manage this fragile and dynamic ecological region (Figure 7.2). Both management regimes conduct similar restoration actions in terms of assisting natural regeneration, guiding faunal reproductively for enhancing the resilience of the ecosystem. The extent of management actions are different as management capacity is the guiding factor to conservation (Nelson et al., 2016). Forest-centric economic functions like tourism, fishing, and other resource collection are also managed for ensuring conservation (Lopes et al., 2015). Tourism management in the Indian

Sundarbans is quite systematic and controlled, which is helpful for maintaining the ecological balance (Reddy & Wilkes, 2012). Bangladesh is launching CBT to reduce forest dependency as alternative livelihoods, eventually, CBT can contribute to mitigation by reducing forest extraction. This research indicates that the desired goal of conservation policy (e.g. controlling hunting and illegal logging) is largely determined by the strength of national law enforcement system.

The understanding behind the current management actions is: protecting the Sundarbans is mandatory - not to contribute to the global mitigation effort, but to protect the community from extreme climate events and to ensure the long-term availability and sustainability of the forest resources. Both countries are giving priority to tourism as a replacement for traditional forest resource collection with a belief mentioned by many scholars including Chettiparamb and Kokkranikal (2012) and Sharpley (2012), that tourism can ensure financial benefit justify the protection of biodiversity. However, the national governance system is threatening the resilience of the ecosystem and the World Heritage status of the Bangladesh Sundarbans by establishing thermal power plants at the edge of the mangroves. Degradation of the Bangladesh Sundarbans because of power plants might affect the biodiversity of Indian Sundarbans in the long-run, but India is ignoring that concern. For achieving resilient ecosystems, national and regional economic development policy should be parallel to the conservation policy (IPCC, 2014).

While conservation actions in Bangladesh and India offer many parallels, the extent of those actions is different because of independent management reaching across the single ecosystem. The available conservation policies should be supportive to the management functions for conservation, but the extent of practices and actions in terms of law enforcement and coordination is different between the two nations. The Indian Sundarbans offers leadership in forest and wildlife conservation as the country has superior law enforcement systems in place. The Bangladesh Sundarbans is found to be performing well in climate education, adaptation, and disaster resilience. In both management regimes, policy for environment, conservation, climate change, tourism and WHS management are helpful to build the resilience of the Sundarbans. Like many developing countries, however, management actions cannot reach the policy standard in all aspects to build resilience (Heller & Zavaleta, 2009). Lack of intra-departmental

integration and transboundary coordination (Hall, 2009), and misuse of available environmental and conservation policy are the reasons of this policy-action gap.

This research addresses the policy frameworks and management operational actions of the Sundarbans World Heritage in Bangladesh and India. It indicates, despite having limited capacity, the management of two parts of the Sundarbans have scope to improve. For practitioner stakeholders (e.g. government departments, NGOs, international conservation agencies), **Table 7.6** identifies a range of practical initiatives that could enhance the resilience of the Sundarbans. The two counties have scope to work and learn together and share their knowledge to conserve this unique World Heritage area. Integrated conservation actions across nations offer effectiveness and efficiency (Zapata & Hall, 2012) but involve a challenge of equitable effort sharing (IPCC, 2014). Thus, the authorities of the two counties can mutually work in some management areas (Table 7.6) as pilot tests and, if feasible, they can work together on a regular basis by incorporating a state of partnership in management policy.

Table 7.6: Practical management initiatives to enhance resilience in the Sundarbans

Areas of management	Scopes of improvement
Climate change response	Avoiding project-based approach (allocating regular funds for climate change management) Focusing on resilience (rather than immediate vulnerability management)
Forest and wildlife conservation	Intra-departmental integration Transboundary collaboration (research, training, knowledge-sharing) Impact assessment of wildlife adaptation support, such as - pond excavation for ensuring fresh water availability, use of nylon net to control human-animal conflict Transparency in conservation data (e.g. wildlife reproduction and release) and progress monitoring
Community development	Sustainable adaptation and livelihoods Sustainability of utilisation of CBT Transboundary knowledge-sharing for effective and efficient community adaptation Scope of planned harvesting of forest resource
Tourism and WHS management	Communicating the importance of World Heritage Community involvement in (daily) WHS management Assessing carrying capacity (ecological and tourism) Measuring tourists' movement (e.g. statistics) Determining relative ecological costs between tourism and forest resource collection

7.7 Conclusion

This research reports upon a comparative study of management regimes of relevance to the social-ecological resilience of the climate-vulnerable Sundarbans WHA in Bangladesh and India. Most of the management actions to enhance the resilience of the

mangroves are grounded in the important roles of communities by considering them as one of the big threats to and potential beneficiaries of the protection of this complex ecosystem. To enhance the ecological resilience of the World Heritage, beside conventional biodiversity management practices, the climate vulnerabilities of the communities are addressed in terms of adaptation, livelihoods for enhancing social resilience. Reduction of community vulnerability can reduce community-induced forest depletion (Adger & Tompkins, 2004) because vulnerable communities are a further threat to the ecosystem due to potential resource exploitation. Both management regimes are inspired to conserve the World Heritage status of the region for enhancing community resilience and for utilising tourism as an avenue of conservation: the forest is for the community (livelihoods and climate disaster protection) and the community is for the forest (conservation).

Based on the literature background (Table 7.1) and contextual findings, this research has conceptualised a framework where community, forest, and wildlife are considered as three dimensions of biodiversity conservation for social-ecological resilience (Figure 7.2). The framework is an extension of the theoretical concept 'community-based forest management' which suggests the policies of sustainable forest management through involving community people in forest management and satisfying local needs by forest resources (Brosius et al., 1998; Noe & Kangalawe, 2015). Aligning with the concept of community-based forest management, the framework presented in Figure 7.2 further suggests that communities are an integral part of the (eco)system as the climate vulnerabilities of communities influence forest resilience. Therefore, policies to satisfy community needs only related to forest resources is not sufficient, but the non-forest related community needs (e.g. climate education, adaptation, livelihoods) should be addressed for achieving resilience. The framework can be generalised for developing country policy contexts in which communities are directly depending on forest resources.

Several key policy implications emerged from the current research. Firstly, climate education is necessary but not sufficient for conservation and climate action in the case of vulnerable poor communities. Secondly, addressing forest and non-forest related community needs in the conservation policy can enhance resilience by increasing natural protection, availability of forest resources, and tourism value of the World

Heritage. Thirdly, project-based actions may not be appropriate for a continuous, long-term challenge like climate change, and management agencies, therefore, need to implement continuous programme-based adaptation strategies. Fourthly, law enforcement systems based on policy priorities are one of the key contributing factors for the success of conservation. Poor national law enforcement system reduces the effectiveness of micro-level management actions for conservation. Finally, management integration in regional-international scale may provide mutual advantages in climate change adaptation, biodiversity conservation efforts and world heritage management.

This research suggests the World Heritage managers of both the Bangladesh and Indian Sundarbans would benefit from meeting regularly to discuss, plan and implement joint management initiatives in areas of common concern relating to climate change. All the regulations and policies regarding climate change, environment, conservation, World Heritage and tourism which need to apply for building the resilience of the Sundarbans should be compiled under a single coordinating strategy for conservation managers. Relevant practitioner stakeholders' involvement in developing strategic and operational action plans (Figure 7.1, phase 3) based on available laws and policies need to be ensured. Despite the considerable threat posed by climate change, relatively little research relating to policy, planning and management responses to climate change have directly addressed highly vulnerable developing world contexts. This research examines key policy and management structures in the Bangladesh and Indian Sundarbans management regimes, as they relate to social-ecological resilience. The potential for planning and management collaboration spanning to the India-Bangladesh border emerges as a potentially fruitful pathway forward for a complex and dynamic socio-ecological region that faces the ever-growing threat of climate change.

Chapter 8

Integrated Discussion and Conclusion

8.1 Introduction

Following the last three findings chapters (Chapter 5 to 7), this chapter presents an integrated discussion of the key literature and research findings. In the beginning, this chapter addresses a brief research background of this project in terms of theoretical and contextual perspective. This chapter addresses the key findings of this research in relation to the objectives and three research questions. It also outlines research implications and contributions to existing literature. To do so, this chapter depicts the theoretical contribution to the concepts of understanding, adaptation, and resilience. Besides, two frameworks (social-ecological resilience framework and framework for climate change management through tourism) have been developed to address the integrated findings of this research project. The chapter finishes with a discussion of future research and a concluding statement.

8.2 Research background

Climate change is a great threat to the survival of human and other living beings and to the economic functions all around the world. A range of gradual and rapid changes including sea level rise, high intense cyclones, and salinity intrusion brings multifaceted effects onto the social and ecological system, particularly in coastal areas. The impacts of climate change bringing more vulnerability to the coastal communities of developing nations because of limited coping capacity. Resources such as finance, skilled manpower, and access to technology are very important, but the first and foremost component for responding to climate change is how the climate change is understood by a society. Uncovering the understandings of climate change and the sources of those understandings may assist management agencies of a vulnerable society to develop appropriate communication strategies, which may be helpful for responding to climate change (Whitmarsh et al., 2012).

The nature of climate response varies, based on vulnerabilities and capacity to cope with the emerging crisis. In case of the climate vulnerable coastal societies in developing countries, adaptation is the main response strategy (McNaught et al., 2014). The developing societies often emphasis on quick and short-term solution for vulnerability management through adaptation interventions, because of their demographic background, which may lead to maladaptation and bring further vulnerabilities. Over emphasising on the current vulnerabilities and overlooking the

future risks is the major reason for adaptation failure (Barnett & O'Neill, 2010). Application of the adaptation interventions should help to build the resilience of a system. Investigating the responses to climate change may assist to develop appropriate climate management strategies which help to build climate resilient social-ecological systems (Boyer, 2013).

Forest biodiversity is also affected by climate change, at the same time forest ecosystem plays a direct role to reduce climate change impacts (Heller & Zavaleta, 2009). Forests are the carbon banks (trees are the storehouse of CO₂) of the world, and the trees can reduce the effects of climate change. In many developing nations, forest resource collection is a great source of livelihoods for the communities living adjacent to a forest ecosystem. It becomes a great challenge for management agencies to conserve forest for combating climate change and arrange livelihoods for the vulnerable community. Tourism is a promising avenue to utilise forest without degrading biodiversity (Reddy & Wilkes, 2012). Studying management functions of climate change across different nations relating to forest biodiversity, forest community, and World Heritage and tourism offers learning opportunity (IPCC, 2014; Perry & Falzon, 2014). A comparative study on the ecosystem-based management of two countries explores lessons for good practices in response to climate change.

This research is conducted in the context of the Sundarbans World Heritage (Bangladesh and India), as the coastal mangrove forest and its community both are highly vulnerable to climate change. The forest community is struggling in their day-to-day life for livelihoods and survival because of climate change. Due to the regional poverty, the community people deplete the forest resources as much as it is about to lose its resilience. The mangrove forest is important to safeguard the community from different types of extreme climate events and the forest resources are important means of livelihoods for the community (World Bank, 2014a). By considering the theoretical and contextual background, this research project attempted to fill-up few existing research gaps related to understandings of and responses to climate change in the Sundarbans WHA. Adopting a constructivist philosophy, in doing so, this research used qualitative methods – semi-structured interviews and document analysis.

8.3 Key research findings

8.3.1 First objective – Research question 1

The first objective of this thesis is to critically examine the understandings (awareness, knowledge, and perception) of climate change held by multiple stakeholders (local communities, tourism demand-supply stakeholders, and conservation and management agencies) of the Sundarbans in Bangladesh. Semi-structured interviews were utilised to reveal this objective (research question 1). For achieving this objective, thirty-five participants including the community residents, tourism businesses, tourists, management agencies and NTO were interviewed in Bangladesh. The findings of ‘research question 1’ which examined the current understandings of key stakeholders of the Sundarbans in Bangladesh regarding climate change and how are those understandings constructed among them are presented in Chapter 5.

Research question 1 reveals that climate change understanding varies within and/or between stakeholder groups. All the participants involved in this part of the research have personal experience of climate change. The participants (thirty-two out of thirty-five) who heard about climate change believe that climate change is anthropogenic. Academically educated participants (e.g. management stakeholders, tourists) were explained better about the cause, effects and risks of climate change than uneducated participants (e.g. community residents). Community people have misconceptions about the cause of climate change, but tourist participants describe correctly how climate change is human-induced. The tour operators have varied types of climate change understandings because of different demographic backgrounds. The participants from the management stakeholders have clear conceptions about climate change as they are involved in climate change management in the Sundarbans area.

General understanding or awareness is important but not enough for the vulnerable coastal communities of the Sundarbans for responding to climate change. They need knowledge about different types of adaptation techniques such as cyclone preparedness, livelihoods management. In response to climate change impacts, their attitude is highly reactive as they have so many current problems such as food security, employment, and healthcare. The current knowledge related to community adaptation is mostly communicated by management stakeholders. This research finds that tour operators do not take any significant action in spite of understanding that

climate change may stop tourism business in the Sundarbans. The common understanding of the stakeholders of the coastal Sundarbans is: mangroves conservation is necessary for adapting to contextual climate events such as tidal waves, intense wind force.

Climate risk perceptions of the stakeholder groups (e.g. community residents, tourism business stakeholders, tourists) of the Sundarbans depend on the adaptive capacity and the potential chance of being affected. The community residents are afraid of losing lives and livelihoods, the tourism business operators feel the risk of losing businesses, and tourists of the Sundarbans rarely feel the contextual risks of climate change. The community residents of the Sundarbans live with the fear of weather-driven disasters like cyclones, tidal waves. Having high-risk perceptions may not lead to any climate action due to poverty. The community residents of the Sundarbans who know about the scientific predictions of climate change consider the predictions as distant risks. The common understanding of the community people is to manage the current vulnerabilities of climate change; future risks (e.g. one-metre sea level rise at the end of the 21st century) are highly ignored by them.

In the context of the Sundarbans in Bangladesh, this research identifies four major sources of constructing climate change understanding – observed physical impacts, formal and informal communication, media, and academic and self-inquiry. Experiencing the climate change impacts is a reason for believing in climate change among the participants. The participants have noticed a range of changes in the weather system which are affecting their day-to-day life. For example, the impacts of climate change in the Sundarbans altering the livelihood patterns of the community residents and affecting the tourism business by shrinking the tourism season. This study finds that climate change understanding cannot develop only by the experience of physical changes in the weather system; information from any source of communication is obvious to understand that the rapid weather pattern change is anthropogenic climate change.

The findings also denote that tourism is a driving force of climate awareness and environmentally responsible behaviour in the coastal Sundarbans World Heritage in Bangladesh. Tourism enhances climate awareness through community-tourist

interactions, and CBT promotes the need of being eco-friendly at the face of climate change. Despite being highly vulnerable to climate change, the community residents and tourism business stakeholders barely blame the high carbon emitting developed and rapidly developing nations for the effects and their miseries. The participants of this research reported that they do not have sufficient information for climate change actions, particularly for adaptation; but they reported that all the available communication sources are reliable and trustworthy for climate change information. It also comes from the research that information requirements regarding climate change are different for different group of stakeholders. The research findings indicate the lack of environmental education of the user group stakeholders of the Sundarbans (Bangladesh).

8.3.2 Second objective – Research question 2

The second objective of this thesis consists of two research questions. The second objective is to critically examine how the conservation and management agencies of the Sundarbans are responding to climate change in terms of adaptation and resilience building. The findings of ‘research question 2’ that examined the management functions for community adaptation in the Sundarbans in Bangladesh are presented in Chapter 6. Fifteen semi-structured interviews with conservation and management agency stakeholders including government, NGOs, and international agencies, and document analysis were utilised to reveal this research question. Under the second objective, research question 2 reveals several contextual empirical findings.

Cyclone Aila (2009) appears to be a critical event that drew great attention to the urgency of climate action. Management agencies of the Sundarbans are trying to ensure meaningful involvement of community people in the forest and climate change management structure. Community people are successfully involved in disaster risk reduction in their own locality with the government and non-government agencies. The NGOs working in Bangladesh Sundarbans have extensive climate awareness programme which is a reason for higher awareness in the mangroves area than most of the other parts of Bangladesh. For reducing community vulnerabilities, the management of the Bangladesh Sundarbans takes adaptation actions to manage three major climate change impacts: 1) salinity intrusion, 2) sea level rise, tidal waves and floods and 3) cyclones and storm surges.

The prime contextual climate change management functions in the Bangladesh Sundarbans is adaptation to the climate impacts. In doing so, forest management authority stops forest resource harvesting to enhance forest resilience so that the forest can buffer the climate change effects like cyclones, tidal waves. As the forest community are vulnerable to climate events and cannot do subsistence farming due to high salinity ingress in the Sundarbans area, the management agencies are helping the vulnerable people in many ways including livelihoods management. They are also offering a range of alternative employment options including CBT to reduce forest dependency by decreasing forest resource collection based employment. Since CBT can ensure income generation without degrading mangrove resources, management agencies are putting increasing focus on CBT in the WHA. The adaptation actions are very important, but all the actions are not equally contributing to the resilience of social system of the Sundarbans.

8.3.3 Second objective – Research question 3

The findings of ‘research question 3’ which examined the areas of convergence and divergence in the management actions of the Sundarbans World Heritage in response to climate change across the international border of Bangladesh and India are presented in Chapter 7. Twenty-two semi-structured interviews with conservation and management agency stakeholders of Bangladesh and Indian Sundarbans and document analysis were utilised to disclose this research question. The research question 3 that is emerged from the second objective of this research project reveals several empirical findings.

This research finds that the management authorities of the two parts of the Sundarbans (the eastern side in Bangladesh and the western side in India) are independent but the operational functions are quite similar, although, the extent of practising those functions often vary. The Forest Department of both countries of the Sundarbans focuses on conservation in response to climate change. Both seek to conserve the forest vegetation and protect the wildlife from community-driven depletion for maintaining the ecological balance of the mangroves. The purpose of biodiversity conservation is to develop the resilience of the mangrove ecosystem so that the forest can protect the community people by buffering the effects of climate events like cyclones.

This research argues that macro-environmental components have a strong influence on the micro-level management efforts. It identifies few external factors – national law enforcement system, coordination among management stakeholders, economic functions besides the forest area, and geopolitical regimes have enormous influence on the success of micro-level climate change management (e.g. forest management) in the Sundarbans of Bangladesh and India. National level policy highly determines the success of conservation and climate change management at the local level. For example, establishing thermal power plant at the edge of the Sundarbans is widely (almost all the interview participants from management stakeholders of Bangladesh and India) considered as an unwise decision of the Bangladesh Government in relation to long-term sustainability and resilience.

The climate change management actions in Bangladesh Sundarbans is very much visible since the NGOs which are helping the community for adaptation involve in self-promotion of their climate management initiatives. Compared to the Indian Sundarbans, the Bangladesh Sundarbans is taking lead in community vulnerability management through educating, capacity building, adaptation support, disaster risk reduction, and livelihood support. The extent of climate change response in terms of community adaptation is wider in the Bangladesh Sundarbans, but mostly project-based. At the end of every project tenure, management agencies need to find funds to continue operations. A significant number of adaptation functions are based on foreign funding (either loans or donations). On the other hand, the climate change management actions in the Indian Sundarbans are mostly managed by the government in terms of authority, implementation, and funding.

In comparison to the Bangladesh Sundarbans, the Indian Sundarbans is doing better in mangroves conservation and wildlife protection because of the stronger domestic law enforcement system. Forest and wildlife conservation efforts are good in the Bangladesh Sundarbans, but poor national law and order system ruins the effectiveness. The tourism operations are quite structured in terms of environmental preservation, community involvement, and visitor management in the Indian Sundarbans compared to the Sundarbans in Bangladesh. Indian Sundarbans has already started practising tourism functions to preserve the World Heritage, whereas Bangladesh Sundarbans is still in planning stage. This research reports that intra-

departmental coordination among different government agencies in response to climate change is weak in both Bangladesh and Indian Sundarbans. Cross-border integration between the management authorities of the Sundarbans of the two countries is not strong as well. This research also finds a few potentials for cross-border concentration in WHA and tourism management to forest transition away from resource depletion, build awareness of climate change, and engage in climate action.

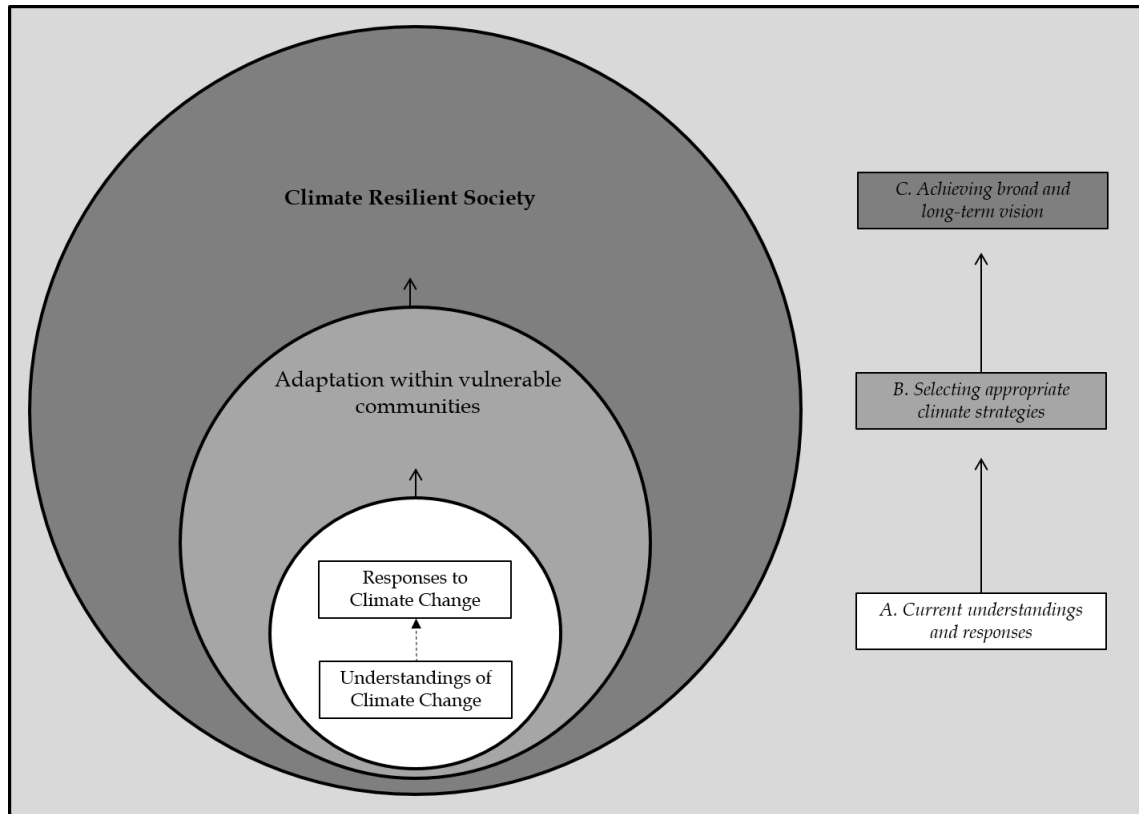
8.4 Research implications and contributions to literature

There is a broad vision to choose the two objectives of this thesis: understandings of climate change (first objective) and responses to climate change (second objective). The purpose of investigating these current understandings and responses is to contribute to selecting appropriate response strategies (particularly for adaptation) which ultimately contribute to building climate resilient society (**Figure 8.1**). Revealing understandings of climate change of the people of a society can inform their current position in relation to climate change (Lyttle, 2014). Lee et al. (2015) mention that understandings of climate change of the people of a society determine the arrangement of their climate change responses [This thesis is not intended to explore the relationship between understandings of climate change and responses to climate change indicated by the dotted arrow in the smallest circle of figure 8.1]. Investigation of the climate change responses of a society helps to select suitable strategies for adaptation (Boyer, 2013). For building climate resilient society and ensuring sustainable development, there is no choice without applying apposite response strategies for the climate vulnerable societies (IPCC, 2014).

The research findings presented in this thesis have several implications for practitioners. The findings presented in Chapter 5 (understandings of climate change) may be useful for the management agencies who are engaged in climate change communication in the Sundarbans. This research identifies the general awareness, knowledge (particularly for adaptation), nature of risk perceptions of the stakeholders of the Sundarbans, which might be useful for developing effective climate communication materials. From the findings presented in Chapter 6, the present and future management agencies may get an overarching idea about the contextual adaptation functions which may help them to select appropriate strategies for further actions. That chapter also indicates some approaches about how to enhance the

resilience of adaptation interventions. Chapter 7 indicates a few policy-action gaps in relation to climate change, forest and wildlife conservation, community development, tourism and World Heritage management. The agencies which are engaged in managing climate change in the Sundarbans may consider those recommendations (see Table 7.6) as the scope for improvement.

Figure 8.1: Purpose of conducting this research project



The research findings presented in Chapters 5 to 7 have several implications for and contribution to academic literature. In Chapter 5, by framing the theoretical components of climate change understanding – awareness, knowledge, and risk perceptions, this research lists out the attributes of the three components based on available literature (see Figure 5.1). It argues that awareness is the general information about climate change. Climate change awareness comprises of: heard about climate change or not, aware of cause, impacts and risks, any observation or experience of climate change. Knowledge is the set of learnings for responding to climate change. Climate change knowledge comprises of: adaptation skills, information of mitigation options, ways of disaster risk reduction, resilience building strategies. Risk perceptions comprise of: degree of uncertainties, nature of risks (e.g. distant, immediate, societal,

personal, gradual and catastrophic risks). All the identified attributes of the three components have implication on constructing social understandings of climate change.

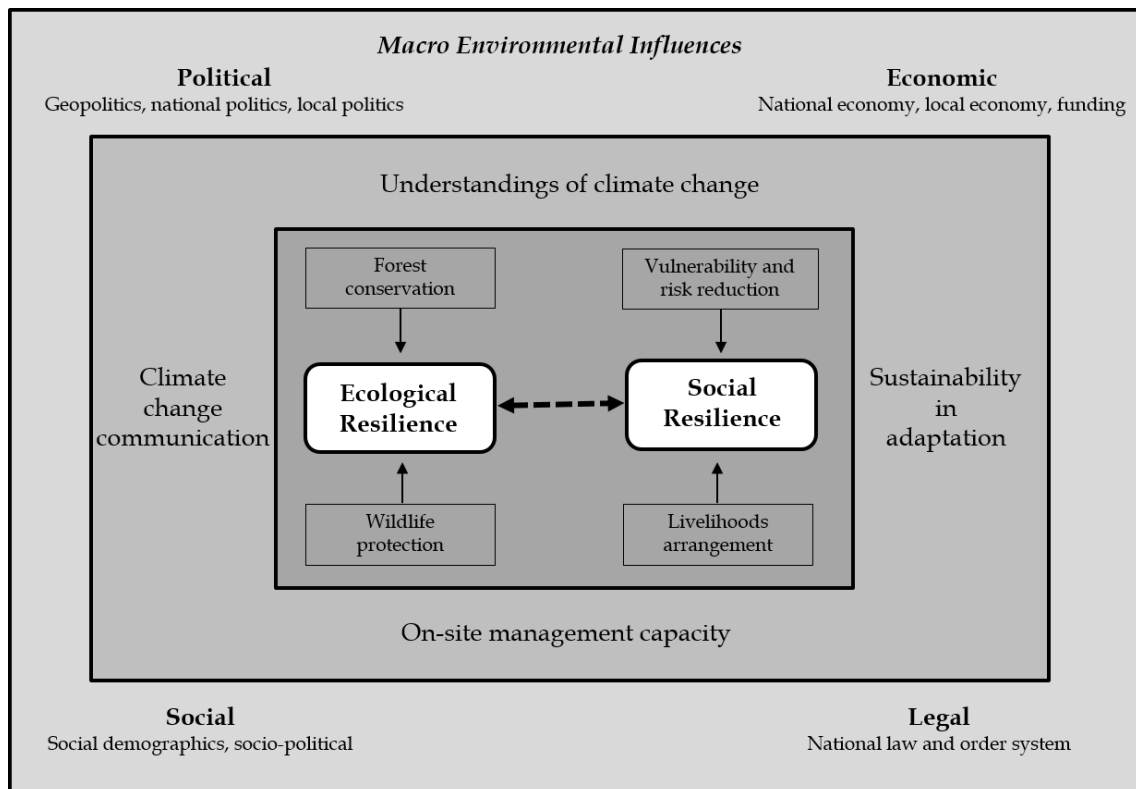
In Chapter 6, based on literature and empirical findings, this research proposes climate adaptation continuum (see Figure 6.2) to evaluate the effectiveness of climate change adaptation interventions. The continuum utilises a four-point scale – relief, hazard, market, and resilience approaches to examine the adaptation interventions. For evaluating the effectiveness of adaptations, the key claim of this continuum is: the more an adaptation intervention contributes to the resilience of a system, the more the adaptation is sustainable. The continuum describes that sustainability is lower for the approaches to adaptation which contribute little to develop resilience. Sustainability of an adaptation intervention is higher when it helps to build resilience. If the adaptation interventions can build capacity of a society to face the climate change impacts without external assistance, the interventions are more resilient, eventually more sustainable. The continuum also suggests several ways to develop sustainability of adaptation interventions by building resilience.

In Chapter 7, this research frames three dimensions – community, forest, and wildlife – of biodiversity conservation for social-ecological resilience (see Figure 7.2). The framework of three dimensions defines the community as an integral part of the forest (eco)system, particularly when the forest is a crucial means of survival (e.g. disaster protection) and livelihoods for those people. This framework is a contribution to literature as it is an extension of the widely established framework of ‘community-based forest management’ (Nath et al., 2016; Noe & Kangalawe, 2015). It supports that non-forest related community needs such as adaptation and livelihoods should be addressed for building the resilience of the social-ecological system. Irreversibly, the findings coming throughout this thesis might be generalised for similar type of contexts, perhaps by doing little research. Further overarching contributions of this study to literature have been the development of two models (frameworks) related to contextual social-ecological resilience (Figure 8.2) and general scope of tourism to contribute to the resilience of the social-ecological system of WHA (Figure 8.3).

8.4.1 Framing the contextual social-ecological resilience

A contribution arising from this research project is the development of the ‘social-ecological resilience framework’ presented in **Figure 8.2**. As the Sundarbans area consists of mangroves and people, both ecological and social resilience are important to combat climate change. The mangrove ecosystem protects the people from extreme weather events and reduces the effects of climate change (World Bank, 2014a). Mangroves need to be resilient as the trees of the forest can reduce the wind force of the cyclones and the strength of tidal waves. The ecological resilience of the Sundarbans determines the survival of humans at the edge of the forest. However, climate change impact on the forest biodiversity is highly uncontrollable. The on-site forest management (e.g. the Forest Department) cannot do almost anything for the forest in response to climate change. For example, the increased salinity in the water of Sundarbans is gradually converting the big freshwater mangroves swamp into small size marine mangroves, but the Forest Department has nothing to do in this regard.

Figure 8.2: Social-ecological resilience framework



In order to enhance the resilience of the mangrove ecosystem, the management agencies of the Sundarbans conserve the forest and the wildlife from community-lead

depletion (see section 7.5, theme 'A' for detail). For enhancing the forest strength as it can bounce back easily after having climate events, the management agencies are regenerating new island forests by planting different mangrove species. The Forest Department halts almost all type of tree harvesting and taking strong initiatives to stop exploitation. The management agencies are also serious about protecting the wild animals as they are also important for the ecological balance and developing the forest ecosystem. In the context of the Sundarbans, ecological resilience is highly important for social resilience as the forest protects the community and offers livelihoods.

For enhancing the social resilience of the mangrove communities, different type of adaptation supports is provided by the management agencies (see section 6.4, theme 'B'). The community people need help to adapt to three main type of climate change impacts: intense cyclones, salinity intrusion, and sea level rise. If their vulnerability increase, they deplete the forest for their livelihoods, which decreases the forest resilience and increase further climate vulnerability to the community people. The forest needs to be conserved – not in response to the global climate change mitigation, but for the survival of the community. Protecting the forest ecosystem also ensures availability of the forest resources. The forest community needs alternative livelihoods because of climate change impacts (e.g. salinity intrusion in the cultivable lands) and government restrictions on forest resource collection.

The mangrove forest is a means of the survival from climate related disasters and a major way of livelihoods for the community residents. But, excessive extraction of the forest resources reduces the forest resilience and threaten the survival of the community. To make a balance between these two types of local needs – survival and livelihoods, a few NGOs and government agencies of Sundarbans are trying to encourage CBT in response to climate change. The CBT offers to keep ecological resilience of the forest and livelihood opportunity by using the forest, without exploiting the forest. CBT enhances social resilience by creating local employment again it enhances ecological resilience by reducing excessive forest resource extraction. As social resilience and ecological resilience of the Sundarbans are highly inter-connected – if one of the two systems (ecological and social) becomes vulnerable, the other system also becomes vulnerable (presented in the most inner box of Figure 8.2).

The social-ecological resilience of the Sundarbans further depends on a few factors – climate change communication in terms of the awareness campaign, adaptation knowhow, and mitigation options; stakeholders’ understandings of climate change; sustainability of adaptation interventions; and on-site management capacity (presented in the middle box of Figure 8.2). Communication is the starting point of climate action (Lee et al., 2015) which eventually contributes to building resilience. The relevant climate information needs to be conveyed to the members of the coastal society of the Sundarbans. They need to be updated about the new adaptation techniques and future risks of climate change. For enhancing resilience, the messages and information of climate change should be communicated such a way that the target audience (the user groups of the Sundarbans such as community people, tourism stakeholders) can realise the importance (Schneider, 2016).

The communication should create explicit understandings of climate change, as direct climate actions may not possible to take without having any idea about the environmental changes occur in the weather system (Whitmarsh et al., 2012). The understandings of climate change comprise of general awareness of the cause and effects, information about future risks, perceiving climate change as a threat to the social-ecological system, and knowledge of adaptation and mitigation techniques. Enriched social understandings of climate change is a prerequisite for resilience (IPCC, 2014). Realising climate change as the cause of present vulnerabilities and future threats motivates people to support climate-friendly policy (Lee et al., 2015). Side by side, apposite knowledge to deal with the impacts in terms of adaptation, and mitigation is important for being resilient.

The adaptation functions of the Sundarbans need to be sustainable in long-term timeframe by addressing the current vulnerabilities and future risks. Chapter 6 indicates that the adaptation measures need to be independent of external supports for ensuring sustainability. The external support in terms of funding, relief aids reduces the sustainability of the adaptation measures. The money inflow from donors should be used to build capacity of the members of a society so that they can tackle the vulnerabilities and risks of climate change. Climate management interventions which create further vulnerabilities are called as maladaptations are not sustainable. By applying different strategies to the existing adaptation functions, sustainability of

adaptation can be increased (see Chapter 6). Sustainable adaptation is necessary to enhance social resilience and ecological resilience of the Sundarbans.

On-site management capacity in terms of knowhow, skilled staff, infrastructure, technology is important for maintaining the resilience of the Sundarbans. The community members of the Sundarbans cannot manage their vulnerabilities without the help of management agencies. If the management agencies are not capable enough to assist the community, the social resilience will be under threat. The agencies need up-to-date training for handling climate change. Community involvement can enhance the capacity and strength of the on-site management (Bulkeley & Newell, 2015). Integration among all the management agencies working for the Sundarbans is necessary to increase the effectiveness of climate management functions (Ogden & Innes, 2007). And an integrated management approach to the vulnerabilities and risks can offer effective and efficient use of the limited available resources and enhance the resilience of the Sundarbans.

A range of macro-environmental elements including political, economic, social, and legal factors are influencing the social-ecological resilience of the Sundarbans (presented in the outermost box of Figure 8.2). Macro-environmental elements, generally, have an influence on the resilience of any system (IPCC, 2014). Those elements can influence both ways – positively or negatively (Kotler, 2010). The positive influence of macro-environment can enhance resilience, and negative influence of macro-environment can reduce the resilience of a system. Usually, developed nations have a favourable position by having a positive influence of macro-environment and developing nations may not get that favour in this regard. The findings chapter, particularly Chapter 7 (section 7.5, theme 'B'), indicate to a range of macro-environmental components (e.g. economic, political, legal, technological, environmental) which are influencing the resilience of the Sundarbans.

The resilience of the mangroves will be threatened by the political decision of establishing industrial zone including thermal power plant beside the Sundarbans in Bangladesh. It might ruin the result of micro-level (on-site) conservation efforts in the long-term timeframe. The Indian government has considered the immediate threat of the coal-based power plant to the forest, but the Bangladesh government has ignored

the environmental issue because of geopolitical interest. However, the Indian government has also ignored the long-term effect of the thermal power plant on the Indian part of the Sundarbans (as it is a single ecosystem) and the worldwide threat of the anthropogenic climate change. National and local political interests are also threatening the ecological conservation of the Sundarbans. Politicians sometimes abuse their power by sheltering poaching, pirates, and illegal fishing in the Sundarbans of Bangladesh.

Economic capacity is a big contributor to the resilience of a system. There is a favourable relationship between economic strength and social resilience (Davoudi et al., 2012). Availability of funding for adaptation largely determines social resilience. Poverty enhances further vulnerability and decreases resilience (Adger & Tompkins, 2004). Conservation for resilience may be compromised because of national or local economic needs. For example, the Government of Bangladesh cannot stop using the rivers of the Sundarbans as navigation route to and from the second important sea-port in the Mongla. Again, shrimp farming at the edge of the Sundarbans is not good for the ecosystem, but it is necessary for the local economy. Overall, economic situation largely defines the nature of climate change communication, sustainability in adaptation, and on-site management capacity.

In the context of the Sundarbans, the resilience of social system certainly depends on the socio-demographic characteristics of the residents. The community residents of the Sundarbans hardly respond to the future risks of climate change, because they have many current problems such as poverty, food security. Their knowledge of climate change is not as sharp as the academically educated people. Most of the forest dependents do not have regular fixed income, therefore when there is a disaster, they exploit the forest for their livelihoods. By managing the local politicians, this community often does illegal fishing and shrimp fry collection from the rivers. Of course, an imbalance in one part of the ecosystem (e.g. fauna of the rivers) has an effect on the ecological resilience of the mangroves.

National legal environment shapes the degree of practice of the available conservation laws and policies. Both Bangladesh and India have environmental legislation, conservation acts and policies, climate change regulations, and tourism laws and

policies. However, this research has clearly revealed that Indian Sundarbans is doing well in terms of forest conservation and wildlife protection just because of having stronger law enforcement system (see section 7.5, theme 'B/1'). The improper legal system of Bangladesh is the reason for unaccountability in crocodile release, forest employee corruptions, political influence on conservation, and abuse of forest resources by forest community. Thus, the national legal system is an important component to climate change response in terms of resilience building.

This model 'social-ecological resilience framework' presented in Figure 8.2 avoids the environmental aspect of macro-environment⁶⁸ as the framework itself deals with natural environmental resilience. Technological component of macro-environment is also important for the resilience, which is not examined profoundly by the current research. The bottom line of this framework is contextual ecological resilience and social resilience largely depending on each other. Forest conservation and wildlife protection can maintain ecological resilience; and vulnerability and risk reduction, and assisting livelihoods arrangement can enhance the social resilience of the highly vulnerable Sundarbans area. Communication for creating climate change understanding is necessary for climate actions. The on-site management needs to be capable of ensuring sustainability of adaptation functions. The findings of this research also show that macro-environmental elements have a high influence on the social-ecological resilience of the Sundarbans WHA.

8.4.2 Tourism and climate change management framework

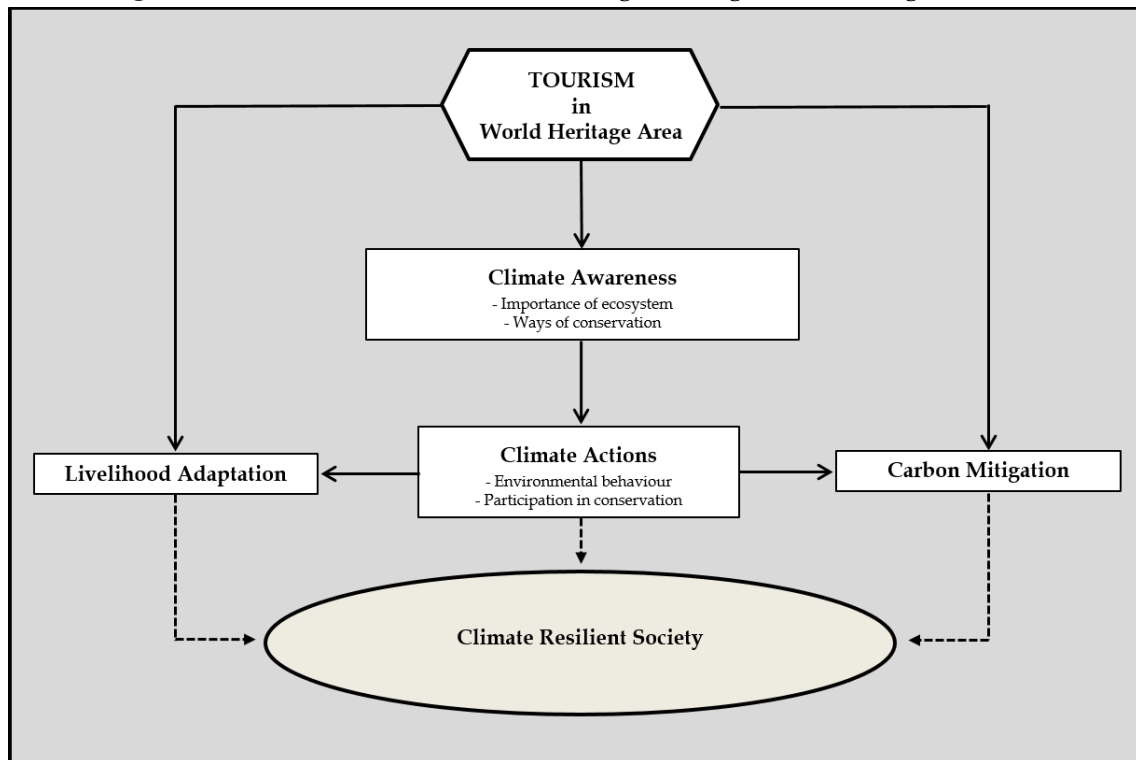
A second contribution arising from this research project - based on literature and empirical materials - is the development of the 'framework for climate management through tourism' presented in **Figure 8.3**. The framework addresses multiple usages of tourism to manage climate change in the natural WHA. The core idea of the framework is that tourism can create climate awareness which leads a vulnerable society to climate actions, particularly for adaptation. Climate actions, specifically adaptation and mitigation, are essential requirements to build resilient society at the face of climate change. Overall, the framework exhibits how tourism can contribute to creating climate

⁶⁸ Macro-environmental elements are often noted as PESTEL factors - political, economic, social, technological, environmental, and legal

resilient society in the natural World Heritage belongs to a climate vulnerable developing society.

Community residents of the Sundarbans mainly involve in forest resource collection for their livelihoods. They hardly involve in tourism as an earning source. To reduce forest dependency in terms of forest resource collection, few management agencies including NGOs are trying to motivate and support those people to earn from CBT. Earlier they only knew about the timber value of the forest, now they know about the aesthetic value of the forest for tourism business. For this reason, the community residents have a strong direct reason to withdraw themselves from forest resource collection (see section 6.4, theme 'B/4'). The people who involve in CBT are much more aware of the importance of forest; they do not exploit the forest anymore and prohibit others from depleting the forest. Tourism is utilised (by the management agencies) to create awareness of conservation and respond to climate change. Higham et al. (2014) also argue that tourism can be an avenue of creating climate change awareness when tourists are informed about their emissions.

Figure 8.3: Framework for climate change management through tourism



Tourist-community interaction is one of the reasons why the residents of the Sundarbans World Heritage area come to know about the information of climate change including the cause of intense cyclones, the role of mangroves to prevent climate events, and importance of forest conservation for vulnerability reduction. The interaction creates awareness in both ways – tourists share information about the climate change risks, and the community residents share their first-hand experience in the weather system. The management agencies develop amusement spots like small parks in different places in the Sundarbans area for local visitors and tourists. Those spots contain billboard type information boards in which many information are written like the necessity of being eco-friendly for tourism, the importance of conserving the nature, and role of forest to combat climate change. It is not like tourism stops the forest exploitation totally in the Sundarbans, but the forest exploiters at least have some guilty feelings (see section 5.4, theme 'B/2').

Awareness of climate change is the first step to climate actions in terms of mitigation and adaptation (Boyer, 2013). van der Linden et al. (2015a) explain that when people understand the reason for climate change, they are likely to contribute to solving it. The residents of the Sundarbans area start thinking of conservation when they come to know about the importance of the mangroves in terms of protecting them from extreme natural events and earning livelihoods from tourism. Even though a few of the community members involved in forest depletion, most of the community people possess a sense of ownership of the forest. They think that it is not good to exploit the forest resources such as fishes, trees, and wild animals. A number of community members voluntarily involve in CPG to watch and control forest misuse. This behaviour can be defined as the reflection of their awareness and tourism is partially contributing to creating this awareness.

Tourism itself can be an adaptation tool for livelihood in the Sundarbans area as the farmers cannot grow traditional crops because of salinity and erratic rainfall and as the Forest Department restricts forest resource collection (see Chapter 6). The World Heritage has enormous potential to provide employment for the rural communities. Many scholars including Becken and Hay (2007), Scott (2011), and Tervo-Kankare and Saarinen (2012) argue that tourism industry needs to cope with climate change. Tourism, however, can be a means of livelihood adaptation for the vulnerable residents

of natural World Heritage. Of course, increased aviation and long-haul travelling can further increase climate change vulnerabilities (Peeters, 2015), but a managed CBT for domestic and medium-haul international tourists can be a resilient livelihood solution. This research also addresses that CBT may face challenges because of climate change (e.g. lack of fresh water for tourists) and may not create employment for a large number of forest dependents of the Sundarbans.

Gössling et al. (2009) argue tourism can be utilised as a means of conservation of ecologically fragile areas like forests. Tourism also can be an avenue of mitigation (UNWTO, 2014). Tourism is a carbon-emitting sector, but if utilisation of tourism can reduce overall emissions then it surely contributes to mitigation. Say for an example, the mangroves of the Sundarbans are carbon banks. Cutting trees means releasing more CO₂ in the atmosphere, catching excessive fishes means disturbing the food chain which affects on the flora of the forest and eventually less CO₂ is absorbed (Goldenberg, 2015; Reddy & Wilkes, 2012). If tourism can be utilised to replace or reduce the forest depending livelihood options, then it surely will contribute to mitigation. Tree logging can be replaced by nature watching, commercial fishing and crab catching can be replaced by game fishing.

WHS and tourism are synonymous (Hall, 2006a). However, many developing nations are unsuccessful in utilising the scope of WHS properly (Sharpley, 2012; von Droste, 2012). In the case of coastal natural WHS, often, it is far more challenging to utilise the opportunity because of climate change. However, tourism is a promising avenue to climate change management in coastal natural World Heritage area in terms of awareness building, mitigation, and adaptation (presented in Figure 8.3). For ensuring long-lasting benefits from tourism, it should be practised such a way so that it does not affect the ecological balance and preserves the aesthetics of nature. The money generated from tourism can enhance WHS conservation which literally contributes to reducing climate change and building climate resilient society.

Under the 'framework for climate change management through tourism', this research project has compiled all the tourism utilisation aspects in response to climate change. The framework introduces tourism as a livelihood adaptation tool. It has also highlighted the implications of tourism to enhance forest resilience by reducing

community-driven forest depletion. Utilising tourism such a way, so that the forest biodiversity can be protected, and economic benefits can be continued from the forest without degrading its value. The framework presented in Figure 8.3 is applicable mostly for the vulnerable developing nations where people collect forest resources for their livelihoods. If any nation (e.g. developed nation) can keep the natural protected area untouched, that is better for climate change mitigation.

8.5 Further research scope

While there have been several significant insights resulting from the research presented in this thesis, including the identification of components of climate change understanding, approaches to build resilience for making the adaptation functions sustainable, and highly influential macro-factors which shape the contextual micro (and meso) level climate actions. The overall goal (and motivation) of this thesis is to contribute to building climate resilient society in the case study context. Exploring contextual understandings of and responses to climate change are necessary, but not sufficient to achieve the overall goal (presented in Figure 8.1). There is room for further progress in determining how climate understanding can make stronger to lead to climate actions, identifying more strategies to build resilience to make the adaptation functions sustainable, and finding the scope of joint climate management in the Sundarbans between Bangladesh and India. Future studies on the current topics are therefore recommended.

This thesis comes up with few general and contextual findings regarding climate change in terms of understanding, adaptation, and resilience building. Further studies, which take these findings into account, will need to be undertaken. In Chapter 5, this research reveals that contextual understandings of climate change are highly based on the first-hand experience of changes in the weather system; now it needs to look at how those experiences can be utilised and attached to improve stakeholders' understanding towards climate actions. This research has also claimed that information requirement of climate change is different for different stakeholders; thus, there is research scope of determining the information requirements (e.g. types of information, forms of information, volumes of information) for different stakeholder groups. Management agencies including NGOs are running different types of climate communication campaigns in the coastal Sundarbans, here the effectiveness of climate

change campaigns needs to be accessed for knowing how the communication programme is contributing to the understandings of climate change among key stakeholders of the Sundarbans.

In Chapter 6, the thesis identifies the management structure of climate change in the Sundarbans in Bangladesh, but the degree of coordination and integration among the management agencies (e.g. government, NGOs) need to be accessed for enhancing resilience. This research has argued that external inputs (e.g. funding, management assistance) can enhance the resilience of the social-ecological system, but dependency on external supports may reduce system resilience. For this reason, it is necessary to look at how the management structure of the Sundarbans can be self-dependent over time. Further work is required to establish the proposed scale of climate adaptation continuum (See Figure 6.2). The characteristics of each of the four approaches – relief, hazard, market, and resilience - can be clarified, and how the approaches can be upgraded in terms of sustainability by inserting inputs to contribute to resilience. It is also very important to examine how the theoretical strategies of resilience building, available in the academic literature, contribute to the resilience of a system in the real-world situations. The management agencies consider CBT as a tool for sustainable climate change adaptation in terms of climate education and livelihoods. Therefore, the future researchers may look at how the CBT would provide continuous benefit to the vulnerable groups and what should be done for tourism development to mitigate future risks.

Arising from the research presented in Chapter 6, future researchers may also look at the nature and extent of community responses through self-organisation that could be coordinated with the top-down activities of the stakeholders of the management agencies. Management agencies' interventions (e.g. training for entrepreneurship, cash for alternative farming activities, handicraft training for export quality toy making) can serve as catalysts to latent entrepreneurs in search of opportunity. Further research may reveal how those entrepreneurs survive and grow their business in relation to climate change and other social challenges. This research has found that NGOs and other management agencies provide cash support to community residents who face the challenges of climate change, however, it is yet to be known how micro-finance (e.g. provided by the NGOs such as Grameen Bank) and village banking help community

members to realise increasing economic independence. It would also be interesting to know how the agencies manage situations when, for example, they lose control of the systematic or desired changes, and what are the relative roles of climate change and social setting of the Sundarbans in this regard.

Although prevented in the current research project due to financial and time constraints, widening the scope of the research to incorporate understandings of climate change of the Indian Sundarbans can offer greater insights. A relative comparison between understandings of climate change between Bangladesh and India might assist to generalise the existing findings for a wider context. Future research may examine the relationship between three dimensions of biodiversity conservation for resilience (see Figure 7.2) and propose actions to enhance social-ecological resilience in each dimension. The process of transforming conventional forest-based resource exploitation through tourism development needs to be accessed for understanding the impacts of tourism on the forest biodiversity and communities. Some developed countries manage tourism jointly in unique ecosystems, thus the feasibility of cross-border forest management, World Heritage and tourism management in the context of developing countries and relative benefits to mitigate climate change can be assessed by the future researchers.

Further research could theoretically and empirically advance the two frameworks presented in this chapter. The social-ecological resilience framework (see Figure 8.2) can be applied to a range of research contexts both within and beyond the coastal social-ecological perspectives in developing nations, thus it requires further empirical and conceptual exploration. It is clear that achieving social-ecological resilience is a very complex procedure, and a one-size-fits-all approach does not apply here as resilience is highly place-specific. Further research should be done to investigate the resilience building strategies for other contexts. Future research might fruitfully address and enrich the proposed framework of social-ecological resilience in the context of Sundarbans. There is a huge potential for research on how micro-level (on-site) management can overcome or minimise the effects of macro environmental influences to achieve a resilient social-ecological system.

The proposed framework for climate change management through tourism (see Figure 8.3) needs to examine and expand conceptually to generalise it for other World Heritages. There is enormous scope to investigate more approaches to and strategies for awareness creation and climate actions (e.g. adaptation and mitigation) by utilising tourism. For contributing to building social resilience, tourism itself need to be climate resilient; future researchers may have look at how tourism can be a resilient earning source in a climate vulnerable coastal WHA. The model is conceptualised based on existing literature and empirical materials of this research project, which requires further inspection in terms of opportunity-cost of social transformation of livelihoods by tourism. It is also required to check what preserves more economical and ecological interest of World Heritage - controlled tourism (applying visitor management programme and carrying capacity), controlled forest resources extraction, or any combination of tourism and forest resource collection.

8.6 Concluding statement

Considering contextual vulnerability to climate change, this thesis focusses on understandings of and responses to climate change with a belief in the established literature that understandings lead to climate action that may contribute to enhancing resilience. Understandings of climate change may shape climate responses, however, capacity in terms of financial, human resources, and technological resources are necessary to act according to knowledge. Most vulnerable developing nations, which are not responsible for huge GHG emissions like many developed and rapidly developing nations, are backward to advance those capacities. The international community realises that helping those vulnerable nations is the responsibility of the high carbon emitting developed world. In response to that realisation, vulnerable nations sometimes receive funds as low-interest loans or donations. Of course, the funding is not sufficient for those vulnerable nations, but helpful. The climate change funding should be used such a way so that it builds the capacity of vulnerable groups and do not need further assistance - by educating them about climate change and helping them in terms of resilience building.

Climate effects do not know poor or rich. Often, the coastal communities in the developed countries are affected because of climate impacts like intense cyclones. To enhance resilience, mitigation needs to go hand in hand with adaptation. An urgent

step is required to build resilience through climate actions among highly vulnerable developing world communities who are not much responsible for emissions. Creating apposite climate understanding (awareness and knowledge) is likely to reduce their vulnerabilities related to lives and livelihoods. Utilisation of some promising techniques such as tourism in the protected areas should enhance resilience by building climate understanding and fostering climate actions. Climate change is a global problem – all citizens of the world need to be engaged to understand this reality. Collective action is required to manage climate vulnerabilities and to limit worldwide temperature rise to 2 °C above pre-industrial levels and achieve the SDGs by 2030. Collective action only can bring a sustainable solution and make this world climate change resilient. This thesis examines the understandings of and responses to climate change in the context of highly vulnerable developing nations to contribute to globally inclusive collective action.

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Appendices

**Appendix A(1): Core interview questions – step one
(Core questions for user group stakeholders)**

Research Objectives	Research Questions	Stakeholder Group	Core Interview Questions	Clues / Prompts
First Objective To critically examine the understandings (awareness, knowledge, and perception of risks & vulnerability) of climate change held by multiple stakeholders (local communities; tourism demand-supply stakeholders; and conservation & management agencies) of the Sundarbans in Bangladesh.	Q 1. What are the current understandings of key stakeholders of the Sundarbans in Bangladesh regarding climate change?	Local Communities	Do you think the regional weather system/environment is changing? Why do you think climate is changing? Describe your personal experience about climate change. How are those changes influencing your community? Do you think climate change is real? Why or why not? What are the reasons for this present climate change? Do you believe the scientists' future predictions about climate change? What extent do you feel the risks of climate change? (Optional clue)	Contextual experience i.e. Life and livelihood Anthropogenic? Clue: Scientists predict one metre SLR at the end of this century.
		Tourism Business Stakeholders	Do you think the regional weather system/environment is changing? Why do you think climate is changing? Describe your personal/business experience about climate change. How are those changes influencing your business? Do you think climate change is real? Why or why not? What are the reasons of this present climate change? Do you believe the scientists' future predictions about climate change? What extent do you feel the risks of climate change (for your business)? (Optional clue)	Contextual experience Anthropogenic? Clue: Scientists predict one metre SLR at the end of this century.
		Tourists	Have you heard about climate change? When do come to know about climate change? Do you have any personal experience of climate change? Do you think climate change is real? Why or why not? What are the reasons of this present climate change? Are you aware about scientific predictions of climate change? Do you believe the scientists' future predictions about climate change? What extent do you feel the risks of climate change as a tourist?	What? On tour or at home? Overall experience Anthropogenic? Clue: Scientists predict one metre SLR at the end of this century.

Research Objectives	Research Questions	Stakeholder Group	Core Interview Questions	Clues / Prompts
	<p>Q 2. How are those understandings of climate change constructed among them?</p>	<p>Local Communities</p>	<p>How have you learned about the climate change? Do you discuss climate change in social gatherings? Do your friends and family feel the same way as you say about climate change?</p> <p>What are the reliable sources of information to you? Are your understandings reliably informed? Do you think the information you have is sufficient to respond?</p> <p>Have you found any role of institutional bodies to communicate climate change in your area? What else do you expect from the institutional bodies?</p>	<p>TV, Radios, friends etc.</p> <p>Respond means taking actions to cope with, to lessen emission, or to build resilience. Institutional bodies mean Govt., NGOs, or international agencies</p>
		<p>Tourism Business Stakeholders</p>	<p>How have you learned about the climate change? Is there any platform of climate change discussion in the industry? Do your colleagues feel the same way as you say about climate change?</p> <p>What are the reliable sources of information to you? Are your understandings reliably informed? Do you think the information you have is sufficient to respond? Do you want more information on climate change?</p> <p>Have you found any role of institutional bodies to communicate climate change for betterment of your business? What else do you expect from the institutional bodies?</p>	<p>TV, Radio, friends etc. Contextual platform</p> <p>Respond means taking actions to cope with, to lessen emission, or to build resilient business. Institutional bodies mean Govt., NGOs, or international agencies like UNESCO</p>
		<p>Tourists</p>	<p>How have you learned about the climate change? Do you discuss climate change in during the tour?</p> <p>What are the reliable sources of information to you? Are your understandings reliably informed? Do you think the information you have is sufficient to respond?</p> <p>Have you found any role of tour operators to communicate climate change during your tour?</p>	<p>TV, Radio, friends etc. Tour in and around the study context</p> <p>Respond in terms of adaptation and mitigation</p>

Appendix A(2): Core interview questions – step one
(Core questions for conservation & management stakeholders)

Research Objectives	Research Questions	Stakeholder Group	Core Interview Questions	Clues / Prompts
First Objective To critically examine the understandings (awareness, knowledge, and perception of risks & vulnerability) of climate change held by multiple stakeholders (local communities; tourism demand-supply stakeholders; and conservation & management agencies) of the Sundarbans in Bangladesh.	Q 1. What are the current understandings of key stakeholders of the Sundarbans in Bangladesh regarding climate change?	Conservation and Management Agencies	How is the Sundarbans vulnerable due to climate change? What are the specific risks/aspects? Does your organisation have a stated position on the climate change? Do you have a policy statement? What extent the conservation and management agencies accept and believe on scientists' future predictions about climate change?	Agree or reject?
		Tourism Management Stakeholders	Is there any influence of climate change on tourism in the Sundarbans? What are the specific risks/aspects? Does your organisation have a stated position on the climate change? Do you have a policy statement? What extent your organisation accepts and believes on scientists' future predictions about climate change?	Agree or reject?
	Q 2. How are those understandings of climate change constructed among them?	Conservation and Management Agencies	How do you inform the employees/staffs of your organisation about climate change? From which source your organisation collects/ receives information regarding climate change?	
		Tourism Management Stakeholders	Do you inform the employees/staffs of your organisation about climate change? How? From which sources does your organisation collect/ receives information regarding climate change?	
Second Objective To critically examine how the conservation & management agencies of Sundarbans are engaging in climate change communication in terms of adaptation, mitigation, and building resilience.	Q 3. How effective (or ineffective) are the climate change communication (in relation to more immediate problems e.g. poverty, pollution, population, food security) functions of the Sundarbans in Bangladesh?	Conservation and Management Agencies	What does your organisation do to communicate climate change? What is the focus of those communications? Is there any integration among Government, NGOs and International agencies to communicate climate change? Which organisations are mostly responsible to help the Sundarbans cope with climate change? What extent are your organisation responsible to inform/action? How you assist the Sundarbans to face future risks of climate change? What are the challenges (or opportunities) you face to communicate climate change? What is the relative importance of climate change to other socio-economic problems of the region? What the conservation and management organisations can do for climate change? Which extent the present efforts successful/ fail?	Among local, tourists, business etc. Mitigation, adaptation, resilience building or any combination of these? Opinions Relative responsibility Socio-economic problem like poverty, pollution, food security etc.

Research Objectives	Research Questions	Stakeholder Group	Core Interview Questions	Clues / Prompts
		Tourism Management Stakeholders	<p>How do you inform the tourism business operators about climate change? What is the focus of those communications?</p> <p>Is there any integration among Government, NGOs and International agencies to communicate climate change?</p> <p>Which organisations are mostly responsible to help the Sundarbans cope with climate change? What extent are your organisation responsible to inform/action? How do you assist the Sundarbans to face future risks of climate change?</p> <p>What are the challenges (or opportunities) to communicate climate change?</p>	<p>Mitigation, adaptation, resilience building or any combination of these?</p> <p>Opinions</p> <p>Relative responsibility i.e. Climate change communication through tourism</p>
	<p>Q 4. What are the areas of convergence and divergence in the management of the Sundarbans in relation to climate change communication across the international border of Bangladesh and India?</p>	Conservation and Management Agencies	<p>How is climate change being addressed?</p> <p>Do you think tourism can be an effective means of climate change communication?</p>	<p>In terms of: Public education (interpretation) Forest management Species management Advocacy Community involvement Risk management (information) Is it currently? How/in what ways?</p>
		Tourism Management Stakeholders	<p>How is climate change being addressed?</p> <p>Do you think tourism can be an effective means of climate change communication?</p>	<p>In terms of: Destination management Visitor management (safety) Site/ facilities design Risk assessment Climate management (seasonality) Is it currently? How/in what ways?</p>

Research Objectives	Research Questions	Stakeholder Group	Core Interview Questions	Clues / Prompts
	Q 5. What are the relative merits of climate change management regimes in the Indian and Bangladeshi Sundarbans, both generally, and specifically in relation to fostering climate actions?	Conservation and Management Agencies	Are you talking to each other? Do you have any cooperation/collaboration among the organisations in the other side of the Sundarbans? Is there any benefit to work together to communicate climate change in this context?	How?
		Tourism Management Stakeholders	Do you have any cooperation/collaboration among the organisations in the other side of the Sundarbans? Is it working? Do you feel any problem?	How?

Appendix B: Interview schedules – step two⁶⁹

Typical interview questions for Local Communities (Dependents / Residents / Community Leaders)

Awareness and knowledge

1. Do you think the regional weather system/environment is changing? (Or, has the weather in the region stayed the same over the time?)
2. Why do you think climate is changing?
3. Describe your personal experience about climate change (Contextual). (What are the specific changes you observed?)
4. Do you think the intensity of cyclone and storm surges have been increased than past?
5. How are those changes influencing your community? (i.e. life and livelihood?)

Cause

6. Do you think climate change is real?
7. Why or why not?
8. What are the reasons for this present climate change? Anthropogenic?

Risk perception

9. Do you believe the scientists' future predictions about climate change? (Optional clue)
10. What extent do you feel the risks of climate change?

Source of information

11. How have you learned about the climate change? (TV, Radios, friends etc.)
12. Do you discuss climate change in social gatherings?
13. Do your friends and family feel the same way as you say about climate change?
14. What are the reliable sources of information to you?
15. Are your understandings reliably informed?
16. Do you think the information you have is sufficient to respond? (Respond in terms of adaptation, mitigation, resilience building)

Institutional role

17. Have you found any role of institutional bodies to communicate climate change in your area?
18. What else do you expect from the institutional bodies?

Others

19. What extent you are involved in tourism business?
20. Do you think tourism is polluting the region?
21. What the government and NGOs are doing to protect the forest?
22. What are you doing to reduce dependency of the forest resources?
23. How do you adapt with the natural disasters?
24. What are the challenges of adaptation?
25. Do you think you are able to adapt to new different climates?

⁶⁹ The underlined questions are core interviewed questions which were developed in step one. The interview schedules were consisted of core interview questions – based on research objectives, and few related important questions.

Typical interview questions for Tourism Business Stakeholders (Business owners / Managers / Tour Guides)

General issues

1. What are the impacts of tourism activities on environment of Sundarbans?
2. What are you (tourism business operators) doing to reduce those effects?
3. What are the most challenging issues to operate tours in the Sundarbans?

Awareness and knowledge

4. Do you think the regional weather system/environment is changing?
5. Why do you think climate is changing?
6. Describe your personal/business experience about climate change. (Contextual experience)
7. How are those changes influencing your business?
8. What extent the tourism business operators serious about climate change?
9. How tourism is affected by the weather (seasonality) of Sundarbans?
10. Do you think the intensity of cyclone and storm surges have been increased than past?
11. How those are affecting your business? (Do tourists cancel their bookings after hearing extreme weather forecast; how have you settled booking cancelation?)
12. How you adapt with those cyclones and storms?

Cause

13. Do you think climate change is real?
14. Why or why not?
15. What are the reasons of this present climate change? Anthropogenic?

Risk perception

16. Do you believe the scientists' future predictions about climate change? (Optional clue)
17. What extent do you feel the risks of climate change (for your business)?

Source of information

18. How have you learned about the climate change? TV, Radio, friends etc.
19. Is there any platform of climate change discussion in the industry? Contextual platform.
20. Do your colleagues feel the same way as you say about climate change?
21. What are the reliable sources of information to you?
22. Are your understandings reliably informed?
23. Do you think the information you have is sufficient to respond? (Respond in terms of adaptation, mitigation, and resilience building)
24. Do you want more information on climate change?

Institutional role

25. Have you found any role of institutional bodies to communicate climate change for betterment of your business?
26. What else do you expect from the institutional bodies?

Typical interview questions for Tourists (Domestic and International)

General issues

1. What are the issues that you consider before taking travel decision to the Sundarbans?
2. What do you know about the natural calamities of Sundarbans?
3. How those calamities influence your travel decision?
4. Have you ever changes travel decision (booking cancelation) after having extreme weather forecast?
5. Do you think tourism activities are affecting the environment of the Sundarbans? How?
6. What are the concerns against the sustainability of the forest?

Awareness and knowledge

7. Have you heard about climate change? What?
8. When do come to know about climate change? On tour or at home?
9. Do you have any personal experience of climate change? (Overall experience)

Cause

10. Do you think climate change is real?
11. Why or why not?
12. What are the reasons of this present climate change? Anthropogenic?

Risk perception

13. Are you aware about scientific predictions of climate change? (Optional Clue)
14. Do you believe the scientists' future predictions about climate change?
15. What extent do you feel the risks of climate change as a tourist?

Source of information

16. How have you learned about the climate change? (TV, Radio, friends etc.)
17. Do you discuss climate change in during the tour? (Tour in and around the study context)
18. What are the reliable sources of information to you?
19. Are your understandings reliably informed?
20. Do you think the information you have is sufficient to respond? (Respond in terms of adaptation and mitigation)

Institutional role

21. Have you found any role of tour operators to communicate climate change during your tour?
22. What extent the tourism business operators serious about climate change?
23. What about role of others like forest departments in this regard?

Typical interview questions for Conservation and Management Agencies (Government, NGOs and International Agencies)

Understanding

1. How is the Sundarbans vulnerable due to climate change?
2. What are the specific risks/aspects?
3. Does your organisation have a stated position on the climate change? Agree or reject?
4. Do you have a policy statement?
5. What extent the conservation and management agencies accept and believe on scientists' future predictions about climate change?

Information flow

6. How do you inform the employees/staffs of your organisation about climate change?
7. From which source your organisation collects/receives information regarding climate change?

Communication role

8. What does your organisation do to communicate climate change?
9. What is the focus of those communications?
10. Is there any integration among Government, NGOs and International agencies to communicate climate change?
11. Which organisations are mostly responsible to help the Sundarbans cope with climate change?
12. What extent are your organisation responsible to inform/action?
13. How you assist the Sundarbans to face future risks of climate change?
14. What are the challenges (or opportunities) you face to communicate climate change?
15. What is the relative importance of climate change to other socio-economic problems of the region?
16. What the conservation and management organisations can do for climate change?
17. Which extent the present efforts successful/ fail?
18. What do you do to reduce environmental pollution?
19. What you could do to reduce dependency on the forest?

Extent

20. How is climate change being addressed? In terms of:
Public education (interpretation)
Forest management
Species management Advocacy
Community involvement
Risk management (information)
21. Which efforts (success factors) can foster understandings of climate change in the Sundarbans?
22. What extent you follow those factors?

23. Do you think tourism can be an effective means of climate change communication? Is it currently? How/in what ways?

Collaboration

24. Are you talking to each other?
25. Do you have any cooperation/collaboration among the organisations in the other side of the Sundarbans? How?
26. Is there any benefit to work together to communicate climate change in this context?
27. What are the scope?
28. How international agencies deal with the both parts? Together or separately?
29. Are international agencies (i.e. UNESCO) ask you to work together?
30. Which agencies are involved? What is being done?

Typical interview questions for Tourism Management Organisations (NTO and other Government Tourism Management Organisations)

General issues

1. What extent extreme weather / natural events create challenge to the tourism business in Sundarbans?
2. Have you observed any changes in recent years in climate pattern than past?
3. What type of complains do you receive from tourism business operators about climate?

Understanding

4. Is there any influence of climate change on tourism in the Sundarbans?
5. What are the specific risks/aspects?
6. Does your organisation have a stated position on the climate change? Agree or reject?
7. Do you have a policy statement?
8. What extent your organisation accepts and believes on scientists' future predictions about climate change?

Information flow

9. Do you inform the employees/staffs of your organisation about climate change?
10. How?
11. From which sources does your organisation collects/receives information regarding climate change?

Communication role

12. Is there any scope to communicate climate change through tourism activities?
How?
13. How do you inform the tourism business operators about climate change?
14. What is the focus of those communications? Mitigation, adaptation, resilience building or any combination of these?
15. Is there any integration among Government, NGOs and International agencies to communicate climate change?
16. Which organisations are mostly responsible to help the Sundarbans cope with climate change? (Personal opinion)
17. What extent are your organisation responsible to inform/action? (Relative responsibility)
18. How do you assist the Sundarbans to face future risks of climate change? (i.e. Climate change communication through tourism)
19. What are the challenges (or opportunities) to communicate climate change?
20. How do you help the tourism business in Sundarbans in order to cope with the climate effects?
21. What do you do to reduce environmental pollution by the tourism business?
22. What do you do to involve community people in tourism (alternative employment) to reduce dependency on the forest?
23. Is there any plan of your organisation to assist the tourism business in Sundarbans to become climate resilient? What are those?

Extent

24. How is climate change being addressed? In terms of:
 - Destination management
 - Visitor management (safety)
 - Site/ facilities design
 - Risk assessment
 - Climate management (seasonality)
25. Which efforts (success factors) can foster understandings of climate change in the Sundarbans?
26. What extent you follow those factors?
27. Do you think tourism can be an effective means of climate change communication? Is it currently? How/in what ways?

Collaboration

28. Do you have any cooperation/collaboration among the organisations in the other side of the Sundarbans? How?
29. Is it working?
30. Do you feel any problem?
31. Do you have any common regimes of climate change and tourism between Bangladesh and India?
32. How important to work together across border in order to manage climate change?
33. What are the scope?
34. How international agencies deal with the both parts? Together or separately?
35. Are international agencies (i.e. UNESCO) ask you to work together?
36. Which agencies are involved? What is being done?

Appendix C: Human ethics application form (University of Otago)

(Application Form for ethical consideration of research and teaching proposals involving human participants)



UNIVERSITY OF OTAGO HUMAN ETHICS COMMITTEE APPLICATION FORM: CATEGORY A

1. University of Otago staff member responsible for project:

Higham James Professor

2. Department/School: Tourism

3. Contact details of staff member responsible

Professor James Higham, Office Commerce 4.40, Tel: 64 3 479 8500;
james.higham@otago.ac.nz

4. Title of project: Communicating Climate Change: A Cross-border Analysis of the Sundarbans

5. Indicate project type and names of other investigators and students:

Staff Co-investigators Names: Associate Professor Ben Wooliscroft
(Marketing Department)

Student Researchers Names: Md Kamrul Hassan

Level of Study (PhD, Masters, Hons): PhD

External Researchers Names: Dr Debbie Hopkins

Institute/Company: Centre for Sustainability

6. Is this a repeated class teaching activity?

NO

7. Fast-Track procedure

Do you request fast-track consideration?

NO

8. When will recruitment and data collection commence?

May 2016

When will data collection be completed?

August 2016

9. Funding of project

Is the project to be funded by an external grant?

NO

10. Brief description in lay terms of the purpose of the project (approx. 75 words):

The purpose of this research is to investigate understandings of climate change in a developing world country specifically in the context of the Sundarbans UNESCO world heritage site which is situated along the coastline of Bangladesh and India and how climate change communicated and understood among multiple stakeholders.

11. Aim and description of project

Aim: The overall aim of my PhD is to explore the climate change communication in terms of understanding and responding to climate change. It will focus on the key stakeholders of the Sundarbans in Bangladesh (local communities; tourism demand-supply stakeholders; and conservation & management agencies) in terms of the ecological and socio-economic functions of this UNESCO World Heritage Area. The aim extends to an international comparative analysis of how the Sundarbans is managed by Indian and Bangladeshi management agencies in relation to understandings of climate change.

First Objective: To critically examine the understandings (awareness, knowledge, and perception of risks & vulnerability) of climate change held by multiple stakeholders (local communities; tourism demand-supply stakeholders; and conservation & management agencies) of the Sundarbans in Bangladesh.

Research Questions

1. What are the current understandings of key stakeholders of the Sundarbans in Bangladesh regarding climate change?
2. How are those understandings of climate change constructed among them?

Second Objective: To critically examine how the conservation & management agencies of Sundarbans are engaging in climate change communication in terms of adaptation, mitigation, and building resilience.

Research Questions

3. How effective (or ineffective) are the climate change communication (in relation to more immediate problems e.g. poverty, pollution, population, food security) functions of the Sundarbans in Bangladesh?
4. What are the areas of convergence and divergence in the management of the Sundarbans in relation to climate change communication across the international border of Bangladesh and India?
5. What are the relative merits of climate change management regimes in the Indian and Bangladeshi Sundarbans, both generally, and specifically in relation to fostering understandings of climate change among key stakeholders?

Implications and benefits: This research will address the existing climate change understanding and communication pattern in developing countries, particularly for the Sundarbans, which will assist to develop appropriate climate change adaptation and mitigation strategies which will lead the forest to be climate resilient and towards sustainable development.

12. **Researcher/instructor experience and qualifications in this research area**

The researcher, Md Kamrul Hassan, who will be conducting the fieldwork, has experience in collecting primary data through in-depth semi-structured interviews in his Bachelor and Master's level degrees. He has participated in a workshop regarding Qualitative Research Techniques during his PhD.

Professor James Higham, who is supervising this PhD project, has widespread experience conducting qualitative research projects including this current research area (climate change, public perceptions and management actions) which will further assist the researcher to carry out rigorous fieldwork. Associate Professor Ben Wooliscroft (Marketing) and Dr Debbie Hopkins (Centre for Sustainability) are co-supervising this PhD project.

13. Participants

13(a) Population from which participants are drawn:

In Bangladesh (Dhaka and Khulna Division) and India (West Bengal), only individuals from specific and defined stakeholder groups will be invited to participate in interviews. The sample will include participants from local communities, tourism demand-supply side stakeholders and conservation & management agencies (local government i.e. forest department and NTO, NGOs, Environmentalists and international agencies).

13(b) Inclusion and exclusion criteria:

Inclusion criteria - Participants must have direct interest in terms of residence, livelihood, occupation, tourist destination management or policy/planning in the study context (Sundarbans). The researcher will invite participants based on their direct relationship to the study area. The study participants must be aged 18 years minimum.

Exclusion criteria - Anyone who is at risk because of the research, people who are psychologically disturbed or have low intellectual capacity.

13(c) Estimated number of participants:

Approximately 40; interviews will be conducted until information saturation emerges in each stakeholder group. The total number of interviews is unknown due to the nature of qualitative research.

13(d) Age range of participants:

Adult (at least 18 years)

13(e) Method of recruitment:

By following non-probability judgemental sampling technique, the researcher will include the participants of this project. A potential sampling framework is given bellow:

Table: Interview Plan (sampling outline)

Beneficiaries of Sundarbans in Bangladesh		Conservation & Management Agencies		
Identity	No. of Respondents	Identity	No. of Respondents	
			Bangladesh	India
Local Communities (Farmers, Fishermen, Honey hunters, Woodsmen, Community leaders, Aged community members specially women)	8	Non-profit Organisations NGOs working on Sundarbans/ Environmental Advocates Researchers (University)	4	3
Tourism (demand-side) Stakeholders (Domestic and international Tourists)	5	Government Ministry of Environment & Forest, Forest Department /Office	4	2
Tourism (supply-side) Stakeholders (Tour Operators, Tour Guides)	5	Government National Tourism Organisation	3	2
		International Agencies UNESCO, IUCN, WWF, World Bank	3	1 (WWF)
Total=	18		14	8

The given table shows the potential interview plan. In this project, the number of respondents in each category will be determined by considering nature of organisation and structure. Interview will be conducted until reaching in a point of data redundancy for each category. The student researcher will consider the aim of the project and apply his own judgement (judgemental sampling technique) for selecting respondents for personal interview. The researcher will visit the study area (field) and will request potential respondents to participate in interviews; in some cases (where necessary) early appointment will be taken before having the interviews.

13(f) Specify and justify any payment or reward to be offered:

No payment. Refreshments will be offered to interview participants.

14. Methods and Procedures:

In order to collect primary data in this project, qualitative research methods, specifically semi-structured open-ended interviews, will be utilized. Because, climate change is a complex phenomenon in-depth face to face interviews are more appropriate to get profound insides of multiple stakeholders' understandings regarding it than quantitative methods. The research will provide an opportunity to observe participants non-verbal expressions which will further assist to realize the degree of seriousness about their responses.

The expected length of each interview is approximately one hour and the whole interview will be digitally recorded with the prior permission of participants. The recordings will assist to get unbiased information from the interviews and allow for the utilization of direct quotes which support to interpret the qualitative findings. The recordings will be partially transcribed and translated in English (where applicable) by the researcher and coded by using latest version of qualitative research software Nvivo. However, the interviews conducted for this project will address three elements (**Interview schedule attached**):

- The extent of climate change awareness and preparedness among the coastal communities in the developing country
- The ways and effectiveness of climate change communication in the coastal communities in developing world
- Comparative analysis of Climate Change Actions across the Bangladesh/India international boarder

Note: The 'Interview schedule' and 'Consent Form for Participants' will be translated into Bengali language and will be using where necessary. And the interviews will be taken either in Bengali or English, based on respondent's preference and ability.

15. Compliance with The Privacy Act 1993 and the Health Information Privacy Code 1994 imposes strict requirements concerning the collection, use and disclosure of personal information. The questions below allow the Committee to assess compliance.

15(a) Are you collecting and storing personal information (e.g. name, contact details, designation, position etc) directly from the individual concerned that could identify the individual?

YES. (The gender, age, occupation, level of education and position in organisation will be requested; in case of international tourists country of origin will be asked.)

15(b) Are you collecting information about individuals from another source?

NO

15(c) Collecting Personal Information:

- Will you be collecting personal information (e.g. name, contact details, position, company, anything that could identify the individual)?

YES

- Will you inform participants of the purpose for which you are collecting the information and the uses you propose to make of it?

YES

- Will you inform participants of who will receive the information?

YES

- Will you inform participants of the consequences, if any, of not supplying the information?

YES

- Will you inform participants of their rights of access to and correction of personal information?

YES

15(d) Outline your data storage, security procedures and length of time data will be kept:

The researcher will record, transcribe and translate into the English (where applicable) the audio recordings of the interviews; and secure those on a computer which will be protected by password within the Department. The access to those recordings will be limited to Professor James Higham and Md Kamrul Hassan and will be managed in accordance with the requirements of the University of Otago. The data will be deleted 5 years after the completion of the project.

All the participants will be informed of these points before starting the interviews.

15(e) Who will have access to personal information, under what conditions, and subject to what safeguards? If you are obtaining information from another source, include details of how this will be accessed and include written permission if appropriate. Will participants have access to the information they have provided?

Only the researcher, Md Kamrul Hassan and the primary project supervisor, Professor James Higham will have access to the audio recordings and transcripts.

Participants can ask for a copy of the information they have provided.

15(f) Do you intend to publish any personal information they have provided?

NO

15(g) Do you propose to collect demographic information to describe your sample? For example: gender, age, ethnicity, education level, etc.

Yes. In order to describe the population characteristics in some cases, the researcher would use some demographic information like gender, age, occupation, education level; personal identifiers will not be used (e.g. name).

15 (h) Have you, or will you, undertake Māori consultation? Choose one of the options below, and delete the option that does not apply:

Applied for Māori consultation and waiting for response.

16. Does the research or teaching project involve any form of deception?

NO

- 17. Disclose and discuss any potential problems or ethical considerations:**
 (For example: medical or legal problems, issues with disclosure, conflict of interest, safety of the researcher, etc. Note: if the student researcher will be travelling overseas to undertake the research, refer to item 12 of the *Filling Out Your Human Ethics Application* document. Please note that approval from the Human Ethics Committee does not override the University of Otago’s Field Policy and Travel Policy, which must be complied with.)

Not applicable.

- 18. *Applicant's Signature:**

Name (please print): Professor James Higham

Date:

*The signatory should be the staff member detailed at Question 1.

- 19. Departmental approval:** *I have read this application and believe it to be valid research and ethically sound. I approve the research design. The Research proposed in this application is compatible with the University of Otago policies and I give my consent for the application to be forwarded to the University of Otago Human Ethics Committee with my recommendation that it be approved.*

Signature of **Head of Department:

Name of HOD (please print): Associate Professor Neil Carr

Date:

**Where the Head of Department is also the Applicant, then an appropriate senior staff member must sign on behalf of the Department or School.

Appendix D: Information sheet for interview participants

[Reference Number: 16/014]

[9 March 2016]



Communicating Climate Change: A Cross-border Analysis of the Sundarbans

INFORMATION SHEET FOR PARTICIPANTS

Thank you for showing an interest in this project. Please read this information sheet carefully before deciding whether or not to participate. If you decide to participate we thank you. If you decide not to take part there will be no disadvantage to you and we thank you for considering our request.

What is the Aim of the Project?

This project is being undertaken as part of the requirements for PhD in Tourism at the University of Otago (New Zealand). The aim of this project is to investigate awareness, knowledge, and responses to climate change in relation to the Sundarbans World Heritage Area (Bangladesh and India).

What Type of Participants are being sought?

Participants will be sought from local communities, tourism business operators, tourists of the Sundarbans in Bangladesh and then again pursued from Government organisations including tourism, NGOs, and international agencies working for the Sundarbans in Bangladesh and India.

The research will approach the potential participants to take part in a semi-structured interview lasting approximately for one hour. Approximately 40 respondents will be sought for this study.

Participation is voluntarily (**no money will be paid**); participants may request a summary of findings arising from the interviews.

What will Participants be Asked to Do?

Should you agree to take part in this project, you will be asked to participate in a face-to-face interview lasting approximately 60 minutes.

Please be aware that you may decide not to take part in the project without any disadvantage to yourself of any kind.

What Data or Information will be Collected and What Use will be Made of it?

The data collected will be securely stored in such a way that only those mentioned below will be able to gain access to it. Data obtained as a result of the research will be retained for **at least 5 years** in secure storage. Any personal information held on the participants (such as name, position, contact details, audio or video tapes, after they have been transcribed etc.) may be destroyed at the completion of the research even though the data derived from the research will, in most cases, be kept for much longer or possibly indefinitely.

The results of the project may be published and will be available in the University of Otago Library (Dunedin, New Zealand) but every attempt will be made to preserve your anonymity.

This project involves an open-questioning technique. The general line of questioning includes:

- Awareness of climate change
- Responses to climate change
- Climate Change management actions in the Sundarbans world heritage area

The precise nature of the questions which will be asked have not been determined in advance, but will depend on the way in which the interview develops. Consequently, although the University of Otago Human Ethics Committee is aware of the general areas to be explored in the interview, the Committee has not been able to review the precise questions to be used.

In the event that the line of questioning does develop in such a way that you feel hesitant or uncomfortable you are reminded of your right to decline to answer any particular question(s) and also that you may withdraw from the project at any stage without any disadvantage to yourself of any kind.

Can Participants Change their Mind and Withdraw from the Project?

You may withdraw from participation in the project at any time and without any disadvantage to yourself of any kind.

What if Participants have any Questions?

If you have any questions about our project, either now or in the future, please feel free to contact either:-

Md Kamrul Hassan

and

Professor James Higham

Department of Tourism

Department of Tourism

Telephone:- 64 3 479 8520

Telephone:- 64 3 479 8500

Email: hasmd158@student.otago.ac.nz

Email: james.higham@otago.ac.nz

This study has been approved by the University of Otago Human Ethics Committee. If you have any concerns about the ethical conduct of the research you may contact the Committee through the Human Ethics Committee Administrator (ph +643 479 8256 or email gary.witte@otago.ac.nz). Any issues you raise will be treated in confidence and investigated and you will be informed of the outcome.

Appendix E: Consent form for interview participants

[Reference Number: 16/014]
[9 March 2016]

Communicating Climate Change: A Cross-border Analysis of the Sundarbans

CONSENT FORM FOR PARTICIPANTS

I have read the Information Sheet concerning this project and understand what it is about. All my questions have been answered to my satisfaction. I understand that I am free to request further information at any stage.

This project involves an open-questioning technique. The general line of questioning includes environmental changes, management and tourism. The precise nature of the questions which will be asked have not been determined in advance, but will depend on the way in which the interview develops and that in the event that the line of questioning develops in such a way that I feel hesitant or uncomfortable I may decline to answer any particular question(s) and/or may withdraw from the project without any disadvantage of any kind.

I know that:-

1. My participation in the project is entirely voluntary;
2. I am free to withdraw from the project at any time without any disadvantage;
3. Personal identifying information digital recording will be destroyed at the conclusion of the project but any raw data on which the results of the project depend will be retained in secure storage for at least five years;
4. The results of the project may be published and will be available in the University of Otago Library (Dunedin, New Zealand) but every attempt will be made to preserve my anonymity.

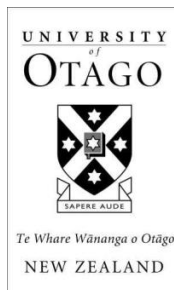
I agree to take part in this project.

.....
(Signature of participant)

.....
(Date)

.....
(Printed Name)

This study has been approved by the University of Otago Human Ethics Committee. If you have any concerns about the ethical conduct of the research you may contact the Committee through the Human Ethics Committee Administrator (ph +643 479 8256 or email gary.witte@otago.ac.nz). Any issues you raise will be treated in confidence and investigated and you will be informed of the outcome.



Appendix F(1): List of documents - organisational prospectus

No.	Title/subjects of documents	Organisation	Year	Language of the documents
1.	Climate change and Disaster Resilience Programme	Islamic Relief, Bangladesh	Accessed-June, 2016	English
2.	Community Climate Change Project	Palli Karma-Sahayak Foundation (PKSF)	March, 2016 (Issue 4)	English
3.	Hatchery Based Mud Crab (<i>Scylla spec.</i>) Production in Bangladesh: Sustainable Development and Biodiversity Conservation in Coastal Protection Forests, Bangladesh (SDBC-Sundarbans)	German Cooperation (giz)	August, 2015	English
4.	Embankment Rehabilitation and Management through Participation of Resident Population: Sustainable Development and Biodiversity Conservation in Coastal Protection Forests, Bangladesh (SDBC-Sundarbans)	German Cooperation (giz)	September, 2015	English
5.	Sustainable Development and Biodiversity Conservation in the Coastal Protection Forests of Bangladesh	German Cooperation (giz)	September, 2014	English
6.	Dike greening: A Win-Win Concept for Organic Shrimp Farming in a Nurturing Coastal Environment: Sustainable Development and Biodiversity Conservation in Coastal Protection Forests, Bangladesh (SDBC-Sundarbans)	German Cooperation (giz)	September, 2015	English
7.	Sundarbans- The Magical mangrove	The Guide Tours Ltd. (Tourism Business)	Accessed-July, 2016	English
8.	Framing Ecosystem-Based Adaptation to Climate Change: Applicability in the Coast of Bangladesh	Mangroves for the Future (Int. Agency)	Accessed-August, 2016	English
9.	Creating Climate Resilient Communities: The Bangladesh Lighthouse Project	CCDB (NGO)	Accessed-June, 2016	English
10.	(A document showing the issues need to know in a baseline survey)	Brotee (NGO)	Accessed-June, 2016	Bengali
11.	Our Nature Our Right, Save the Nature Join the Fight (A promotional flier published for World Environment Day)	Save the Nature of Bangladesh (Social movement)	June, 2016	Bengali
12.	Climate Change Unit	CCDB (NGO)	Accessed-June, 2016	English
13.	Community Climate Change Project	Palli Karma-Sahayak Foundation (PKSF)	November, 2012	English
14.	Annual Report, 2014-2015	Bangladesh Climate Change Trust (Ministry of Environment and Forest)	Accessed-May, 2016	Bengali

No.	Title/subjects of documents	Organisation	Year	Language of the documents
15.	Empowerment is Key to Poverty Eradication and Human Dignity- A New Holistic PKSF Approach: Enrich	Palli Karma-Sahayak Foundation (PKSF)	August, 2015	English
16.	(Enrich - Utilisation of the Family Assets for Poverty Eradication and Capacity Building)- translated title	Palli Karma-Sahayak Foundation (PKSF)	April, 2015	Bengali
17.	Sustainable Development and Biodiversity Conservation in Coastal Protection Forests	German Cooperation (giz)	January, 2012	Bengali and English
18.	Prospectus of Bangladesh Environment and Development Society (BEDS)	BEDS (NGO)	May, 2016	English
19.	Enrich - A Holistic Approach to Household-focused Poverty Eradication: A new initiative of PKSF	Palli Karma-Sahayak Foundation (PKSF)	September, 2014	English
20.	Enhancing Climate Change Adaptation and Disaster Resilience in Bangladesh: Agricultural Adaptation Strategies for Climate change for the Coastal Area	Islamic Relief UK, and UKAid	Accessed- June, 2016	Bengali
21.	Education materials (Posters developed by BEDS and Korea Green Foundation) about climate change, sustainable development goals, eco-village, forests, Biodiversity of the Sundarbans	Collected from BEDS	Accessed- July, 2016	Bengali
22.	Tagore Society for Rural Development - Rangabalia project brochure [Indian document]	Tagore Society for Rural Development	2015	Bengali and English

Appendix F(2): List of documents - Newspaper articles

No.	Title/Subject	Producer/ Authors	Publication year	URL Link
1.	Forest minister: It is not possible to keep tigers alive forever	Dhaka Tribune (Online) by Nure Alam Durjoy	December 03, 2016	http://www.dhakatribune.com/bangladesh/2016/12/03/minister-not-possible-tigers-alive/
2.	Tiger census in Sundarbans to confirm population by 2019	Dhaka Tribune (online) by- Hedait Hossain Molla, Khulna	July 28, 2017	http://www.dhakatribune.com/bangladesh/environment/2017/07/28/sundarbans-tiger-population-2019/
3.	More hazards for the Sundarbans [translated title]	Daily Prothom Alo	12 August, 2017	http://www.prothomalo.com/opinion/article/1285711/%E0%A6%B8%E0%A7%81%E0%A6%A8%E0%A7%8D%E0%A6%A6%E0%A6%B0%E0%A6%AC%E0%A6%A8%E0%A7%87%E0%A6%B0%E0%A6%86%E0%A6%B0%E0%A6%93%E0%A6%AC%E0%A6%BF%E0%A6%AA%E0%A6%A6
4.	Thousands to march against coal plant threat to Bangladesh's Sundarbans forest	The Guardian	2 March, 2016	https://www.theguardian.com/environment/2016/mar/02/thousands-to-march-protest-coal-plant-threat-bangladeshs-sundarbans-forest
5.	11 Amazing Facts about Sundarbans	Pallavi Shah	25 July, 2014	http://topyaps.com/11-amazing-facts-sundarban
6.	A Look Into Journalist Mohsin-ul Hakim's Courageous Story	Ice Today (Online) By Chand Sultana Khan	3 May, 2017	http://icetoday.net/2017/05/a-look-into-journalist-mohsin-ul-hakims-courageous-story/

Appendix F(3): List of documents - YouTube videos

No.	Title/Subject	Producer/ Authors	Publication year	URL Link
1.	41st World Heritage Committee 5 July 2017 PM	UNESCO	Streamed live on Jul 5, 2017 (Afternoon Session)	http://whc.unesco.org/en/sessions/41com/
2.	The way tigers are shrinking	Maasranga Television	31 July 2017	https://www.youtube.com/watch?v=Y2Kriwg5JK8
3.	Tiger counting through camera trapping method	Channel 24	8 March 2017	https://www.youtube.com/watch?v=7Qy22_C1mD8
4.	INVESTIGATION 360 Degree"BD Crimes Watch! "Poribesh porichiti Sundonbon"	Jamuna TV	August, 2017	https://www.youtube.com/watch?v=cGuL2a100jc
5.	Investigation 360 degree - (Misuse of climate change fund)	Jamuna TV (TV show)	Accessed- August, 2017	https://www.facebook.com/newbasherkeella/videos/1554651401289485/
6.	(Smugglings of the tigers of Sundarbans)	ATN News	12 June, 2015	https://www.youtube.com/watch?v=j8orpgi6G24
7.	(Captive breeding of Batagur baska)	Channel 24	10 September, 2017	https://www.youtube.com/watch?v=iJNQ2BxYsO4
8.	Man Eating Tigers Of The Sundarbans	BBC	April, 2013	https://www.youtube.com/watch?v=4u3zDpe5AS4
9.	Sundarbans - Story of Survival by Green Explore Society HD	Green Explore Society	September, 2014	https://www.youtube.com/watch?v=K-efniRgE5Y
10.	Earth from Space: Sundarbans web	European Space Agency, ESA	July, 2016	https://www.youtube.com/watch?v=dfcadj23vdY
11.	Birds eye view of the Sundarbans	Pothik	April, 2016	https://www.youtube.com/watch?v=DE_KkFi7QaA
12.	National Geographic - Man-Eating Tigers of The Sundarbans	BBC Nature Documentary by James Frink		https://www.youtube.com/watch?v=SYoyhLyha1g
13.	Sundarbans and Climate Change - Part 1	British Council India	June, 2009	https://www.youtube.com/watch?v=m5WDbEzbpKE
14.	Sundarbans and Climate Change - Part 2	British Council India	June, 2009	https://www.youtube.com/watch?v=6MjR1ysrS6o
15.	Sundarbans and Climate Change - Part 3	British Council India	June, 2009	https://www.youtube.com/watch?v=eusyA74ghg8
16.	Sundarbans and Climate Change - Part 4	British Council India	June, 2009	https://www.youtube.com/watch?v=knqGD1teNls

No.	Title/Subject	Producer/ Authors	Publication year	URL Link
17.	(Reasons of tiger reduction)	Channel 9	November, 2016	https://www.youtube.com/watch?v=HGLEuGAe0Hw
18.	(Tiger poaching)	R TV (news report)	June, 2017	https://www.youtube.com/watch?v=74W0tVPdQYM
19.	SUNDARBAN: It's Not About The Tiger Only (Documentary)	Jungle Book Leisure Pvt. Ltd.	March, 2017	https://www.youtube.com/watch?v=ohJkzni8zTE
20.	(Television news report)	Jamuna TV report by Mohsin-ul Hakim	October, 2017	https://www.facebook.com/newbasherella/videos/1613475558740402/
21.	CHANNEL 24 - News Channel of Bangladesh (Pirates in the Sundarbans)	Channel 24	November, 2017	https://www.youtube.com/watch?v=vvrjSW5wRFo

Appendix F(4): List of documents - Websites

No.	Title/Subject	Producer/Authors	Accessed	URL Link
1.	(Official website of Sundarban Biosphere Reserve)	Sundarban Biosphere Reserve	2016	http://www.sundarbanbiosphere.org/html_files/introduction.htm
2.	Sundarbans	Wikipedia	2015	https://en.wikipedia.org/wiki/Sundarbans
3.	Sundarbans National Park	Wikipedia	2015	https://en.wikipedia.org/wiki/Sundarbans_National_Park
4.	About Sundarbans	WWF	2016	http://www.wwf.org/india/about_wwf/critical_regions/sundarbans3/about_sundarbans/
5.	Sundarbans mangroves	WWF	2016	http://wwf.panda.org/about_our_earth/ecoregions/sundarbans_mangroves.cfm
6.	Sundarbans: Nature's bio-shield	BBC	2015	http://www.bbc.com/future/story/20130212-sundarbans-natures-bioshield
7.	Sundarbans, Bangladesh: Image of the Day	Nasa Earth Observatory	2017	https://earthobservatory.nasa.gov/IOTD/view.php?id=7028
8.	Mangroves save coastal communities in the Sundarbans, India	Livelihoods Funds	2016	http://www.livelihoods.eu/mangroves-save-coastal-communities-in-the-sundarbans-india/
9.	Climate Change in India - The Vanishing Islands of India's Sundarbans	Ari Shapiro	2016	http://www.npr.org/sections/parallels/2016/05/23/478393443/the-vanishing-islands-of-indias-sundarbans
10.	Access to electricity (% of population) [Contribution to emissions]	World Bank	2017	https://data.worldbank.org/indicator/EG.ELC.ACCS.ZS?end=2012&locations=BD&start=2005
11.	@SaveSundarbans.SaveBangladesh	Facebook Page	2017	https://www.facebook.com/SaveSundarbans.SaveBangladesh/?hc_ref=NEWSFEED&fref=nf
12.	Stop Rampal Project Save Sundarbans	Facebook Page	2017	https://www.facebook.com/hashtag/stoprampal?source=feed_text&story_id=1378842955565857
13.	Forest of Tides: The Sundarbans	Louis Werner	2016	http://www.aramcoworld.com/en-US/Articles/September-2016/Forest-of-Tides-The-Sundarbans
14.	Nature: transforming lives	Concern Worldwide	2014	https://medium.com/@Concern/nature-transforming-lives-3bf33602ee64
15.	Tragedy in the Himalayas and Ganges-Brahmaputra Plain - Flood, drought, earthquake and cyclone	SOS-arsenic.net	2009	http://www.sos-arsenic.net/english/development/waterlogging.html
16.	Healing of the Sundarbans following Sidr	Dr Saiful Islam (The Daily Star, on December 2007)	2007	http://www.thedailystar.net/news-detail-16760

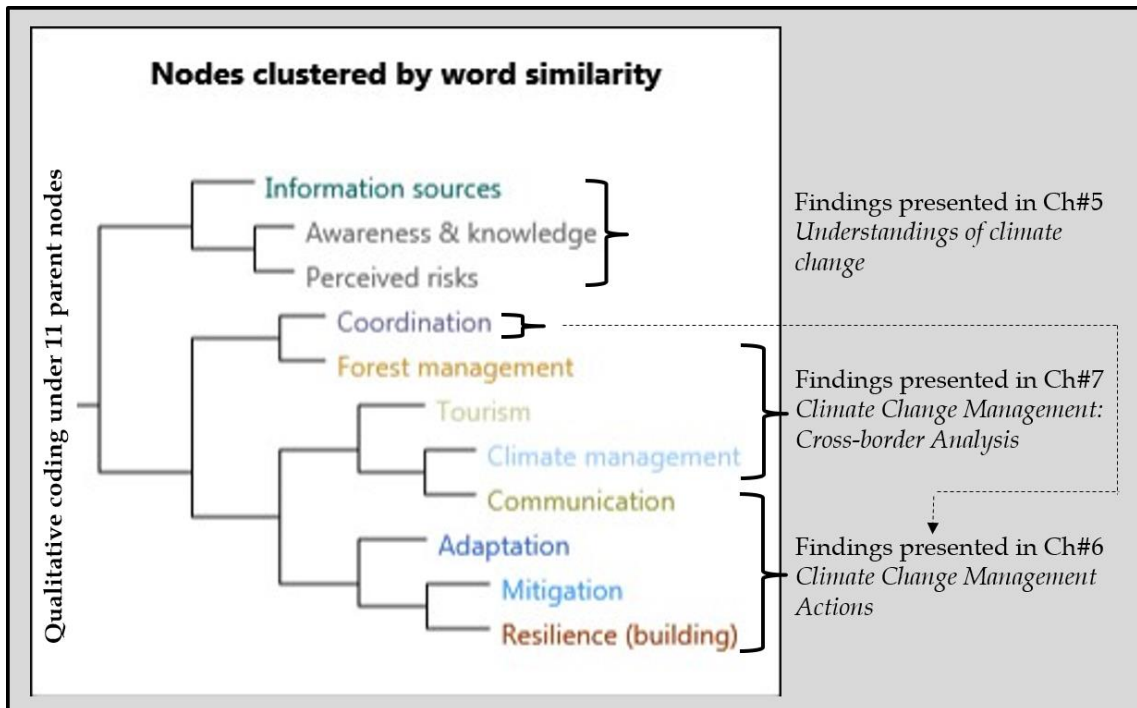
No.	Title/Subject	Producer/ Authors	Accessed	URL Link
17.	Sidr in Sundarbans: Super Cyclone in Bangladesh	Sirajul Hossain	2007	http://www.thedailystar.net/news-detail-16760
18.	What is a super cyclone?	India Today	2013	http://indiatoday.intoday.in/story/super-cyclone-phailin-odisha-cyclone-1999/1/314159.html

Appendix H: Node list imported from NVivo project

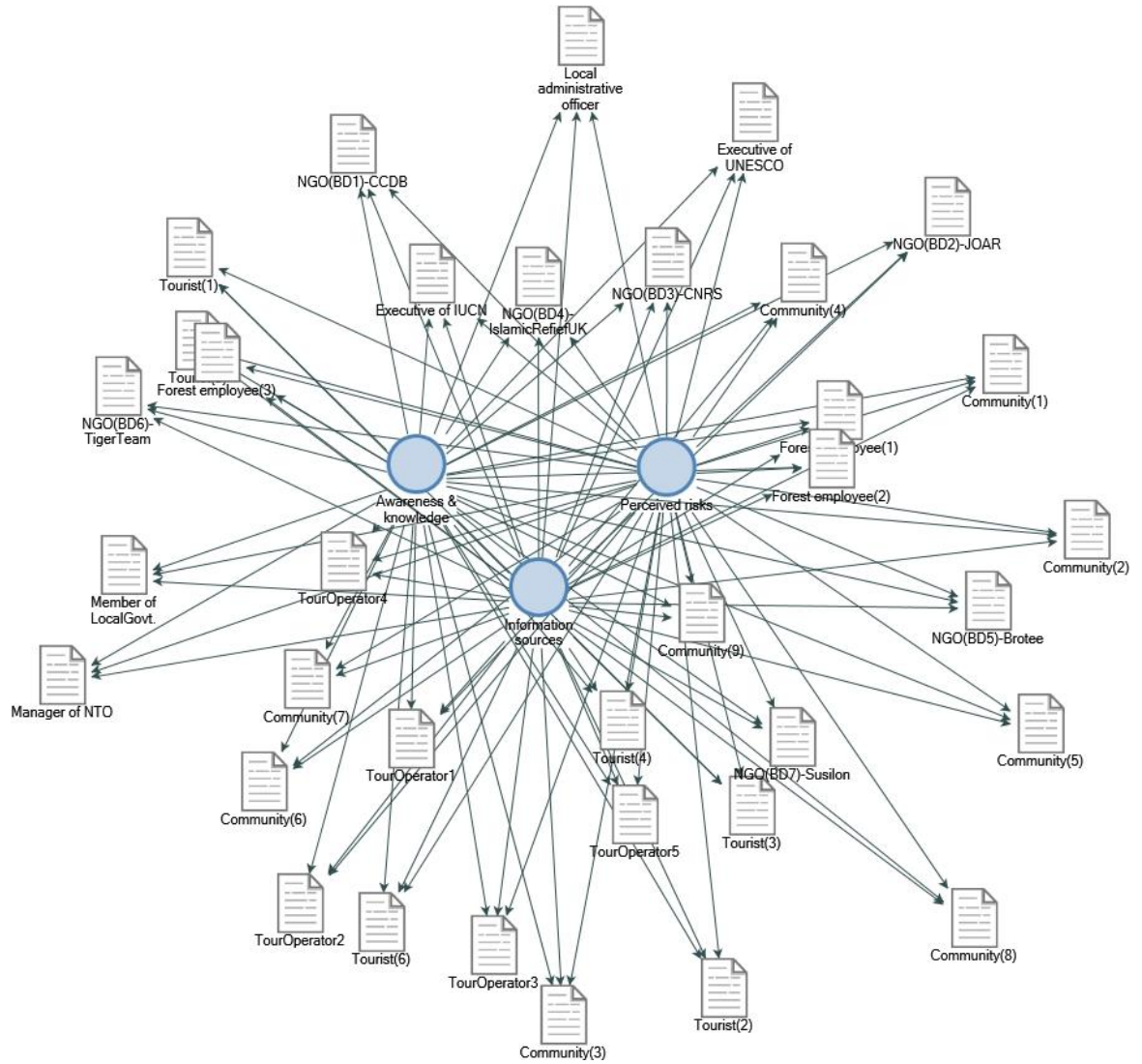
Name of nodes	Sources	References
Adaptation	15	35
Approaches and strategies		
Disaster Management		
Responsibilities		
Challenges		
Maladaptation		
Migration		
Awareness & knowledge	35	207
Attitude - climate change		
Behaviours		
Believes		
Causes - climate change		
Consumption and usages		
Definition - climate change		
Causes		
Knowledge		
Environmental		
Oil spill		
Rampal		
Shrimp farming		
Tourism		
Experience - climate change		
Impacts		
Impacts and vulnerabilities		
Impacts		
Effects		
Cyclone		
Drought		
Erosion		
Flood & tidal waves		
Salinity		
Sea level rise		
Temperature		
Misconceptions		
Pollution		
Oil spill		
Rampal		
Shrimp farming		
Tourism		
Weather system		
Climate management	22	140
Public education		
Advocacy		
Bangladesh Sundarbans		
Climate change strategies		
Relative scenarios		
Indian Sundarbans		
Liaison with Bangladesh		
Community involvement		
Disaster management		
Challenges		
Challenges - climate actions		
Forestry		
Scope to work together		
Livelihood support		
Arranging livelihoods		

Name of nodes	Sources	References
Communication	15	47
Approaches and strategies		
Challenges		
Message development		
Responsibility		
Coordination	15	73
Institutional roles		
International Agencies		
Institutional liaison		
Benefits		
Challenges		
International coordination		
Benefits		
Scope		
Typologies		
Scope		
Bangladesh Sundarbans		
Climate change strategies		
Relative scenarios		
Indian Sundarbans		
Forest management	22	208
Conservational practices		
Governance system		
Policy and laws		
Socio-economic aspects		
Species Management		
Species Management - India		
Information sources	35	152
Information flows		
Media		
Reliability		
Information sufficiency		
Mitigation	15	24
Alternative livelihoods		
Approaches and strategies		
Challenges		
Man-made problem		
Responsibilities		
Perceived risks	35	59
Future plans		
Attitude to scientific predictions		
Current risks		
Preparation		
Resilience (building)	15	30
Approaches and strategies		
Challenges		
Infrastructure		
Planning and development		
Responsibility		
Tourism	22	108
Development approaches		
Alternative livelihood		
Dilemma		
Effects		
Tourist behaviour		
Monitoring and control		
Observed vulnerabilities		
Climate awareness		
Pollution		
Risk management		

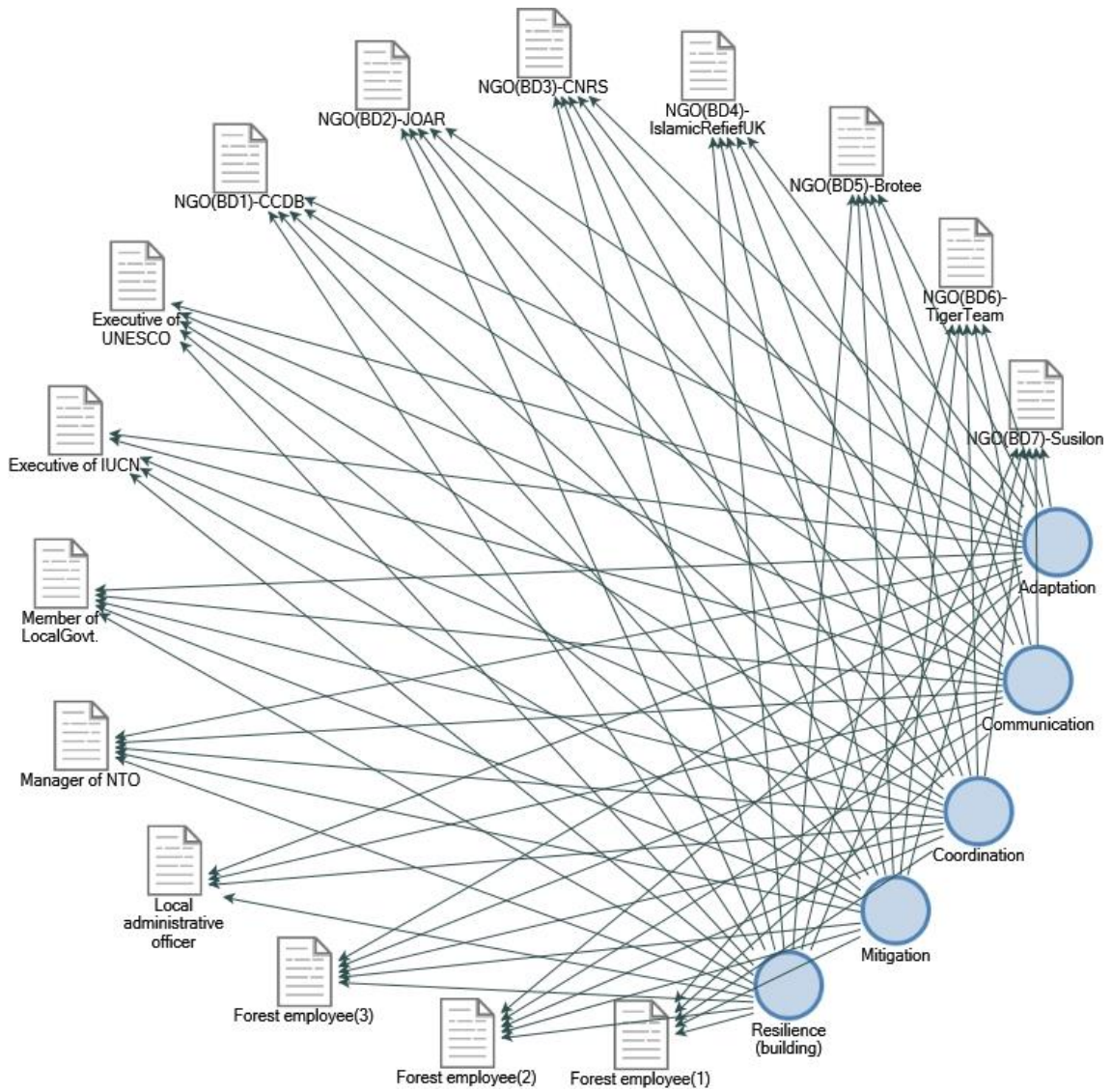
Appendix I: Cluster analysis of qualitative coding (NVivo output)



Appendix J(1): Project map for findings presented in Ch#5 (NVivo output)



Appendix J(2): Project map for findings presented in Ch#6 (NVivo output)



Appendix J(3): Project map for findings presented in Ch#7 (NVivo output)

