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Social-ecological dynamics of the small scale fisheries in Sundarban Mangrove Forest, Bangladesh

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ABSTRACT

The Sundarban Mangrove Forest (SMF) is an intricate ecosystem containing the most varied and profuse natural resources of Bangladesh. This study presents empirical research, based on primary and secondary data, regarding the social-ecological system (SES), social-ecological dynamics, different stakeholders and relevant management policies of small-scale or artisanal fisheries such as the SMF; showing how, despite extensive diversification, the livelihood activities of the artisanal fishers in the SMF all depend on the forest itself. Regardless of this critical importance of mangroves, however, deforestation continues due to immature death of mangroves, illegal logging, increased salinity, natural disasters and significant household consumption of mangrove wood by local people. As the mangroves are destroyed fish stocks, and other fishery resources are reduced, leading to moves of desperation among those whose livelihood has traditionally been fishing. The present study also considers several risks and shock factors in the fishers' livelihood: attacks by wild animals (especially tigers) and local bandits, illness, natural disasters, river bank erosion, and the cost of paying off corrupt officials. The artisanal fishers of the SMF have adopted different strategies for coping with these problems: developing partnerships, violating the fisheries management laws and regulations, migrating, placing greater responsibility on women, and bartering fishing knowledge and information. This study shows how the social component (human), the ecological component (mangrove resources) and the interphase aspects (local ecological knowledge, stakeholder's interest, and money lenders or middle man roles) of the SMF as an SES are linked in mutual interaction. It furthermore considers how the social-ecological dynamics of the SMF have negative impacts on artisanal fishermen's livelihoods. Hence there is an urgency to update existing policies and management issues for the sustainable utilization of the SMF resources, eventually contributing to the improvement of the artisanal fishers' livelihoods.

1. Introduction

1.1. Artisanal fisheries and the Sundarban Mangrove Forest (SMF)

Artisanal or small-scale fisheries involves a consistent fleet, made up of small vessels with low tonnage. Unlike the large-scale fishing industry, the artisanal segment relies on small capital investments and is characterized using rather diversified fishing gear (Farrugio, Oliver, & Biagi, 1993). Artisanal fishing activities vary significantly from one to another, depending not only on biological and environmental conditions but also on the social, economic and historical contexts in which fishers live (Battaglia, Romeo, Consoli, Scotti, & Andaloro, 2010). Small-scale fisheries are critically important as sources of nutrition, income, and well-being for hundreds of millions of people around the world. They are a vitally important interface between people and marine or aquatic resources, depending heavily on the health and resilience of these marine and aquatic ecosystems (Allison et al., 2009). Despite their importance, however, studies regarding the artisanal fishery sector —— characteristics of their fleets and fishing gear, seasonality,

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catches, yields, revenues, and costs —— have been somewhat limited. This is particularly important in that understanding and reducing the impacts of artisanal fisheries on marine ecosystems is a rapidly emerging priority for marine conservation. In the context of ecosystems being degraded, ever-growing human populations and increasing efforts required in artisanal fishing, there is urgent need to develop sustainable management strategies for artisanal fisheries (Johnson et al., 2013).

Mangrove forest is one of the primary features of coastlines throughout the tropics and subtropics globally (Alongi, 2002). As the source of a variety of renewable resources, mangroves play a significant role in the local economy and livelihood of the people who live among them, in the national economic development of tropical coastal nations, and in the regional environmental balance (Islam & Wahab, 2005). Mangroves have direct, tangible value as a source of timber, fuelwood, and fruit; and indirect value through their functions as a coastal shelter belt, tourist attractions, feeding and breeding ground for fish and wildlife, and as a source of floral biodiversity unto themselves. These values result from intrinsic characteristics of the mangrove ecosystem and its continuous interaction with other ecosystems (Iftekhar & Islam, 2004). Furthermore, mangroves are characterized by higher biodiversity in their fisheries as well as higher standing stock (Chong, Sasekumar, Leh, & D'cruz, 1990).

The Sundarbans is a unique mangrove ecosystem of considerable ecological and economic value, a world heritage site and the most significant mangrove forests in the world, shared between Bangladesh (62%) and India (Iftekhar & Islam, 2004). The total land area is 4143 km^2, surrounded by a water area of 1874 km^2 composed of rivers, small streams, and canals. The Sundarbans form an ideal mangrove ecosystem, supporting vast stocks of fish, shrimp and edible crab which supply a staple food and income for the coastal communities (Hoq, 2003). With over 3.5 million people in the surrounding areas depending directly or indirectly on the Sundarbans for their livelihood, the forest has been shrinking alarmingly day by day (Shah, Huq, & Rahman, 2010). In addition to over-fishing, over the last two decades, mass shrimp fry collection has become a further threat to the coastal ecosystem (Hoq, 2007). Trees have also been damaged by fishing boats being tied off to them. Estimated Maximum Sustainable Yields (MSY) of significant fishery resources, and existing acts/regulations to protect them have been covered well by Hoq (2007). His data is presented in Tables 1 and 2. However, little attention has been paid to the functional maintenance of this valuable resource. Consequently, there has been no sound management and research guidelines for the valuable mangrove fisheries (Islam & Haque, 2004).

1.2. Social-ecological system (SES) approach

Human social and economic systems are shaped by the ecological endowments of a region as a co-evolutionary process (Simmie & Martin, 2010). These processes occur in a variety of scales, from local to global. Hence, a stream of scholars has recently suggested that the focus of sustainability science should be on linked "social-ecological systems" (Berkes & Folke, 1998). The potential loss of fisheries, forests, and water resources is a major problem worldwide. Understanding of the processes that lead to improvements in or deterioration of natural resources is limited because scientific disciplines use different concepts and languages to describe and explain complex SESs (Ostrom, 2009). An SES is an ecological system intricately linked to and affected by one or more social systems (Anderies, Janssen, & Ostrom, 2004). Also, SESs are nested, multilevel systems that provide essential services to society, such as the supply of food, fiber, and energy (Binder, Hinkel, Bots, & Pahl-Wostl, 2013).

If we take small-scale fisheries, both inland and coastal, as an example here, they are important social-ecological systems in many developing countries, providing essential ecosystem services and livelihood opportunities to communities that are often considered amongst the world's poorest and most vulnerable (Be'ne´et al., 2010). Various research approaches have been developed and applied in different studies, in which the interaction between the social system and the ecological system has been explicitly considered (Binder et al., 2013). Concurrently, frameworks have been developed to establish a common language to structure research into SESs, and to provide guidance toward a more sustainable development of SESs (Pahl-Wostl, 2009).

1.3. Resilience thinking

At the core of the SES approach to managing human–nature relations are the concept of resilience (Glaser, Krause, Oliveira, & Fontalvo-Herazo, 2010). Resilience is a system's ability to reorganize and renew itself without loss of functions or diversity when disturbed (Alcorn, Bamba, Masiun, Natalia, & Royo, 2003). The resilience of any living (including social-ecological) system is centrally affected by the way the system reacts to change. Resilience thinking is a collection of concepts that combines many of the ideas developed in integrated, collaborative and ecosystem-based management with unique ways of dealing with the other dimensions of complexity (Duit, Galaz, Eckerberg, & Ebbesson, 2010). Furthermore, it has emerged as one conceptual framework with which to understand change and the multiple, cross-scale interactions in social–ecological systems (Holling & Gunderson, 2002; Berkes, Colding, & Folke, 2008). Although grounded in the ecological sciences (Holling, 1973), resilience has increasingly been tested and applied by natural and social scientists to examine a range of ecological communities (Gunderson, 2000), linked SESs (Berkes et al., 2008), and institutional and organizational arrangements (Anderies, Walker, & Kinzig, 2006). Resilience thinking is an important addition to the range of frameworks and approaches that can be used to understand and manage complex SESs like small-scale fisheries (Béné et al., 2011). Also, resilience thinking shifted the concept of sustainability from the early focusses on how to achieve and maintain stability, manage resources effectively, control change, pursue economic growth and increase human well-being, and deal with changes, disturbances, and uncertainties (Ahern, 2011; Berkes 2007).

1.4. Social-ecological dynamics

The social system and the ecological system although often treated separately, are two interrelated dimensions in the field of resource management. Some researchers had started to investigate the dynamics of integrated social systems and ecological systems to improve the resource management when the conventional resource management systems failed to achieve its goal (Ludwig, Hilborn, & Walters, 1993). Social-ecological dynamics focus on mechanisms for building social-ecological resilience in a world that is continuously changing (Folke, 2006). It explores the social aspects of ecosystem management, which includes adjustment of management practices and associated organizational and institutional structures and processes, guided by monitoring of feedback signals of environmental change (Olsson, Folke, & Berkes, 2004). According to Seixas (2002), Social-ecological dynamics can be used as tools to address questions of local knowledge, socio-ecological resilience, common pool or common property resource management, adaptive management, and stakeholder conflicts.

Considering the above-mentioned theoretical concepts, three major goals of this study are settled: defining the SMF as an SES in

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