

# **International Symposium on Healthy Mangroves and Sustainable Fisheries for Climate Resilient Coastal Community in South Asia**

## **Technical Report**

**1-3 March 2023**

**Fisheries and Marine Resource Technology Discipline (FMRT)  
Khulna University, Khulna, Bangladesh**



# International Symposium on Healthy Mangroves and Sustainable Fisheries for Climate Resilient Coastal Community in South Asia

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## PREPARATION OF THE DOCUMENT

This Technical Report was prepared by Plenary Consultancy (PC) based on the verbatim reports of the rapporteurs, the audio recordings of the sessions, and other pertinent materials from the International Symposium on Healthy Mangroves and Sustainable Fisheries for Climate Resilient Coastal Communities in South Asia. PC has made every effort to ensure that the verbatim reports of the rapporteurs accurately reflected the presentations and discussions by cross checking with the audio recordings and other symposium related documents provided by the organizers to ensure objectivity and balance.

The document presents the following information for each thematic session of the Symposium: the session overview; the summary of the plenary discussions; and the major findings and key recommendations. Moreover, the document synthesizes the main cross-cutting messages and recommendations that emerged from the speakers, panelists and participants throughout the different Symposium sessions.

PC expresses its gratitude to the local Organizing Committee members of the symposium from Khulna University and Bangladesh Environment and Development Society (BEDS) who cooperated with the preparation of this report by supplying all necessary documents and organizing evaluation meetings. The verbatim notes and audio-visual resources that the PC staffs Khadiza Khatun, Sagarika Singh, Md. Naim Islam, and Oindrela Hazra prepared during the symposium are remarkable examples of professional skill, teamwork, and dedication. Team BEDS should be especially appreciated for providing some of the missing video segments and supplying a comprehensive list of the posters presented. Anup Kumar Karmokar from PC is highly appreciated for his dedication and hard work for compiling the verbatim notes according to the sessions and for creating the layout and formatting the document in its final printable PDF form.

Finally, PC expresses its sincere gratitude to Prof. Dr. Md. Nazmul Ahsan of Khulna University for his insightful criticism and suggestions on the initial draft as well as for his meticulous editing of the English for greater readability and clarity in the final version of this report.

15 April 2023  
Khulna, Bangladesh

Prema Hazra  
Executive Director  
Plenary Consultancy  
Khulna, Bangladesh



## FOREWORD

The International Symposium on Healthy Mangroves and Sustainable Fisheries for Climate Resilient Coastal Community in South Asia was held to discuss critical issues and to share successful experiences on managing natural resources in a sustainable way. The symposium brought together more than 250 participants from 15 countries, including researchers, policymakers, practitioners, and community representatives, to share their knowledge and experiences on the role of mangroves and fisheries in enhancing the resilience of coastal communities to climate change impacts. The symposium also provided a platform for dialogue and collaboration among various stakeholders to identify challenges and opportunities for the conservation and management of mangroves and fisheries in the region.

This post-symposium report summarizes the main outcomes and recommendations of the symposium, as well as the highlights of the keynote speeches, plenary sessions, panel discussions, and poster presentations. The report also showcases some of the best practices and innovative solutions that have been implemented or proposed by the symposium participants to address the issues related to mangroves and fisheries in South Asia. The report aims to disseminate the key messages and lessons learned from the symposium to a wider audience and to inspire further action and cooperation for the sustainable development of coastal communities in the face of climate change.

As the Chair of the Organizing Committee of the symposium, I would like to express our sincere gratitude to all the participants, speakers, moderators, rapporteurs, sponsors, partners, and volunteers who contributed to the success of this event. We hope that this technical report will serve as a useful reference and a catalyst for future initiatives on healthy mangroves and sustainable fisheries for climate resilient coastal community in South Asia.

Prof. Dr. Md. Golam Sarower  
Head  
FMRT Discipline, Khulna University, Bangladesh; and  
Chair, Symposium Organizing Committee

## ABBREVIATIONS AND ACRONYMS

ACIAR	Australian Centre for International Agricultural Research
BEDS	Bangladesh Environment and Development Society
BFD	Bangladesh Forest Department
BFRI	Bangladesh Fisheries Research Institute
BMZ	Federal Ministry of Economic Cooperation and Development
CBET	Community-based Ecotourism
CCF	Chief Conservator of Forests
CMS	Coastal and Marine Science
CMSP	Coastal and Marine Spatial Planning
CRenIEO	Center for Research on New International Economic Order
CYAH	Coastal Youth Action Hub
DCCF	Deputy Chief Conservator of Forests
DG	Director General
DoF	Department of Fisheries
FMRT	Fisheries and Marine Resource Technology
FWT	Forestry and Wood Technology
GBF	Global Biodiversity Framework
GHG	Greenhouse Gas
GNF	Global Nature Fund
ICZM	Integrated Coastal Zone Management
IFA	Integrated Farm Assurance
IMA	Integrated Mangrove Aquaculture
KfW	German Development Bank
KU	Khulna University
LAB	lactic acid bacteria
LBD	Lower Bengal Delta
MP	Micro Plastic
NEWS	Nature, Environment and Wildlife Society
OTP	One Tree Planted
PC	Plenary Consultancy
PL	Post Larvae
SAIME	Sustainable Aquaculture of Integrated Mangrove Ecosystem
SDG	Sustainable Development Goals
SEMP	Sundarbans Ecosystem Mangrove Project
SonG	Swatch of No Ground
SPF	Specific Pathogen Free
TNC	The Nature Conservancy
TRM	Tidal River Management
WUR	Wageningen University and Research

## EXECUTIVE SUMMARY

The International Symposium on Healthy Mangroves and Sustainable Fisheries for Climate Resilient Coastal Community in South Asia took place in Khulna University, Khulna, Bangladesh from March 1-3, 2023. It was held to discuss key technical challenges, showcase best practices from around the world for sustainable management of fisheries and mangrove resources, and promote partnerships and collaboration among academics, practitioners, business leaders, and policymakers.

The Symposium was attended by about 250 exceptionally diverse and gender balanced participants from academia, industries, government, international organizations, and non-governmental organizations, from around 15 countries of the world. The Symposium had several sessions on different themes, where speakers and panelists from different countries and sectors shared their insights and suggestions through the discussions in each session.

The Symposium produced two documents: a Book of Abstract that contained background information, session description and contents and main challenges addressed by each session, which was prepared before the meeting; and this document, which serves as the proceedings for the meeting. Moreover, a special issue of Khulna University Studies with full articles presented at the meeting is being prepared.

The purpose of this document is to provide an overview of the discussions, key takeaways, and recommended next steps that came out of the different sessions of the Symposium. This report reflects a shared vision on how to advance sustainability with a request for action by all concerned parties. The major points and recommendations that are relevant for both fisheries and mangroves aspects of the coastal area of Bangladesh and other South Asian countries are highlighted while a detailed list of recommendations of each session is described later in this report.

Conservation of biodiversity should be at the core of future development cooperation and different actors must work towards a common goal to achieve this;

Livelihoods from the Sundarbans come overwhelmingly from its fisheries resources and, therefore, understanding the linkage between forest attributes and fisheries productivity is necessary to determine governance mechanism that can best safeguard equitable access and sustainable resource management;

Stock assessment and population biology of commercially important fish of the Sundarbans is highly imperative for science-based conservation measures;

Nursery role of mangroves should be investigated using tracer and tagging techniques and other proven tools (e.g. otolith microchemistry) as well as DNA-based techniques;



Abundance and distribution of plankton community together with key water quality indices across different seasons and tidal regimes will provide meaningful and quantifiable indicators of ecological change in short timescales;

Troubleshooting prawn and mud crab hatchery operations as well as development of seabass hatchery with domesticated brood from other Asian countries and integrating the wild fish seed collectors in the downstream hatchery value chains;

Promoting healthy mangroves, thriving coastal communities and robust aquaculture value chain ecosystem-based farming practices that are compatible with the salinity regime of the coastal area including, for example, salt-tolerant rice, integrated mangrove-aquaculture involving shrimp or mud crab, agroforestry and so on;

Enhancing the awareness and participation of the local communities including women and youth in the conservation and management of the coastal ecosystem and biodiversity, and provide them with alternative livelihood options that are sustainable and resilient to climate change and other environmental stressors;

Investing in climate-smart infrastructure and technologies that can improve the productivity and efficiency of coastal food systems, such as water-saving irrigation, renewable energy, cold storage, and post-harvest facilities;

Strengthening the coordination and collaboration among different stakeholders, such as government agencies, research institutions, NGOs, private sector, and local communities, to ensure a holistic and integrated approach to linking coastal livelihoods and biodiversity conservation in the Sundarbans region.



# INTRODUCTION



## INTRODUCTION

### SYMPOSIUM CONTEXT

Coast is not merely an interaction of tides at an intertidal zone as once thought; rather the interaction extends as far inland as watersheds and out to the ocean bearing physical, ecological and socio-economical interconnectivity. The coastal resources particularly fisheries and mangroves as well as their interactive dynamic ecosystems play a vital role for food security, income generation and export earnings for many coastal countries in South Asia. However, the connectivity between these two ecosystems is poorly understood while their salient features are being increasingly disturbed by various anthropogenic and climate-induced events and this compromises their future contribution to food security and nutrition. This is particularly true for the coastal fisheries sector of Bangladesh, which remains at a critical juncture. As one of the major food production systems that relies on healthy mangrove ecosystem, the sector must continue to grow sustainably while adapting to a rapidly evolving development and climate change regimes.

Given this context, the International Symposium on Healthy Mangroves and Sustainable Fisheries for Climate Resilient Coastal Community in South Asia was held from 1-3 March 2023 at Khulna University campus to address key technical questions, to highlight global best practices on sustainable fisheries and forestry resource management and to facilitate partnerships and cooperation with academia, practitioner, industry, and policymakers.

The Symposium provided an ideal platform for contentions and consensus following thematic presentations to understand the national and regional context for sustainable management of coastal fisheries and forest resources and the constraints operating at the community level that undermine the viability of this important sub-sector. The key messages and recommended actions that emerged from the Symposium were building blocks for the development of a climate resilient coastal community based on judicious exploitation and management of coastal fisheries and mangrove resources on a sustainable and equitable basis. These outputs and outcomes are also expected to contribute to achieving some of the targets and objectives of the Sustainable Development Goals (SDG) within the Agenda 2030 for Sustainable Development including SDG 1 (no poverty), SDG 2 (zero hunger), SDG3 (good health and well-being), SDG4 (quality education), SDG5 (gender equality), SDG10 (reduced inequalities), SDG13 (climate action), SDG14 (life below water), SDG15 (life on land) and SDG 17 (partnerships for the goals)



The International Symposium on Healthy Mangroves and Sustainable Fisheries for Climate Resilient Coastal Community in South Asia was jointly organized by a consortium of national and international partners including Fisheries and Marine Resource Technology (FMRT) Discipline of Khulna University, Bangladesh Environment and Development Society (BEDS) and Global Nature Fund (GNF) with financial supports from Khulna University, the Federal Ministry for Economic Cooperation and Development (BMZ) of the Federal Republic of Germany, Foundation Ursula Merz and Mercedes-Benz.

## SYMPOSIUM SESSIONS AND STRUCTURE

The International Symposium on Healthy Mangroves and Sustainable Fisheries for Climate Resilient Coastal Community in South Asia was structured around a series of several thematic sessions as follows:

Day 1 Wednesday 1 March, 2023	SESSION 1	Food security, coastal aquaculture and tidal forest nexus
	SESSION 2	Sustainable aquaculture and fisheries in south Asia
	SESSION 3	Panel discussion on ecosystem approach linking coastal livelihoods and biodiversity conservation
Day 2 Thursday 2 March, 2023	SESSION 4	Vulnerability context and coping strategy of coastal community against climate change
	SESSION 5	Inclusive and equitable market and value chains development
	SESSION 6	Panel discussion on policy options for climate resilient coastal food system in south Asia
Day 3 Friday 3 March, 2023	FIELD TRIP	Cruising around the Sundarbans mangrove forest followed by visits to integrated mangrove aquaculture farms, women-led mangrove nursery and other alternative livelihood activities of the forest-dependent communities in Dacope, Khulna, Bangladesh

In response to a call for abstracts, more than 250 people from all over the globe registered as participants, with approximately 150 abstracts submitted via a symposium-specific website. The abstracts were reviewed rigorously by the Editorial Team in consultation with the International Scientific Committee. The Editorial Team chose 33 abstracts for oral talks at the four thematic sessions and 99 for poster presentations.



The sessions were structured in a way that the presentations of a given session were continuous and the entire session continued without interruption for questions, which were addressed during a panel discussion session by the speakers while a panel of experts provided further insights on the topics being discussed. Following a keynote speech during the inaugural session setting the stage for the symposium, each session began with a plenary lecture followed by thematic presentations and a panel discussion session. The plenary lectures synthesized the state of knowledge and highlighted prominent topics within the session theme. A closing session on Day 2 consisted of recap and reflections on the events and messages, appreciation of the session chairs, declaration of best poster presenters followed by concluding remarks. The detailed program scheduled is provided in Annex I.





# INAUGURAL SESSION





## INAUGURAL SESSION

To mark the event as an exemplary cross-sectoral, multi-disciplinary initiative, representatives from both fisheries and forest departments of Bangladesh delivered their opening remarks at the inaugural session of the International Symposium. Presided over by Head, FMRT Discipline, Khulna University (KU), the inaugural session was attended by the Director General (DG), Department of Fisheries (DoF); the Deputy Chief Conservator of Forests (DCCF), Bangladesh Forest Department (BFD); and the Dean, Life Science School, Khulna University as the Special Guests while the honorable Vice Chancellor of Khulna University graced the session as the Chief Guest. The distinguished guests thanked the organizers for arranging such global gathering in Khulna, the southwest coastal city of Bangladesh situated a few kilometers off the world's largest single-tract mangrove forest, provided sectoral perspectives and strategic guidelines, underscored the need for collaborative research and called for joint action for the sustainable management of the mangroves and coastal fisheries resources. The session ended with a presentation by the Symposium Speaker from James Cook University TropWATER Centre, Australia.

The session began with a warm welcome from Prof. Dr. Muhammad Abdur Rouf of FMRT Discipline, KU. Then, Prof. Dr. Abul Kalam Azad, Dean of Life Science School, KU, spoke about the vital role of mangroves in supporting fisheries and the challenges they face from pollution, deforestation and development activities in the upstream areas. He thanked the organizers for bringing attention to this crucial issue.

The DCCF of BFD, Md. Jahidul Kabir, highlighted the vital role of mangroves in providing various ecosystem services to the coastal community and in safeguarding the country's coastline from natural disasters. He stressed the need to not only conserve the Sundarbans mangrove forest but also to create a green belt along the coast through coastal afforestation with mangrove plantation. Mr. Kabir then gave a brief overview of BFD's mandate and activities in managing the resources of the Sundarbans, mentioning various conservation and monitoring measures such as complete ban on timber harvesting, creation of sanctuaries, Dolphin sanctuaries and seasonal prohibition on fisheries resource extraction from the forest. He emphasized the need for collaboration among fisheries and forestry experts and policy makers and called for a comprehensive stock assessment of the aquatic and terrestrial resources of the forest. He also encouraged the researchers to come up with innovative tools and approaches in this regard. He concluded by expressing his hope that the Symposium would help BFD in making





science-based decisions for better management of the Sundarbans and its aquatic resources.

The DG of DoF, Kh. Mahbubul Haque delivered his speech by an opening remark that with about 0.5 million metric ton annual production Bangladesh is self-sufficient in fish production and this has been made possible by research and dissemination. Having been self-sufficient, there is no place for complacency as the efforts must continue to further increase the production to meet the requirement of increasing population and to meet the demand from expanding export market with particular attention on fish quality while not jeopardizing the natural resource base. Mr. Haque then stated that coastal aquaculture offers tremendous opportunity for growth in a sustainable and environment-friendly manner as this region provides important nursing and breeding ground for a variety of fish, shrimp and crab species. He suggested cluster farming and mangrove integration in shrimp ponds as some of the environment-friendly approaches that the researchers might find interesting to explore. He hoped that Khulna University would play a key role in attracting international researchers and assured that DoF would provide all kinds of cooperation including research fund allocation.



The Chief Guest of the inaugural session Prof. Dr. Mahmood Hossain, honorable Vice Chancellor of Khulna University happened to be an eminent mangrove scientist of Bangladesh. Citing from his and other scientists' recent publications he stated that mangroves provide many ecosystem benefits and services, of which the fisheries resource is most important for the livelihoods of the coastal community and therefore understanding how mangroves support fisheries could be an interesting avenue of research. In this regard, he posed some research questions including what type of fish species depend on mangroves and why? Does mangrove composition affect fish assemblage? How do fish respond to change in mangrove ecology? What effects do tidal regime have on mangrove composition and fish biodiversity? With these thought-provoking research questions, Prof. Hossain emphasized the importance of large-scale collaboration among governments and research and development organizations in achieving the objectives for which the Symposium had been organized.



As the Symposium Speaker, Dr. Norman C Duke from James Cook University TropWATER Centre, Australia delivered a Key Note presentation entitled, "Caring about mangroves ecosystem health is caring about people", where he articulated several threats to mangrove health including loss of habitat, shoreline erosion, saline water intrusion and carbon emission. Dr. Duke described four broad nested-process levels to understand the dynamics and responses of tidal wetlands and mangroves including geographic setting of



the forest, trends in air temperature and rainfall, natural turnover of mangroves and regeneration process following disturbance. All four levels were described in details with particular emphasis on factors influencing each level and what can be done to minimize the influence and restore the habitats.

Showing data and images from different parts of Queensland, Australia such as Gulf of Carpentaria, Brunett River, Starcke River, Daintree River estuary, Princess Charlotte Bay, Moreton Bay, Brisbane River, Cape Flattery, Port Curtis, Luggage point and Mackay region, Dr. Duke provided a vivid description of how mangroves were affected by several factors ranging from natural causes such as sea level rise and drops, severe floods, tropical cyclones, lightning strikes, shoreline erosion, low rain fall to anthropogenic causes including landfill reclamation, oil spills and agricultural runoffs. Interestingly, Dr. Duke provided empirical evidence that mangrove covers are directly proportionate to the extent of associated wetland covers whereas human activities such as large oil spills and agricultural herbicides seriously affect the fisheries resources of the mangrove waterbodies jeopardizing the livelihoods of the fishermen community. The Keynote presentation underscored the need for a comprehensive stocktaking of the Sundarbans mangrove ecosystem through field studies and predictive modeling to devise appropriate monitoring and management tools. In this regard, awareness and capacity development of local community groups to assist in monitoring of the condition of mangroves, fish and other wild lives in partnership with scientists and managers were recommended.









# Thematic Session

1

## Food Security, Coastal Aquaculture and Tidal Forest Nexus

This session contained one plenary lecture followed by six thematic presentations, focusing on the importance of coastal fisheries and mangroves and their direct and indirect contribution to food security, income generation and other macroeconomic benefits for many coastal countries in South Asia. The session opened with a plenary lecture that highlighted the context and the knowledge gaps to understanding the connectivity between these two ecosystems followed by presentations that addressed phytoplankton community dynamics, fine root carbon dynamics, pesticide and plastic contamination affecting the biodiversity and a final presentation underscoring the need for conserving biodiversity as the core area of future development cooperation.

### Plenary Lecture



In the plenary lecture entitled, "Coastal Aquaculture and Mangrove Forest Nexus: State of Affairs and Future Research Needs", Prof. Nazmul Ahsan from Khulna University provided an overview of the productionist paradigm of development in the coastal area that led to unplanned expansion of commercial shrimp farming. Earthen embankments, known as 'polder', constructed during 1960s to boost rice yield created severe saline water logging problem that compelled farmers to switch to shrimp aquaculture. Now, fishing and aquaculture remain the only economic activities in altered coastal landscape due to the altered landscape and the coastal aquaculture portfolio has been expanding to include other brackish water species with seeds sourced from the wild. The way mud crab farming has been expanding is alarming. Initially, only hard-shell adult crabs had export value and, therefore, fishermen used selective gears leaving a portion to mature and reproduce. Subsequently, however, forest-dependent community started indiscriminate harvesting of all types of crabs of any age group as various forms of crab aquaculture system spread in the coastal area. The impacts of such unsustainable practice of shrimp and mud crab farming on ecosystem are largely speculative but include the effects of saltwater intrusion, loss of natural vegetation, destruction of biodiversity and other forms of land and water degradations. With this contextual overview, Prof. Ahsan provided a number of empirical research questions that need to be answered to understand the nexus and suggested some entry points for intervention for building a climate resilient coastal community.



## Contributed Papers



Ralph Dejas from Global Nature Fund (GNF), Germany provided vivid examples of how anthropogenic activities have resulted in rapid decline of earth's biodiversity in his titled, "Food for Biodiversity." He also identified intensive agriculture, invasive species and climate change, as the major causes of biodiversity loss, with negative impacts on human health and ecosystems due to ammonia and methane emissions. He highlighted the challenges of overcoming the crisis of species extinction and emphasized the importance of protecting biodiversity, which delivers ecosystem services through the interplay between a habitat and its animal and plant inhabitants. To achieve this, he outlined development goals such as the protection of marine and terrestrial ecosystems, the promotion of sustainable consumption and production, and climate protection. In this regard, he discussed about two such initiatives including 'Food for Biodiversity Association' and 'Naturland' and provided a roadmap to achieving the Biodiversity Targets 2030.

Phytoplankton serve as the foundation of the ocean food web, providing sustenance and economic resources to billions of people worldwide. These microscopic organisms are responsible for almost 50% of the oxygen supply in the ocean. Kashafad Bin Hafij from BSMR Maritime University, Dhaka, Bangladesh delivered a lecture on the dynamics of phytoplankton community and highlighted the significance of planktonic algae on global scale. He focused on the factors that limit and control the abundance of phytoplankton stating that factors such as salinity and turbidity have the greatest impact on their abundance in estuaries, while upstream areas are affected to a lesser extent. Additionally, He provided data showing that salinity is a limiting factor for individual groups while Nitrate, Chlorophyll-a, Temperature, pH and DO are considered as the controlling factors for the total abundance of phytoplanktons.



Dr. Md. Kamruzzaman from Forestry and Wood Technology (FWT) Discipline, KU presented his findings on contribution of fine root in carbon dynamics of the Sundarbans mangrove ecosystem. He explained the process of biomass carbon production, nutrient turnover and carbon storage in these forests. The results suggest that with the mean above-ground biomass of 154.8 Mg/ha, the productivity of the Sundarbans mangrove forest is higher compared to other tropical and sub-tropical mangrove forests of the world. The author further found that fine root contributed almost one-eighth of the below-ground biomass contributing a substantial amount in carbon stocks, which suggests a crucial role of the Sundarbans in climate change mitigation through sinking atmospheric carbon dioxide. Dr. Kamruzzaman concluded his presentation with a recommendation to further quantify fine root mass production, providing information on fine root decomposition and determining the amount of necro mass in the different saline zones of the Sundarbans mangrove forests.



Protecting biodiversity from pollution is a global concern, particularly in the agro nexus where pesticide pollution and micro plastic (MP) pollution are emerging issues that require immediate attention. In this regard, two important lectures were delivered by Prof. Golam Sarower and Prof. Mustafizur Rahman from FMRT Discipline, KU. Prof. Sarower's lecture focused on the potential toxicity of pesticides and their transformation from products to aquatic organisms. Although the use of pesticides has declined since 2008, the residues could still be detected from estuaries and mangroves canals. Through a controlled experiment, Prof. Sarower showed how pesticides altered gene expression pattern in fish cell. Additionally, he described the effect of sub-lethal exposure to cypermethrin and pyrethroid which significantly retarded growth performance, enzyme activity, digestion and reproduction of fish. On the other hand, Prof. Rahman addressed plastic pollution in mangrove forests, where he found significant changes in both phenotypic and reproductive traits of fish. In a controlled experiment, 50% mortality of guppy fish was observed due to 2% MP exposure. These lectures emphasized the urgent need to address the growing problem of pesticide and MP pollution in order to protect biodiversity and maintain healthy ecosystems of mangroves and its surrounding waterbodies.



Dr. Stefan Alfred Groenewold delivered a lecture on GIZ's new core area of development cooperation on biodiversity between Bangladesh and Germany. He talked about Montreal Global Biodiversity Framework (GBF) and emphasized the need for mobilization of public and private resources and an increase in international financial flows to conserve biodiversity. Identifying the main issues of biodiversity in Bangladesh, he urged government agencies, universities, national and international organizations and communities to work together for biodiversity conservation so as to protect the future from food scarcity and maintain a sustainable livelihood. Narrating GIZ's past activities regarding biodiversity conservation in the Sundarbans, Dr. Groenewold provided a brief overview on its current project, 'Integrated Management of the Sundarbans and Swatch of No Ground Marine Protected Area (SonG)'. Looking forward, Dr. Groenewold highlighted the importance of smooth collaboration among different departments, integration of all essential stakeholders in planning, creating buffer zones for resource users, strengthening of awareness and youth involvement, enhancing women's participation, making science-based decisions, regular monitoring and surveillance, sharing ecosystem benefits, and enhancing guardianship and citizen science as success factors of biodiversity. He also proposed a future plan to strengthen the blue-green network along the coast and underscored the need for transboundary collaboration between Bangladesh and India on issues related to biodiversity conservation in the greater Sundarbans.

## Major Findings

Unlike other south east Asian countries, mangrove loss due to coastal aquaculture is negligible in Bangladesh. However, the unplanned expansion of commercial shrimp farming has caused alterations to the coastal landscape, resulting in saltwater intrusion, loss of natural vegetation and biodiversity destructive practice of wild post larvae (PL) collection from the Sundarbans area;

The current practice of mud crab farming and export warrants immediate attention as indiscriminate harvesting of all types of crabs from the Sundarbans area pose significant threat to the biodiversity and ecosystem of the forest;

Phytoplankton dynamics are vital to the food web of coastal and marine waters, which are affected by changes in salinity, turbidity, nitrate, chlorophyll- $\alpha$ , temperature, pH and DO;

Mangrove fine root constitutes one-eighth of the below-ground biomass contributing a substantial amount in carbon stocks, which suggesting a crucial role of the Sundarbans in climate change mitigation through sinking atmospheric carbon dioxide;

Pesticides and micro plastic pollutions negatively affects fish growth, survivability, enzyme activity, digestion and reproduction;

Protecting biodiversity is essential for delivering ecosystem services, promoting sustainable consumption and production and achieving climate protection goals.

## Key Recommendations

Stock assessment and population biology of commercially important fish is highly imperative for science-based conservation measures;

Nursery role of mangroves should be investigated using tracer and tagging techniques and other proven tools (e.g. otolith microchemistry) as well as DNA-based techniques;

Abundance and distribution of plankton community together with key water quality indices across different seasons and tidal regimes will provide meaningful and quantifiable indicators of ecological change in short timescales;

Troubleshooting prawn and mud crab hatchery operations as well as development of seabass hatchery with domesticated brood from other Asian countries;

Fine root decomposition and the amount of necro mass in different saline zones of the Sundarbans to better understand the carbon dynamics of the Sundarbans;

Address the problem of pesticide and MP pollution in order to protect biodiversity and maintain healthy ecosystems of mangroves and its surrounding waterbodies;

Conservation of biodiversity should be at the core of future development cooperation and different actors must work towards a common goal to achieve this.





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3 March, 2023

## Thematic Session

2

## Sustainable Aquaculture and Fisheries in South Asia

This scientific session was chaired by Dr. Jayati Chourey from SaciWATERS and co-chaired by Dr. Muhammad Abdur Rouf from Khulna University. This session contained one plenary lecture followed by six thematic presentations, focusing on sustainable aquaculture practice in the South Asian region. During this session, experts delivered various presentations dealing with climate smart environment friendly aquaculture and aquatic animal health issues for sector sustainability. Topics covered include the correlation between mangrove and aquaculture, the use of mangrove leaf litter and supplemental feed in aquaculture, the benefits of using indigenous probiotics in black tiger shrimp, Global G.A.P.'s Aquaculture Certification Standard, science-based solutions to improve community livelihoods and mud crab fisheries in the Sundarbans mangrove forest. Activities of and lessons learned from Sustainable Aquaculture of Integrated Mangrove Ecosystem (SAIME) project was also covered in this session.

### Plenary Lecture



Dr. Marc Verdegem from Wageningen University and Research (WUR), the Netherlands presented a plenary lecture on an innovative 'nutritious pond' concept, where 50% less aquafeed would be required as the natural system of a nutritious pond has the ability to provide protein, omega-3 fatty acid, phosphorus and lysine to fish. He mentioned that only 20-40% of formulated feeds are consumed by fish in current aquaculture practice and the rest goes to waste, causing poor water quality and unhealthy fish. With 'nutritious pond' approach it is possible to replace environmentally unsustainable fishmeal in aquafeed. However, replacing fish meal with cost effective and environment-friendly plant-based alternatives affects fish growth as plant ingredients are low in essential amino acid, lysine. Showing data from a comparative growth study of tilapia fed with balanced and low levels of dietary lysine, Dr.

Verdegem mentioned that the food web present in pond provides natural foods containing lysine, allowing the fish to overcome the dietary lysine deficiency. He also showed that the protein efficiency ratio in pond-raised tilapia was also improved substantially, which was not the case with those raised in clear-water aquaria. Dr. Verdegem concluded that an ecological intensification or circular economy can be achieved by applying 50% less feed while recycling methane and ammonia resulting in higher production, cheaper feed and easier management in a healthy environment. He also suggested to rely on plant-based fish diets as it can contribute to the provision of lysine in food webs whereas synthetic L-lysine can be used where the pond condition is suboptimal to allow for appropriate food web development.



## Contributed Papers



Articulating the importance of shrimp aquaculture in altered coastal landscape where rice has no future, Dr. Iftakharul Alam emphasized the need for integration of mangroves with shrimp aquaculture. This is significant because shrimp is profitable export commodity and an important source of nutrition in Bangladesh. Additionally, mangroves are highly productive and provide coastal protection and biodiversity hotspots. The use of mangrove-shrimp aquaculture enhances circulatory and system health, as mangroves produce food for shrimp and improve water quality. Dr. Alam found that the combination of leaf litter and feed resulted in over 30% higher weight gain of juvenile shrimp PL than based on the combined contributions of leaf litter or feed alone, indicating synergism. The results suggest that integration of mangroves in aquaculture systems will not only serve as an inexpensive source of food but will also result in a higher pond productivity from less supplementary feeding through synergistic effects. However, further studies are required to determine the maximum amount of leaf litters that would not affect shrimp growth and to understand the long-term impacts of leaf litter on water quality and shrimp performance in extensive aquaculture system.

Rakibul Islam from Bangladesh Fisheries Research Institute (BFRI) discussed the effect of indigenous probiotics on *Vibrio* propagation and digestive enzyme activity in black tiger shrimp. He explained that how probiotics can minimize disease outbreaks, discourage the use of antimicrobial drugs, and boost digestive mechanism and growth. Due to the increasing demand for probiotics in the world aquaculture industry, their annual import has mounted to over 3000 MT, with a market worth more than 30 billion BDT. However, imported probiotics have compromised efficiency due to their inability to adapt to the subtropical environment in addition to high cost involvement. To address this issue, Mr. Islam and his team searched for local probiotic bacteria through DNA extraction, next-generation sequencing and metagenomics analysis. They found that the local probiotics have higher temperature tolerance and biodegradation rates, with a growth inhibition of up to 74% in in vitro inhibitory effect against *Vibrio*. The probiotic isolates were also found to inhibit *Vibrio* propagation in vivo (shrimp gut and hepatopancreas) and in situ (pond soil and water) tests and their application resulted in higher digestive enzyme activities, better immune parameters and increased growth in shrimp. The use of local probiotics reduces the stress of shrimp and increases growth, especially in wide ranges of temperature, salinity and water quality. The limitations of the research were the short time frame and the evaluation of combined effect of probiotics with fewer immune parameters. Further works involving efficacy of individual bacterial isolates, different combination and composition of isolates and inclusion of various prebiotics including growth promoters and immune boosters were suggested.



Dr. Pham Viet Anh spoke about Global G.A.P.'s Aquaculture Certification Standard, which aims to promote safe and sustainable agriculture worldwide. He discussed the voluntary certification standards for agricultural products and how more and more producers,



suppliers and buyers are adopting them. The organization launched shrimp standards in 2008 and utilizes integrated farm assurance (IFA) aquaculture. Dr. Anh also mentioned Global G.A.P.'s risk assessment categories, including social practice, food safety, animal health and welfare, environmental sustainability, workers' well-being, and legal management and traceability. The organization's solution considers four pillars from the FAO technical guidelines: food safety, animal health and welfare, environmental integrity and socioeconomic aspects. Dr. Anh discussed the importance of good aquaculture practice in managing brood stock and seedlings, and how the organization could provide a capacity building roadmap for all stakeholders involved in the production process.

Dr. Nora Devoe from Australian Centre for International Agricultural Research (ACIAR) initiated her presentation by asking a thought-provoking research question as to how can we use research for development to improve the livelihoods of the Sundarbans community. The presentation focused on development objectives such as improving food security, reducing poverty, managing natural resources, enhancing human nutrition, promoting gender equity, and strengthening scientific and policy capabilities. Dr. Devoe discussed about a new development research project entitled, Sundarbans Ecosystem Mangrove Project (SEMP), which involves the study of hydrology, social dependency, adaptive management of polder, and fisheries linkage. The research questions for the SEMP study include identifying drivers of change in key forest attributes and their implication to human welfare. Since fisheries resources are currently the main livelihoods means understanding the linkage between forest attributes and fisheries productivity is a crucial research question at the heart of the planned SEMP project. Once understood, appropriate management response can be devised to restore habitat loss and improve the livelihoods of the local community.



In her lecture, Mst. Sharmin Nahar discussed the mud crab fisheries in the Sundarbans mangrove forest of Bangladesh, with an emphasis on crab habitat distribution and fishing patterns in relation to vegetation type and water quality. Crab collectors prefer different gears in different regions with longline being the most dominant one throughout the forest area. Spatially, different forest ranges (area) have different water, soil, and vegetation characteristics that influence mud crab distribution. Sarankhola range is moderately saline with dominant vegetation of Sundori providing habitats for larger crabs. Overall crab distribution (number, size and sex) is influenced by different habitat factors with, however, severe harvesting pressure on female mud crabs in all ranges of the forest.

The final deliberation of this session included a contextual overview, current activities and future plan of SAIME project in transboundary Sundarbans. While the project partner Ralph Dejas from Germany provided an overview of GNF's vision to create a climate adaptive, ecosystem-based approach ensuring livelihood security of coastal communities and the organization's various mangrove protection and restoration activities in various countries of the world, partners from India (Nature, Environment &

Wildlife Society; NEWS) and Bangladesh (Bangladesh Environment & Development Society; BEDS) provided country specific inputs and insights in this joint presentation. The overall goal of SAIME is to promote healthy mangroves, thriving coastal communities and robust aquaculture value chain in the Sundarbans of India and Bangladesh. In both countries, integrated mangrove aquaculture (IMA) is being piloted where selected mangrove species were planted in shrimp ponds. NEWS is implementing IMA in 29.46 ha area involving 42 farmers in two groups in India. Farmers received technical capacity building trainings on topics related to pond preparation, soil and water quality management, mangrove plantation and monitoring as well as forward market linkage with Badabon Farmers' Producer Company Limited.



The piloting project activities resulted in over 300% net profit gain by the IMA farmers in comparison with the traditional shrimp farmers. In Bangladesh, BEDS planted more than 20,000 mangrove saplings in 5.18 ha shrimp farm and trained 1,250 farmers across three coastal districts. Apart from overall capacity building trainings on topics related to IMA and access to IMA cooperative building facilities (shrimp processing, cold storage and transportation), farmers were linked with specific pathogen free (SPF) shrimp hatcheries and were trained to record regular IMA farm activities, such as water quality parameters, growth of mangrove saplings and shrimp and other fish harvest through maintaining farm record books, which were actively monitored and supervised by project staffs. In addition, BEDS established seven community-based mangrove nurseries run by women and raised about 300,000 mangrove saplings for IMA and other mangrove restoration activities. In future, BEDS plans to increase IMA pilot area to 75 ha, operationalize IMA cooperative through forward market linkage, branding IMA shrimp and promoting other mangrove-based products in the local and international markets.

## Major Findings

Lack of certain essential amino acids in plant-based alternatives to environmentally unsustainable fish meal in aquafeed does not affect fish growth in pond because the food web present in the pond system provides the missing amino acid;

The synergistic effect between leaf litter and supplemental feed can help coastal farmer to minimize the shrimp production cost by lowering the feed input and by enhancing mangrove tree coverage on pond dikes as an inexpensive source of natural food;

Application of probiotic bacteria isolated from local environment have resulted in higher digestive enzyme activities, better immune parameters and increased growth in shrimp;

Aquaculture certification scheme will ensure food safety, animal health and welfare, environmental integrity and socioeconomic aspects of coastal aquaculture;

Understanding the drivers of change in key forest attributes and their implication to human welfare are fundamental to sustainable management of the Sundarbans. Since fisheries resources are currently the main livelihoods means understanding the linkage between forest attributes and fisheries productivity remains as one of the major research questions;

Water, soil, and vegetation characteristics of the Sundarbans influence mud crab distribution in respect to number, size, sex etc. but severe harvesting pressure on female mud crabs is evident in all ranges of the forest.

## Key Recommendations

In coastal area where the pond condition is suboptimal to allow for appropriate food web development, use of plant-based fish diet fortified with synthetic L-lysine is recommended instead of unsustainable fish meal-based diets to ensure sustainable aquaculture;

Determine the maximum amount of leaf litters that would not affect shrimp growth and to understand the long-term impacts of leaf litter on water quality and shrimp performance in extensive coastal aquaculture system;

Studies dealing with efficacy different combination and composition of bacterial isolates from local environment and inclusion of various prebiotics including growth promoters and immune boosters are necessary;

Livelihoods from the Sundarbans come overwhelmingly from its fisheries resources and, therefore, understanding the linkage between forest attributes and fisheries productivity is necessary to determine governance mechanism that can best safeguard equitable access and sustainable resource management;

To promote healthy mangroves, thriving coastal communities and robust aquaculture value chain in the Sundarbans integrated mangrove aquaculture (IMA) model should be adopted after piloting in different field contexts.







## Thematic Session

**3**



## Panel Discussion on Ecosystem Approach Linking Coastal Livelihoods and Biodiversity Conservation

Management of fish and other aquatic resources of the Sundarbans mangrove forest will result in more resilient ecosystems with greater biodiversity of forest and fisheries resources, which would ultimately help sustain livelihoods of the forest dependent community. Panelists in this session answered to the questions raised from the audiences while also discussed issues related to tradeoffs between coastal livelihoods and biodiversity conservation and the ways to find a right balance. Moderated by Panchanon Kumar Dhali (GIZ), the panelists included Dr. Nazmul Ahsan (KU), Dr. Nora Devoe (ACIAR), Dr. Stefan Groenewold (GIZ), Mr. Stefan Holler (GNF) and Dr. Elke Hellstern (KfW).



A number of key questions were raised when addressing ecosystem approach linking coastal livelihoods and biodiversity conservation in the coastal areas adjacent to the Sundarbans since human activities affect the ecosystem in various ways. To what extent the coastal ecosystem has already been degraded and how many people are affected by ecosystem degradation? Is it possible to directly attribute the loss of livelihoods to mangrove degradation? Shrimp aquaculture is often blamed but how about upstream activities detrimental to coastal ecosystem such as industrial pollution, pesticides, plastics and finally what would be the best approach to reconcile food security and biodiversity objectives.

Agricultural runoffs containing residual pesticides and/or their degraded products remain a real challenge to aquatic biodiversity as these may hamper development of endocrine glands with dire consequence on the reproductive potentiality. Interestingly, in controlled studies it was found that the degradation products of agricultural

pesticides; are more harmful than the parent molecules and therefore it was suggested that research should be focused not only on effects and withdrawal periods of pesticides but their degradation products as well. The same holds true for microplastic pollution and it was unanimously discussed that urgent measures should be undertaken to minimize indiscriminate use of plastics, particularly single-use plastics as these also was found to affect fish gonadal development.

With regard to ecosystem-based farming, it was discussed and agreed upon that the decision whether rice farming needs to be promoted to avoid further salinity intrusion should be based upon a thorough understanding of the dynamics of soil and water quality in the coastal area as the change in tidal river administration (polderization) has also changed the salinity regime and there are some areas where the level of salinity is too high to be suitable for rice. In such case, IMA can be a sustainable approach where mangrove integration was found to increase the shrimp productivity while also providing other ecosystem benefits to the wider coastal community. However, further studies are necessary to determine the optimum tree composition and tree cover based on canopy cover, leaf decomposition and effect of shade on pond productivity.

Unlike past, fishing and aquaculture remain the only economic activities in altered coastal landscape due to past anthropological and recent climate-induced changes. And this creates a number of sustainability concerns such as more intensified and diversified fisheries resource extraction, recurrent disease in shrimp hatchery and almost complete shutdown of prawn hatchery putting more pressure on wild harvest of seeds. Thus, the pressing question remains how to sustain community livelihoods while maintaining a healthy ecosystem and a rich biodiversity? Organizations and academia working in isolation on forestry, fisheries and biodiversity should converge on a triple bottom line – ecosystem, social and economic sustainability – and generate empirical data and bring community onboard to devise mechanisms for shared accountability and joint action.

### **Key Recommendations**

Conduct a comprehensive assessment of the extent and impact of coastal ecosystem degradation on the livelihoods and well-being of the local communities, especially those dependent on mangrove resources;

Identify and address the root causes of mangrove degradation, such as shrimp aquaculture, industrial pollution, agricultural runoffs, and plastic waste, and implement appropriate mitigation and adaptation measures to reduce their negative effects on the coastal ecosystem and biodiversity;

Diversify the species composition of mangrove plantations to increase their resilience to pests, diseases and climate change impacts. This can also improve the habitat quality and diversity of wildlife, fish and other estuarine and marine fauna;

Integrate mangrove afforestation with other climate-resilient livelihood options such as bee keeping, floating vegetable gardens and fish cultivation. This can provide additional income and food security for the coastal communities while reducing their dependence on mangrove resources;

Promote ecosystem-based farming practices that are compatible with the salinity regime and soil and water quality of the coastal area, such as salt-tolerant rice varieties, IMA, or agroforestry;

Enhance the awareness and participation of the local communities and strengthen the coordination and collaboration among different stakeholders to ensure a holistic and integrated approach to linking coastal livelihoods and biodiversity conservation in the Sundarbans region.











# Thematic Session

4

## Vulnerability Context and Coping Strategy of Coastal Community against Climate Change

Chaired by Dr. Stefan Alfred Groenewold from GIZ and co-chaired by Dr. Masagus M Prima Putra from Indonesia, this session aimed to explore the challenges and opportunities of coastal landscape transformation due to human and climate factors and how coastal communities are adapting to these changes. The session started with a keynote lecture on tidal river management as a viable strategy for enhancing climate resilience and continued with eight presentations that addressed various aspects of climate change impacts and community responses such as locally-led adaptations practices through multi-stakeholder engagement, blue carbon trading through mangrove restoration, livelihood diversification through beekeeping in mangrove forests, native tree planting for multiple benefits for communities and ecosystems, women and youth involvement in mangrove restoration and conservation initiatives and marine spatial planning for integrated and harmonized coastal land use.

### Plenary Lecture



In his plenary lecture entitled, "Is tidal river management a viable tool for climate resilience in the lower Bengal Delta?" Prof Dilip Kumar Datta from Environmental Science Discipline, KU provided a vivid description of lower Bengal Delta (LBD) formation through a geological time journey and described how this deltaic setting is generally vulnerable to lateral channel migration and the resultant river bank collapse along with a number of anthropogenic and geogenic hazards. Briefly, the LBD attained its morphometrics during 10 to 11 ka BP and was aggregational until at least 7.5 ka BP followed by the process of progradation since 5 ka BP through phased overlapping of sediments during tidal cycles and was maintained by bio-tidal accretional processes. Although land reclamation started during 13th century by the then land lords at community level, it was 1960s and onward that a highly top-down engineering solution dramatically altered the coastal landscape. Earthen embankments, known as polder, were built along the entire coastal districts to reclaim lands for settlement and agriculture with inevitable consequence including sediment deposition outside and saline waterlogging inside the embanked areas. Suffering from a prolonged drainage congestion and waterlogging, the community of Beel Bhaina in Khulna district came up with a solution that allow accretion of sediment-starving tidal floodplains and temporal decline in ambient salinity of coastal regime, known as Tidal River Management (TRM). This approach was also found to dispense sediments from river bed creating opportunities for fish and other aquatic organisms to thrive. While TRM appeared to be a viable nature-based solution to restore tidal river dynamics, up and out scaling of this requires a site-specific detailed appraisal with regard to societal, technical, environmental, financial and institutional sustainability aspects.

## Contributed Papers



The first presentation of this session by Thies Geertz from GNF and Sourav Bagchi Ratul from BEDS dealt with a multistakeholder approach to promoting locally-led adaptations practices and sustainable livelihood options for improving the resilience of the coastal communities in South Asia. Sharing some locally-led best practices such as solar lamps for fishing community in Sri Lanka and IMA in Bangladesh and India the presentation proceeded on to provide insights on major social and environmental problems encountered by the coastal community throughout the year and proposed a model for solution that includes training the villagers, developing their knowledge about climate change, adopting livelihood practices to suit the changing climate conditions and presenting climate resilient designs on mangrove restoration and repair. The authors also shared their current climate resilient project activities in one fishermen village and one ethnic Munda community village in southwest coastal district, Satkhira, Bangladesh. The activities included community-based ecological mangrove restoration, rain water harvesting, establishment of solar energy system, IMA, homestead farming as identified by the local community to increase climate resilience and maintain livelihoods. Additionally, the project also constructed a versatile cyclone center that serves as a school and as a climate information hub with provision to celebrate local cultural events of fishermen and Munda communities.

The Nature Conservancy (TNC) is a non-profit organization dedicated to protecting and preserving nature. Zena Good elaborated on the mission, programs and activities of TNC with particular emphasis on mangrove rehabilitation project in Papua New Guinea. Their primary focus is on conserving the lands and waters that sustain all life, with a particular emphasis on sustainable livelihoods, food security, mangrove rehabilitation, learning hubs, blue carbon and empowering women. In Dogura, 3.1 ha mangrove forest has been lost due mainly to blood worm harvesting and felling trees for firewood. Taking this as a pilot case, Dogura Mangrove Rehabilitation Project successfully planted 3,500 seedlings with about 90% survival rate. Future activities include measuring carbon stock, managing the resource for the community and linking the community to the market.



Kazi Amdadul Hoque from Friendship NGO presented a case study on how afforestation of mangroves can contribute to a sustainable solution for climate resilience in Bangladesh. The project involved training and engaging local communities in planting and taking care of the planted mangrove trees, which provided additional incomes through bee keeping, honey collection, crab and shrimp farming. The project was implemented in Asashuni and Shyamnagar of Satkhira, where monitoring and evaluation were essential components of the mangrove reforestation process. The project demonstrated that mangrove

afforestation can be an effective and sustainable solution for climate resilience in Bangladesh, with the help of Friendship's integrated adaptation solution that brings together all stakeholders to protect and gain new skills and capacities for the local community.



Dr. Samaddrita Roy from One Tree Planted (OTP) gave a presentation on their journey towards a climate resilient shoreline and their mission is to reforest the world. OTP is an official partner of the United Nations Decade on Ecosystem Restoration 2021-2030 and operates in 47 countries, with their reforestation efforts based on six sustainability pillars: air, water, biodiversity, social impact, health and climate. OTP works with vetted planting partners to ensure quality projects, from seedling to mature tree, and employs strategies such as planting native tree species, community-led knowledge, and quality monitoring and maintenance to achieve over 80% survival rate. Considering mangroves immense ecosystem services including shoreline protection from sea level rise and natural calamities, superior carbon sequestering ability, biodiversity enhancement and various provisioning services for livelihoods, OTP has funded 22 projects in 9 countries, planted about 3 million mangrove trees and engaged in various forms of monitoring to sustain the efforts. Sharing OTP's current and future plantation activities across the globe including Bangladesh, Dr. Roy concluded her presentation with a call for concerted action towards working together to restore degraded habitats and to build climate resilient community.

The Center for Research on New International Economic Order (CRenIEO) led by Dr. Devadhasan Vincent from India showcased a case study on how aquaculture can be a sustainable solution to the development agenda of women empowerment. As part of Building a transnational, civil society partnership to increase the resilience of coastal populations in South Asia, the focus of the case study was Women Empowerment by demonstration of mangrove associated brackish water aquaculture of Asian seabass (*Lates calcarifer*) and green mud crab (*Scylla serrata*) in land-based farms. The presentation highlighted the project's emphasis on environmental and biological monitoring, stakeholder involvement, training programs and innovative methods to safeguard coastal ecosystems, including the participation of civil society organizations. The beneficiaries were trained to collect and maintain data regularly during the culture period. He mentioned the main achievements of their work include an increase in biodiversity, community development and eco-friendly mode of aquaculture. However, Dr. Vincent also discussed the hurdles faced by the community people, including the death of sub-adult crabs due to sudden changes in salinity caused by continuous rains, as well as due to lack of anticipated cooperation from the forest officials.



The impact of the Bangladeshi youth-led climate movement on coastal communities was the topic of deliberation by Sohanur Rahman from YouthNet for Climate Justice, focusing





on empowering the next generation. He discussed the organization's background, including its vision, mission and goals, which aim to empower and mobilize young people to take climate action and promote justice, equity and inclusivity. Mr. Rahman presented some images depicting how young people are responding to the needs of the climatically stressed coastal community including rescuing flood-affected people, disaster relief distribution, canal excavation, mangrove restoration and preventing plastic pollution. Mr. Rahman explained their working strategies, interventions and achievements, including the establishment of the Coastal Youth Action Hub (CYAH), which provides a space for co-creation, knowledge management and access to resources that enabled YouthNet to ensure participation in COP 26 and COP 27. Mr. Rahman concluded his presentation with recommendations for national and global climate policies, youth participation and accountability, climate literacy and investment in young-led climate interventions and education.

Dr. Muhammad Abdur Rouf from Khulna University discussed the necessity of adoption of coastal and marine spatial planning (CMSP) in Bangladesh and highlighted the related management issues and capacity development needs. He described the coverage of the coastal and marine areas in Bangladesh with the living and non-living resources providing various ecosystem services. Dr. Rouf identified management issues in various fields like fisheries, mangrove forests, environment, tourism, land and industry and enlisted different ministries and agencies of the government that deal with these issues. He also mentioned how Khulna University and other universities in Bangladesh are working towards identifying and finding solutions to the challenges of CMSP. Besides, he emphasized the importance of integrating the CMSP framework within the SDGs framework and briefly discussed seven phases of CMSP. Finally, with a brief introduction to scientific capacity building in assessing the coastal dynamics including the influence of climate change in the coastal zone, Dr. Rouf mentioned that the Coastal and Marine Science (CMS) branch of FMRT Discipline at Khulna University has been offering masters and PhD degree, the output of which might of relevance towards adopting a country-specific MSP Framework in near future.



In the final deliberation of this session, Dr. Adi Gangga from Jakarta, Indonesia presented a case study on the role of mangrove ecosystems in mitigating climate change in Berau. He highlighted the importance of mangroves for climate change mitigation, as well as their significance for local subsistence. He noted that land cover conversion contributes to greenhouse gas (GHG) emissions, while avoiding mangrove degradation and restoring mangrove habitats can help reduce emissions and support Indonesia's climate commitment. However, there is a lack of knowledge on carbon dynamics in intact and degraded mangroves. Dr. Gangga considered three types of land covers in his study including

secondary mangrove, restored mangrove and aquaculture practices. The findings showed that the highest GHG flux was observed in the secondary mangroves than in other two land covers compared to restored mangroves and aquaculture sites. While the restored mangrove had the highest CO<sub>2</sub> flux the secondary mangrove appeared to be the major CH<sub>4</sub> emitter. On the other hand, the aquaculture site had the least GHG emission due to limited carbon storage. Dr. Gangga concluded his presentation with a recommendation to measure GHG fluxes and assess carbon stock from different areas having different land covers and mangrove systems.

### **Major Findings:**

Top down structural interventions delimited the distribution of river sediments in the coastal tidal floodplain of the LBD resulting in severe saline water logging problem over time. Among many nature-based solutions TRM appeared to be the most successful community driven approach to reduce the effects of waterlogging and sediment starvation of the floodplain;

Multi-stakeholder approach has been shown to be necessary to promoting locally-led adaptations practices and sustainable livelihood options for improving the resilience of the coastal communities in Bangladesh and other South Asian countries;

In addition to awareness raising and capacity building, linking local community with additional income generating activities such as bee keeping, honey collection, crab and shrimp farming acts as a catalyst for successful mangrove afforestation and sustainable solution for climate resilience;

Key elements to successful afforestation projects funded by external donors are selecting partner organizations at the community level and employing various strategies such as using indigenous community knowledge into project design and implementation, planting mangroves and native tree species, quality monitoring and regular maintenance;

Youth-led climate movement is effective in responding to the needs of the climatically stressed coastal community including rescuing flood-affected people, disaster relief distribution, canal excavation, mangrove restoration and preventing plastic pollution;

Bangladesh needs to catch up with other maritime nations in CMSP, a complex and universal concept that requires various skills and knowledge. The country has experts in universities who can collaborate with international partners to develop a suitable CMSP in the future;

Carbon dynamics differ among different land covers. Total GHG emissions in secondary mangrove site is higher than restored mangrove and aquaculture sites. Aquaculture has the least GHG emission due to limited carbon storage.

## Key Recommendations

Multi-stakeholder approaches involving local authorities, NGOs, academics and policy makers should be followed for promoting locally-led adaptations practices towards a climate resilient coastal community;

TRM can improve climate resilience in the LBD, but a thorough evaluation of its sustainability across societal, technical, financial, environmental and institutional factors is necessary for sustainable implementation;

Mangrove afforestation can enhance climate resilience and provide multiple benefits. It should be linked with carbon trading, resource management, market access, and alternative income trainings for better community participation and ownership;

Bangladesh needs a robust CMSP to benefit from the new maritime boundary. Since the concept of CMSP is subject to multiple interpretations and sectoral conflicts efforts should be made to assess the ecosystem service of the coast and the ocean with a particular focus on the Sundarbans mangrove forest on a priority basis.









1 - 3 March, 2023

## Thematic Session

5

## Inclusive and Equitable Market and Value Chains Development

This was the final scientific session of this International Symposium, which was chaired by Ajanta Dey from Nature Environment and Wildlife Society and Dr. Vinita Apte from TERRE Policy Centre. Researchers and practitioners presented their activities and findings on topics related to inclusive and equitable market and value chains development in aquaculture and fisheries sub-sector involving forest dependent coastal farming community. The plenary lecture of this session highlighted the risks of climate change to coastal aquaculture and the significance of linking salt producers and aquaculture farmers with Artemia initiatives to boost productivity. To the continuation of this session, community-based ecotourism (CBET), mangrove afforestation, quality assessment of fermented fish products, replacement of fish meal in aquafeed and ecosystems services of mangroves in relation to gender were presented with recommendations including value chain development for local Artemia cyst production, establishment of ecovillages through CBET, planting Keora as the priority species for mangrove afforestation, and using lactic acid bacteria to improve the fermented fish products by combating histamine producing bacteria.

### Plenary Lecture



This session started with a plenary lecture titled “Climate smart Artemia pond culture in Bangladesh” presented by Dr. Muhammad Meezanur Rahman from WorldFish. With a brief on the potential hazards that climate change poses to coastal aquaculture, Dr. Rahman discussed about enhancing agriculture and food systems by engaging salt producers with innovative Artemia culture technology. As one of the crucial live foods at the early life stages of fish, shrimp and other farmed aquatic animals the importance of Artemia-which is currently being sourced from overseas-cannot be over emphasized. With 53% protein content Artemia is rich in all essential amino acids and polyunsaturated fatty acids, which was found to increase spawn frequency and nauplii count in domesticated shrimp. Interestingly, the superior nutritional quality of Artemia make it amenable to human consumption as well in various forms and thus provides another avenue for income generation while ensuring food and nutrition security of the population. Dr. Rahman explained how climate-induced threats such as temperature fluctuations and natural disasters affect salt production and consequently Artemia production in southeast salt panes. On the other hand, the absence of Artemia biomass processing and preservation facilities coupled with extended transportation to the aquaculture sites in the southwest contributes to mortality and loss of quality. To address this, efforts should be made to promote Artemia pond culture and establish its marketing facilities and network

throughout Bangladesh, which can improve coastal aquaculture production by utilizing locally produced *Artemia* cyst and biomass in one hand while, on the other hand, this can greatly contribute to combat malnutrition and boost the income of both shrimp and salt farmers.

### Contributed Papers



A conceptual framework that highlights the use of community-based ecotourism (CBET) to develop coastal livelihoods and conservation efforts in Bangladesh was presented by Prof. Wasiul Islam from Forestry and Wood Technology Discipline of Khulna University. He described the concept of ecovillage as a community-led initiative to address social, economic and environmental issues that serves as a learning center for a sustainable future and promotes social innovation. Ecovillages are designed by the local community and aim to harmonize the relationship between humans and nature to improve overall living standards. The principles practiced by an ecovillage include keeping the environment free from pollution, using the natural resources sustainably and prioritizing the environment over profit. The focus is on building a resilient local community through improved natural resource management, enhancing governance competitiveness and increasing community benefits. Creating an ecovillage can provide many job opportunities for rural residents, leading to an improved lifestyle. The ecovillage concept through CBET can directly contribute to healthy mangroves, sustainable fisheries and climate resilient coastal community development. Dr. Islam finished his deliberation with a concluding remark that the CBET is an iterative and adaptive process that requires partnership among a wide variety of stakeholders with a community-focused business plan grounded on three core sustainability pillars: green business, community development and biodiversity conservation.

Anusree Ghosh from BRAC's Climate Change Program gave a presentation titled "The trial and error of mangrove plantation in a reclaimed land." On the river mouth of the Feni River to the Bay of Bengal, BRAC initiated mangrove afforestation on a 54.5 acre piece of reclaimed land in Mirsarai, Chattogram in August 2021 for climate mitigation and economic benefits of COVID-19 vulnerable communities. The presentation included preliminary results on mangrove species survivability. Mangroves saplings were collected from nurseries and the management included soil and water salinity test, irrigation, application of cow dung, cultivation of Dainchha (*Sesbania bispinosa*) and no grass removal. Following 18 months plantation, it was found that 90-98% of the Pashur, Kakra, Sundari and Goran saplings survived while the survivability of Gewa and Baen was 65 and 55%, respectively but negligible (3%) for Keora saplings. Interestingly, Keora, Baen and Gewa are the most commonly planted mangrove species for afforestation with better survivability rates elsewhere. The author concluded that mangrove plantation in the reclaimed land is expected to provide a habitat for increased biodiversity while



contributing towards climate mitigation through atmospheric carbon sequestration in the planted mangrove biomass.



The fishermen community of the coastal districts of Indonesia derive part of their livelihood incomes from activities related to fermented fish product processing and marketing. Dr. Masagus Muhammad Prima Putra from Indonesia shared his research results summarizing the problem of fish fermentation and a potential solution thereof. In Indonesia, fishermen produce various fermented fish products from scombroid fish such as tuna, skipjack and similar other fish. This type of fish allows for formation of histamine that often causes intoxication. The author found that lactic acid bacteria (LAB) produce compounds that can combat histamine-producing bacteria. After characterizing 187 potential LAB isolates, Dr. Putra successfully isolated *Weisella* sp. as a candidate to be used as a bacterial starter. Antibacterial tests showed that the bacteriocin produced by the isolated *Weisella* sp. was able to inhibit the growth of *Staphylococcus aureus*, *Salmonella* sp. and *Citrobacter freundii*, and that the bacteriocin was stable at various temperatures. Preparation of fermented fish products in presence of *Weisella* sp and determination of its effect on histamine production and other quality attributes of fermented products were planned for further investigation.

Dr. Sheikh Julfikar Hossain from Khulna University talked about the health benefits of fruits from the mangrove tree *Sonneratia apetala*, locally known as Keora. The fruit is popularly consumed by people living in the coastal villages around the Sundarbans. It is mostly consumed either by cooking with other food items or as a condiment after processing to produce pickles and at times the raw juice is taken to treat diarrheal ailments. It is widely believed that the fruit contains various nutritional compounds that contribute to its nutraceutical and pharmacological properties although empirical data supporting this hypothesis are lacking. The study involved collecting fruit samples from the Sundarbans, separating the pericarp and seed, drying and pulverizing them into fine powder and extracting substances to determine various nutraceutical and pharmacological properties of the fruit. It was found that the fruit contained various active compounds, polyphenols, flavonoids, anthocyanins, vitamin C and antioxidants while the fruit extracts showed antioxidant, anti-diabetic, antibacterial, hepatoprotective, inhibition of elastase induce lung injury, anti-aging, anti-diarrheal, and analgesic properties in various in vitro and in vivo tests. Gallic acid, catechin, caffeic acid, epicatechin, ellagic acid, and quercetin were the major polyphenols in methanol fraction of the Keora seed whereas linoleic acid, palmitic acid, ascorbyl palmitate, and stearic acid comprised 85% of n-hexane fraction of the seed. These results suggest that the mangrove fruit offers tremendous potential for the development of functional foods and dietary supplements. Hence, efforts should be made to conduct further studies and establish appropriate value chain for such products linking coastal community to the wider market system.







There is a dearth of knowledge on ecosystem services and gender relations among the Sundarbans dependent communities in the coastal polders of Bangladesh. To this effect, Md. Siddikur Rahman from Solidaridad presented a paper that aimed to assess local people's perception of the ecosystem services of mangroves in relation to gender ;and socioeconomic status. Data were collected through semi-structured interviews with male and female mangrove resource collectors in three socioeconomically contrasting upazillas (sub-district) belonging to three southwest coastal districts. The study found that both men and women in the Sundarbans area depend on the forest seasonally and have similar perceptions of its importance. However, preferences, collection quantities and value of per unit mangrove resources/services differ between men and women and among the socioeconomically contrasting areas with increasing distance from the Sundarbans. Thus, Mr. Rahman recommended that gender should be taken into account when valuing ecosystem services and protecting mangrove forests, especially in the Sundarbans and that appropriate policy and fiscal supports should be devised for women and other resource poor sections of the forest dependent community.

Fishmeal is the single most cost limiting factor for the sustainable development aquaculture in Bangladesh and maggot meal could provide an ideal solution to this problem. This was the topic of the presentation by Dr. Md. Shah Alam Sarker from Bangladesh Open University where, citing research results from rainbow trout *Oncorhynchus mykiss*, he discussed how maggot meal could be used as a substitute for fish meal in the diets of fish. Maggot meal is a relatively new approach to using insects in fish nutrition and is produced from the semitransparent larval stage of the house fly worm, *Musca domestica*. After feeding maggot meal to rainbow trout for 12 weeks, Dr. Sarker found that the nutritional composition of the fish improved and that maggot meal can be used as a total replacement for fish meal in practical diets for rainbow trout, as there were no significant differences in the measured parameters.



## Major Findings

Instead of importing, Artemia can be grown in salt panes instead of imported. The cultured Artemia was rich in all essential amino acids and polyunsaturated fatty acids, and was found to increase spawn frequency and nauplii count in domesticated shrimp hatchery. The superior nutritional quality of Artemia make it amenable to human consumption as well providing another avenue for income generation by impoverished coastal community while contributing to aquaculture sub-sector sustainability;

Ecovillage as a CBET initiative has the potential to harmonize the relationship between humans and nature to improve overall living standards through utilizing the natural resources sustainably and prioritizing the environment over profit;

*Weisella* sp., a Lactic acid bacterium can prevent histamine production in fermented fish products made from scombroid fish, a problem encountered by coastal fishermen community;

Mangrove fruit Keora contains various nutraceutical and pharmacological properties making this fruit as a potential raw material for the development of functional foods and dietary supplements that could incentivize coastal community to protect and promote mangroves;

Preferences, collection quantities and value of per unit mangrove resources differ between men and women and among different socioeconomic strata in the coastal districts of Bangladesh;

Maggot meal can be used as a total replacement for environmentally unsustainable and highly cost-prohibitive fish meal in practical diets for fish.

### Key Recommendations

Pond culture of *Artemia* and establishment of its marketing facilities should be ensured to improve coastal aquaculture production and to boost the income of both shrimp and salt farmers;

CBET is an iterative and adaptive process that requires partnership among a wide variety of stakeholders with a community-focused business plan grounded on three core sustainability pillars: green business, community development and biodiversity conservation;

Preparation of fermented fish products in presence of *Weisella* sp and determination of its effect on histamine production and other quality attributes of fermented products were planned for further investigation;

The mangrove fruit offers tremendous potential for the development of functional foods and dietary supplements. Hence, efforts should be made to conduct further studies and establish appropriate value chain for such products linking coastal community to the wider market system;

Gender should be taken into account when valuing ecosystem services and protecting mangrove forests, especially in the Sundarbans and that appropriate policy and fiscal supports should be devised for women and other resource poor sections of the forest dependent community;

Maggot meal can be used as a total replacement for fish meal in practical diets for rainbow trout, as there were no significant differences in the measured parameters.







## Thematic Session

6



## Panel Discussion on Policy Options for Climate Resilient Coastal Food System in South Asia

Climate change poses a serious threat to the food security and livelihoods of millions of people living in coastal areas of South Asia who depend on agriculture, fisheries, and aquaculture. Rising sea levels, saltwater intrusion, extreme weather events, and changes in fish stocks in the Sundarbans are some of the challenges that coastal communities of Bangladesh face. To cope with these challenges, there is a need for climate resilient coastal food systems that can adapt to the changing conditions and reduce the vulnerability of the people. To address these challenges, there is a need for policy interventions that can enhance the resilience and adaptation capacity of the coastal food system. Panelists in this session explored the current state of knowledge and practice on climate resilient coastal food system in south Asia, and identified the key policy options and recommendations for different stakeholders. The session was moderated by Prof. Nazmul Ahsan (KU), and featured the following panelists: Mr. Rana Mohammad Sohail (Member of Parliament, Bangladesh), Mr. Moin Uddin Ahmed (Solidaridad Network Asia), Prof. Wasiul Islam (KU) and Ms. KM Reyes (OTP).



South Asia is home to more than 1.8 billion people, many of whom depend on agriculture, fisheries and aquaculture for their food and income. However, these sectors are highly vulnerable to the impacts of climate change, such as rising sea levels, saltwater intrusion, cyclones, floods, droughts and heat waves. These impacts can reduce crop yields, damage infrastructure, disrupt supply chains and increase the risk of pests and diseases. Therefore, it is necessary to build a climate resilient coastal food system that can

maintain or enhance its productivity, diversity and quality under changing climatic conditions, while not exhausting the natural resource base as has been the case with the Sundarbans and its fisheries resources in Bangladesh and India.

Science-based management of fish and other aquatic resources of the Sundarbans mangrove forest and nature-based solutions to coastal aquaculture such as IMA will result in a climate resilient food system contributing to social and economic development by enhancing food security, nutrition, income and livelihood opportunities for the coastal communities. However, there are many challenges to achieving a climate resilient coastal food system in Bangladesh and other South Asian countries. Some of these challenges include:

Lack of adequate data and information on climate risks and vulnerabilities of the coastal food system and its stakeholders.

Limited access to finance, technology, innovation and knowledge for climate smart aquaculture and agriculture in the coastal area.

Weak institutional capacity and coordination among different actors and sectors involved in the development of coastal area.

Low awareness and participation of local communities, especially women and marginalized groups, in climate action and decision-making.

Policies and regulations do not often take climate considerations into the development decision and are highly shortsighted and sector-specific lacking the integration of long-term multidisciplinary outcomes.

## Key Recommendations

To overcome the above-mentioned challenges, the panelists urged to adopt a holistic and participatory approach that involves all relevant stakeholders in the planning, implementation and monitoring to build a climate resilient coastal food system that can ensure food security, nutrition, income and livelihoods for its people while contributing to global efforts to combat climate change. Some of the key policy options and recommendations to this goal are:

Adopt integrated coastal zone management (ICZM) within the broader scope of CMSP that balances the social, economic, and environmental aspects of coastal development and conservation;

Address water security issues. Agricultural product-oriented farmers' groups with realistic market instruments has the potential to offer an in-built sustainability mechanism for sustainable water management;

Develop value chains to diversify coastal livelihoods and income sources. Mainstreaming mangrove-based products through on line and off line means could be an interesting avenue to explore with market-focused research and piloting;

Invest in climate-smart infrastructure and technologies that can improve the productivity and efficiency of coastal food systems, such as water-saving irrigation, renewable energy, cold storage, and post-harvest facilities;

Enhance the capacity of coastal communities to cope with disasters and climate shocks, such as early warning systems, disaster risk reduction plans, social protection schemes, and climate insurance;

Strengthen the governance and institutional arrangements for coastal food systems, such as participatory planning, stakeholder coordination, cross-sectoral collaboration, and policy coherence.









# Poster Session



The symposium featured 99 posters that were exhibited at a special venue for two days. The titles, authors and affiliations of the posters are listed in Annex II. The posters covered various topics of research and were presented by young students and scientists from different universities and professional organizations. They aimed to provide a concise overview of their research goals, methods, findings and implications, and to offer a brief oral explanation to the interested audience. The poster session was an excellent platform for the young researchers to display their work, interact with potential partners and get feedback from peers and experts. A panel of five distinguished scientists from different countries evaluated the posters based on the content quality, the presentation style and the communication clarity. The poster competition winners were announced and rewarded at a closing ceremony after the end of the scientific sessions on the last day of the symposium.

Some of the topics of research that were showcased in the posters included: climate change and its impacts on ecosystems and biodiversity, impact of salinity intrusion and water logging, vulnerability context and coping strategy of coastal communities against climate and man-made changes, sustainable aquaculture technologies, environmental pollution affecting the aquatic animal health in the Sundarbans mangrove forest, disease diagnosis of fish and shrimp, mud crab hatchery operation, fish product development and market linkage, among others. The posters were organized into thematic clusters according to their main research area, and a designated moderator facilitated the discussion and interaction among the presenters and the audience.

The poster session was well-attended by symposium participants as well as external visitors who were interested in learning more about the current research trends and challenges in sustainable coastal aquaculture. The presenters received constructive feedback and suggestions from the audience, as well as questions and comments that stimulated further discussion and debate. The poster session also provided an opportunity for networking and collaboration among researchers who shared similar interests or complementary expertise. Some of the presenters reported that they had established new contacts or initiated new projects as a result of their participation in the poster session.

The best poster competition was one of the highlights of the symposium, as it recognized and rewarded the outstanding work of the young researchers who had demonstrated excellence in their research content, presentation style and communication clarity. The panel of judges consisted of five eminent scientists who had extensive experience and knowledge in various fields of research. They evaluated each poster according to a set of criteria that included: originality and significance of the research question or problem, appropriateness and rigor of the research methods, validity and reliability of the research findings, relevance and implications of the research for theory or practice, clarity and coherence of the poster layout and design, effectiveness and confidence of the oral presentation, and responsiveness and engagement with the audience. The judges also

provided constructive feedback to each presenter on how to improve their poster or presentation in the future. The poster competition winners were announced and awarded on the final day of the symposium during the closing ceremony.

The poster session was a successful and enriching component of the symposium that showcased the diversity and quality of research conducted by young students and scientists from different countries and disciplines. It also fostered a culture of exchange, collaboration and innovation among the research community.











# Closing Session



A closing session on Day 2 of the International Symposium consisted of session summaries, recap and reflections on the events and interactions, appreciation of the session chairs, declaration of best poster presenters followed by concluding remarks and vote of thanks. Presided over by Head, FMRT Discipline, Khulna University the concluding session was attended by the Chief Conservator of Forests (CCF), BFD as the Special Guest and honorable Vice Chancellor of Khulna University as the Chief Guest.

In his opening speech, Dr. Md. Nazmul Ahsan, Professor, FMRT Discipline, Khulna University provided an overview on the session topics and presentations and informed the participants that the session summaries and key messages would be compiled and condensed into a detailed report format for wider distribution. Reflecting on overall session plans Prof. Ahsan expressed his profound satisfaction that the adaptive design assisted in conducting the sessions in an unprecedented schedule enabling the symposium speakers, panelists and participants to stay focused and interested that resulted in the Symposium being one of the most memorable and contributing learning, sharing, networking event for Khulna University. He noted that the symposium was a valuable opportunity to exchange and discuss information on various aspects of coastal ecosystem and hoped that the symposium would inspire further development activities and collaborations among the participants.

Following the opening speech, Dr. Marc Verdegem from Wageningen University, Netherlands announced the best poster winners on behalf of the panel of five independent judges who evaluated the posters as to the content, style and presentations. He praised the poster presenters for their innovative and original research ideas and their effective communication skills. Dr. Verdegem said that he was impressed by the level of enthusiasm and creativity shown by the young researchers and concluded his speech by congratulating the winners and encouraging them to pursue their research goals.

The winners received certificates of recognition, crests as well as cash prizes as token of appreciations. The first prize went to a poster titled "Effect of Microplastics on Phenotypic Traits and Enzyme Activities in Guppy (*Poecilia reticulata*)", presented by a master's student from FMRT Discipline, KU. The second prize went to a poster titled "Biochar as a Potential Soil Conditioner in Saline Prone Coastal Area of Bangladesh", presented by a PhD student from Soil, Water & Environment Discipline, KU. The third prize went to a poster titled "Effects of Plastic Feeding and Predation on Reproductive Performance of Guppy (*Poecilia reticulata*)", presented by an undergraduate student from FMRT Discipline, KU. The judges also gave honorable mentions to two other posters that had scored highly in their evaluation.

Position	Name of the Awardee	Title of The Poster
1st	Rani Akhter	Effect of Microplastics on Phenotypic Traits and Enzyme Activities in Guppy ( <i>Poecilia reticulata</i> )
2nd	Monowara Khatun	Biochar as a Potential Soil Conditioner in Saline Prone Coastal Area of Bangladesh
3rd	Amena Arefin Trisha	Effects of Plastic Feeding and Predation on Reproductive Performance of Guppy ( <i>Poecilia reticulata</i> )
4th	Nittyta Sarkar	Biodiversity assessment of fish species in relation to fishing gear in Rupsha River of Khulna district, Bangladesh)
5th	Nimatul Jannat	In Vitro Antibacterial Activity of Ethanolic Extract of Drumstick ( <i>Moringa olifera</i> ) Leaf Against Shrimp Pathogenic Bacteria <i>Vibrio parahaemolyticus</i>

#### SPEECH BY THE SPECIAL GUEST:

Thanking the organizers for arranging such a valuable symposium on the forestry-fisheries nexus of the Sundarbans ecosystem, Md. Amir Hossain Chowdhury, Chief Conservator of Forests (CCF), BFD, shared his personal experience of working in the Sundarbans for seven years and how he learned to appreciate its beauty and diversity. The CCF said that he was well aware of the complex and unique ecosystem of the Sundarbans, which includes the nexus of freshwater and saline water, the diverse mangrove species, the rich fisheries resources and the local community that depends on them. He stressed the importance of managing the Sundarbans in a way that reduces the pressure from human activities and protects its ecological balance. He stressed that the local community should be involved and participate in the conservation and management of the mangrove forest. Expressing his concern over the declining fisheries resource in the face of climate change, the CCF urged for more research, monitoring and collaboration among stakeholders to address these challenges and ensure the sustainability of this unique ecosystem. He concluded his speech by expressing his hope that the symposium outcome would generate new insights and recommendations for the betterment of the Sundarbans and its community.



#### **SPEECH BY THE CHIEF GUEST:**

The honorable Vice Chancellor of Khulna University delivered his speech as the Chief Guest of the closing session with an opening remark on how mangroves are vital for the survival and prosperity of coastal communities, as they provide habitats and food sources for fish and crabs. He emphasized that mangroves, fisheries and communities are linked in a linear chain that requires sustainability. He also discussed the historical significance of coastal areas as resource-rich regions that attracted human settlements and civilizations. He thanked the diverse group of participants from different parts of the world, who represented various stakeholders such as policymakers, managers and researchers, for attending the symposium and contributing to the dialogue. He highlighted that our research strategy places a high priority on studying the coastal ecosystem and its impact on the coastal community. Finally, the honorable VC expressed his appreciation to the organizing committee and students for their hard work and dedication in making the symposium a success.

The International Symposium came to a successful conclusion with a vote of thanks from Thies Geertz from GNF and a concluding remark by the Chair of the Organizing Committee, Prof. Dr. Md. Golam Sarower. They acknowledged the contributions of the participants who had come from various countries to share their expertise and perspectives on the topics of discussion and thanked the members of the organizing committee for their remarkable efforts in planning and executing such a valuable and informative event.





# Field Trip



The International Symposium on Healthy mangroves and sustainable Fisheries for Climate Resilient Coastal Community was a valuable learning experience for the participants, who gained insights into the ecological and socio-economic aspects of the mangrove ecosystems and their linkage to fisheries productivity in Coastal Bangladesh. The field trip to the Sundarbans area in the southwest coastal district, Khulna, was a highlight of the symposium, as it enabled the participants to witness first-hand the rich biodiversity and productivity of the mangrove habitats and their fishery resources.

The symposium participants who registered for the field trip visited several sites where they interacted with the local communities and learned about their livelihoods and practices related to the mangrove and fishery resources. The attendees visited the SAIME project's IMA pilot site run by BEDS, which is situated in Banishanta union of Dacope upazila (sub-district), Khulna. The site is located along the western bank of Dhangmari River, facing the Sundarbans on the eastern bank. The shrimp farms are outside the embankment and directly connected to the tidal river, making it an ideal location for testing IMA. The participants observed how shrimp farmers have adopted a more environmentally friendly and profitable approach by integrating mangrove trees into their ponds. They also met with women entrepreneurs who run mangrove nurseries and supply seedlings to the IMA farmers and other stakeholders. The participants appreciated the role of women in promoting mangrove conservation and restoration.

At the IMA center, the participants observed the community-based fish processing, packaging and marketing facilities that could improve the quality and value of the fishery products. They also learned about the challenges and opportunities faced by the shrimp farmers in accessing markets and complying with standards and regulations. The participants were impressed by the level of cooperation and coordination among the different actors involved in implementing IMA and thanked BEDS for conceptualization and construction of this Center in the form of IMA Farmers' Cooperative Building and Information and Education Center.

The participants visited the BANOJIBI (forest dependent community) campus as the last destination of the field trip. There, they observed various livelihood activities that rely on the mangrove resources, such as making pickles, processing honey, producing organic rice with wooden husking pedal, integrating agri-aqua-livestock farming, crafting handicrafts and promoting ecotourism. They also gained insights into the history and culture of the BANOJIBI people, who have a strong motivation to coexist with the mangrove forest. The participants commended the efforts of the BANOJIBI people in maintaining their traditional knowledge and practices while adapting to changing environmental and socio-economic conditions.

The field trip was a memorable and enriching experience for the participants, who expressed their gratitude to the organizers, facilitators and hosts for their hospitality and guidance. The participants also expressed their interest in applying some of the lessons learned from the field trip to their own contexts and sharing them with their colleagues and networks.











# **Annexure**



## ANNEX I: PROGRAM SCHEDULE

DAY 01 (01 March, 2023)

08.45 – 09.30	<b>REGISTRATION</b>
<b>INAUGURAL SESSION</b>	
09.30 – 10.45	<p><b>National Anthem of Bangladesh</b></p> <p><b><u>Welcome Address:</u></b></p> <p><b>Dr. Muhammad Abdur Rouf</b> Professor, Fisheries and Marine Resource Technology Discipline, Khulna University</p> <p><b><u>Address by the Special Guests:</u></b></p> <p><b>Dr. Abul Kalam Azad</b> Dean, Life Science School, Khulna University</p> <p><b>Md. Jahidul Kabir</b> Deputy Chief Conservator of Forests, Bangladesh Forest Department Ministry of Environment, Forest and Climate Change The People's Republic of Bangladesh</p> <p><b>Kh. Mahbubul Haque</b> Director General, Department of Fisheries Ministry of Fisheries and Livestock The People's Republic of Bangladesh</p> <p><b><u>Address by the Chief Guest:</u></b></p> <p><b>Dr. Mahmood Hossain</b> Vice-chancellor, Khulna University</p> <p><b><u>Symposium Keynote Speech:</u></b></p> <p><b>Norman C Duke</b> James Cook University TropWATER Centre, Queensland, Australia</p> <p><b><u>Speech by the Symposium Chair:</u></b></p> <p><b>Dr. Md. Golam Sarower</b> Head, FMRT Discipline, Khulna University</p>
10.45 – 11.30	<b>TEA BREAK</b>

## SCIENTIFIC SESSION 01: FOOD SECURITY, COASTAL AQUACULTURE AND TIDAL FOREST NEXUS

**Chair:** Dr. Dilip Kumar Datta  
Professor, ES Discipline, Khulna University

**Co-Chair:** Dr. Stefan Holler  
Naturland, Germany

11.30 – 11.45  
(15 min)

### Plenary Lecture:

Coastal Aquaculture and Mangrove Forest Nexus: State of Affairs and Future Research Needs.

Dr. Nazmul Ahsan, Professor, FMRT Discipline, Khulna University

### Contributed Papers

11.45 – 13.00  
(10 min for every presentation except first one)

The Association for Food Biodiversity

Ralph Dejas

Global Nature Fund, Germany

Phytoplankton Community Dynamics and their Environmental Drivers in an Estuarine Mangrove

Kashafad Bin Hafij

Department of Oceanography and Hydrography, BSMRMU

Contribution of Fine Root in Carbon Dynamics of the Sundarbans Mangroves Ecosystems, Bangladesh

Dr. Md. Kamruzzaman

FWT Discipline, KU

Potential Toxicity of Pesticides and its Transformation Products to Aquatic Organisms

Dr. Md. Golam Sarower

FMRT Discipline, KU

Plastic Pollution Affects Courtship Behavior, Phenotypes and Enzymatic Activities of male Guppy (*Poecilia reticulata*)

Dr. Sheikh Mustafizur Rahman

FMRT Discipline, KU

Biodiversity – The New Core Area of the Development Cooperation between Bangladesh and Germany.

Dr. Stefan Alfred Groenewold

GIZ, Dhaka, Bangladesh

13.00 – 14.00

**LUNCH BREAK**

## SCIENTIFIC SESSION 02: SUSTAINABLE AQUACULTURE AND FISHERIES IN SOUTH ASIA

**Chair:** Dr. Jayati Chourey

Executive Director, SasiWaters, India

**Co-Chair:** Dr. Muhammad Abdur Rouf

FMRT Discipline, Khulna University

14.00 – 14.15  
(15 min)

### Plenary Lecture:

Effect of Dietary Lysine Deficiency on Nile Tilapia *Oreochromis niloticus* Production in Fertilized Ponds.

Dr. Marc Verdegem, Wageningen University and Research, Netherlands

14.15 – 15.30  
(10 min for every presentation)

### Contributed Papers

Synergistic Effects of Mangrove Leaf Litter and Supplemental Feed on Water Quality, Growth and Survival of Shrimp (*Penaeus monodon*, Fabricius, 1798) Post Larvae

Dr. Md. Iftakharul Alam

DoF, Ministry of Fisheries and Livestock, Bangladesh

Effect of Indigenous Probiotics on *Vibrio* Propagation and Digestive Enzyme Activity in Black Tiger Shrimp (*Penaeus monodon*)

H M Rakibul Islam

Shrimp Research Station, BFRI

Global G.A.P. Aquaculture Standard: Certifying Safe and Responsible Farming around the World

Dr. Pham Viet Anh

Global G.A.P., Germany

Research for Development of Science to Improve Livelihoods in the Bangladesh Sundarbans: How can We Use?

Dr. Nora N. Devoe

ACIAR, Australia

Mud Crab Fisheries in the Sundarbans Mangrove Forest of Bangladesh: Emphasis on Crab habitat Distribution and Fishing Pattern.

Mst. Sharmin Nahar

Department of Fisheries and Marine Bioscience, JUST

Sustainable Aquaculture in Mangrove Ecosystem (SAIME) in Transboundary Sundarbans: A Climate Adaptive, Ecosystem-Based Approach Ensuring Livelihood Security of Coastal Communities.

Ralph Dejas  
Dr. Sarder Safiqul Islam  
Dr. Nemai Bera  
Dr. Stefan Holler

Global Nature Fund, Germany  
BEDS, Bangladesh  
NEWS, India  
Naturland, Germany



15.30 – 16.30	<b>SCIENTIFIC SESSION 03: PANEL DISCUSSION ON ECOSYSTEM APPROACH LINKING COASTAL LIVELIHOODS AND BIODIVERSITY CONSERVATION</b>  <b>Moderator:</b> Panchanon Kumar Dhali, GIZ, Dhaka, Bangladesh	
16.30 – 17.30	<b>POSTER SESSION</b>	
	<b>Chair:</b> Dr. Khandaker Anisul Huq FMRT Discipline, Khulna University	<b>Co-Chair:</b> Abul Farah Md. Hasanuzzaman FMRT Discipline, Khulna University

## DAY 02 (02 March, 2023)

09.00 – 10.30	POSTER SESSION		
	Chair: Dr. Khandaker Anisul Huq FMRT Discipline, Khulna University	Co-Chair: Abul Farah Md. Hasanuzzaman FMRT Discipline, Khulna University	
10.30 – 11.00	TEA BREAK		
SCIENTIFIC SESSION 01: VULNRABILITY CONTXT COPING STRATEGY OF COASTAL COMMUNITY AGAINST CLIMATE CHANGE			
Chair: Dr. Stefan Alfred Groenewold GIZ, Dhaka, Bangladesh		Co-Chair: Dr. Masagus Muhammad Prima Putra Universitas Gadjah Mada, Indonesia	
11.00 – 11.15 (15 min)	Plenary Lecture:  Is Tidal River Management a Viable Tool for Climate Resilience in the Lower Bengal Delta?  Dr. Dilip Kumar Datta, Professor, ES Discipline, Khulna University		
11.15 – 13.00 (10 min for every presentation)	Contributed Papers		
	Multi-stakeholder Approach for Promoting Locally-led Adaptations Practices and Sustainable Livelihood Options for Improving the Resilience of the Coastal Communities in South Asia: Approaches for Bangladesh	Thies Geertz Sourav Bagchi Ratul	Global Nature Fund, Germany BEDS, Bangladesh

	The Mangrove’s Afforestation Contributes an Integrated Adaptation Solution Implemented by Friendship Provides Sustainable Impact towards Climate Resilience in Bangladesh	Kazi Amdadul Hoque	Friendship NGO, Dhaka-1212, Bangladesh
	One Tree Planted Journey towards a Climate Resilient Shoreline	Dr. Samaddrita Roy	One Tree Planted, Asia Pacific
	Aquaculture Initiation Towards Women Empowerment	Dr. Devadhason Vincent	CReNIEO, Tamil Nadu
	Empowering the Next Generation: The Impact of the Bangladeshi Youth-Led Climate Movement on Coastal Communities	Sohanur Rahman	YouthNet for Climate Justice, Barishal
	Coastal and Marine Resources Management Issues and Capacity Development Needs for the Possible Adoption of Coastal and Marine Spatial Planning (CMSP) – Scenarios from Bangladesh and Thailand	Dr. Muhammad Abdur Rouf	FMRT Discipline, Khulna University
	What Mangrove Ecosystem Offer to Climate Change Mitigation: A Case Study in Berau, East Kalimantan	Dr. Adi Gangga	Yayasan Konservasi Alam Nusantara, Jakarta, Indonesia
13.00 – 14.00	LUNCH BREAK		
SCIENTIFIC SESSION 02: INCLUSIVE AND EQUITABLE MARKET AND VALUE CHAINS DEVELOPMENT			
Chair: Ajanta Dey Nature Environment and Wildlife Society, India		Co-Chair: Dr. Vinita Apte Founder Director, TERRE Policy Centre, India	
14.00 – 14.15 (15 min)	Plenary Lecture: Climate Smart Artemia Pond Culture in Bangladesh Dr. Muhammad Meezanur Rahman, WorldFish, Dhaka, Bangladesh		

14.15 – 15.30 (10 min for every presentation)	Contributed Papers		
	Concept of Ecovillage through Community-Based Ecotourism: A Conceptual Framework	Md. Wasiul Islam	FWT Discipline, Khulna University
	The Trial and Error of Mangrove Plantation in a Reclaimed Land	Anusree Ghosh	Climate Change Programme, BRAC
	Screening of Potential Lactic Acid Bacteria Which Produced Antibacterial Substance for Future Application on Fermented Fish Product	Dr. Masagus Muhammad Prima Putra	Department of Fisheries, Universitas Gadjah Mada, Indonesia
	Health Benefits of <i>Sonneratia apetala</i> (Buch.-Ham.) Fruit.	Dr. Sheikh Julfikar Hossain	BGE Discipline, Khulna University
	Mangrove Ecosystem Services and Gender Relation among the Sundarbans Dependent Communities in the Coastal Polders of Bangladesh	Siddikur Rahman	Solidaridad Network Asia
	Maggot Meal as a Potential Substitute of Fish Meal Ingredient in Practical Diets of Rainbow Trout, <i>Oncorhynchus mykiss</i>	Dr. Md. Shah Alam Sarker	Bangladesh Open University, Bangladesh
15.30 – 16.30	SCIENTIFIC SESSION 03: PANEL DISCUSSION ON POLICY OPTIONS FOR CLIMATE RESILIENT COASTAL FOOD SYSTEM IN SOUTH ASIA  Moderator: Prof. Dr. Nazmul Ahsan, FMRT Discipline, Khulna University		
16.30 – 17.30	CLOSING SESSION		
	<u>Recap and Reflection</u> Dr. Md. Nazmul Ahsan Professor, FMRT Discipline, Khulna University		
	Best Poster Award		
	Appreciations to Session Chairs		



	<b><u>Speech by Special Guest</u></b> <b>Md. Amir Hossain Chowdhury</b> Chief Conservator of Forests, Bangladesh Forest Department Ministry of Environment, Forest and Climate Change The People's Republic of Bangladesh  <b><u>Address by the Chief Guest:</u></b> <b>Dr. Mahmood Hossain</b> Vice-chancellor, Khulna University
	<b>Vote of Thanks</b>
	<b><u>Closing Speech by the Symposium Chair:</u></b> <b>Dr. Md. Golam Sarower</b> Head, FMRT Discipline, Khulna University

### DAY 03 (03 March, 2023)

08.00 – 10.00	Travel from hotel to IMA pilot farm site, Paschim Dhangmari, Dacope
<b>Session 01</b>	
10.00 – 11.20	Meeting with IMA Farmers
<b>Session 02</b>	
11.20 – 11.50	Visit IMA Pilot farm where the farmers will present to participants
<b>Session 03</b>	
11.50 – 12.30	Visit community based mangrove nursery (Central Mangrove Nursery under SAIME Project)
<b>Session 04</b>	
12.30 – 13.10	Travel from Paschim Dhangmari to Mangrove plantation site at Kakrabunia
13.10 – 13.30	Kakrabunia plantation site to BANOJIBI Campus
13.30 – 14.00	Check in at BANOJIBI
14.00 – 15.00	Lunch
15.00 – 16.00	Refreshment and observe BANOJIBI initiative
16.00 – 18.00	Travel back to Khulna

## ANNEX II: TITELS OF POSTERS WITH AUTHORS AND AFFILIATIONS

ID	Poster Presenter	Title of Poster	Affiliation
PP01	Rukaiya Hossain	Effects of Pesticide on the Cellular and Physiological Alterations in Zebra Fish ( <i>Danio rerio</i> )	FMRT, KU
PP02	Nurunnahar Nadira	Antibiotic Sensitivity of <i>Vibrio</i> spp. Isolated from Egg of Mud Crab ( <i>Scylla olivacea</i> ) Collected from Hatchery	FMRT, KU
PP03	Md Shamim Hasan	Health Safety Concern among the Improved Traditional Shrimp Farmers in the Southwestern Region of Bangladesh	FMRT, KU
PP04	Sheikh Shaon Ahmmed	Effects of Ginger ( <i>Zingiber officinalis</i> ) Extracts on Giant Tiger Shrimp ( <i>Penaeus monodon</i> ) Growth and Immune Responses	FMRT, KU
PP05	Joya Biswas	Effect of Vasaka, <i>Justicia adhatoda</i> Leaf Extract on Growth and Immunity of Shrimp, <i>Penaeus monodon</i>	FMRT, KU
PP06	Asikur Rahman	Seasonal Variation of Sex Ratio, Growth Pattern, form factor and condition factor of the <i>Otolithoides pama</i> (Hamilton, 1822) From The Bay of Bengal, South-West Bangladesh	FMRT, KU
PP07	Rakib Hossain	Effect of Dietary Protein Levels on Growth Performance, Body Composition, and Hematology of GIFT Tilapia Reared in Biofloc System	FMRT, KU
PP08	Md. Adnan Sajib	Impact of Salinity Intrusion on Land Use, Biodiversity and Ecosystem Services in Tala, Satkhira	FMRT, KU
PP09	Saikat Bain	Effects of Replacing Fish Meal with Pangus Waste Silage in Diets on Growth Performance, Survival and Feed Efficiency of Nile Tilapia, <i>Oreochromis niloticus</i>	FMRT, KU
PP10	Md. Nurul Islam	Big Behind the Small: Destruction of Commercially Important Fish and Shrimp Species in the Name of Tiny Ones	FMRT, KU
PP11	Srabanti Das Ankhi	Impact of Waterlogging on Land Use, Biodiversity, and Ecosystem Services in Tala, Satkhira	FMRT, KU
PP12	Md. Khaladur Rahman Shohag	Health Safety Concerns among the Semi-Intensive Shrimp Farmers in the South-Western Region of Bangladesh	FMRT, KU

PP13	S.M. Nahid Jobayer	Assessment of Physicochemical Parameters of Water in an Industrial Scale In Pond Raceway System	FMRT, KU
PP14	Pial Paul	Climate Change Effects on the Small Scale Fisheries in the Northern Part of Bangladesh and Associated Adaptation Measures	FMRT, KU
PP15	Jannatul Ferdaus Jyoti	Opportunity of Commercially Important Vegetables Culture in Fish Farm: A Review	FMRT, KU
PP16	Dristi Das	Combined Effects of Salinity and Increasing Temperature on Zebra fish ( <i>Danio rerio</i> )	FMRT, KU
PP17	Amena Arefin Trisha	Effects of Plastic Feeding and Predation on Reproductive Performance of Guppy ( <i>Poecilia reticulata</i> )	FMRT, KU
PP18	Halima Tus Sadia	Impact of <i>Sesbania grandiflora</i> (Vegetable hummingbird) Leaves Extract on Growth and Immune Responses of <i>Penaeus monodon</i> (Shrimp)	FMRT, KU
PP19	Farhana Nasrin	In Vitro Antibacterial Activity of <i>Lawsonia inermis</i> Leaf Ethanolic Extract against Shrimp Pathogenic Bacteria <i>Vibrio parahaemolyticus</i>	FMRT, KU
PP20	Israt Jahan Tissa	Seasonal Variation of Sex Ratio, Growth Pattern, form Factor and Condition Factor of <i>Gudusia chapra</i> (Hamilton, 1822) from the Bay of Bengal, South-West Bangladesh	FMRT, KU
PP21	Md. Ridwanul Islam	Health Safety Concern among Fish Hatchery Workers in The South-Western Region of Bangladesh	FMRT, KU
PP22	Md. Mahmudul Hasan	Availability of Trace Metals and Their Spatial and Seasonal Distribution in the Aquatic Environment of Rupsha-Passur river and Some Selected Locations of Sundarbans	FMRT, KU
PP23	Rani Akhter	Effect of Microplastics on Phenotypic Traits and Enzyme Activities in Guppy ( <i>Poecilia reticulata</i> )	FMRT, KU
PP24	Shabrin Nahar Mithila	Habitat and Tissue Specific Heavy Metal Pollution of Hilsa in Bangladesh	FMRT, KU
PP25	Mahir Faisal Rahi	Impacts of Climate Change on Small-Scale Fisheries in the North-Eastern Region of Bangladesh	FMRT, KU
PP26	Md. Musfiquur Rahman	Effect of Salinity on Selected Biological Traits of Zebrafish ( <i>Danio rerio</i> )	FMRT, KU



PP27	Nimatul Jannat	In Vitro Antibacterial Activity of Ethanolic Extract of Drumstick ( <i>Moringa Olifera</i> ) Leaf Against Shrimp Pathogenic Bacteria <i>Vibrio parahaemolyticus</i>	FMRT, KU
PP28	Ikramul Islam Shovqn	Fishing with poison: A threat to Aquatic Biodiversity in the Sundarbans Area	FMRT, KU
PP29	Sanjida Yeasmin	Effect of Mangrove Leaf Litter on Shrimp ( <i>Penaeus monodon</i> , Fabricius, 1798) Growth and Color	FMRT, KU
PP30	Rahat Bin Shahid	Availability of Fishes under Legal Size in Local Fish Markets of Khulna	FMRT, KU
PP31	Supriya Roy Tithi	Effects of Macroalgae, <i>Stuckenia pectinata</i> Based Bioactive Compounds on Growth and Metabolic Activities in Monosex Tilapia ( <i>Oreochromis niloticus</i> )	FMRT, KU
PP32	Khadiza Khatun	Assessment of Infectious Hypodermal and Hematopoietic Necrosis Virus and Monodon Baculovirus by Molecular Technique in Penaeid Shrimp Hatcheries	FMRT, KU
PP33	Airin Sultana	Influence of Biofloc Technology on Water Quality Parameters in Aquaculture: A Meta-analysis	FMRT, KU
PP34	Umma Habiba	Effect of Size Variation in the Proximate Composition of Tuna Fish ( <i>Auxis thazard</i> )	FMRT, KU
PP35	Fatema Tuz Zahura Anti	Spatial Distribution of Particulate Organic Carbon and its relation with Current and Oceanic Nino Index in the Northern Bay of Bengal	FMRT, KU
PP36	Ahisha Siddika	Impact of Salinity Stress on Selected Physiological Traits of <i>Labeo rohita</i> (Hamilton, 1822)	FMRT, KU
PP37	Lopa Mudra Das	Microplastics in <i>Sillaginopsis panijus</i> , <i>Otolithoides pama</i> and <i>Johnius argentatus</i> from the Sundarbans of Bangladesh	FMRT, KU
PP38	Md. Nahidul Islam	Assessment of Physico-Mental Health and Sexual Abuse of Child Labour Involved in Fishing and Fry Collection in Khulna District, Bangladesh	FMRT, KU
PP39	Nittyta Sarker	Diversity of fish species in relation to fishing gear in Rupsha River of Khulna district, Bangladesh	FMRT, KU
PP40	Afia Anjum	Effect of Stocking Density on Growth Performance of Climbing Perch <i>Anabas testudineus</i> in Biofloc System	FMRT, KU

PP41	Sumaia Sidratin Muntaha	Infection by <i>Macrobrachium rosenbergii</i> Nodavirus (MrNV) Associated with Extra Small Virus (XSV), Agent of White Tail Disease (WTD) in <i>Macrobrachium rosenbergii</i> : A Review	FMRT, KU
PP42	Sagarika Singh	Microplastics in <i>Mystus gulio</i> , <i>Lates calcarifer</i> and <i>Hyporhamphus limbatus</i> from the Sundarbans of Bangladesh	FMRT, KU
PP43	Tamanna Fardoshi	Analysis of Macroalgae ( <i>Chara braunii</i> ) Derived Bioactive Compounds to Evaluate Their Effect on Growth Performance and Biochemical Changes in Metabolic Activities in Mono-sex Tilapia ( <i>Oreochromis niloticus</i> )	FMRT, KU
PP44	Md. Raihan Kaiser Raju	Intra-specific Diversity of the Silver grunt ( <i>Pomadasys hasta</i> ) from Three Locations of Bangladesh Based on Morphometric Analysis	FMRT, KU
PP45	Mst. Anika Khatun	Trace Metal Distribution in Water, Sediment and Selected Benthos and Effects on Benthos Community Structure across Rupsha-Passur River System	FMRT, KU
PP46	Jerin Tasnim	Study of Some Biological Aspects of the Freshwater Mud Eel ( <i>Monopterus albus</i> )	FMRT, KU
PP47	Mousumi Akter	Women Involvement in Mud Crab Fattening and Culture Activities in Southwest Coastal Region	FMRT, KU
PP48	Bijoy Biswas	Development and Evaluation of a Diet for Nile Tilapia Replacing Fish Meal with Silage Prepared from Fish Wastes	FMRT, KU
PP49	Abdus Samad	Effects of Partial Substitution of Fish Meal with Carp Waste Silage in Diets on Growth Performance of Nile Tilapia	FMRT, KU
PP50	Samiur Rahman	Population Parameters of <i>Pomadasys hasta</i> in the Coastal Region of Bangladesh	FMRT, KU
PP51	Munna Khatun	Molecular Diagnosis of White Spot Syndrome Virus (WSSV) and Acute Hepatopancreatic Necrosis Disease (AHPND) Causative Agent in Black Tiger Shrimp Hatcheries	FMRT, KU
PP52	Ashim Kumar Ghosh	Study of Population Structure with Peak Breeding Season of the Asian Seabass <i>Lates calcarifer</i> (Bloch, 1790) along the Coastal Areas of Bangladesh	FMRT, KU

PP53	Shanchita Zaman Chowdhury	Sustainable Ecosystem Based Prawn Farming System in Southwest Coastal Bangladesh	FMRT, KU
PP54	Md. Nuruzzaman Khan	Identification of Sex Determination Mechanism and Sex Linked Markers of the Migratory River Shad, Hilsa ( <i>Tenulosa ilisha</i> )	FMRT, KU
PP55	Prianka Paul	Effect of Stocking Density on Water Quality and Growth Performance of <i>Ompok pabda</i> Reared in Biofloc Technology System	JUST
PP56	Monowara Khatun	Biochar as a Potential Soil Conditioner in Saline Prone Coastal Area of Bangladesh	SWE, KU
PP57	Md. Rashedul Islam	Total Bacterial Load and Some Chitinolytic Bacteria in the Production Line of Mud Crab ( <i>Scylla olivacea</i> ) Hatchery	FMRT, KU
PP58	Md. Amirul Islam	Effect of Biofloc on Feed Efficiency, Growth and Production of Giant Freshwater Prawn ( <i>Macrobrachium rosenbergii</i> De Man, 1879)	BFRI
PP59	Al-Hasan Antu	Potential Fishing Zone Forecasting: An Innovative Approach for Sustainable Fisheries Management in the Bay of Bengal, Bangladesh	FMRT, KU
PP60	Munira Afroz Tithi	Adapting to Coastal Climate Change: An Investigation of House Evolution in Maukhali Village, Pankhali Union, Dacope Upazila, Khulna District	URP, KU
PP61	Kaushik Kumar Das	A Cross-sectional Study on the Adaptation of Indigenous Munda Communities Taking Support of Different Organizations Addressing Climate Change	Friendship NGO
PP62	Nushrat Alam Nabila	An Assessment of Livelihood Vulnerability of Climate Induced Migrants: A Micro Level Study in Dumuria Upazila of Khulna District, Bangladesh	ES, KU
PP63	Syed Sazidul Islam	Performance Evaluation of Main Crop and Ratoon Crop for Boro Rice in Saline Soil Condition of Southwest Coastal Region of Bangladesh	SWE, KU
PP64	Babu Kumar Roy	Freshwater Prawn ( <i>Macrobrachium rosenbergii</i> ) Culture through Post Larvae Production in Earthen Ponds in the Coastal District of Satkhira, Bangladesh	FMRT, KU
PP65	Md. Alamgir Hossain	Integrated Environmental Assessment for Marine Spatial Planning of St. Martin's Island, Bangladesh	BSMRMU



PP66	Sheikh Fahim Faysal Sowrav	Multi-Dimensional Approach for an Environmental Health Assessment of a Deltaic Mangrove Ecosystem, Sundarbans	BSMRMU
PP67	Md. Kamrul Islam	Population Dynamics of the Mud Crab ( <i>Scylla olivacea</i> ) from the Territorial area of the Sundarbans Mangrove Forest in Bangladesh	JUST
PP68	Zakia Jahan Shuchi	Proximate Composition and Fatty Acid of Mud Crab ( <i>Scylla olivacea</i> ) in Respect of Different Habitat and Seasons from Sundarbans Mangrove Forest, Bangladesh	JUST
PP69	Fatima Pervin	Growth Performance of Asian Stinging Catfish, <i>Heteropneustes Fossilis</i> Considering Different Stocking Densities and Feed in Cistern Condition	JUST
PP70	Zahid Hasan	Comparative Study on the Mud Crab ( <i>Scylla Olivacea</i> ) Fishery Between the Territorial and Deep Mangrove Forest of Bangladesh	JUST
PP71	Prema Hazra	Consumer Perception about Ready to Cook (RTC) Fish and other Meat Products from Southwest Coastal Community of Bangladesh	Plenary Aqua
PP72	Md. Sazedul Hoque	MPs in Marine Fishes from the Bay of Bengal: a Concern for the Sustainable Marine Fisheries of Bangladesh	PSTU
PP73	Md. Sazedul Hoque	Occupational Safety and Health Issues of Artisanal Hilsa Fishers in the Coastal Area of Bangladesh	PSTU
PP74	Mst. Sharmin Nahar	Water Quality Parameters and Heavy Metals Concentrations in Water, Sediment and Fish organs of Mugil ( <i>Rhinomugil corsula</i> ) from Pashur River	JUST
PP75	Md. Masudul Haque	Crabnet Production in Hatchery and Nursing Performance in Ponds of Mud Crab <i>Scylla olivacea</i> in Southwest Coastal Bangladesh	NGF
PP76	Kazi Amdadul Hoque	Friendship Mangroves afforestation contributing significantly to socio economic development of the coastal communities in Assasuni and Shyamnagar Upazilas of Satkhira District, Bangladesh	Friendship NGO
PP77	Munia Akhter	Comparison of Proximate Composition and Fatty Acids of Mud Crab ( <i>Scylla olivacea</i> ) in Respect of Sexes and Territorial and Deeper Mangrove Forest of Bangladesh	JUST

PP78	B.K. Dey	Effect of Temperature on Digestibility of Non-starch Polysaccharide Rich Ingredients in Nile Tilapia ( <i>Oreochromis niloticus</i> )	WUR, Netherlands
PP79	Md. Mustafizur Rahman	Isolation, Identification and Bioactivity Evaluation of Endophytic Fungi from <i>Brownlowia tersa</i> , a Mangrove Plant of Sundarbans	Pharmacy, KU
PP80	Chandrima Sinha and Ajanta Dey	Impact Of Improvised Chullah to Reduce Forest Dependency of Sundarban Women	NEWS, India
PP81	Md. Shah Alam Sarker	Evaluation of Different Stocking Density of Small Indigenous Fish Pabda With Carp Polyculture System	BOU
PP82	R. Moses Inbaraj	Advances Of Biofloc Aquaculture Technology	CRenIEO, Chennai
PP83	Mohammad Hasnal Alam	Plankton Abundance and Primary Productivity in an Industrial Scale in Pond Raceway System	WorldFish
PP84	Md. Arifur Rahman	Practice of Aquasilviculture at Shyamnagar Upazilla in Shatkhira	FWT, KU
PP85	Md. Seikh Sadiul Islam Tanvir	Physio-chemical Characteristics of Honey from the Bangladesh Sundarbans Mangrove Forest	FWT, KU
PP86	Ranajit Kumar	Application of Probiotics and Prebiotics for Promoting Growth of Tiger Shrimp ( <i>Penaeus monodon</i> ): An Approach to Eco-friendly Shrimp Aquaculture	DoF
PP87	Md. Mosharraf Hossain	Aquaponics: A Smart Technology for Adaptation to Climate Changes in the South-western Coastal Region of Bangladesh	BAU
PP88	Tanzera Khatun	Effect of Fish Fry Collection on Biodiversity and Alternative Livelihood Options for Fry Collectors in Rupsha River	FMRT, KU
PP89	Jamie McMurtrie	Assessment of Oxytetracycline Exposure on Fish Skin Microbiomes in an Earthen Pond Polyculture Pond System	UK
PP90	Md. Moshir Rahman	Integrated Agriculture: A Climate Resilient Farming Approach to Cope with Waterlogging in the South-Western Region of Bangladesh	USA

PP91	Partho Pratim Debnath	The Capacity of the Tilapia Lake Virus (TiLV) to Survive in the Environment (Water and Sediment) and Sustain its Infectiousness in the Absence of a Host	Thailand
PP92	Joyanta Bir	Addressing Histopathological Alterations in Brackish Water Mussels ( <i>Mytilus trossulus</i> ) Exposed to Oil spill (WAF) and WAF-D through Tissue-level Biomarkers	Spain
PP93	Sarower Mahfuj	Evaluating Phenotypic Heterogeneities of <i>Hyporhamphus Limbatus</i> Using Conventional and Truss-Based Morphometrics	Thailand
PP94	Shikder Saiful Islam	Algal Microbiomes, Their Interactions, And Functions in Ecosystem Structure	Australia
PP95	Md Mahmud-Al-Hasan	Mitigation Of Winter Thermal Stress in European Seabass ( <i>Dicentrarchus Labrax</i> ) Through Nutritional Manipulation	Australia
PP96	Bhaba Biswas	Natural and Modified Clay Minerals to Tackle Antibiotic Residues Pollution in Aquaculture Water	Australia
PP97	Roshmon Thomas Mathew	Effects of Periodic of Salinity on Compensatory Expression of Phenotypic Traits in Nile Tilapia ( <i>Oreochromis niloticus</i> )	KFU, Saudi Arabia
PP98	Yousef Ahmed Alkhamis	Influence of pH-Induced Stress on Biodiesel Production Under Mixotrophic and Autotrophic Microalgae Cultivation	KFU, Saudi Arabia
PP99	Md. Al-amin Mollah	Species Composition and Carbon Stock of Trees in the Sundarbans Mangrove Forest in Relation to Habitat and Salinity Differences	FWT, KU