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Limits and barriers to adaptation to climate variability and change in Bangladeshi coastal fishing communities

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ABSTRACT

Limits and barriers to adaptation restrict people's ability to address the negative impacts of climate change or manage risks in a way that maximises their wellbeing. There is a lack of evidence of this on small-scale fishing communities in developing countries. This study identifies and characterises limits and barriers to adaptation of fishing activities to cyclones and examines interactions between them in two fishing communities in Bangladesh, using household questionnaires, oral history interviews, vulnerability matrices and focus group discussions. The limits include physical characteristics of climate and sea like higher frequency and duration of cyclones, and hidden sandbars. Barriers include technologically poor boats, inaccurate weather forecast, poor radio signal, lack of access to credit, low incomes, underestimation of cyclone occurrence, coercion of fishermen by the boat owners and captains, lack of education, skills and livelihood alternatives, unfavourable credit schemes, lack of enforcement of fishing regulations and maritime laws, and lack of access to fish markets. These local and wider scale factors interact in complex ways and constrain completion of fishing trips, coping with cyclones at sea, safe return of boats from sea, timely responses to cyclones and livelihood diversification. The findings indicate a need for further detailed research into the determinants and implications of such limits and barriers, in order to move towards an improved characterisation of adaptation and to identify most suitable means to overcome the limits and barriers.

1. Introduction

Adaptation is inevitable to address the impacts of climate variability and change but adaptation efforts are impeded in many ways. Limits and barriers to adaptation restrict people's ability to identify, assess and manage risks in a way that maximises their wellbeing [1–4]. Limits are obstacles that are in some sense absolute [5], while barriers are mutable [6]. Limits and barriers to adaptation arise due to certain characteristics of the people involved, the nature of the specific systems involved and/or the larger context within which the people and systems operate [4]. Barriers to adaptation can prevent the development and implementation of adaptations from taking place [5]. Due to presence of barriers high adaptive capacity does not necessarily translate into successful adaptation [7].

Small-scale fisheries that support livelihoods of more than 90% of capture fisherfolk and produce about 50% of global seafood catches [8] are impacted by climate variability and change. These impacts include not only those on fish populations [9–11] but also on the livelihoods of the dependent communities [12–17]. To minimise these impacts and take advantage of opportunities they need to adapt successfully. Morgan [18] suggests that due to the high vulnerability of fisherfolk and a heavy reliance on specific fisheries for income, fishing communities may face considerable limits and barriers to adaptation to climate change. Many of these limits and barriers are interrelated and combine to constrain adaptation [5,19]. But there is a lack of evidence on limits and barriers to adaptation and interactions between them. The objective of this study is to identify and characterise the limits and barriers to adaptation of fishing activities to cyclones and examine interactions between them, gaining insights from two coastal small-scale fishing communities in Bangladesh.

In what follows, Section 2 reviews the existing literature on limits and barriers to climate related adaptation. Section 3 describes case studies and methodology. Section 4 identifies and characterises the limits and barriers to adaptation as well as examines their interactions. Section 5 situates findings into other

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literature and discusses the theoretical contribution. Section 6 concludes by highlighting the main findings and practical implications.

2. Limits and barriers to adaptation to climate variability and change

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" [1, p. 869]. In many cases local adaptation measures are reactive and short-term (coping strategies) [20] which can limit the scope for adaptation in the longer term [2]. In this study both short- and long-term responses are regarded as adaptation. Limits and barriers to local adaptation measures can emerge at multiple spatial and temporal scales [21].

Some distinguish limits and barriers to adaptation, while others use the terms interchangeably. This study considers limits as "the conditions or factors that render adaptation ineffective as a response to climate change and are largely insurmountable" [5, p. 733]. These limits are faced when thresholds or tipping points associated with social and/or natural systems are exceeded [2]. On the other hand, "barriers are the conditions or factors that render adaptation difficult as a response to climate change" [22, p. 142] but they are often mutable [6] or can be "overcome with concerted effort, creative management, change of thinking, prioritisation, and related shifts in resources, land uses, institutions, etc." [4, p. 22027].

Limits and barriers to adaptation can be natural, technological, economic, social or formal institutional. Natural limits range from ecosystem thresholds to geographical and geological limitations [19]. Dramatic climate change may alter physical environment so as to limit adaptation possibilities [23]. The limits of adaptation will also depend on the inherent sensitivity of some ecosystems, habitats and species [5]. The impacts of climate change can surpass critical thresholds [5] and cause ecosystem regime shifts [24], which in turn can limit economic and social adaptation [25] especially of communities those directly depend on ecosystems such as fisheries and agriculture [5].

Technological barriers (sometimes classified as limits if unaffordable) to adaptation include lack of hard engineering structures, e.g., [26] but lack of smaller equipment, tools and techniques may also constrain adaptation. Although some adaptations may be technologically possible, they may be constrained by economic and cultural barriers [5]. Technological barriers may also lead to inaccurate information due to, for example, limitations in modelling the climate system or lack of accurate weather forecasts. Insufficient information and knowledge on the impacts of climate change may continue to hinder adaptation particularly in Asia [27].

Economic barriers constrain adaptation of low-income households and communities [5]. Mahon [28] contended that cost of vessel insurance, gear replacement, repairs, operation, safety measures and increased investment were all barriers to adaptation among fishing communities. In agricultural communities, lack of financial capital is one barrier to adaptation, such as adoption of improved crop varieties and diversification of livelihoods [29]. In recent years microfinance has emerged in many developing countries but it does not often reach the poorest and most vulnerable groups [30,31]. Budget constraints can also pose a barrier when adaptation measures involve high upfront cost. Those with limited financial capital will focus on short-term gain rather than on the potential long-term benefits of reduced vulnerability [32,33].

Some studies have pointed out the significance of social barriers to adaptation [6,14,19,34]. Adger et al. [6] suggest that ethics (how and what people value), knowledge (how and what people know), risk (how and what people perceive) and culture (how and what people live) are key aspects of social barriers. Thus social barriers are concerned with the social and cultural processes of society [19] including informal institutions and human capital. People perceive, interpret, and think about risks and adaptation to them depending on their worldviews, values and beliefs [4,5]. People frequently underestimate the possibility of the occurrence of climate events even if they are aware of the risks [35]. Some empirical studies have shown that individuals may not seek information on these possibilities of the occurrence of climate events before making their decisions [36–38].

Formal institutional barriers may constrain adaptation because they define the processes and rules that govern and regulate access and entitlement to livelihood assets. The ways in which actors are able to access assets play a role in determining their vulnerability and ability to cope with and adapt to stress [39]. Institutions can restrict the choice of livelihood strategies for some people; on the other hand they can open up opportunities for others [40] and favour some groups over others [41]. Institutional barriers have limited the ability of the rural communities to cope with extreme climate events by limiting access to markets and in terms of unfavourable development policies [42,43].

The discussion above indicates that a range of limits and barriers may influence adaptation to climate variability and change by stopping, delaying or diverting the adaptation process [4]. Empirical studies on limits and barriers to adaptation to climate change have been published in biological, agronomic, economic, sociological, psychological, and urban planning literature. These studies often focussed on a single limit or barrier; hence how they interact has not been properly investigated. A number of studies have developed theoretical frameworks for limits and barriers, e.g., [4, 6]. More empirical studies are needed to aid adaptation decision-making. As Moser and Ekstrom [4, p. 22029] suggest "more systematic empirical research must be undertaken to verify our observations". Most of the studies published to date focus on agricultural communities, e.g., [19, 44]. The studies on fisheries and climate change have largely focussed on physical climate impacts on oceanic productivity and fish production, e.g., [9–11], and macro scale impacts on economies and society, e.g, [45,46]. A limited number of recent studies have focussed on impacts, vulnerability and adaptation to climate variability and change in fishing communities and on their livelihoods, e.g., [13–15], but none has examined limits and barriers at the local scale in developing countries. This study seeks to fill the gap by identifying and characterising limits and barriers to adaptation of fishing activities to cyclones and examining interactions between them in two small-scale fishing communities in Bangladesh. This study focusses only on fishing related limits and barriers because fishing is one of the main livelihood activities in the two communities [15]. This research focusses on both minor and major cyclones as these are the main climate shocks affecting fishing activities.

3. Case study, materials and methods

This article examines coastal small-scale fisheries of Bangladesh, a country with low incomes, poor infrastructure and high dependence on natural resources for livelihoods [47]. Bangladesh and its fisheries sector are victims of global climate variability and change [1,45,48]. The coastal small-scale fisheries support the livelihoods of half a million fisherfolk and their household members [49]. These fisherfolk catch 93% of the total marine catch of Bangladesh [49].

Most fishery-dependent people live in the coastal low-lying areas which are highly exposed to climate change impacts [50]. While their livelihoods are impacted by many climate shocks and stresses such as cyclones, floods and sea level rise, their fishing activities are impacted mainly by cyclones in the Bay of Bengal [15]. There have been more cyclones in the Bay of Bengal