

Climate change vulnerability and adaptation in the low-lying tropics: the case of shrimp farming in coastal Bangladesh

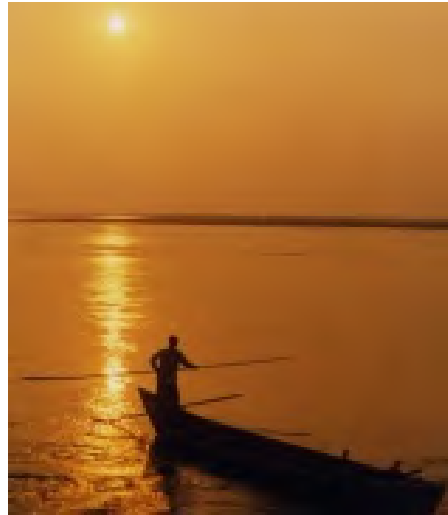


Nesar Ahmed
Bangladesh Agricultural University
&
Leibniz Center for Tropical Marine Ecology
Bremen, Germany





Rural Bangladesh



Livelihoods of Rural People



Around 70%
people live in
rural
Bangladesh



- Agriculture
- Aquaculture
- Fisheries

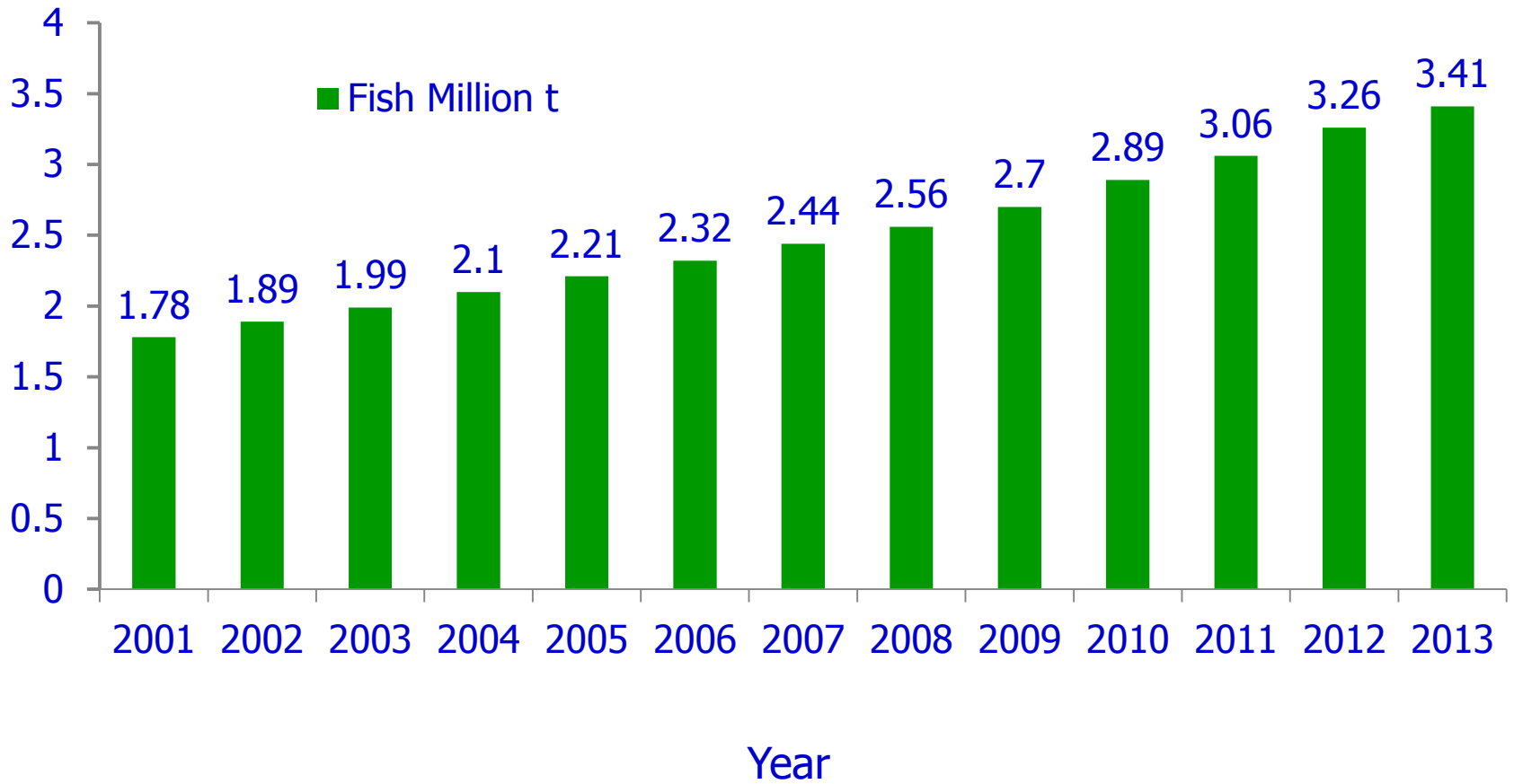


Aquaculture in Bangladesh

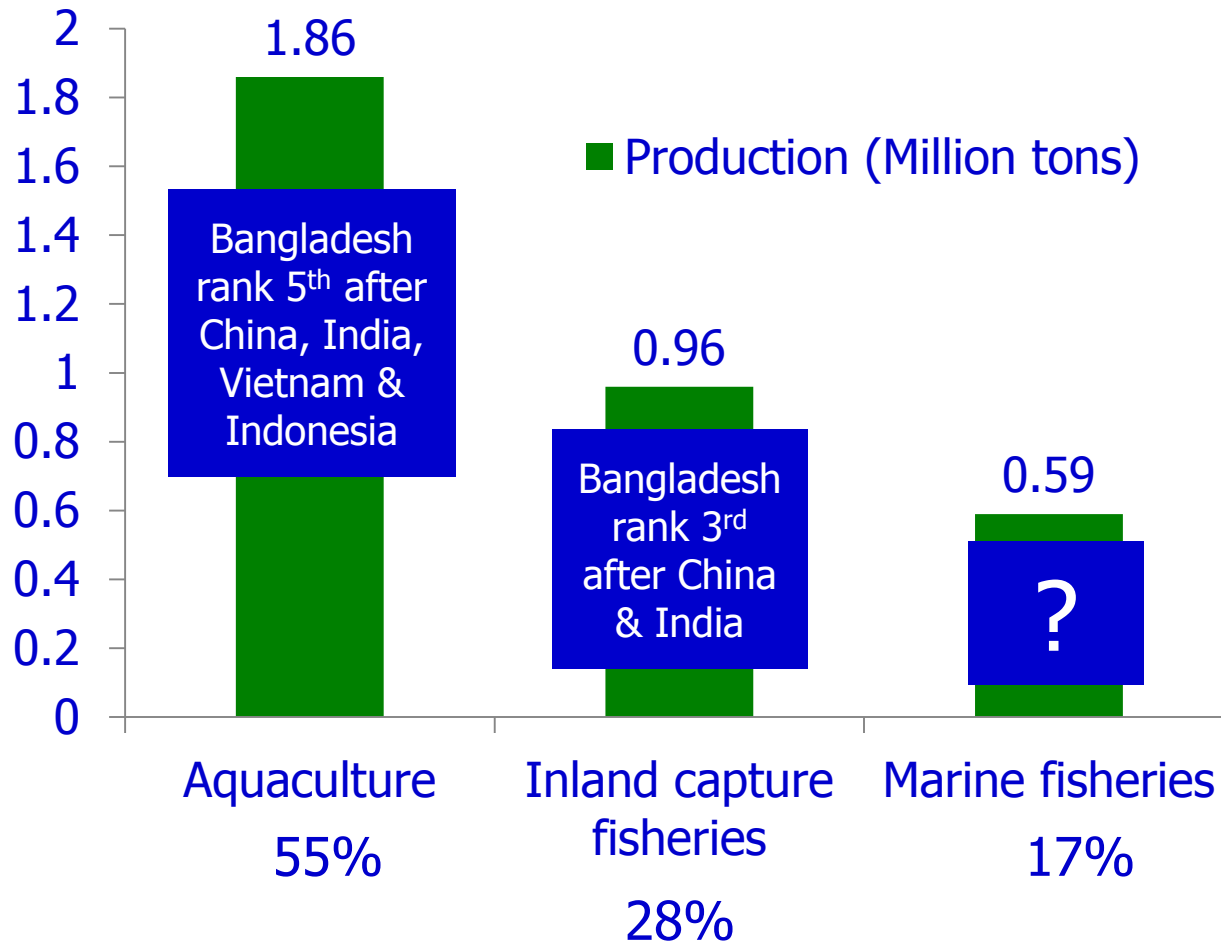
- Suitable for aquaculture - favorable resources, climate
- Aquaculture - fastest growing food producing sector
- An average annual growth rate: 8%
- Source of food & nutrition: 60% protein
- Income and employment opportunities for rural poor
- Fish farmers: 15 million (9.4% population)
- Prawn and shrimp farmers: 0.83 million



Fish Production in Bangladesh Capture & Culture



Fish Production



Total fish production in 2013: 3.41 million t

Sources: DOF (2014)
FAO (2014)

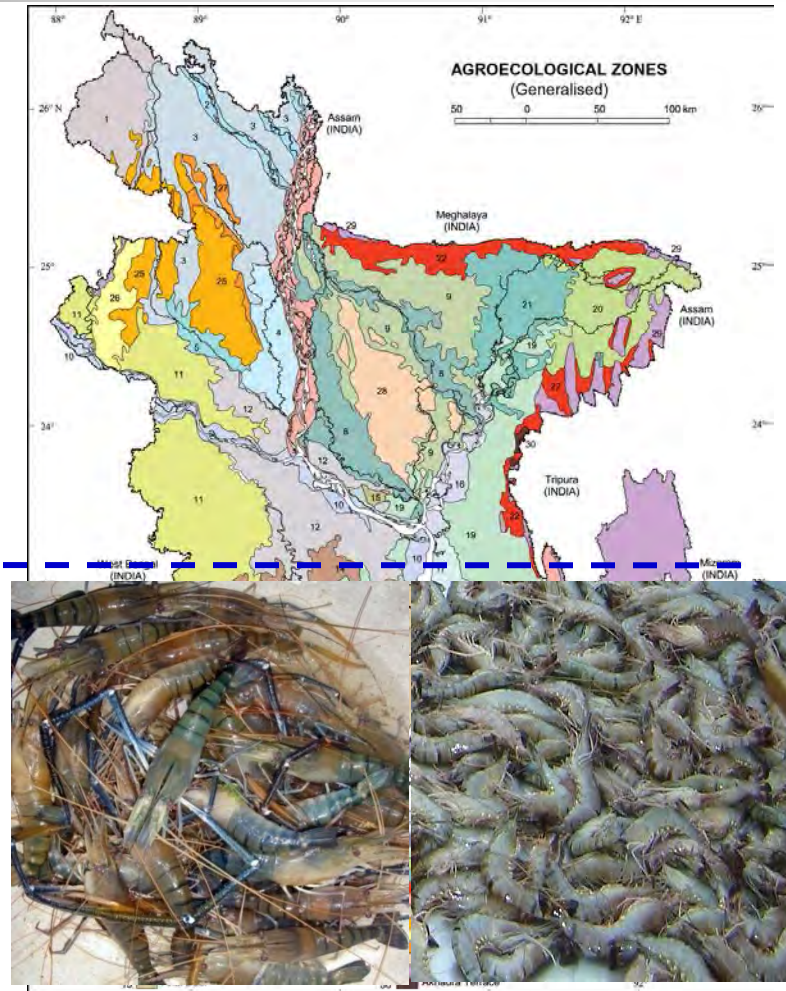
Aquaculture in Bangladesh: Geographical Location

Freshwater
aquaculture

- (1) Carp polyculture
- (2) Catfish farming
- (3) Tilapia

Coastal
aquaculture

- (1) Prawn-fish/ prawn-fish-rice
- (2) Shrimp-fish/ shrimp-fish alternate rice



Coastal Aquaculture: Prawn & shrimp farming

- Prawn and shrimp farming were initiated in the 1970s and began to expand rapidly in the 1980s
- Prawn and shrimp farming are widespread in coastal Bangladesh due to favorable resources
- Export markets – EU and USA
- Export earnings – US\$396 million/year
- Commercially known as “White Gold”
- Coastal aquaculture – 2nd export earner

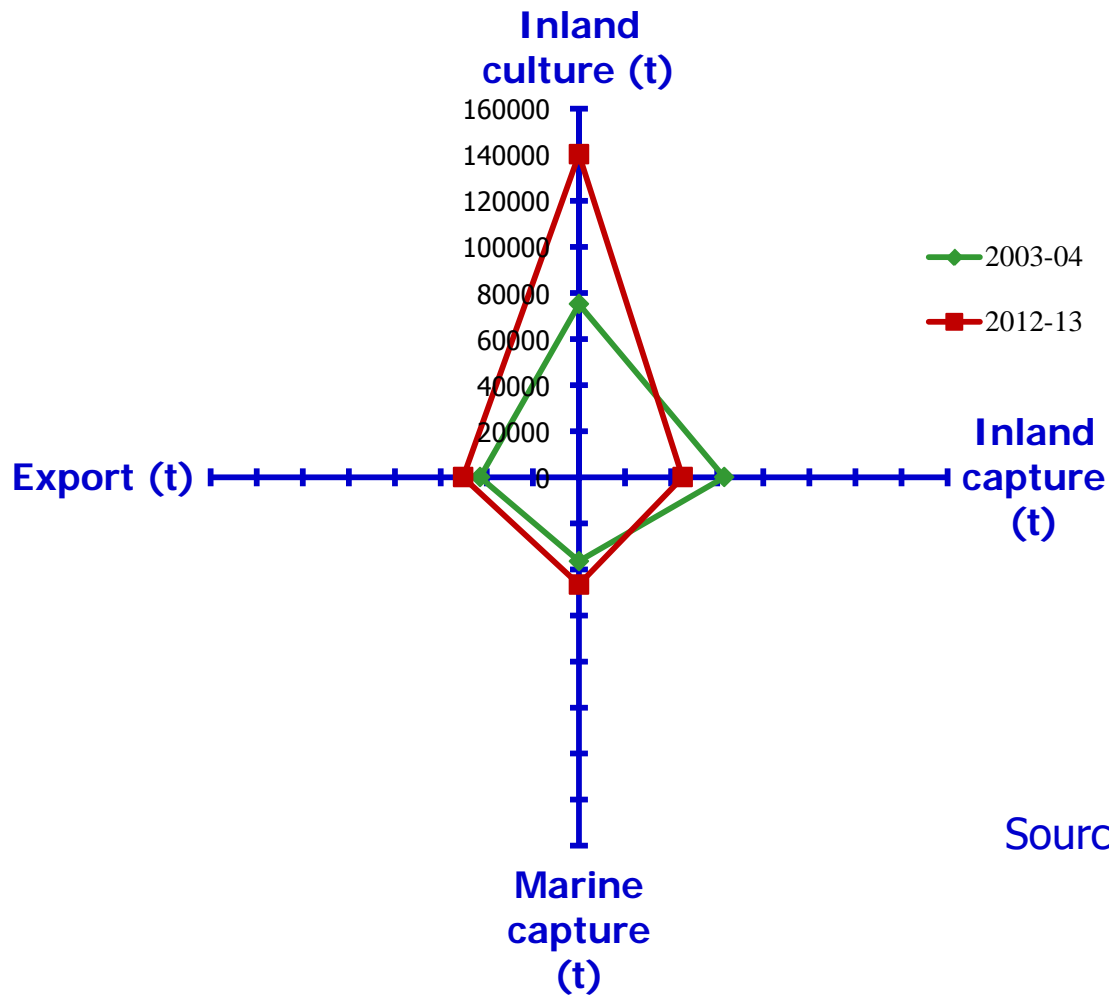


Prawn & Shrimp Post-larvae (PL) Fishing: Capture to Culture

- Prawn and shrimp culture still dependent on wild fry
- About 400,000 coastal people involve in PL fishing
- PL fishing impacts on environment & biodiversity
- In 2000, DOF imposed ban on wild PL fishing
- Total 130 hatcheries – 60% operational – produce 10 billion PL (60% demand)
- PL fishing likely to continue



Production & Export: Prawn & Shrimp

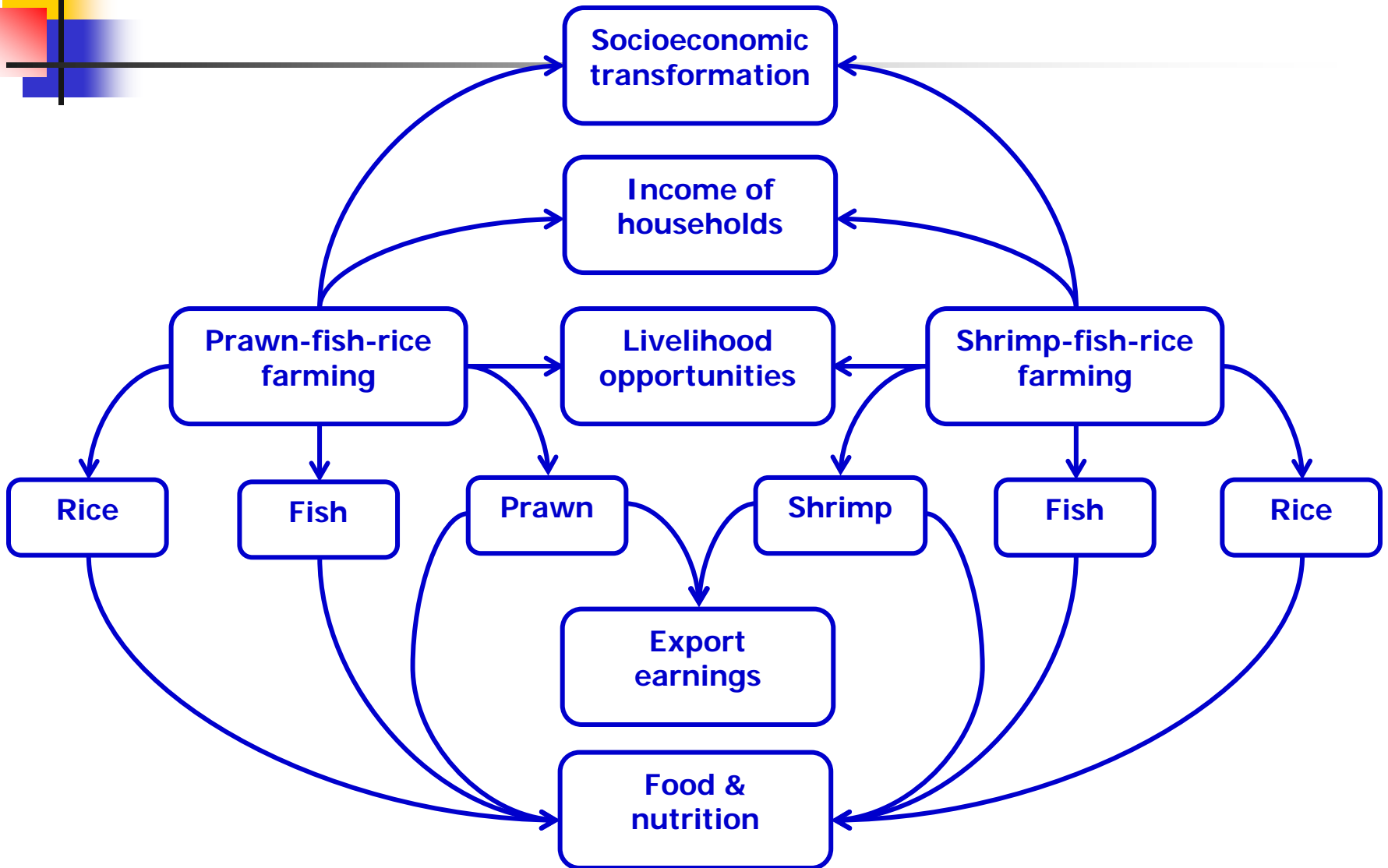


Source: DOF (2014)

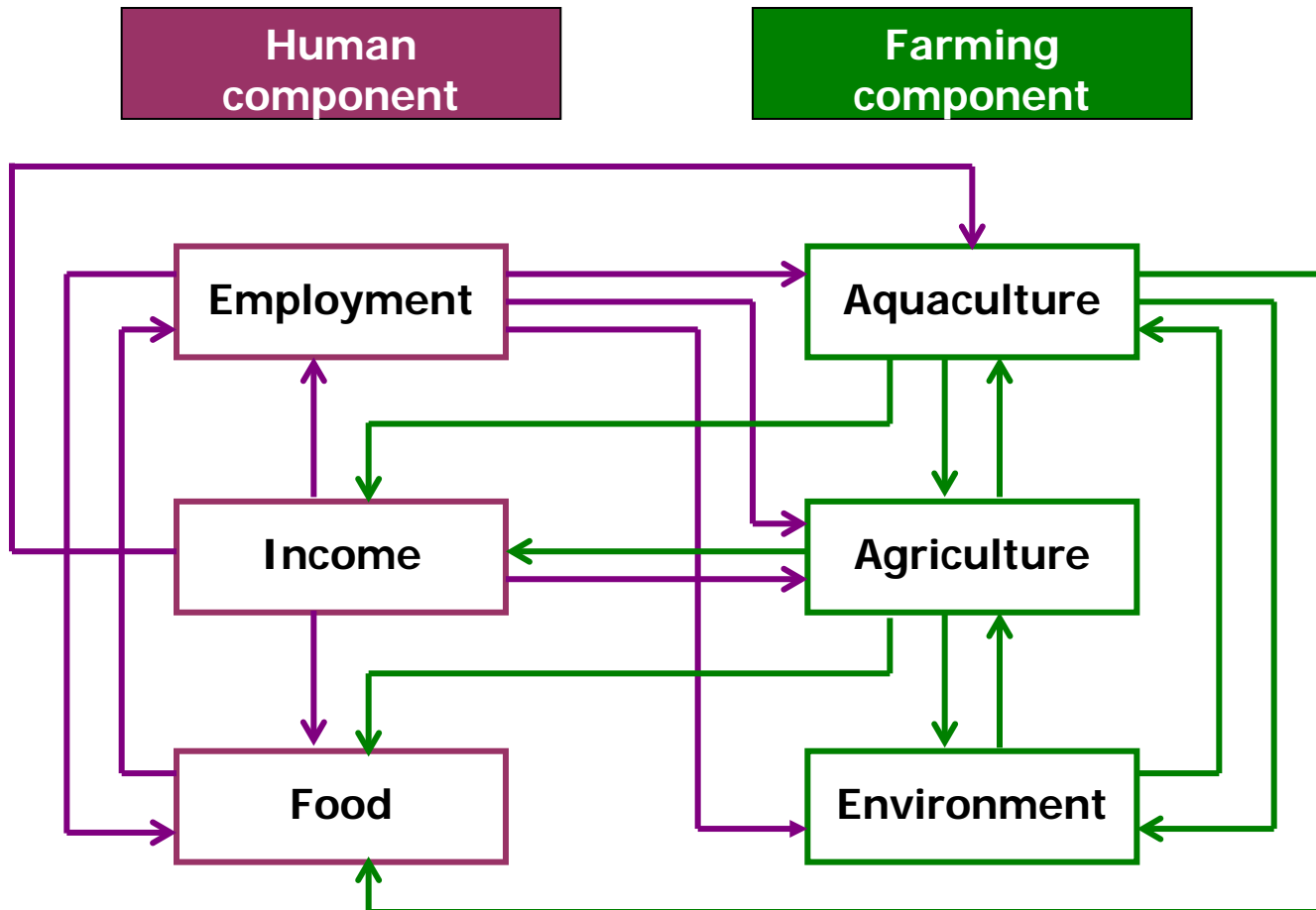
Exporting of Prawn & Shrimp: From Pond to Plate



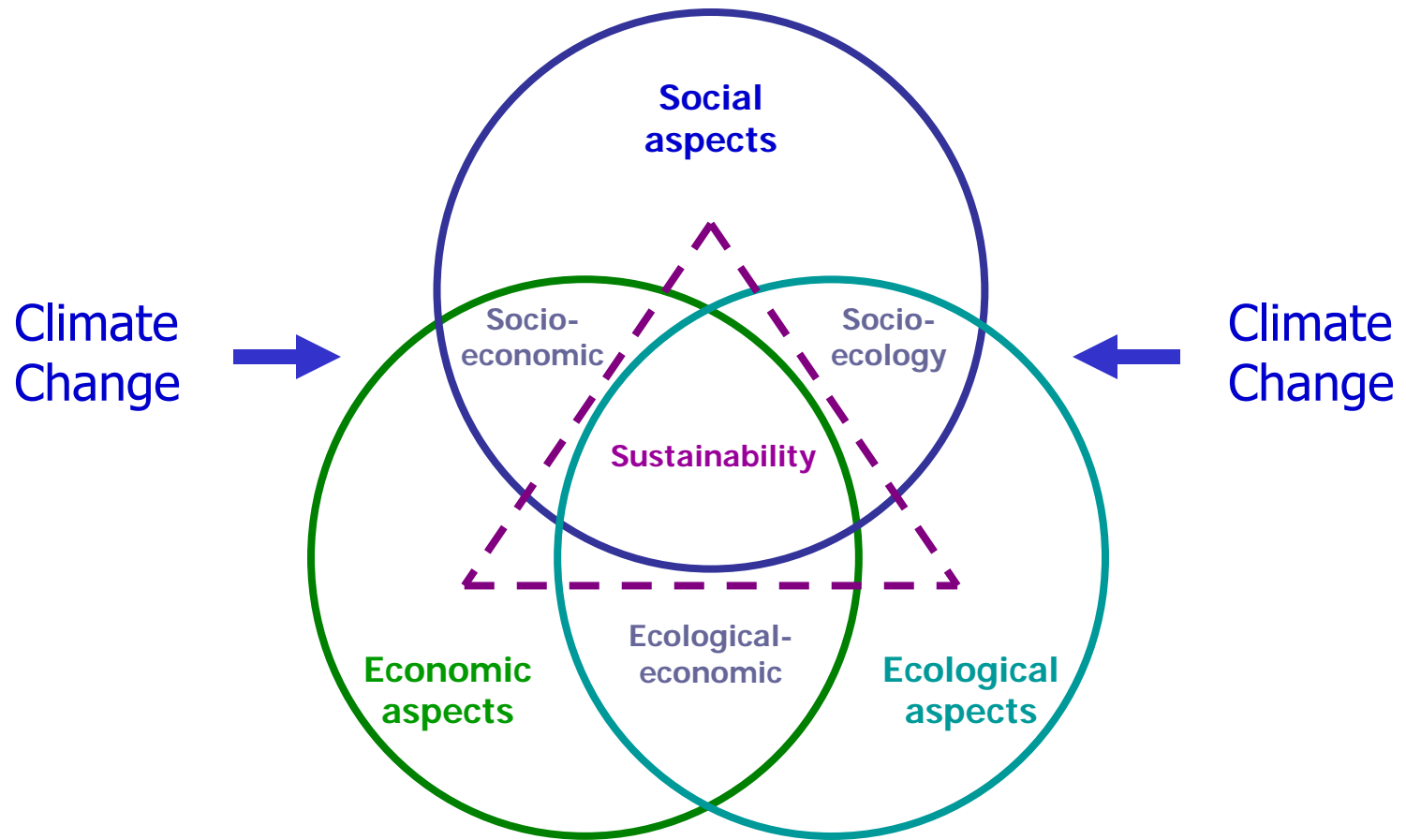
Benefits from Coastal Aquaculture



Coastal Aquaculture: Inter-linkages (Social-Ecological Framework)



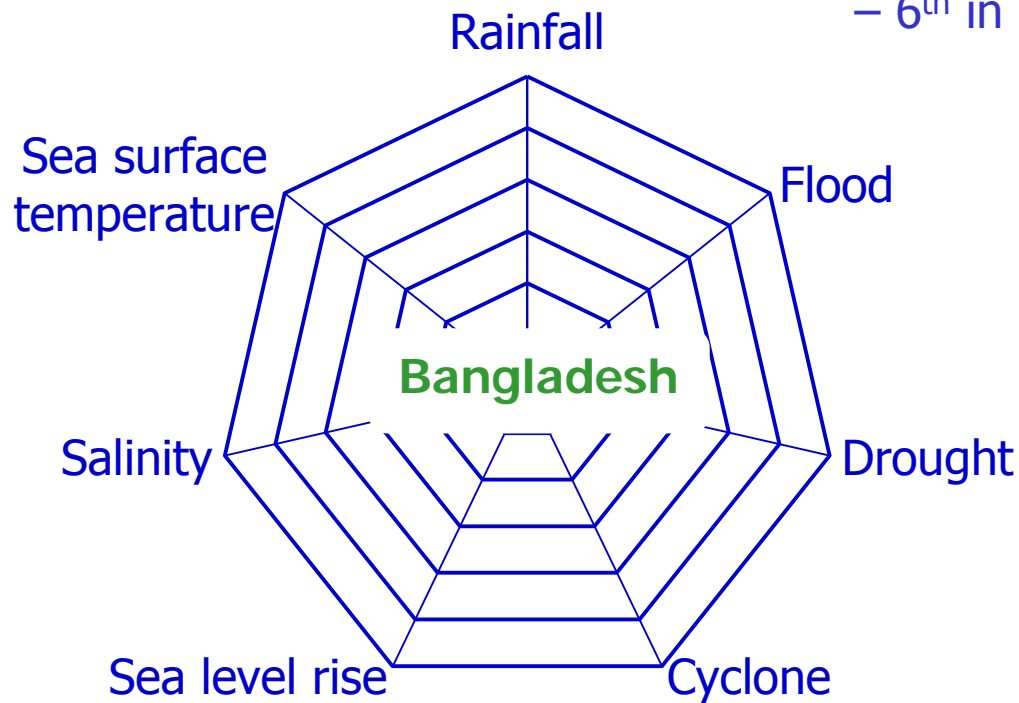
Sustainability of Coastal Aquaculture?



Climate Change & Bangladesh

According to GCRI, Bangladesh rank:

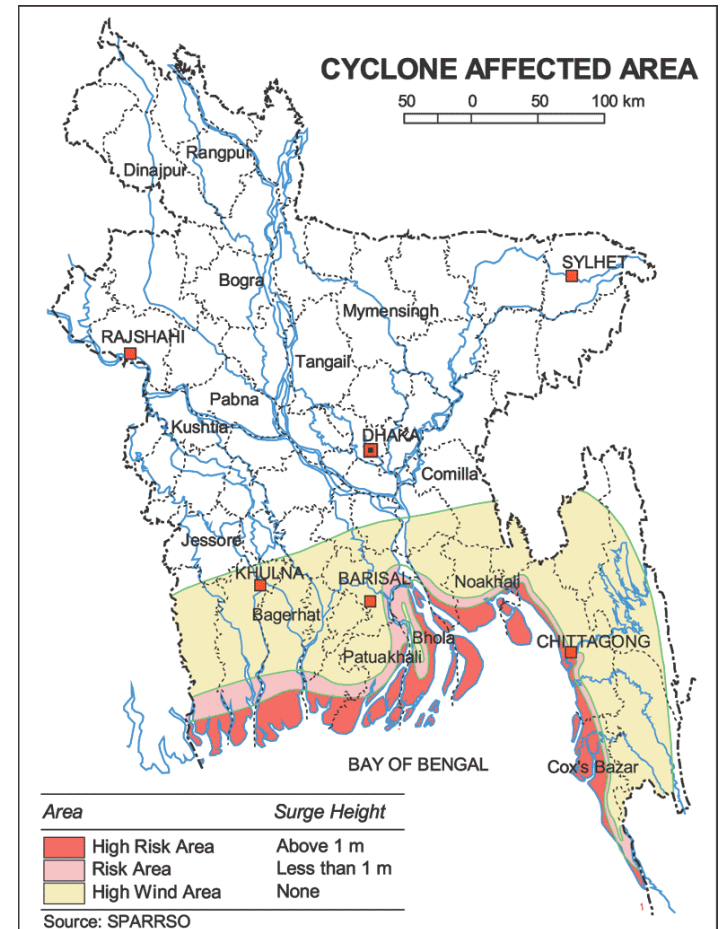
- 1st in 2012
- 4th in 2013
- 5th in 2014
- 6th in 2015



Bangladesh:
a nature's
laboratory on
disasters

Cyclones

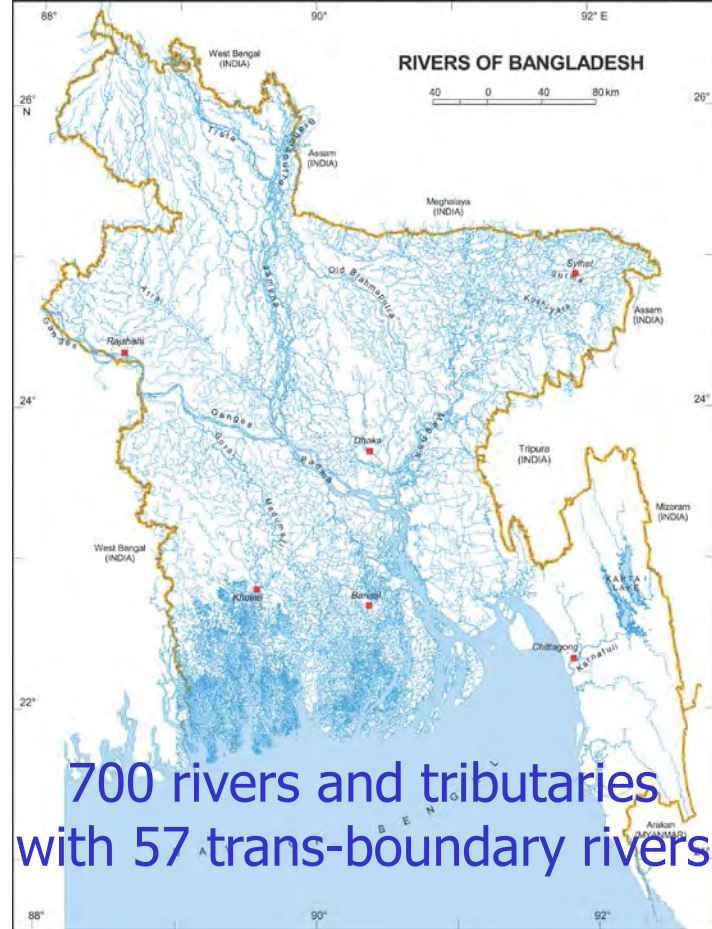
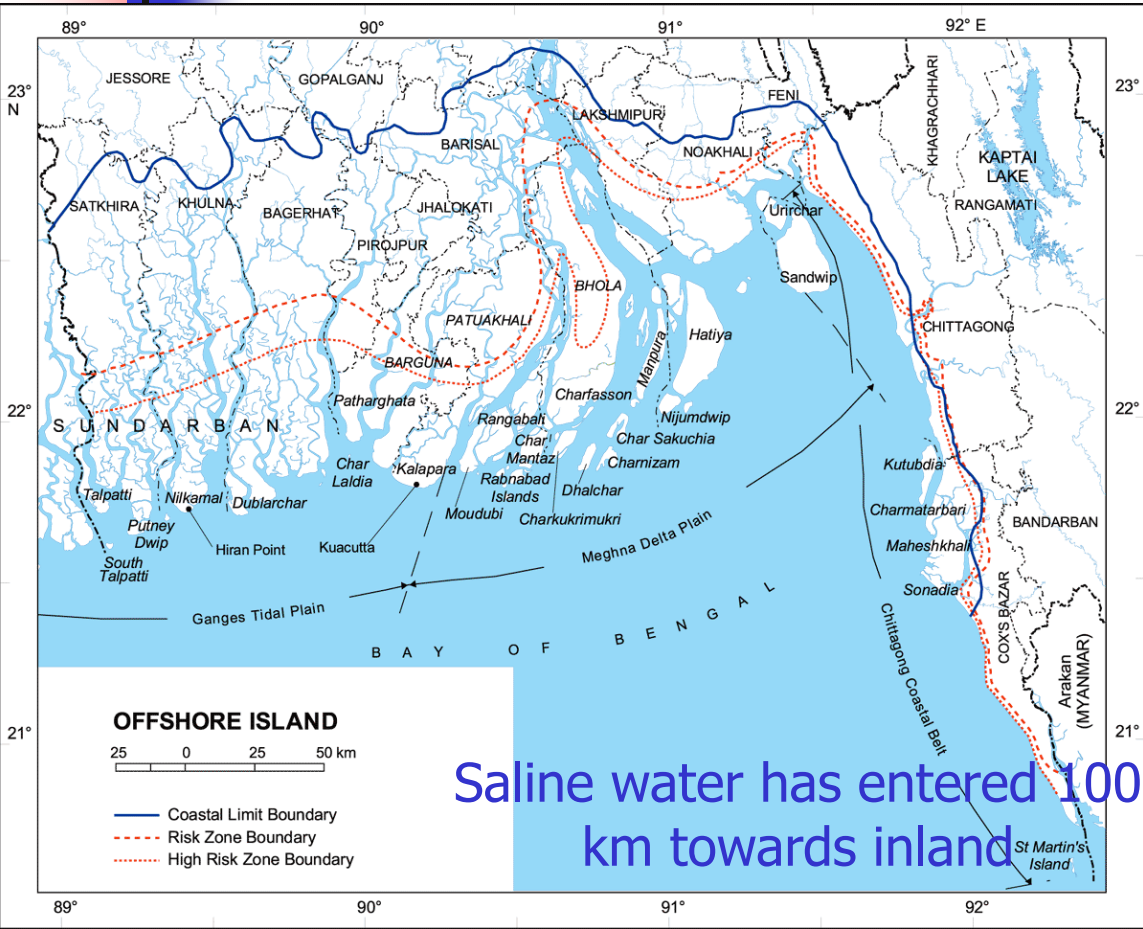
- Cyclone 1970: death 300,000 people
- Cyclone 1991: death 138,000 people
- November 2007: SIDR
- May 2008: cyclone Nargis
- April 2009: cyclone Bijli
- May 2009: cyclone Aila
- October 2010: cyclone Giri
- May 2013: cyclone Mahasen
- October 2013: cyclone Phailin



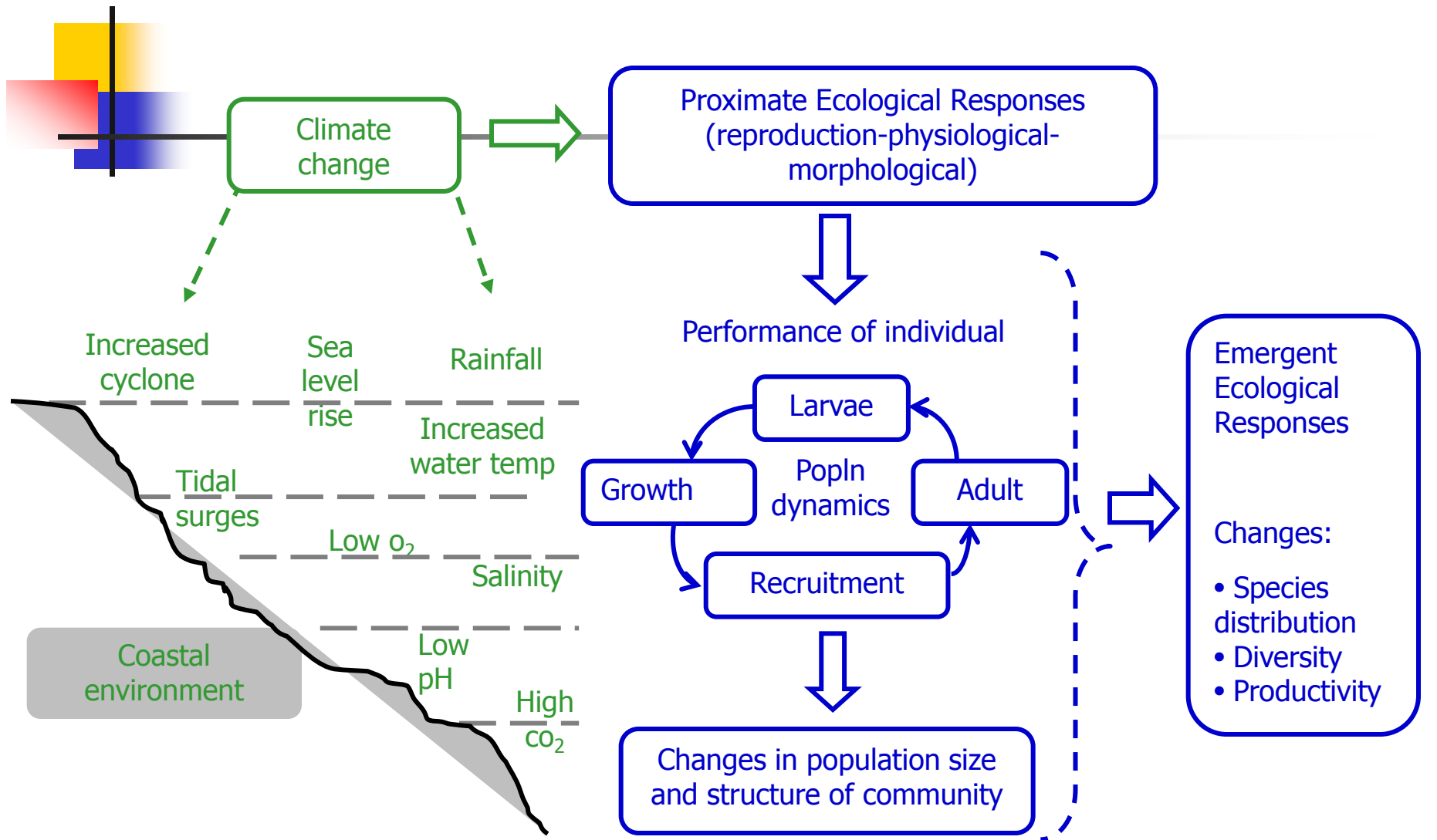
Sea-Level Rise

- Bangladesh is one of the largest deltas in the world, lies just less than 2 m above sea-level
- Sea-level rise in Bangladesh: 15.9–17.2 mm each year
- Global sea-level rise 2–3 mm each year
- If 1 m sea-level rise:
 - 20-27% country under water
 - 15 million people landless
 - Sundarbans mangrove forest will be lost
 - Affect coastal ecosystems and biodiversity

Salinity & Coastal Flooding

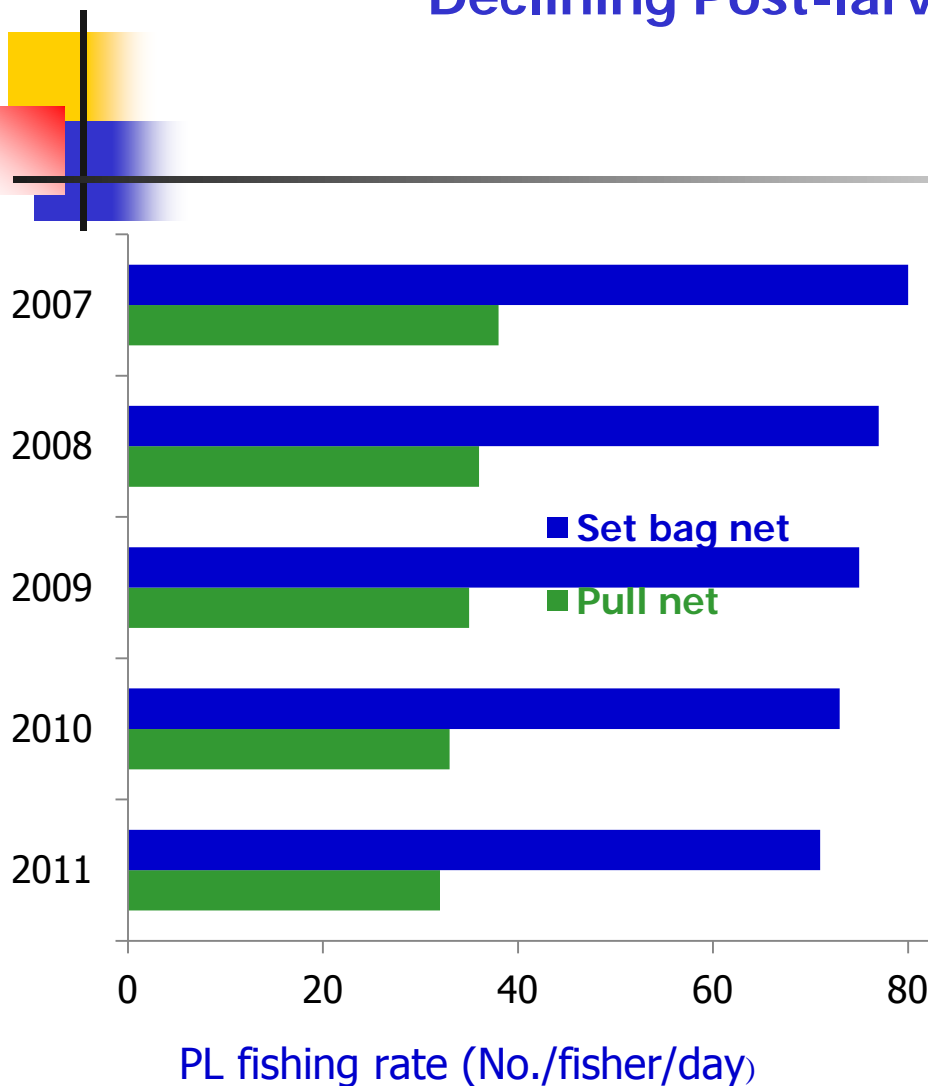


Ecological Effects on Post-larvae (PL)



(adapted from Harley et al. 2006, Occhipinti-Ambrogi 2007)

Declining Post-larvae (PL) Fishing Rate



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The impact of climate change on prawn postlarvae fishing in coastal Bangladesh: Socioeconomic and ecological perspectives

Nesar Ahmed^{a,*}, Anna Occhipinti-Ambrogi^a, James F. Muir^b

^a Department of Earth and Environmental Sciences, University of Pavia, 27100 Pavia, Italy

^b Institute of Aquaculture, University of Stirling, Stirling FK9 4LA, Scotland, UK

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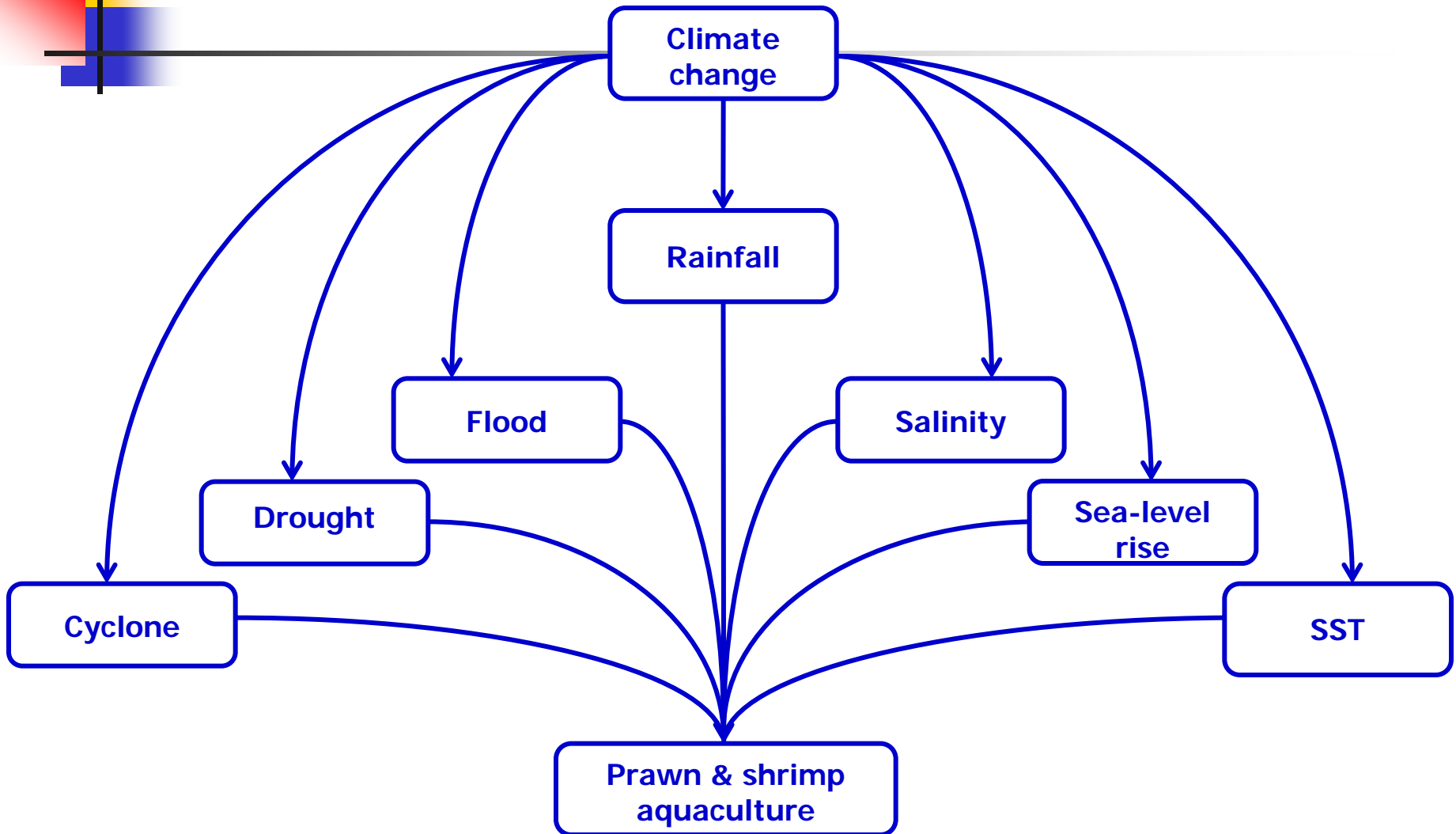
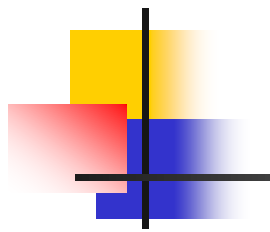
Keywords:
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Fishing
Climate change
Socioeconomic
Ecology
Bangladesh

ABSTRACT

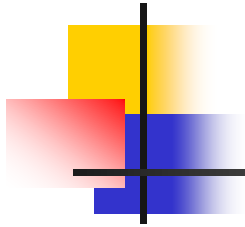
In Bangladesh, prawn (*Macrobrachium rosenbergii*) farming remains dependent on the capture of wild postlarvae as hatchery production is still inadequate. However, prawn postlarvae fishing has been accompanied by concerns over recent climate change. Different climatic variables including cyclone, salinity, sea level rise, water temperature, flood, rainfall, and drought have had adverse effects on coastal ecosystem, thus determining a decline in the availability of prawn postlarvae and thereby catch. The households of postlarvae fishers also face a variety of socioeconomic constraints due to climate change. Considering extreme vulnerability to the effects of climate change, an integrated approach needs to be introduced to cope with the challenges.

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Impacts on Coastal Aquaculture



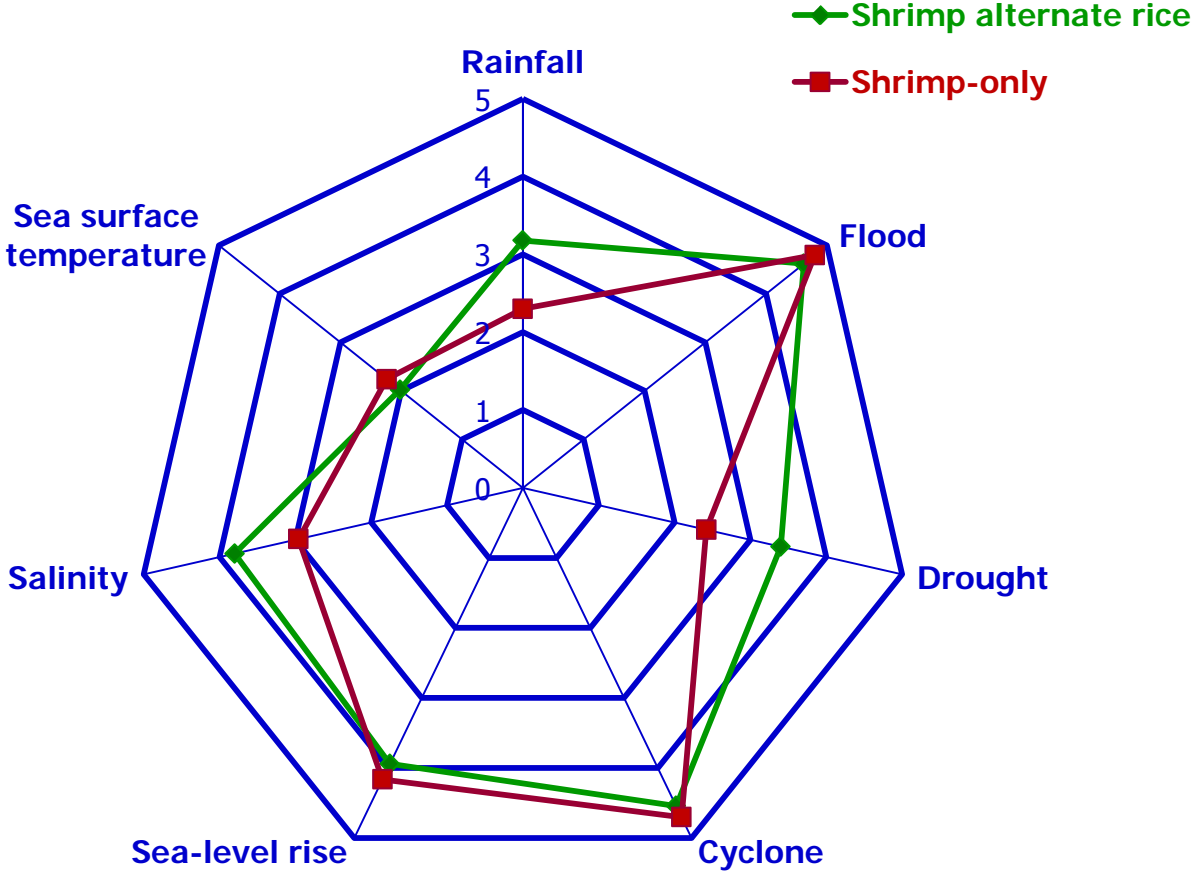
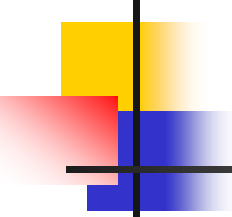
Vulnerability of Shrimp Farming



Climatic variable	Shrimp alternate rice (n = 50)				Shrimp (n = 50)				Mean ordinal rank
	Score		Kendall's W value	Chi-square (χ^2) value	Score		Kendall's W Value	Chi-square (χ^2) value	
	Mean	SD			Mean	SD			
Coastal flooding	4.62	0.60			4.80	0.64			1
Cyclone	4.54	0.84			4.70	0.71			2
Sea-level rise	3.94	0.68			4.16	0.91			3
Salinity	3.80	0.57	0.56	190.55	2.96	0.88	0.51	175.16	4
Drought	3.40	0.97		P<0.0001	2.42	1.01		P<0.0001	5
Rainfall	3.18	0.52			2.30	0.68			6
Sea surface temperature	2.02	0.62			2.24	0.82			7

1 = not vulnerable, 2 = less vulnerable, 3 = moderate vulnerable, 4 = highly vulnerable, and 5 = extremely vulnerable

Impacts on Shrimp Farming



Ecological Effects

Climatic variables

- Coastal flood
- Cyclone
- Sea-level rise
- Salinity
- Water temperature
- Drought
- Rainfall



Ecological effects

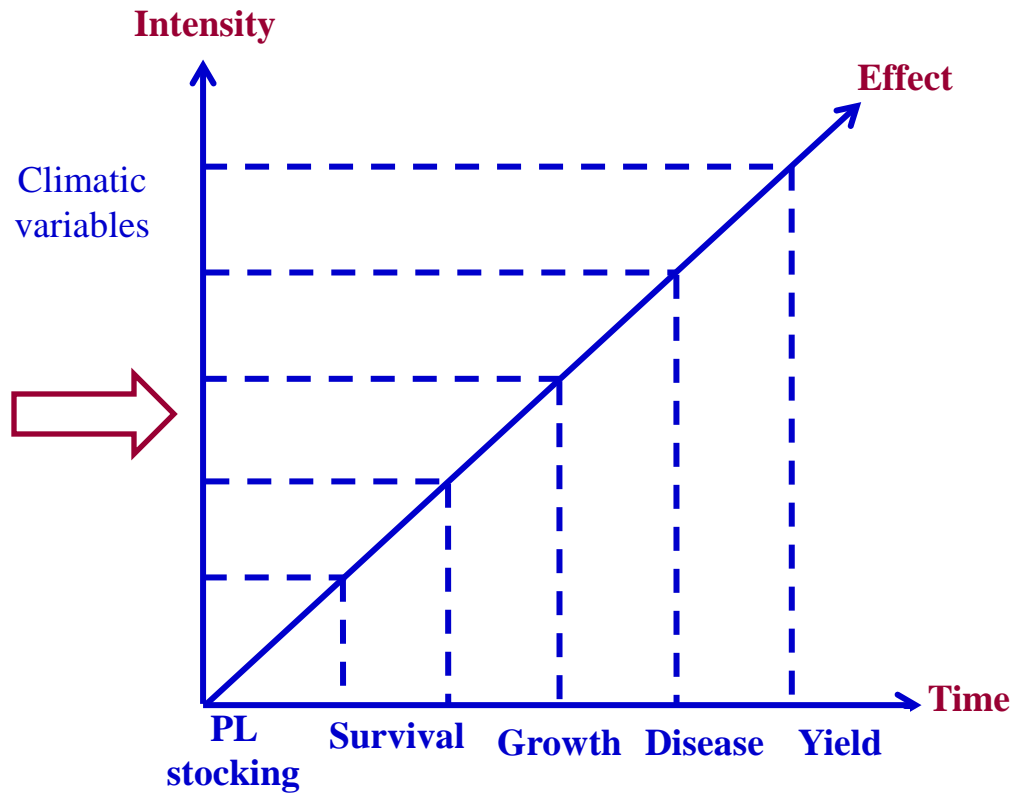
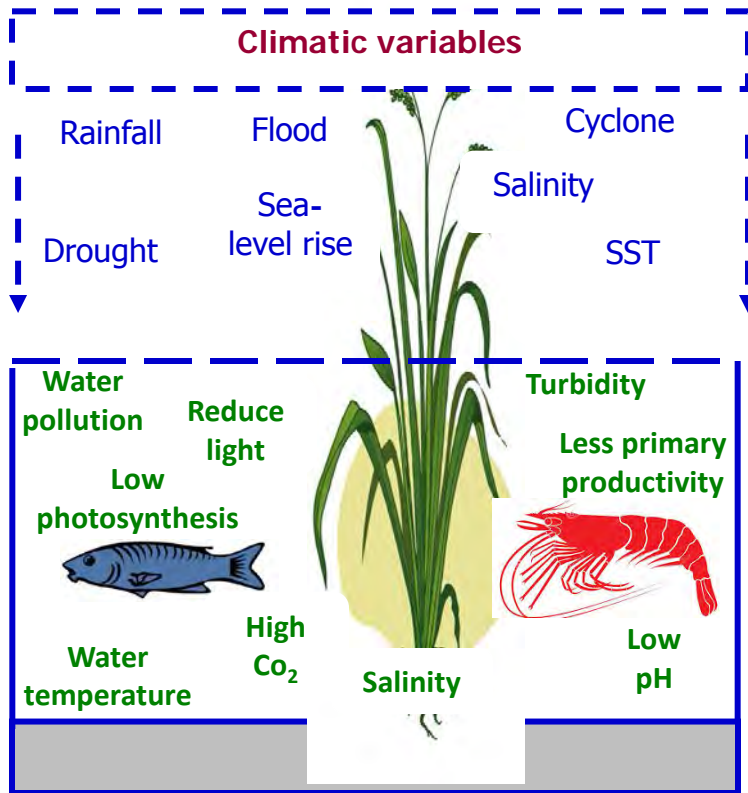
- Increased salinity, reduced freshwater biodiversity
- Sedimentation and erosion of farms
- Increased water pollution and turbidity
- Reduce photosynthesis and O₂ depletion
- Hinder ecological interactions
- Limit primary productivity
- Increased toxicity and CO₂ emission



Production impacts

- Affect stocking survival & growth of PL
- Reduced feeding rate by prawn & shrimp
- Failure growth and recruitment
- Outbreak of prawn & shrimp diseases
- Reduce prawn & shrimp production
- Reduced fish & rice production

Sequential Ecological Effects on Production



Impacts on Socioeconomic Conditions

Climate Change

Food

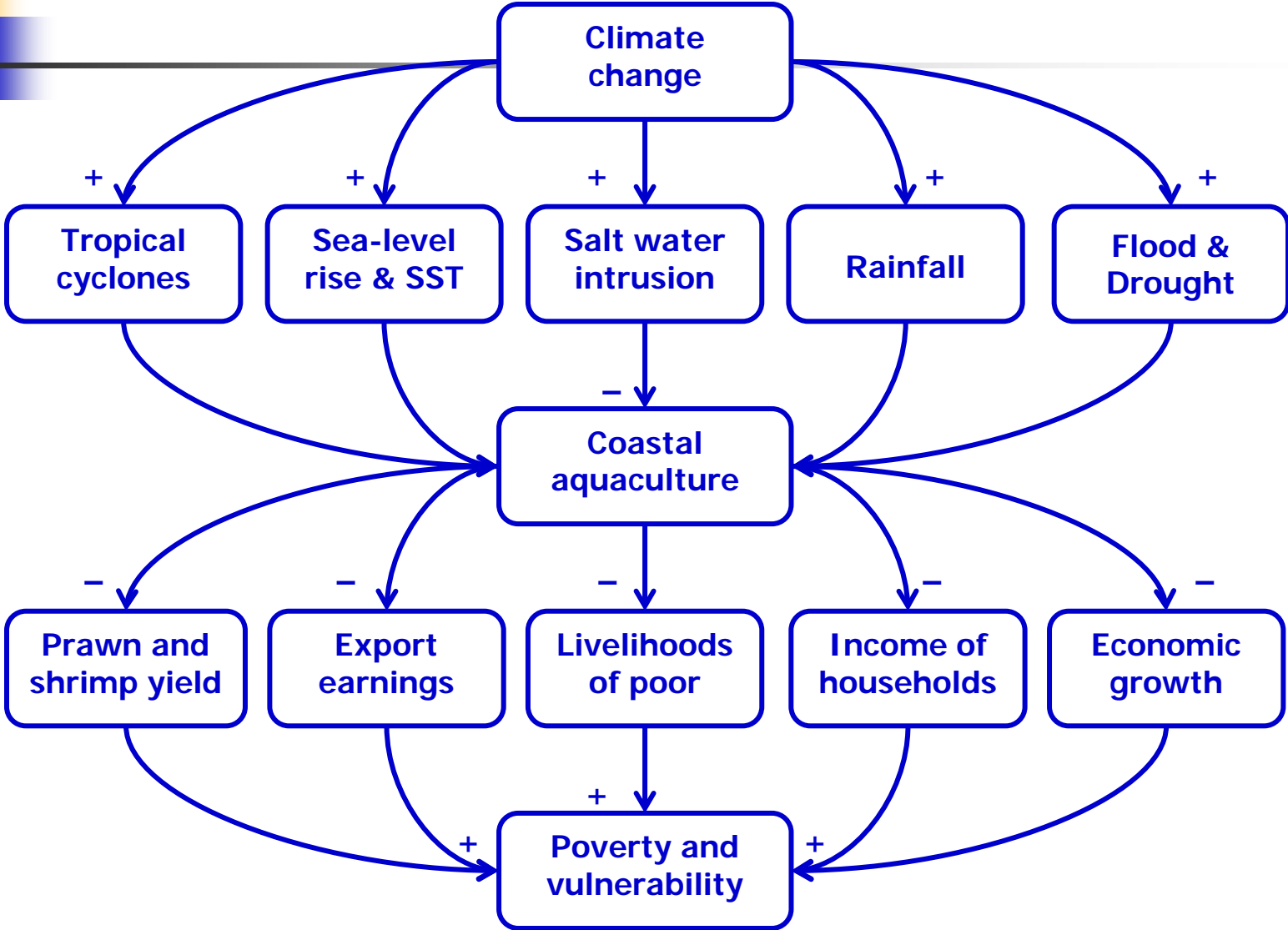
- Rice and freshwater fish
- Vegetable and fruits
- Milk, meat and eggs

Rice straw

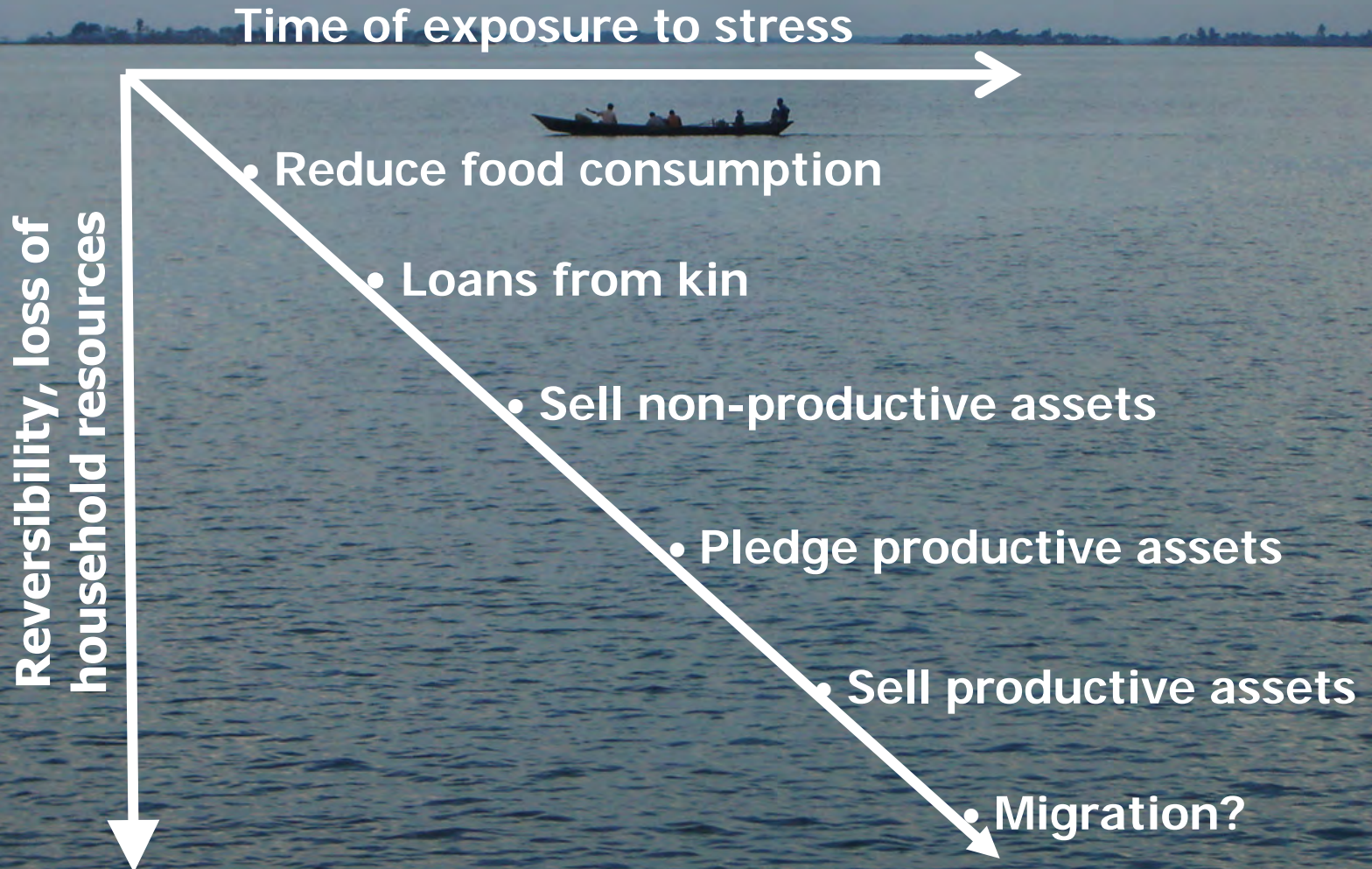
- Fodder for cattle
- Housing building
- Cooking fuel



Wider Impacts: Economy of Bangladesh



Coping Strategies



An aerial photograph of a village completely inundated with floodwater. The houses, many with thatched roofs, are scattered across the water, with only their roofs and some trees visible above the surface. Several wooden boats are also seen floating in the water. The scene illustrates the impact of flooding on a community.

Multiple Challenges

- (1) Climate Change
- (2) Increasing population
- (3) Reducing agriculture land
- (4) Soaring demand for food production

Adaptation Strategies: Community Based adaptation (CBA)

- Community awareness and preparedness
- Construction of earthen dams, embankments
- Netting and higher dike construction around farms
- Irrigation facilities with drainage systems (microirrigation)
 - Dr Daniel Hillel awarded World Food Prize 2012
- Coastal plantation with social forestry
- Introduce salt and drought tolerant rice varieties
- Mixed culture of prawn and shrimp with brackishwater fish





Conclusions

- Integrated Coastal Zone Management (ICZM)
 - Mangrove plantation & forestation (REDD)
 - Coastal embankments
 - Integrated management of coastal rivers and estuaries
 - Disaster management
- Research and Development (R&D)
 - Farming systems (cage culture)
 - Integrated culture systems with euryhaline species

**CBA
+
ICZM
+
R&D**



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Community-based climate change adaptation strategies for integrated prawn–fish–rice farming in Bangladesh to promote social–ecological resilience

Nesar Ahmed^{1,2}, Stuart W. Bunting³, Sanzidur Rahman⁴ and Christopher J. Garforth⁵

- 1 Department of Fisheries Management, Bangladesh Agricultural University, Mymensingh, Bangladesh
- 2 SA Water Centre for Water Management and Reuse, University of South Australia, Adelaide, Australia
- 3 Essex Sustainability Institute, School of Biological Sciences, University of Essex, Colchester, UK
- 4 School of Geography, Earth and Environmental Sciences, University of Plymouth, Plymouth, UK
- 5 School of Agriculture, Policy and Development, University of Reading, Reading, UK

Review

Linking prawn and shrimp farming towards a green economy in Bangladesh: Confronting climate change

Nesar Ahmed^{a,b,*}

^aDepartment of Fisheries Management, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh

^bSA Water Centre for Water Management and Reuse, University of South Australia, Adelaide, SA 5095, Australia

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ABSTRACT

The coastal aquaculture sector in Bangladesh is dominated by export-oriented freshwater prawn and brackishwater shrimp farming, both are commercially known as “white gold” because of transnational value. This article reviews prawn and shrimp farming in coastal Bangladesh that have been linked to a “green economy”. As part of agricultural development in coastal Bangladesh, prawn and shrimp farming were initiated in the 1970s. Over the last three decades, prawn and shrimp culture have undergone a revolutionary development in coastal Bangladesh. Prawn and shrimp farming have brought about widespread social and economic benefits. However, a wide range of environmental issues including climate change have recently been identified to threaten the sustainability of coastal aquaculture. In order to achieve a green economy, environmental challenges must be addressed in translating its benefits effectively to the millions of coastal poor. Considering the extreme vulnerability to the effects of climate change, an integrated green economy system needs to be introduced to cope with the challenges. Effective planning in respect to coastal zone management would also be given particular attention

Correspondence

Stuart W. Bunting, School of Biological Sciences, University of Essex, Wivenhoe Park, Colchester CO4 3SQ, UK.
Email: swbunt@essex.ac.uk

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Abstract

Farming freshwater prawns with fish in rice fields is widespread in the coastal region of southwest Bangladesh because of favourable resources and ecological conditions. This article provides an overview of an ecosystem-based approach to integrated prawn–fish–rice farming in southwest Bangladesh. The practice of prawn and fish farming in rice fields is a form of integrated aquaculture–agriculture, which provides a wide range of social, economic and environmental benefits. Integrated prawn–fish–rice farming plays an important role in the economy of Bangladesh, earning foreign exchange and increasing food production. However, this unique farming system in coastal Bangladesh is particularly vulnerable to climate change. We suggest that community-based adaptation strategies must be developed to cope with the challenges. We propose that integrated prawn–fish–rice farming could be relocated from the coastal region to less vulnerable inland areas, but caution that this will require appropriate adaptation strategies and an enabling institutional environment.

Key words: Bangladesh, climate change adaptation, ecosystem-based management, prawn–fish–rice resilience

Thank You All

