Aquaculture Reports 2 (2015) 67–76

Contents lists available at ScienceDirect

Aquaculture Reports

journal homepage: www.elsevier.com/locate/aqrep

Coastal to inland: Expansion of prawn farming for adaptation to climate change in Bangladesh

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ARTICLE INFO

Article history:
Received 12 January 2015
Received in revised form 28 June 2015
Accepted 12 August 2015
Available online 29 August 2015

Keywords:
Climate change
Prawn farming
Expansion
Adaptation
Bangladesh

ABSTRACT

The practice of prawn (*Macrobrachium rosenbergii*) farming is widespread in coastal Bangladesh due to favorable biophysical resources. However, export-oriented prawn farming is particularly vulnerable to climate change in coastal Bangladesh. This study identified different climatic variables, including salinity, coastal flooding, cyclone, sea-level rise, water temperature, drought, and rainfall have profound effects on prawn farming in the Bagerhat area of southwest Bangladesh. Considering extreme vulnerability to the effects of climate change on prawn production, one of the adaptation strategies is to translocate prawn culture from coastal to inland (i.e., Bagerhat–Gopalganj) that appear less vulnerable to climate change. Although the prospects for prawn–carp polyculture and integrated prawn–fish–rice farming are positive in Gopalganj, a number of challenges were identified for the expansion of prawn culture. We suggest that institutional support would help to adopt prawn production.

1. Introduction

Bangladesh is one of the most suitable countries in the world for freshwater prawn (*Macrobrachium rosenbergii*)[1] farming, because of its favorable biophysical resources (Ahmed et al., 2008). The practice of prawn farming is widespread in coastal Bangladesh due to the availability of wild postlarvae[2] (Ahmed et al., 2010a). A considerable area of shallow water bodies provides an opportunity for prawn production. The total prawn culture area was estimated to be 65,221 ha. Over 75% of the culture area is located in southwest Bangladesh with the remainder in the southeast. The total prawn culture production in Bangladesh was estimated at 43,713 tons in 2012–2013[3], an average annual productivity was 670 kg ha^{-1} (FRSS, 2014). Prawn farming in Bangladesh has diversified livelihood opportunities for the coastal poor, with over 833,000 farmers are involved in prawn and shrimp[4] production (DoF, 2014).

Over the last three decades, the development of prawn and shrimp farming has attracted considerable attention due to export potential in global market, particularly the European Union (EU) and the United States of America (USA). In 2012–2013, Bangladesh exported 43,953 tons of prawn and shrimp valued at US$396 million, of which US$92 million (23%) was prawn (FRSS, 2014). As a whole, the sector is the 2nd largest export industry after readymade garments. Overall, prawn and shrimp production play an important role in the economy of Bangladesh, contributing to export earnings, food production, livelihood opportunities, and poverty alleviation (Ahmed, 2013a).

However, climate change has been identified as a threat to freshwater prawn farming that could have severe effects on export earnings and overall consequences for the economy of Bangladesh (Ahmed, 2013a; Ahmed et al., 2013). Bangladesh is a global hotspot for climate change. According to the global climate risk index, Bangladesh was ranked 1st in 2012 among countries vulnerable to climate change while it is ranked 6th in 2015 (Harmeling and Eckstein, 2012; Kreft et al., 2014). Considering extreme vulnerability of prawn farming to the effects of climate change, adaptation strategies must be developed to cope with the challenges. Adapting prawn farming to climate change, however, requires a combination of strategies and policies. Although community-based adaptation strategies have been suggested to cope with the challenges (Ahmed et al., 2014), one important strategy is translocation[5] of

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[1] Freshwater prawn is a catadromous species that hatch or born in marine habitats and migrate to freshwater areas.

[2] The term "postlarvae" usually applies to animals from the time of metamorphosis up to about 60 days later. Postlarvae and fry are interchangeably used in this paper.

[3] Bangladesh fiscal year: 01 July–30 June.

[4] The term "prawn" is used for freshwater species and "shrimp" for marine and saltwater organisms. Statistics often do not distinguish between prawn and shrimp in Bangladesh.

[5] "Translocation" and "expansion" are interchangeably used in this article.

http://dx.doi.org/10.1016/j.aqrep.2015.08.001

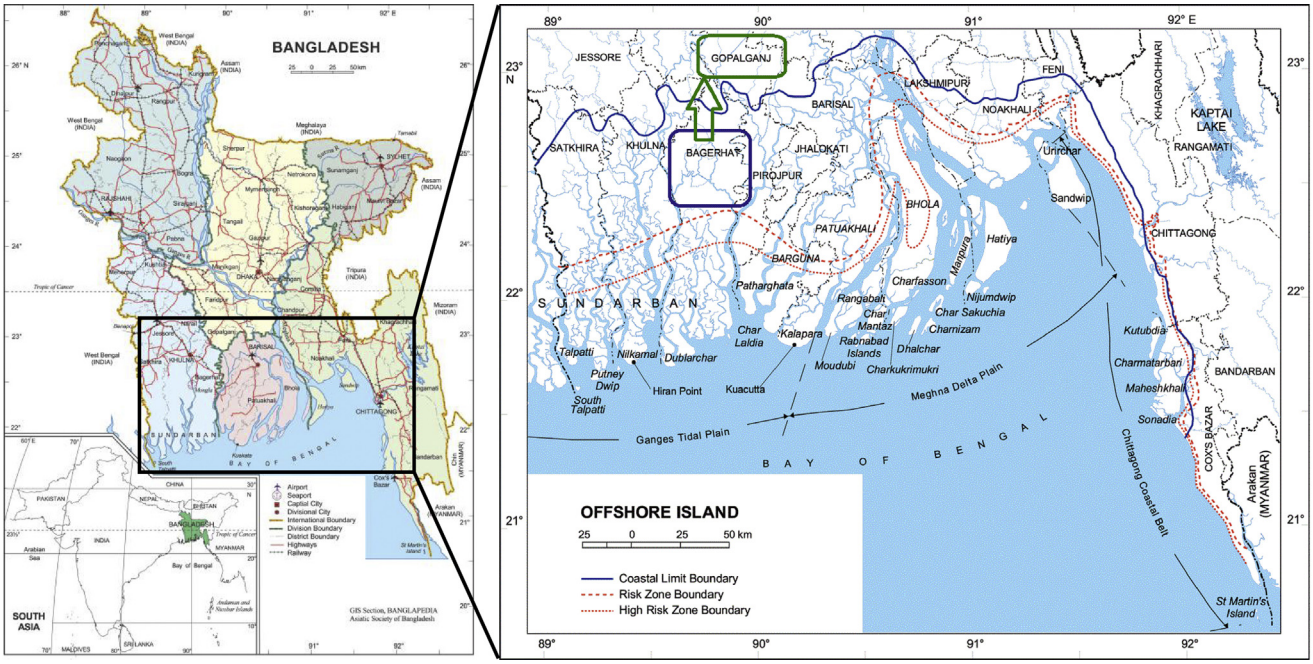

Fig. 1. Map of Bangladesh showing the study areas of Bagerhat and Gopalganj districts.

prawn farming from coastal to inland areas that are less vulnerable to climate change. A few advanced farmers have started the mixed culture of prawn and shrimp in coastal Bangladesh because of increased water salinity (Ahmed, 2013a). Nevertheless, shrimp farming in coastal Bangladesh has also been accompanied by recent concerns over climate change (Ahmed and Diana, 2015). Community-based adaptation strategies may help existing prawn farmers to adapt climate change in coastal Bangladesh, while expansion of prawn farming would increase or maintain prawn production as well as export earnings in Bangladesh.

This paper examines the impacts of climate change on prawn farming in coastal Bangladesh. It also identifies the opportunities and challenges for translocation of prawn farming from coastal to inland. The aim of this paper is to highlight key issues for expansion of prawn farming.

2. Study area and data collection

2.1. Study site

The initial study was conducted in the Bagerhat[6] district of southwest Bangladesh (Fig. 1), a coastal area of the Bay of Bengal. Remarkable development of prawn farming has taken place in Bagerhat where thousands of farmers have converted their rice fields to prawn farms, locally known as "*gher*". The practice of prawn and fish (mainly carp) farming in rice fields, combined with high prices for prawn in the international market, and rice and fish for household consumption and local market, has led to an increasing number of farmers utilizing this method (Ahmed et al., 2008). Although prawn farming practice is still extensive and improved-extensive, an increasing number of farmers are practicing high-input (fry, feed, fertilizer) semi-intensive production. The peak season of prawn farming is from April to November, a culture period of around 6–8 months. Farmers cultivate monsoon season rice during May to August when prawn and fish are in the rice field. The average annual yield of prawn, fish, and rice were estimated at 467, 986, and 2257 kg ha^{-1}, respectively (Ahmed et al., 2010a). In spite of promising conditions for prawn farming, Bagerhat is one of the most disaster-prone areas in Bangladesh due to climate change. Thus, Gopalganj district was also selected for this study to expand prawn farming which is located outside of the coastal boundary (Fig. 1).

2.2. Climate change: Threats to coastal Bangladesh

The coastal region of Bangladesh is subject to seasonal changes in climatic conditions. There is an increasing risk from a combination of climatic variables, including: (1) coastal flooding, (2) cyclone, (3) drought, (4) rainfall, (5) salinity, (6) sea-level rise, and (7) sea surface temperature (Ahmed et al., 2013).

Bangladesh is a flood-prone country with one-fifth of the country normally flooded each year. Over 35% of the country is submerged during extreme floods, and since independence (1971) there have been seven extreme floods (Ahasan et al., 2010; Banerjee, 2010). Coastal flooding is common in Bangladesh due to high river discharge, low drainage capacity, and backwater effects with tidal surges from the Bay of Bengal. Around 14.6 million people in coastal Bangladesh are vulnerable to inundation due to cyclonic surges, and this number will increase to 18.5 million by 2050 (World Bank, 2012). About 5690 km^2 area in coastal Bangladesh has been identified as a high-risk zone where flood of depth over 1 m might occur (Karim and Mimura, 2008).

Coastal Bangladesh is prone to violent storms and tropical cyclones which originate in the Indian Ocean and track through the Bay of Bengal. Between 1877 and 1995, Bangladesh was hit by 154 cyclones, including 43 severe cyclones (Dasgupta et al., 2011). On average, a severe cyclone hits the country every three years (GoB, 2009). Cyclones pose a great threat to lives and properties in coastal Bangladesh. A cyclone in 1970 resulted in the death of around 300,000 people, and another in 1991 caused 138,000 deaths (World Bank, 2000). In November 2007, the coastal region of Bangladesh was affected by tropical cyclone Sidr and 3406 people died with economic losses of US$1.67 billion (GoB, 2008). In May

[6] Bagerhat district is divided into 9 sub-districts, among them 5 northern sub-districts are important for freshwater prawn farming while 4 southern sub-districts are promising for saltwater shrimp farming.