Mekong River Commission
For Sustainable Development

Investment Options and Associated Measures to Optimize Fisheries Production Under Changed River Conditions

Investment Options and Associated Measures to Optimize Fisheries Production Under Changed River Conditions

Regional Report

March 2024

The MRC is funded by contributions from its Member Countries and Development Partners, including Australia, Canada, the European Union, Finland, Flanders/Belgium, France, Germany, Japan, Korea, Luxembourg, the Netherlands, New Zealand, Sweden, Switzerland, and the United States of America.

Copyright © Mekong River Commission, 2024
First published (2024)

Some rights reserved.

This work is a product of the Mekong River Commission Secretariat (MRCS). While all efforts have been made to present accurate information, the Mekong River Commission (MRC) does not guarantee the accuracy of the data included in this work. The boundaries, colours, denomination and other information shown on any map in this work do not imply any judgement on the part of the MRC concerning the legal status of any territory or the endorsement or acceptance of such boundaries.

Nothing herein shall constitute or be considered to be a limitation upon or waiver of the privileges and immunities of the MRC, all of which are specifically reserved.

This publication may be reproduced, in whole or in part and in any form, for educational or non-profit purposes without special permission from the copyright holder provided that the MRC is acknowledged as the source and that notification is sent to the MRC. The MRCS would appreciate receiving a copy of any publication that uses this publication as a source. This publication cannot be used for sale or for any other commercial purpose whatsoever without permission in writing from the MRCS.

Title: Options for Investment and Associated Measures to Optimize Fisheries Production under Changed River Conditions

DOI: 10.52107/mrc.bkqkky

Keywords: Drivers of change in Inland Capture Fisheries; Restoration measures; Climate change; Lower Mekong Basin; Mekong River Commission

For bibliographic purposes, this volume may be cited as:
Mekong River Commission. (2024). *Options for Investment and Associated Measures to Optimise Fisheries Production under Changed River Conditions*. Vientiane: MRCS. DOI: 10.52107/mrc.bkqkky

Information on MRC publications and digital products are available at:
www.mrcmekong.org/publications

All queries on rights and licences should be addressed to:
Mekong River Commission
Documentation and Learning Centre
184 Fa Ngoum Road, Unit 18, Ban Sithane Neua, Sikhottabong District, Vientiane 01000, Lao PDR
Telephone: +856-21 263 263 | E-mail: mrcs@mrcmekong.org | www.mrcmekong.org

CITATION

Mekong River Commission. (2024). *Investment Options and Associated Measures to Optimize Fisheries Production under Changed River Conditions*. Vientiane: MRCS. DOI: 10.52107/mrc.bkqkky

AUTHORS

Management
Mr Phetsamone Khanophet, Director of Environmental Management Division, Mekong River Commission Secretariat.
Dr Pinida Leelapanang Kamphaengthong, Chief Environmental Management Officer, Mekong River Commission Secretariat.

MRC technical expert
Dr Lai Tung Quan, Fisheries Management Specialist, Environment Division, Mekong River Commission Secretariat

National technical experts
Ms Kaing Khim, National Consultant, Cambodia
Ms Souvanny Phommakone, National Consultant, Lao Peoples Democratic Republic
Dr Narueprn Sukumasavin, National Consultant, Thailand
Dr Phan Thanh Lam, National Consultant, Viet Nam

International technical expert
Dr David Coates, Fishery Consultant, Scotland, United Kingdom

CONTENTS

FIGURES

TABLES

ABBREVIATIONS AND ACRONYMS

DoF	Department of Fisheries
FADM	Fisheries Abundance and Diversity Monitoring
FAO	Food and Agriculture Organization of the United Nations
FLD	Fish larvae and drift
GEF	Global Environment Facility
GHG	Greenhouse gas
LMB	Lower Mekong Basin
MC	Member Country
MKD	Mekong Delta
MRC	Mekong River Commission
MRC SP	MRC Strategic Plan
MRCS	Mekong River Commission Secretariat
OAAs	Other aquatic animals
PBAP	Project-based Action Plan
UNFCCC	United Nations Framework Convention on Climate Change

EXECUTIVE SUMMARY

BACKGROUND

Why is the purpose of this report?

The fisheries in the Lower Mekong River Basin (LMB) are crucially important to the economies, food and nutrition security, poverty reduction and sustainable development in all four Lower Mekong Basin (LMB) Member Countries (MCs) (Cambodia, Lao PDR, Thailand and Viet Nam). The fisheries are severely threatened by unsustainable development. Hence, the MRC Strategic Plan (SP) 2021–2025 was developed, whose Output 3.2.5 is "Investment and associated measures to adapt to changes in fish populations and catch composition identified and implemented". The MRCS Environmental Management Division team produced this report towards achieving this output.

National reviews were undertaken in each MC by a national expert, with the support of an international expert and Environment Division staff. A national workshop was held in each MC followed by a regional workshop held on 26 October 2023 to reach a consensus on priority needs and approaches.

A strategic approach was taken to identify and prioritize options for investment and associated measures that considered the projects currently being implemented under the Basin-Wide Fisheries Management and Development Strategy 2018–2022 and its Project-based Action Plan (PBAP) for its implementation, including an associated project proposal for Global Environment Facility (GEF) support, which is at an advanced stage. The options identified do not replace the PBAP but are key lower-cost investments that can now be made to support the PBAP and that will contribute to its eventual updating. The options also support the MRC Strategic Plan 2021–2025 more broadly. The options all also support MCs in implementing their national policies on capture fisheries in the LMB.

STATUS AND TRENDS OF CAPTURE FISHERIES IN THE LMB

Interpreting statistics and other information

Single sources of information (e.g. fisheries statistics) tend to apply to only a part of the fishery. An overview of the status and importance of the fishery, and an indication of overall trends can best be obtained by combining all sources of reasonably reliable national information.

Conclusion 1: Investment should be based on comprehensive assessments using all nationally available information, and assumptions from limited or short-term datasets should be avoided. There is much scope for improving the use of national information to support better decisions and investment choices.

Status and trends in capture fishery production

Based on the most reliable information from multiple sources, annual finfish yield from the LMB fell within a range of 1.5 –1.7 million tonnes for 2022 (**Error! Reference source not found.**), with other aquatic animals (OAAs) (e.g. prawns, frogs) contributing a further 443,000 tonnes. Comparing these estimates to those undertaken using similar methodologies in 2000 and 2010 indicates a 25–30% decline.

Fisheries production estimates for the LMB

	Inland fish yield - official statistics (t)	Inland fish yield - household surveys (t)	Inland fish yield - consumption surveys (t)	Value household surveys based on final retail price $ thousand	Value consumption surveys based on final retail price $ thousand
Cambodia	413,200	486,916	292,614	2,022,484	1,215,420
Lao PDR	70,001	105,998	141,007	645,860	859,174
Thailand	67,873	489,674	732,802	3,407,994	5,100,097
Viet Nam	451,009	427,751	485,436	1,055,530	1,197,876
LMB	1,002,083	1,510,340	1,651,858	7,131,869	8,372,566

Source: MRC (2023b).

Conclusion 2: There is agreement among all four MCs that total production from the LMB capture fishery is declining and will continue to do so without management interventions. Investment is required to sustain production.

Trends in diversity of catches

The species diversity and size composition of catches have declined significantly. The loss of biodiversity in the fishery is a well-documented threat to the ecological sustainability and the socio-economic benefits of the fishery.

Conclusion 3: Strategy and investment should consider not only sustaining overall fisheries production, but also diversity of the catches. Maintaining diversity is essential to sustain the ecosystem and also to sustain the socioeconomic benefits of the fishery.

Status and trends in socio-economic aspects of fisheries in the LMB

The total monetary value of the production from the LMB finfish capture fishery in 2020 based on final sale prices was estimated at between $7.131 billion and $8.372 billion. This is considerably higher than the $2.737 billion to $2.948 billion based on first sale values, showing the mark-up value of the fishery products through the value chain. In addition, the first sale value of OAAs was estimated at around an additional $1.338 billion.

Small-scale, part-time or family fishing continues to dominate the socio-economic benefits of the fishery. Less than about 10% of the fishing population are fishing full-time, whereas over 90% are part-time fishers. Participation in fishing is declining due to declining fish stocks and

other factors. These trends in participation in the capture fishery clearly reflect shifting socio-economic benefits from and dependency on the fishery as well as food security.

Throughout the LMB, most fishers are male, but the involvement of women can still be strong, particularly for collecting OAAs, and their participation in capture fisheries is stronger than for aquaculture. The fishing population is ageing. This has implications for the future of fisheries including the sustainability of catches and food and nutrition security.

Throughout the LMB, fish products remain the main source of animal protein consumption, although the relative consumption varies according to local fishery resources availability.

Conclusion 4: The capture fishery is central to policies that aim to sustain local, national and regional food security and support livelihoods of the rural poor and the vulnerable. These benefits are declining. Investment is required to reverse this decline.

WHAT IS DRIVING THE CHANGES TO INLAND CAPTURE FISHERIES IN THE LMB?

Pressures, which are increasing and arise from rapid economic development, include, among others:

- overexploitation of fishery stocks;
- basin-scale environmental changes such as changes to river hydrology due to the impact of infrastructure, agriculture, hydropower, industrial expansion, mining, etc.; and
- localized environmental degradation from small-scale irrigation development and operation, and land-use change that impacts on fisheries habitats.

Some developments have provided the populations living within the LMB with significant benefits but, overall, it led to the decline of capture fisheries; measures are required to sustain this important resource. To date, only limited regional/transboundary adaptation initiatives, management measures or investments have targeted the fisheries sector while broader economic development strategies have rapidly increased threats to the fish stocks, fish biodiversity, livelihoods, and food and nutrition security.

CAN THE CAPTURE FISHERIES BE SUSTAINED OR EVEN IMPROVED?

A common assumption is that productivity in the capture fishery cannot be sustained nor increased; this limits appetite for investment. But there are proven ways of improving the fishery, including more widespread implementation of co-management of fishery resources and small-scale, local, ecosystem (habitat) restoration undertaken in partnership with local communities. Experiences elsewhere show that a doubling or more of local production can be achieved within only two years.

Conclusion 5: The decline of the capture fisheries is not inevitable. There are options to improve sustainability and, in some cases, increase productivity significantly. This requires shifts in management approach and realigning investment priorities with the importance of capture fisheries to national and regional welfare.

WHAT ROLE DOES AQUACULTURE PLAY?

Losses in capture fisheries cannot be offset simply through gains in production from aquaculture. Aquaculture offers different economic outcomes and distribution of equity to local communities compared to capture fisheries. Livelihood dependency on capture fisheries far exceeds dependency on aquaculture. Aquaculture plays a much less important role in local food security in the LMB than capture fisheries. The bulk of aquaculture production from the LMB is exported, contributing nothing to national or regional food-security, although generating significant economic benefits. Consequently, social inequalities may be increased by policies that seek to replace capture fisheries by aquaculture. Appropriate aquaculture development certainly has the potential to further contribute to sustainable development. But it is not the solution to declining catches.

Conclusion 6: Aquaculture is important but, overall, does not replace lost capture fisheries production in terms of food security or livelihoods. The stakeholders involved and the benefits of the two sub-sectors are different.

LMB FISHERIES AND CLIMATE CHANGE

Projected impacts of climate change on capture fisheries in the LMB

Climate change mainly impacts river hydrology. This makes inland capture fisheries particularly vulnerable. Impacts of climate change on the fishery have been only partially assessed but their nature is generally the same as the impacts of environmental change driven by other, non-climate-related, activities. The anticipated drier conditions in the LMB might reduce fish yields by at least a further 15%; however, the impacts of other non-climate related pressures are very much higher.

Conclusion 7: Investment needs to recognize that inland capture fisheries are particularly vulnerable to climate change

Capture fisheries in the LMB and climate change adaptation

Climate change largely amplifies and accelerates ongoing changes to environmental conditions in the LMB. Measures identified to adapt the fisheries in the LMB to climate change show a high degree of overlap with those identified for general (non-climate change-related) fisheries management. For example, priority measures for responding to climate change and non-climate change-driven pressures on the fishery are bringing exploitation within sustainable limits; conserving and/or restoring habitats; restoring hydrology and connectivity in the rivers; and building capacity in fisheries-dependent communities. Needs for climate change adaptation certainly significantly increase the justification for investment in sustainability in the fishery.

The biggest impact of climate change on the capture fisheries will depend on the type of climate change adaptation measures adopted in other sectors, for example, whether physical infrastructure and water abstraction will increase to the detriment of capture fisheries, or whether there be more uptake of ecosystem-based adaptation, such as nature-based

solutions, that will benefit the fisheries. Capturing the opportunities presented by climate change adaption in other sectors, and avoiding maladaptation will be the defining feature of the future impacts of climate change on the fisheries. There are considerable opportunities on offer through win-win synergies between fisheries, poverty reduction, food security and climate change adaptation.

There are needs and opportunities in all four countries to develop more detailed plans and to integrate them into national development, including adaptation measures in other sectors. This will be particularly important because climate change is likely to have an increasing influence on national policies and investment.

Conclusion 8: Most climate change adaptation measures for capture fisheries in the LMB are the same as those required to respond to drivers of direct overexploitation and environmental change already being caused by other factors. Climate change increases the urgency of those measures.

Conclusion 9: The main impacts of climate change on the LMB fisheries will be determined primarily by the environmental impacts of adaptation measures adopted in other sectors. Fisheries need to be more prominent in, and better integrated into, adaptation policies, plans and investment in these other sectors to realize the significant potential co-benefits, particularly through measures that promote improved environmental resilience.

Capture fisheries in the LMB and climate change mitigation (greenhouse gas emissions)

The greenhouse gas (GHG) emissions from inland capture fisheries in the LMB are negligible because most of the fishing methods do not use motorized gears and fuel. Regarding climate change mitigation, the value of inland capture fisheries in the LMB is reflected in costs avoided in replacing the lost production. For example, the loss of 50% of LMB capture fisheries production would result in increased emissions of between 100 and 300 million tonnes of CO_2-eq per annum depending on whether it was replaced by chicken or beef, respectively. This approaches or exceeds the current national emissions of Lao PDR or Cambodia, and overall is between 15.6% and 46.7% of the combined annual national emissions of the four LMB countries in 2020. Added to this is the avoided cost in terms of other resources including land and water requirements for livestock. GHG emissions from aquaculture depend on the production system but are likely high and estimated to be around the same as for chicken. Current policies for climate change mitigation in all four MCs do not adequately recognize the role of inland capture fisheries regarding avoided costs.

Conclusion 10: Climate change investment needs to give more attention to the climate change mitigation benefits of sustaining the inland capture fisheries.

Conclusion 11. Due to avoided costs, the value of inland capture fisheries for climate change mitigation is highly substantial. Investment needs to take into consideration the costs avoided by sustaining capture fisheries in the LMB, which significantly increases the justification for investing in them.

Conclusion 12: Climate change mitigation values in sustaining capture fisheries in the LMB, also in consideration of avoided costs, provide a very strong justification for accessing climate change financing.

THE IMPLICATIONS OF THE CHANGES OCCURRING WITHOUT IMPROVED INVESTMENTS

The current declining trend in fisheries production and diversity has significant implications for all four MCs and the LMB as a whole, as follows:

- short- to medium-term local, national and regional food insecurity;
- loss of livelihoods and increased poverty for a significant proportion of the populations, i.e. millions of people basin-wide;
- inequitable distribution of the benefits of development;
- significantly increased GHG emissions generated from alternative food production options;
- increased challenges to achieving climate change goals and targets;
- significant losses in economic productivity through losses in overall ecosystem performance; and
- failure to achieve equitable and sustainable development, and the undermining of national and regional development goals and targets.

All of these outcomes are certain to occur without increased investment in the sustainability of the capture fisheries of the LMB.

CAPTURE FISHERIES IN THE LMB: CURRENT POLICIES, INVESTMENTS, CHALLENGES AND PRACTICES

All the official national policies of the four MCs aims at: sustaining, and in some cases increasing, capture fisheries production and its benefits including livelihoods, food security and contribution to the economy; and sustaining, and in most cases, restoring or rehabilitating the environment upon which capture fisheries depend. There is no explicit policy of prioritizing aquaculture over inland capture fisheries, or marine over inland capture fisheries in any MC. But in practice, this is often the case, especially in terms of investment.

The identified challenges facing capture fisheries, which are common among the four MCs, are as follows: management for inland capture fisheries is based on a top-down government-driven regulatory approach, but there is universal agreement that this is not sufficiently effective; all four MCs have identified co-management as a complementary, and usually better and more feasible, approach, and there is experience in its application in each MC; and all four MCs recognize the need for close cooperation between them regarding management of transboundary issues and challenges in the LMB.

Conclusion 13: There is a fundamental need to focus on identifying interconnections, synergies and conflicts among policy areas and on seeking ways forward that improve overall coherent policy delivery across multiple policy areas.

Conclusion 14: There are considerable institutional challenges at play in efforts to influence priorities and practice, and there may also be political constraints. These need to better understood.

INVESTMENT OPTIONS AND ASSOCIATED MEASURES TO OPTIMIZE FISHERIES PRODUCTION UNDER CHANGED RIVER CONDITIONS

Below are three options for investments including the drivers of sustainability addressed, objectives, outcomes, duration and estimated budget.

ity	Objective	Outcomes	Duration (years)
Regional capacity-building to improve national assessments and synthesis of capture fisheries-related datasets and information and their incorporation into national basin development policies, plans and investments			
	To improve the national capacity for assessment and interpretation of multiple existing data and information sources on capture fisheries in the LMB in each MC. To better understand how data and information on inland capture fisheries are integrated (or not) into policies, planning and investments, and to identify constraints in the information-management interface, and ways and means to overcome them. To improve the national capacity for integrating inland capture fisheries into national basin development strategy, planning and investment	Improved, more reliable and accurate, assessments of inland capture fisheries and integration into policy and planning	1
ct 2:	**Regional capacity-building for co-management of fishing and restoration of local habitats to address overexploitation of the fishery resources and local environmental degradation** ***Phase one: Capacity-building among MCs, including for government staff and local communities;*** ***ilot projects to implement co-management arrangements in practice in selected local areas (or strengthened support to existing interventions);***		
of d al	To improve the national capacity for sustainable management of fisheries through strengthened inland capture fisheries co-management To improve the national capacity for co-management in order to rehabilitate and/or restore local ecosystems to increase productivity and sustainability of inland capture fisheries	Increased capacity to manage fisheries for sustainability. Increased and more sustainable catches.	Phase one – 1 year Phase 2 – five years
:	**Integrating the values of inland capture fisheries into national and regional climate change adaptation and mitigation strategies**		
	To improve national capacity for identifying the values of inland capture fisheries, and ways and means to integrate them into national and regional policies, plans and investments for climate change adaptation and mitigation. To design a regional project to invest in the sustainability of inland capture fisheries in the LMB as a contribution of the MCs' obligations to climate change mitigation targets	Refined contributions of MCs to obligations under the Paris Agreement (including NDCs). Avoided costs of replacing lost capture fisheries production identified and realized Increased investments in sustainability of capture fisheries in the LMB	2 years

FOREWORD

The MRC Strategic Plan 2021–2025 Output 3.2.5 is "*Investment and associated measures to adapt to changes in fish populations and catch composition identified and implemented*". To support this activity, the Secretariat engaged the services of four national consultants, with the support of an international consultant. Four national reviews were conducted that included feedback from other relevant national experts. A national workshop was held in each country to discuss the outcomes of the reviews. A regional workshop was held on 26 October 2023 to reach a consensus on priority needs and approaches. This report outlines the conclusions of these consultations regarding the identification of investments to be made and the associated measures to be taken in order to adapt to changes in fish populations and catch composition at the regional scale. A supplementary report provides a summary of these conclusions and options.[*]

[*] MRC. 2023a. Brief: Options for Investment and Associated Measures to Optimize Fisheries Production under Changed River Conditions. Vientiane: MRCS.

1. INTRODUCTION

It is well established that the fisheries in the Lower Mekong River Basin (LMB) are crucially important to the economies, food and nutrition security, poverty reduction and sustainable development in all four LMB Member Countries (MCs) (Cambodia, Lao PDR, Thailand and Viet Nam). Although the fishery is reported to have declined, it has shown remarkable resilience in the face of significant increasing pressure. Pressures continue and are accelerating from rapid economic development, especially overexploitation of fishery stocks and the impact of infrastructure, agriculture, hydropower, industrial expansion, mining, growing human populations and climate change (MRC, 2019). Measures are required to sustain this important resource. To date, only limited regional and/or transboundary adaptation initiatives, management measures or investments[2] have targeted the fisheries sector while broader economic development strategies have rapidly increased threats to the fish stocks, fish biodiversity and livelihoods, and food and nutrition security.

The MRC Strategic Plan (SP) 2021–2025 has highlighted the MRC's role in coordinating with MCs to identify sustainable investment opportunities, options for investments and associated measures, or transboundary adaptation actions to optimize and enhance fisheries production under changed river conditions. This aims to help countries adapt to the changing circumstances in the basin and to achieve the sustainable development, utilization, management and conservation of the water and related resources of the Mekong River Basin under Article 1 of the 1995 Mekong Agreement. Specifically, Output 3.2.5 of the MRC Strategic Plan 2021–2025 is "Investment and associated measures to adapt to changes in fish populations and catch composition identified and implemented". The MRCS Environmental Management Division team has produced this report in response to this need.

National reviews were undertaken in each MC by a national expert, with the support of an international expert and Environment Division staff, with the following outputs:

- a review report on current status, trends and key challenges of sustainable fisheries management, including legal and institutional frameworks, in the respective country;
- for each country, a brief to identify informed and practical recommendations for addressing the above key challenges, including integrated and transboundary adaptive management measures, investments, and cooperation for enhancing fisheries production under changed river conditions;
- a national workshop held in each MC, followed by a regional workshop held on 26 October 2023 to reach a consensus on priority needs and approaches. This report outlines the conclusions of these consultations regarding the identification of investment and associated measures to adapt to changes in fish populations and

[2] In this report, the term 'investment' refers to allocating money or other resources (e.g. people) in the expectation of it producing a return or benefit, for example, improved productivity and/or sustainability of the fisheries and/or improved socioeconomic outcomes, etc.

catch composition at the regional scale. A supplementary report provides a summary of these conclusions and outlines relevant investment options (MRC, 2023a).

1.1 How this report supports the Basin-Wide Fisheries Management and Development Strategy 2018–2022 and its Project-based Action Plan for Implementation

Options for investment and associated measures identified in this report take into consideration the Basin-Wide Fisheries Management and Development Strategy 2018–2022 (BFMDS) (MRC, 2017a) and its Project Based Action Plan for Implementation (PBAP) (MRC, 2021), which reflect national strategies among the four MCs. Seven basin-wide projects are identified in the PBAP at a combined potential cost of US$7,225,000 (2017 costs). For each project, background, objectives, outputs and activities, indicators, risks and assumptions, specific activities, milestones, timelines, implementation schedules and budgets, and implementation arrangements are provided here. But few of these are currently funded. A project proposal for GEF funding is currently in preparation.

This report takes a strategic approach to funding opportunities based on the following:

- projects and activities identified in the PBAP that are already funded and operational, or included in the GEF proposal, were excluded from the current proposals, avoiding duplication; and
- prioritization of strategic lower cost options for investments that will contribute to The Basin-Wide Fisheries Management and Development Strategy 2018–2022 (BFMDS) and its PBAP in a cost-effective manner, pending the availability of more substantial resources.

The projects (options) proposed here are in alignment with and complementary to the projects listed in the PBAP (Table 17; section 9.5).

The options listed here will help inform and complement the updating of the PBAP when undertaken.

2. STATUS AND TRENDS OF CAPTURE FISHERIES AND AQUACULTURE IN THE LOWER MEKONG RIVER BASIN

Several approaches and methodologies are in use within and between MCs in reporting data, particularly for capture fisheries. Differences among them are due to the types of the fishery included (e.g. commercial versus informal, family fishing, or full-time vs. part-time fishing), or what is included (e.g. finfish versus other aquatic animals [OAAs]). In addition, natural factors are known to result in significant variations in both production and socio-economic aspects; for example, the extent and duration of flooding has a major influence on productivity (Ngor et al., 2018a), and sudden changes in economic conditions can trigger shifts in involvement in fishing or aquaculture.

The best way to obtain an overview of the status and importance of the fishery, and an indication of overall trend is to combine all sources of reasonably reliable information such as local knowledge, fish consumption data and area-based assessments of production. The strengths and weaknesses of each underlying information source can be compared and factored into results. This approach has been adopted regionally since the early 2000s (MRC, 2023b). More accurate data on trends can be generated through dedicated monitoring of specific fisheries and sites. By necessity, these are usually restricted to smaller areas and are still subject to potential natural variations. The Fish Abundance and Diversity Monitoring Programme of the MRC (FADM Programme 2018–2022) was established to support the generation of more precise data and has been operating since 2001; however, at the time of writing the data collection process has not been standardized since 2016.

2.1 Status and trends in capture fishery production

The most recent available data suggest that annual finfish yield from the LMB ranges from 1.5 million to 1.7 million tonnes (Table 1), with OAAs contributing a further 443,000 tonnes. The estimate is within the range, but at the lower end, of the estimate provided in the 2018 State of the Basin Report (MRC, 2019) of 1.3–2.7 million tonnes. Comparing these estimates to those undertaken using similar methodologies in 2000 and 2010 indicates a 25–30% decline over this period (MRC, 2023b). There is reasonable confidence that this decline has occurred but its extent is not precisely known. Additional sources of information, as below, confirm this conclusion.

Table 1. Comparison of total catch from the LMB countries in 2019–2020, using different assessment approaches

	Inland fish yield - official statistics (t)	Inland fish yield - household surveys (t)	Inland fish yield - consumption surveys (t)	Value household surveys based on final retail price $ thousand	Value consumption surveys based on final retail price $ thousand
Cambodia	413,200	486,916	292,614	2,022,484	1,215,420
Lao PDR	70,001	105,998	141,007	645,860	859,174
Thailand	67,873	489,674	732,802	3,407,994	5,100,097
Viet Nam	451,009	427,751	485,436	1,055,530	1,197,876
LMB	1,002,083	1,510,340	1,651,858	7,131,869	8,372,566

Note: Sources of data and methods of calculation are described in MRC (2023b). Official statistics can differ at the national level depending on which official statistics are used.
Source: MRC (2023b).

There are widespread reports of local fishers, communities and experts that there has been a long-term and sustained decline in catches across the whole LMB. In recent years, fishers have stated that fish catches have declined considerably and rapidly since the completion of large dams on the mainstream; others, as reported in the Mekong Eye, have stated that they cannot catch sufficient fish to continue working in the fisheries sector. The recent basin-wide assessment (MRC, 2023b) precedes this period but overlaps with the closure of Don Sahong and Lower Sesan 2 hydropower projects and their potential impact on fish migratory pathways and recruitment processes. An improved and longer-term assessment of accurate catch-per-unit-effort data will help build further confidence in conclusions.

Results from the Fish Abundance and Diversity Monitoring (FADM) Programme 2018–2022) show differences in trends among the four MCs (Figure 1). To date, the following conclusions can be made:

- The total catch in Lao PDR and Thailand was fairly stable (2018–2022) with a maximum yearly variation in catch of less than 19%.
- Fish catches declined from 2018 to 2021–2022 by about 60% in the Tonle Sap in Cambodia. However, this fishery is highly sensitive to the extent and duration of flooding and 2019 and 2020 were unusually dry years. Catches could rebound if flooding returns to normal levels. The fish catch in the 3S system also declined from 2018 to 2021, but started to increase again in 2022.
- In the Mekong Delta in Viet Nam, the catch was stable during 2018–2020 but there was an increase of almost 50% in 2021–2022. This could be due to the catch increasing in an expanding estuarine habitat in Mekong Delta due to salinity instruction and sea level rise. It is also possible that the COVID-19 pandemic affected these results because movements of fishers were restricted in 2020–2021, and fishers may have compensated with increased effort (or stocks increased) in 2021–2022.

There are some constraints to interpreting the current FADM data due to method of recording fishing efforts between years. These constraints are being addressed as the methods are continuously improved.

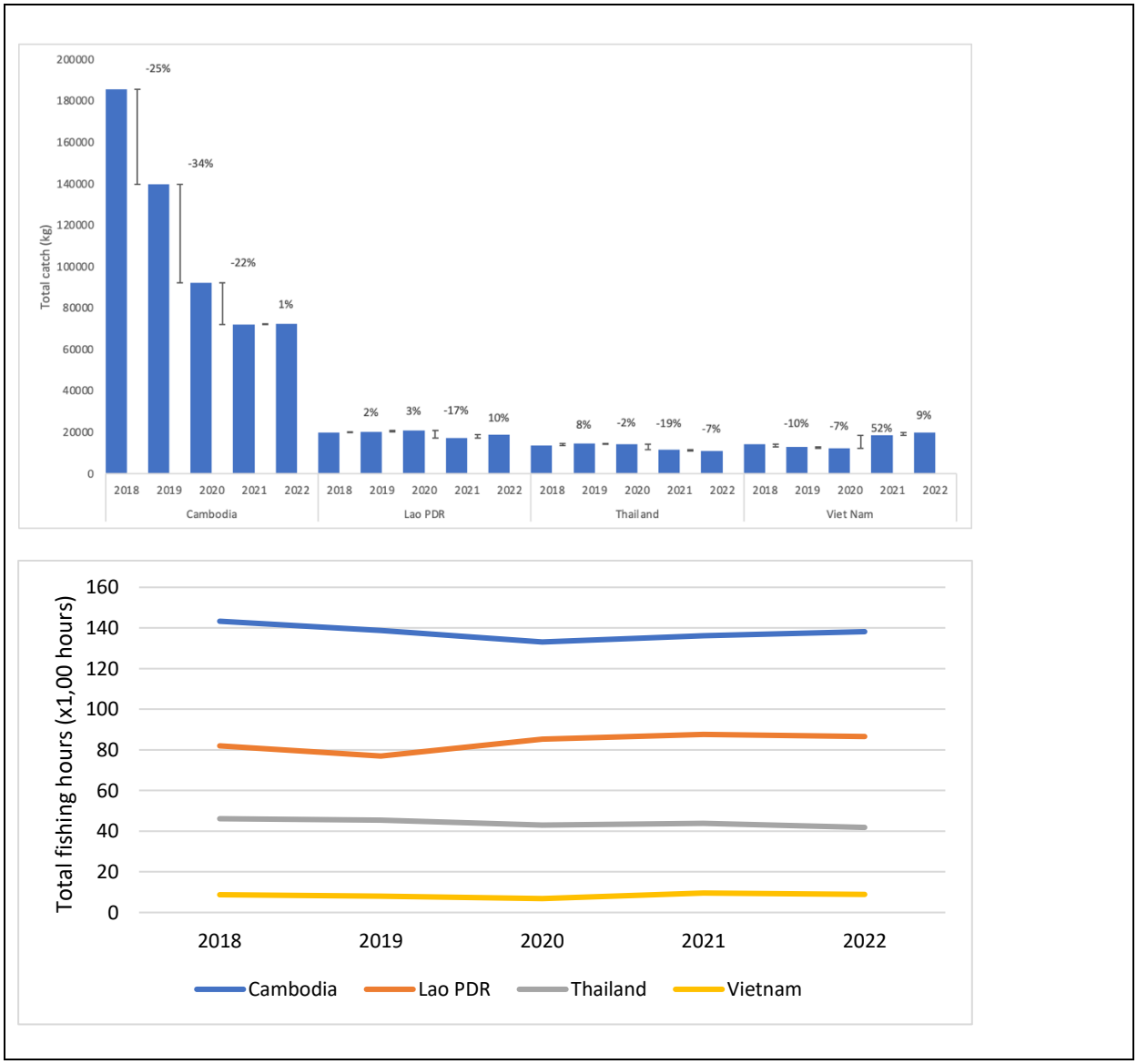


Figure 1. Total weight of catch (kg) from the monitoring stations in the LMB (upper graph); total fishing hours from the monitoring stations in the LMB (bottom graph)

Source: FADM Programme (2018–2022)

These trends in catches and fishing effort shown in Figure 1 are supported by additional sources of information. For example, data reported by FiA (2021) confirm the recent declines for Cambodia. Capture fisheries production in Lao PDR was relatively stable from 62,635 tonnes in 2015 to 64,700 tonnes in 2019 (Department of Livestock and Fisheries National Statistics, 2019). But according to the Department of Livestock and Fisheries National Statistics (2022), the total capture fisheries production increased to 75,000 tonnes in 2022. However, the figures for the capture fisheries production in Lao PDR are considered underestimated due to limited scientific-based information on fish yield in various habitats, for example, stream, flooded, rainfed and reservoirs. For Thailand, the fishery statistics are not easily disaggregated by river basin. The reported total production of capture fisheries from five types of fishing

areas in the Mekong Basin of Thailand declined from about 86,000 tonnes in 2017 to about 59,000 tonnes in 2021 (DoF, 2022). Finfish, OAAs and shrimp and prawn contribute around 96%–98%, 1.2–2.7% and 0.5–1.2%, respectively, of the total production; however, OAAs usually represent a higher proportion of overall catches (e.g. 20–25% of total catch) suggesting that these reports do not cover the whole fishery or are underestimates. Office of the National Water Resources (ONWR, 2023) reports the reduction of the catch per unit effort (CPUE) from fishers' gillnets in the Thai Mekong Basin in the 2022–2023 study period compared to the 2020–2021 study period. However, this is too short a period to conclude on trends.

According to Phan and Pham (2022), there is a trend of decreasing fish catches of fishing households over the last 10 years for the Mekong Delta in Viet Nam (Figure 2). This mirrors the trend of decreasing catches over the same period in the FADM programme (Figure 1) but shows a rebound in 2022. Decreasing OAAs catches of fishing households in the brackish zone and the rainfed zone are also evident in the last 10 years, although catches in the flood zone have increased over the last 10 years. However, sampling biases may have a large impact on these results. Official statistics for the inland capture production of the five freshwater provinces in the Mekong Delta show variations between 2015 and 2020, but no clear trend (Figure 2). There are also large variations between different sources of data. For example, detailed surveys in An Giang province showed that the inland fishing production amounted to 194,000 tonnes in 2000 (Phan and Pham, 2002, 2003(and in a Tra Vinh province, 70,000 tonnes in 2001 (Sjorslev, 2002). In the same year, the Department of Statistics of An Giang province reported around 70,000 tonnes of inland fishing production in An Giang province. The differences are likely due to methodologies and the types of fishery included (Phan and Pham, 2003).

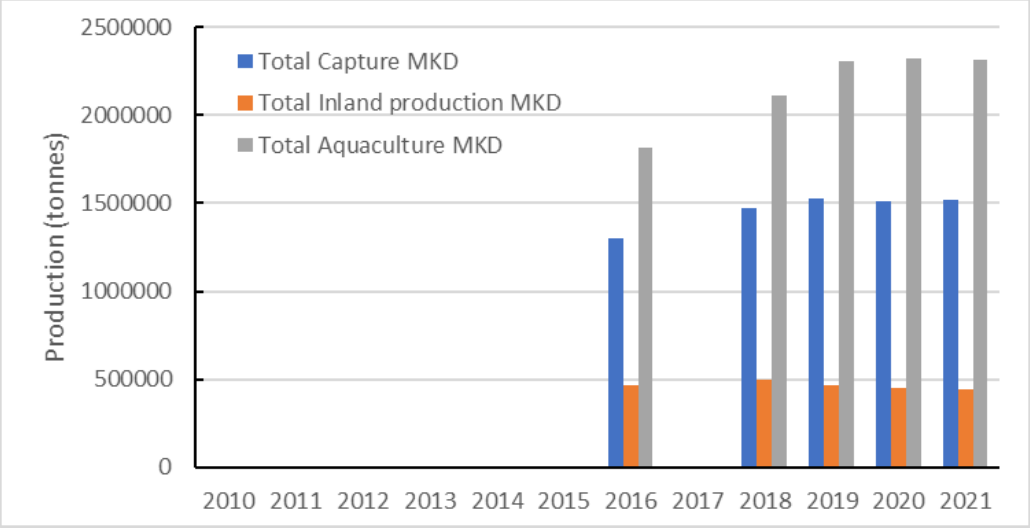


Figure 2. Inland capture fisheries production from provinces in the Mekong River Delta – An Giang, Dong Thap, Can Tho, Vinh Long, Hau Giang provinces

Source: GSO (2021) (reproduced from MRC, 2023b), GSO (2021)

2.2 Catches by habitat type

Overall, for the LMB, most of the capture fishery yield is harvested from rainfed and flooded habitat, contributing 53% and 25% of the catch, respectively, with the brackish water zone in Viet Nam, contributing some 18% of the catch (MRC, 2023b). This distribution of catch highlights the importance of protecting and preserving these key habitats to sustain the fish stocks.

Table 2 shows the total production of 64,700 tonnes from capture fisheries in 2019 disaggregated by habitat type in the three regions of Lao PDR. As expected, these vary by region, mainly due to variations in habitat extent. The importance of production from rice fields is clearly shown, accounting for around 18% of total production.

Table 2. Total production from capture fisheries, disaggregated by habitat for Lao PDR

Region	Production of capture fisheries (tonnes)						
	Mekong River and 14 tributaries	Reservoirs	Irrigation	Shallow lakes, small nature pools, peat swamps, wetlands	Natural pond	Rice field	Communities pond
Northern Region	10,972	71	630	1,028	197	1,563	27
Central Region	8,804	8,984	2,420	4,928	4,695	6,086	575
Southern Region	5,639	102	184	387	745	3,975	2,689
Total	25,415	9,156	3,234	6,343	5,637	11,624	3,291

Source: Department of Livestock and Fisheries National Statistics (2019)

In Lao PDR, the total area of water resources for capture fisheries is estimated at over 1.2 million ha. Based on the official statistics, the production is around 53 kg/ha/year, which is relatively low, suggesting that capture fisheries are not currently limited by resource and that there is scope for increasing (however, the official figures are underestimates).

The capture fisheries production by habitat types in Thailand's Mekong Basin during 2017 and 2021 is shown in Table 3. The production from rivers, drainage, canals and creeks is relatively stable, supporting no obvious trend in total production (Table 3), although production from swamps decreased. Production from rice fields is not independently recorded, although they are extensive in the Mekong Basin in Thailand and some production is reported under aquaculture, or “trap pond”, “irrigation canal” and/or “swamp/other” in Table 3.

Table 3. Quantity of the freshwater animals captured from five types of inland fishing area in Thailand's Mekong Basin (tonnes)

Year	Total	River/drainage/ canal/creek	Irrigation canal	Reservoir	Trap pond	Swamp/other
2021	59,432.18	16,894.26	414.65	10,943.71	126.34	31,053.22
2020	62,364.54	16,521.31	663.58	16,592.07	148.42	28,439.16
2019	53,215.87	14,924.78	858.87	8,228.88	388.89	28,814.45
2018	75,788.75	18,868.62	1,011.99	12,716.89	646.16	42,545.09
2017	86,296.07	16,085.03	950.62	21,504.63	2,176.87	45,578.92

Production of fish from rice fields (and associated irrigations canals, etc. extends along a continuum from wild recruitment with no human interference in the production (e.g. feeding or stocking), but may require related interventions such as maintaining or restoring habitat connectivity to increasing levels of human interventions, which, at the more intensive level, might include stocking and feeding. The former is more the domain of capture fisheries, and the latter is aquaculture. The boundary between the two is ill-defined and different practitioners categorize production in different ways.

The FADM studies from 2017 to 2022 for the Mekong Delta in Viet Nam also illustrate the importance of rice fields (Figure 3).

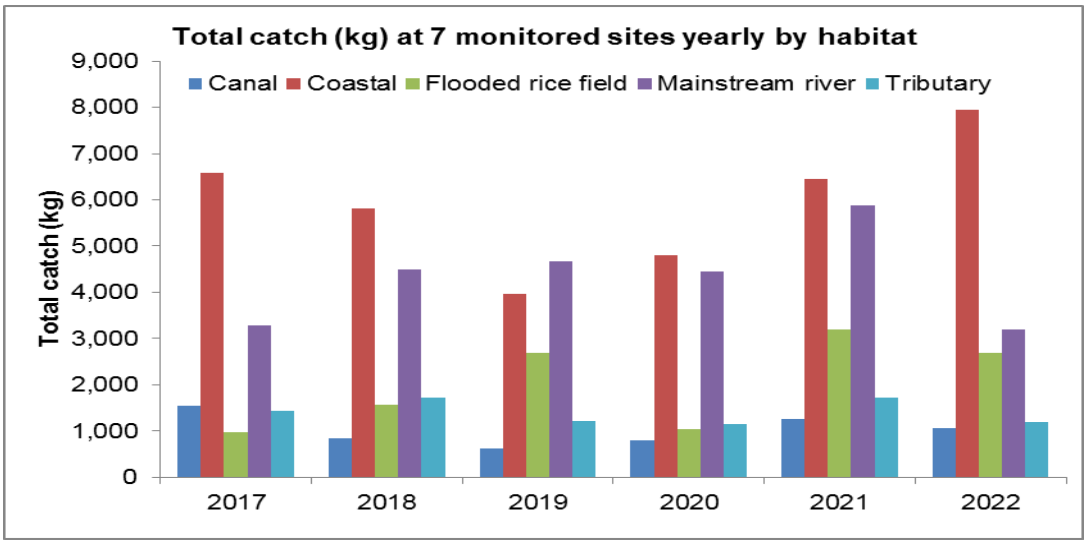


Figure 3. Total catch by habitat type group since 2017 in the Mekong Delta

Source: FADM study in Viet Nam

There was a steady increase in both rice farming area and rice production over the 1995–2016 period, corresponding with the reported decline in fish catches. Large proportions of land were dyked and converted to triple the area of rice farming and fish yield was negatively correlated with rice farming area and production. This illustrates the scope to improve rice field productivity by enhancing fish yields.

2.3 Trends in species composition of catches

Overall catches tell only part of the story of trends in capture fisheries. There are substantial data, reports, and anecdotal evidence that irrespective of trends in total catch, the species and size composition of catches is changing significantly. The decline of large-bodied species has been documented together with an increase in smaller individuals and species, usually of lower value (Van Zalinge, Thuok & Nuov, 2016; Gray et al., 2017; Campbell et al., 2022). Trends in species have been difficult to identify from general trends in catches partly because increases in the biomass of a smaller number of more resilient species, such as *Polynemus melanochir*, in the multi-species fishery mask losses in other species. This underscores the importance of long-term, species-specific catch data to detect trends. The FADM Programme 2018–2022 shows that, contrary to many predictions, the various groups of fishes (guilds) have not shown evidence of changing fish guild composition in the LMB. However, species composition in Cambodia and Lao PDR show signs of decline; the trend is unclear for Thailand and it is increasing in Viet Nam (Figure 4). Longer periods of data are needed to refine any conclusions.

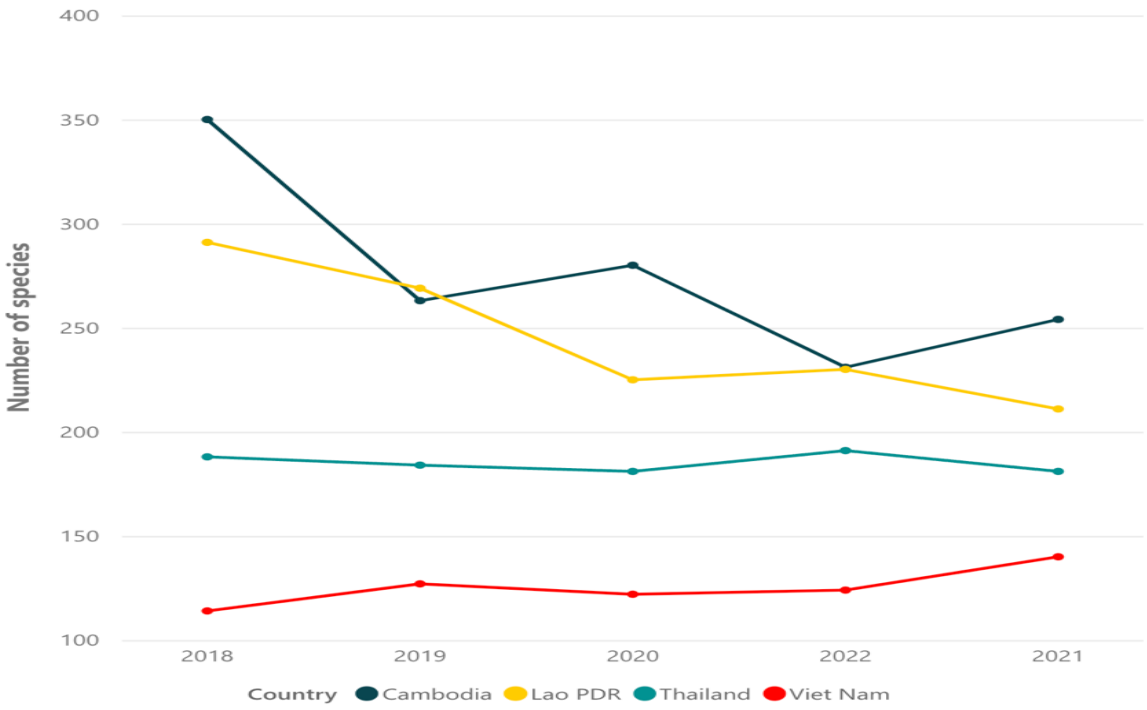


Figure 4. Number of species recorded over period 2018–2022

Source: FAMD programme

Based on the Fish Larval Drift and Juvenile Monitoring (FLD) studies from 2017 to 2021, the density and number of species caught by two monitoring stations in the Mekong Delta decreased over this five-year period (Figure 5). In the same study, the critically endangered species *Aaptosyax grypus, Pangasianodon gigas, Probarbus jullieni and Catlocarpio siamensis* were not present in the 2022 catches.

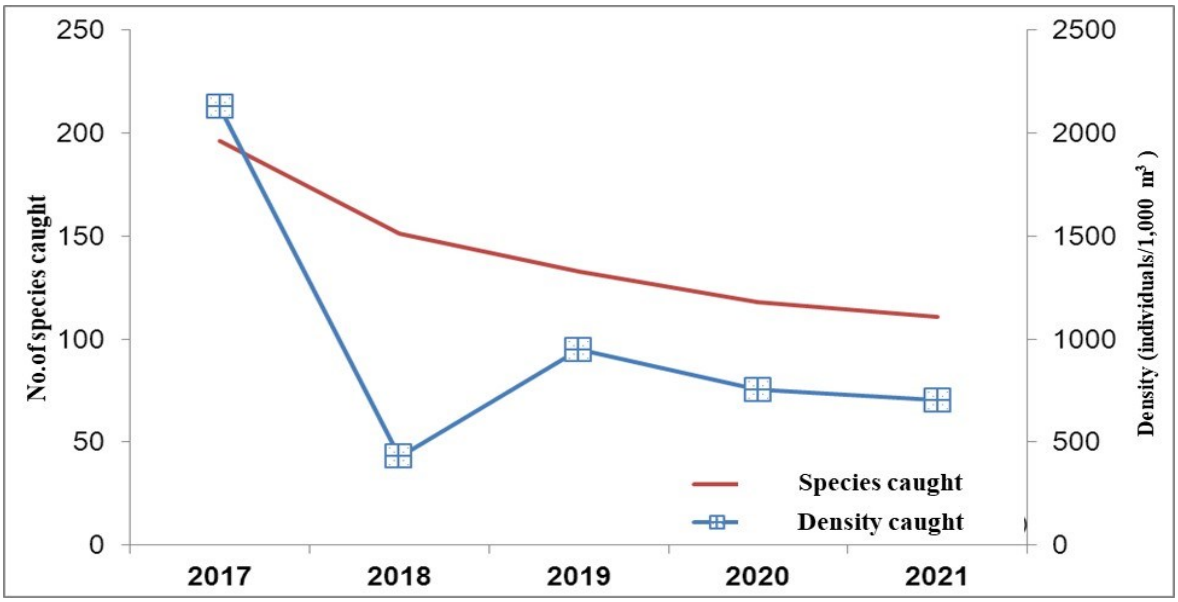


Figure 5. Density and number of species caught at two monitoring stations, 2017–2021

Source: FLD study in Viet Nam

Chevalier et al. (2023) analysed 17 years' time-series fish catch data for 110 species in the Tonle Sap Dai fishery in Cambodia confirming the widespread decline across species assemblages, trophic groups, and life history strategies. This confirms that threats to Mekong fish species extend beyond a small group of what is currently considered the most vulnerable species. Results showed a statistically significant decline in fish populations for 74% of species particularly the largest ones. Declines were found across most migratory behaviours, trophic positions, or (International Union for Conservation of Nature (IUCN) threat categories. Some species have declined so much as to now have virtually disappeared from the fishery over the past 15 years; examples include *Channa micropeltes*, *Channa lucius* and *Trichopodus microlepis*.

The decline of both overall catch and harvest of most individual species reduces economic benefits of the fishery and threatens food and nutrition security. The shift in the fishery becoming increasingly supported by smaller number of smaller species threatens overall system stability and as well as fishing capacity. For example, the number of Dai units in operation in Tonle Sap River decreased from 66 in the 2014/15 fishing season to 53 in 2018/19 and then to 44 in 2021/22 (Chevalier et al., 2023). The percentage of the catch of the most common species increased, due to the use of new and more effective fishing gears.

The loss of biodiversity in the fishery is an obvious threat to the ecological sustainability of the fishery. These trends in simplification of catch composition are known to lead to fisheries collapse in other river basins, even of fisheries based on the most resilient species, for example, in the Amazon River Basin (Heilpern et al., 2022). There are strong links between biodiversity and the socio-economic aspects of the fishery. The high diversity of fishing gears in use in the LMB and their modes of deployment are largely due to the high diversity of species, their behaviour and habitats. This has traditionally, meant that the benefits of the fishery have been distributed widely among local communities who deploy a range of fishing methods according to local species availability, habitat access and other opportunities (Coates

et al., 2003). Loss of that biodiversity undermines socio-economic benefits through loss of livelihoods, particularly for the poorest communities with limited alternatives, and local and regional food and nutrition security.

2.4 Drivers of decline in capture fisheries

The indirect drivers of change in the LMB are economic development, shifting consumption patterns and population growth (MRC, 2019). The two main direct drivers of change in capture fisheries are direct overexploitation of fish stocks and environmental change, as identified for Cambodia and Lao PDR (IFReDI, 2016), Thailand (DoF, 2021) and for Viet Nam (Vu *et al.*, 2014). It can be difficult to determine the relative impact of overexploitation and environmental change. In most cases, these work in tandem and reinforce each other's impact. The trends mirror similar trends in similar tropical river basins experiencing rapid development (e.g. He et al., 2021).

The drivers identified can be categorized as shown below.

2.4.1. Environment and habitat degradation

(a) Dams and other infrastructure

Dams act as barriers to fish movements (river and habitat fragmentation) and influence hydrology. The extent of these impacts varies according to dam size and location, and small dams can cumulatively have a large impact. The purpose of the dam (e.g. hydropower, irrigation, multi-purpose) is less relevant than its actual impacts that are determined by dam design, size, location and operations.

(i) River and habitat fragmentation

Connectivity is critical for maintaining accessibility of fishes to different areas and can be lost through water extraction and diversion, invasive plant growth and the installation of dams, both large. and small-scale) and other water control infrastructure (Januchowski-Hartley et al., 2013). Around 87% of well-known fish species in the Mekong are migratory. The Xayaburi dam, for example, has proven to be an impassable barrier for migratory catfish, which will not be able to swim across a large barrier like a dam to reach its spawning grounds upstream (Joshua, 2013). In recent years, the Mekong Delta has rapidly constructed dykes to prevent water flooding in the inland areas and to protect from salinity intrusion in the coastal areas, and constructed larger dams in the Central Highlands for irrigation and hydropower. The consequences of these activities are harmful for the aquatic animals and fishes species (Lam et al., 2011) leading to increased fragmentation of their habitats and, thus, intercept the migration pathways of fish/aquatic animals during the season, etc. Many fisheries surveys have highlighted impacts of these projects in the LMB (Barlow et al., 2008). The construction of dams, weirs or roads that block or obstruct the passage of aquatic animals causes a loss of biodiversity and productivity for some species.

Although most attention has been devoted to the impact of larger water infrastructure schemes, the localized small-scale fragmentation of the floodplain and the network of smaller

river channels by irrigation infrastructure and levee systems has also had a large cumulative impact. There are around 25,000 small irrigation reservoirs in the LMB region, and there has been an estimated 78%conversion of original wetland habitat, mainly for rice cultivation (Harrod et al., 2018c). For example, in Xe Champhone wetland in Lao PDR, local agricultural and water management practices have severely disrupted connectivity, threatening important biodiversity and significantly reducing fisheries' productivity. Many small-scale interventions can be identified that will help restore connectivity and hydrology, and significantly improve livelihoods, food security and biodiversity, such as small-scale dam and levee removal or modification, small-scale fish passages, removal of invasive plants that choke waterways, among other measures (FAO and IUCN, 2017). There are substantial opportunities for the integration of fisheries into agricultural irrigation systems to improve overall system productivity, usually through ecosystem restoration approaches (FAO, WorldFish and IWMI, 2020). These examples demonstrate that restoring ecosystem health in the LMB need not involve high-cost modifications of large-scale water resources infrastructure. There is great potential for making substantial improvements locally, especially those identified and implemented by local communities.

(ii) Changing hydrology

Upstream developments result in reduced flood extent, floods arriving later and shortened flood duration, all of which can negatively impact fisheries productivity and species populations (Baran, Baird & Cans, 2005; Kummu and Sarkkula, 2008; Heng et al., 2017; Ngor et al., 2018a, 2018b; Arias et al., 2012; Chea et al., 2020). MRC (2017b) predicted that the fish populations would be reduced by between 25% and 40% because of run-of-river hydropower schemes in the mainstem Mekong. This does not include the impacts of hydropower schemes constructed on major tributaries, which are likely to further impact fish stocks, such as on Lower Sesan 2.

The loss of sediment transport because of the cascade of hydropower dams in the Lancang reach of the Upper Mekong will likely cause a loss of productivity in the LMB (Yoshida et al., 2020) and undermine wetland stability in the Mekong Delta (Duc et al., 2020). In the coastal zone of Mekong Delta in Viet Nam, strengthening measures against coastal erosion are highly relevant. In addition, the stability of tidal flats also determines the stability of the yield of clams. Therefore, protection and reforestation of the coastal estuarine zone provides stability to tidal flats and hence sustainability of the clam fields (Bui et al., 2013).

(b) Pollution and degradation of water quality

Pollution from nutrients can increase the production capacity of some fish species, but overall would result in a loss of diversity. This would affect the structure of the fish community. However, water quality is not considered a major threat to the environment of the LMB in the short to medium term in terms of mainstream impacts, although localized problems exist (MRC, 2019). There are increasing plastic pollution in inland water bodies in all four MCs, which cause an interference with fishing activities, as well as direct impacts on fish stocks, including mortality.

2.4.2. Direct impacts of fishing

Overexploitation by the fishery and overfishing has been identified as a major driver of declines in the fishery throughout the LMB. Weak management and enforcement, combined with open-access fishing and overexploitation of aquatic animals cause an unsustainable increase in fishing effort and in the use of illegal gears. As a result, the fish population declines.

2.4.3. Land-use change

Land-use change is a significant driver of fisheries' decline in the LMB. There have been major reductions in the flood zone, which is a critically important habitat that supports fish production, and the extent of open water bodies over the past two decades (Table 4). Over the same period, there has been a large increase in the amount of area under aquaculture, which has contributed to increased production in this sub-sector (see below).

Table 4. Changes in major habitat areas (km^2) in the LMB

Habitat type	2000	2003	2010	2020*
Major flood zone	57,197	58,017	30,183	33,597
Rainfed	126,547	129,835	127,741	133,109
Water bodies	6,533	7,512	5,483	5,251
Brackish-estuarine			12,940	13,013
Total	192,277	197,367	178,357	184,970
Aquaculture	2,095	2,373	6,792	9,910

Note: *The results of this study are largely based on data collected for 2020, combined with 2010–2019 flood conditions. It is thus assumed that the results are valid for 2020 conditions.
Source: MRC (2023b)

These changes in land use in many cases have been beneficial for the overall economy but at the cost of significant trade-offs, such as the destruction of mangrove forests and melaleuca forests, and the construction of dikes to prevent effects of floods and tides. The consequences of these operations have led to negative impacts; for example, the expansion of rice-field area is clearly negatively correlated with total inland capture fisheries production in the Mekong Delta in Viet Nam (Figure 6).

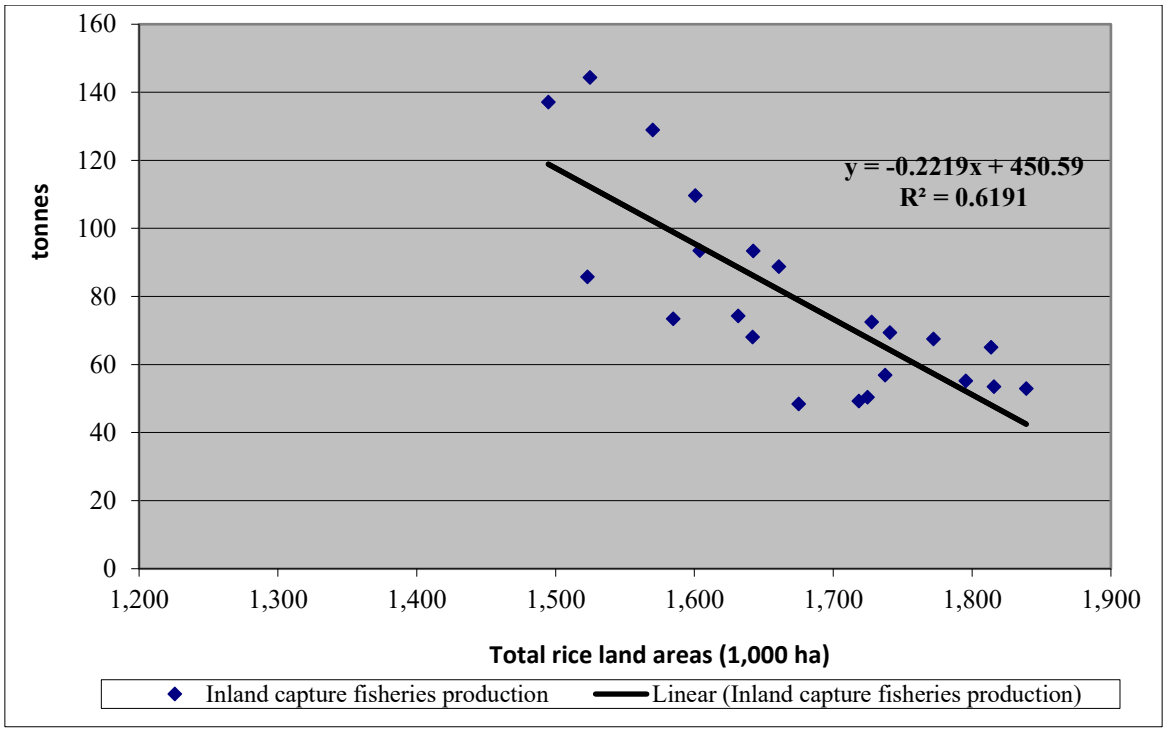


Figure 6. The relationship between annual inland capture yield and rice farming area in the Mekong Delta in Viet Nam

Note: Data for five freshwater provinces only, 2000–2021.
Source: Viet Nam Statistical Yearbook

Inland aquaculture, at least in the Mekong Basin of Thailand, does not pose a significant risk to habitat conversion as does shrimp culture along the coast. Cage culture is the main concern regarding the impacts of inland aquaculture (Lebel et al., 2013).

2.4.4. Loss of genetic diversity of aquatic animals

This loss results from both overfishing and ecosystem change. It can be partly addressed through the protection and rehabilitation of critical and vulnerable habitats, with the participation of local communities, supplemented by breeding and restocking programmes for native species and/or rare and endangered species.

2.4.5. Invasive alien species

Invasion of alien species such as the common sucker (*Hypostomus plecostomus*) and the zebra tilapia (*Heterotilapia buttikoferi*) in water bodies have negative impacts on some native fish and the overall aquatic community structure. Eighteen aquatic alien species are reported in the Mekong Delta (Vu *et al*., 2013) of which three species are considered invasive and strongly impact the fisheries resources – *Trachemys scripta elegans, Pterygophichthys pardalis* and *Pomacea canaliculate*. An assessment of measures to manage impacts was undertaken by the MRC in 2003 (Welcomme and Vidthayanom, 2003).

2.4.6. Climate change

Climate change is recognized as a major threat and driver of change in river conditions that will impact the capture fisheries in the LMB. Overall, its impacts will exacerbate the drivers resulting from environmental change (as listed above), particularly hydrological change. Impacts will arise from the direct effects of climate change (e.g. on water temperature or precipitation) and the climate change adaptation measures adopted by the MCs (e.g. increased water storage). These and other aspects are covered in a dedicated section on *climate change* below.

2.4.7. Differences in drivers among the four MCs

The drivers listed above are common to all four MCs, and differ in the extent of impact they cause. For example, impacts of hydrological change on flooding will have a high impact on major flood zones in Cambodia and the northern part of the Mekong Delta, but there will also be impacts elsewhere; changes in sediment transport creates major vulnerabilities in the lower part of the Mekong Delta and coastal zone. However, due to the dependency of the fishery on migratory fish stocks, many of these and other impacts are transboundary. In addition, since achieving sustainable development of the capture fishery has positive impacts across borders, i.e. affecting both national and regional food security and sustainable development. The drivers of environmental change and overexploitation also operate in tandem; overall, both need to be addressed together. Therefore, in terms of the need to address the drivers of change in river conditions that impact the capture fishery, it can be concluded that all four MCs share a common challenge and require common responses.

2.4.8. The role of ineffective enforcement of regulations, weak management and inadequate information

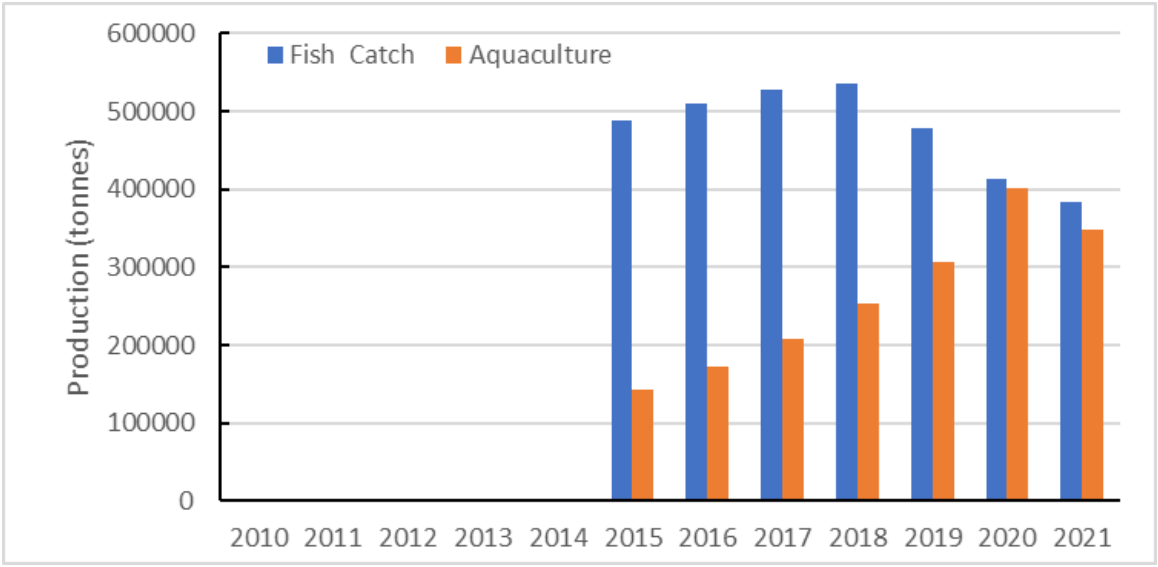
All four MCs recognize significant failings in the current management approach for capture fisheries in the LMB is contributing to their further decline. These failings arise from:

- inaccurate information, particularly catch statistics, which can lead to poor investment and management measures;
- lack of participation of all concerned stakeholders at the planning, implementation and monitoring stages of fishery resource management;
- lack of coordination and communication among departments and the public (e.g. for criteria for releasing aquatic animals);
- lack of awareness of information, fisheries information/news and fisheries co-management; and
- inappropriate laws and regulations, and failures in their implementation and enforcement. In addition, community participation in fishery conservation and management is not encouraged and promoted.

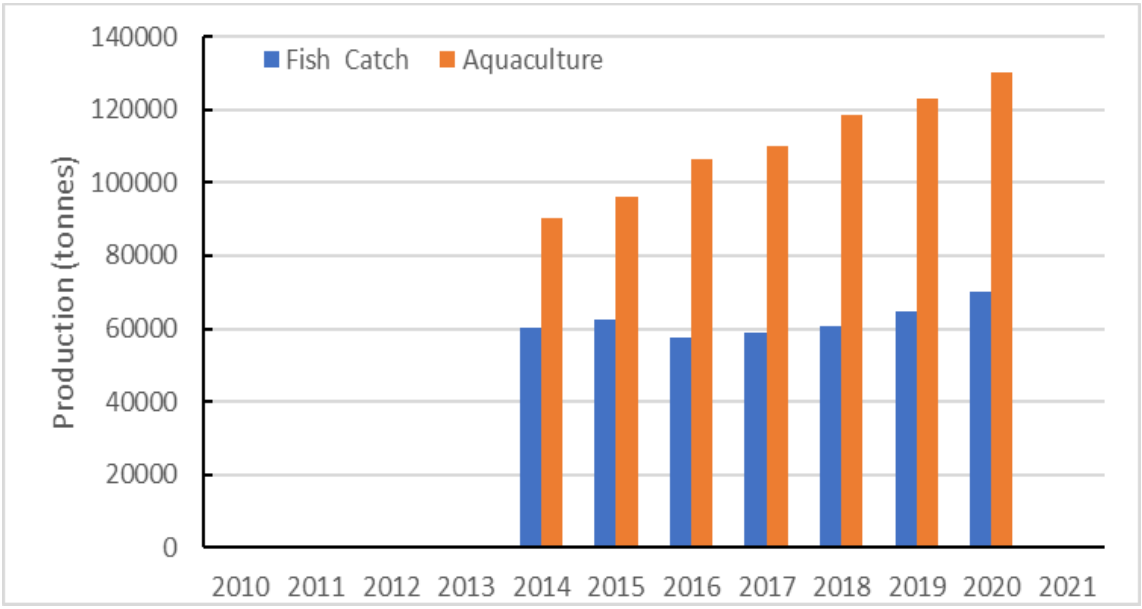
2.5 Status and trends of aquaculture production

Aquaculture production has rapidly increased in all four MCs in marked contrast to relatively stable or declining capture fisheries (Figure 7); however, aquaculture production in Cambodia significantly declined in 2021.

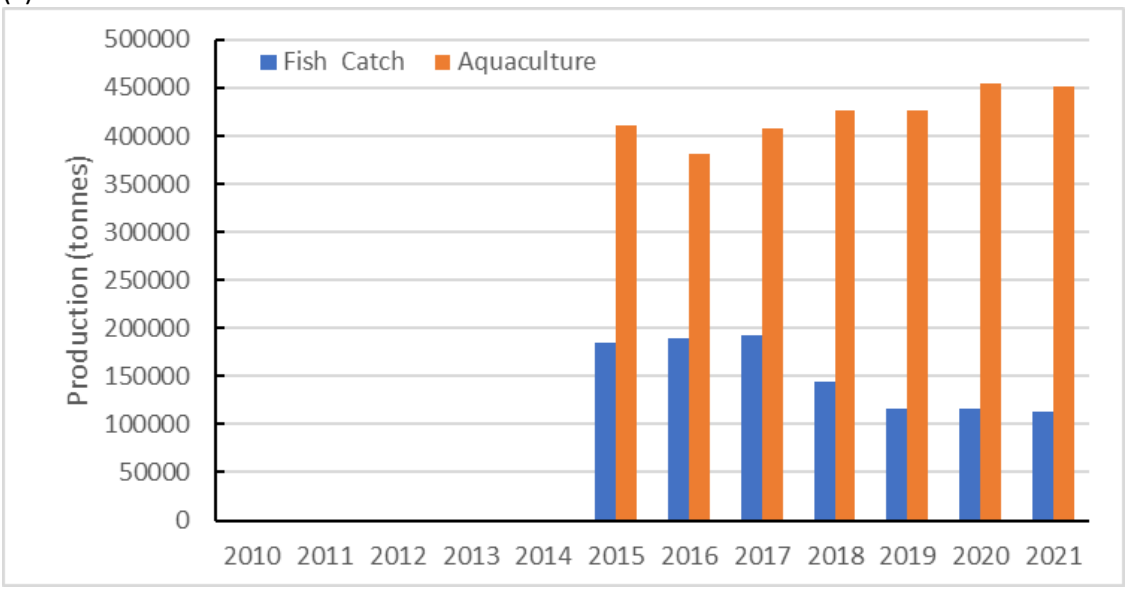
(a) Cambodia



(b) Lao PDR



(c) Thailand



(d) Viet Nam (Mekong Delta only)

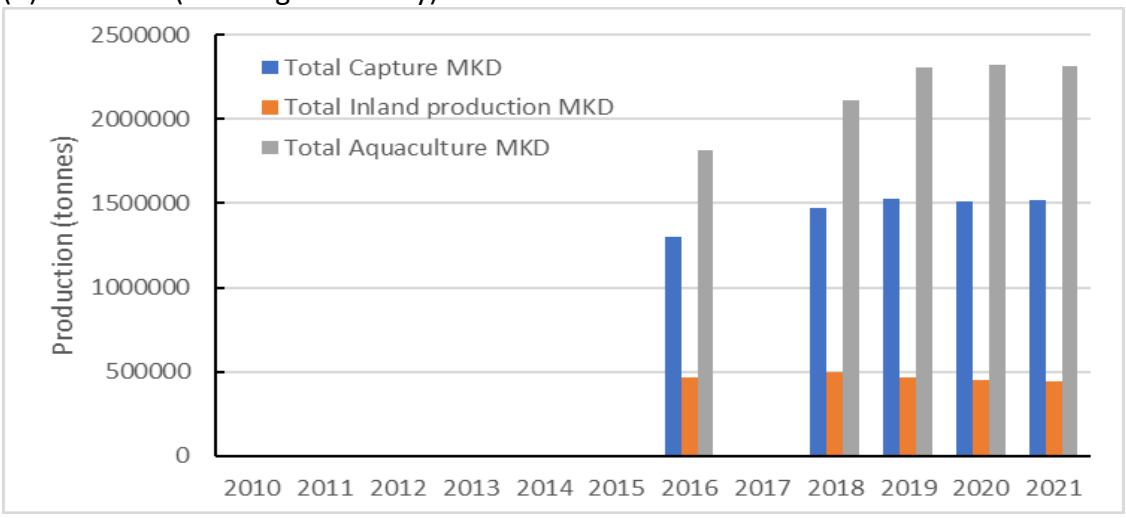


Figure 7. Trends in total annual fish catches and aquaculture production. Figures for Thailand are national, for others the LMB

Source: MRC (2023b)

The total production from aquaculture in Lao PDR was 140,600 **tonnes** in 2022 (Department of Livestock and Fisheries National Statistics, 2022). About 60% of this comes from rice-cum-fish production, highlighting the importance of rice-fish systems, with most of the rest (36.5%) from cage culture, whereas pond production is limited (3.5%) (Department of Livestock and Fisheries National Statistics, 2019).

3. STATUS AND TRENDS IN SOCIO-ECONOMIC ASPECTS OF FISHERIES AND AQUACULTURE IN THE LMB

3.1 Trends in production and socio-economic benefits

The total monetary value of the production from the LMB finfish capture fishery in 2020 based on final sale prices was estimated at $7.131 billion, based on household surveys, and $8.372 billion based on fish consumption surveys (MRC, 2023b). This range is considerably higher than the $2.737 billion to $2.948 billion, respectively, if the first sale values from the 2020 study are used. This clearly shows the mark-up value of the fishery products through the value chain and highlights the value of the fishery in terms of livelihoods for fishing communities and those further up the value chain. It also demonstrates considerable scope to improve benefits to local fishing communities by increasing their equity in profits. In addition to these values for finfish, the first sale value of OAAs was estimated at around $1.338 billion, highlighting the importance of these commodities to the value aquatic food products and food security in the region.

Small-scale, part-time or 'family' fishing is the major recipient of the socio-economic benefits of the fishery, which include food security and a significant livelihood benefits as part of mixed livelihood strategies of local communities. A survey conducted in Stung Treng province, Cambodia showed that fisher households consumed between 251–400 kg per household per year of fish and OAAs (IFReDI, 2016). Most fishers generate most of their income from fishing, which averages $400 to $600 income per month. Most local fishers processed less than 500 kg of fish per year. The survey found that only 8% of the fishing population were full-time fishers, while 92% were part-time fishers, who also engaged in additional livelihood activities such as agriculture, animal husbandry, labour and trade/business. In Cambodia, about 6% of households are engaged in aquaculture compared to 27% engaged in full-time fishing in the LMB, almost all of which are involved in some form of part-time or occasional fishing or OAA gathering (MRC, 2023b). Capture fisheries in rice-fields can be very important. For example, twice as many households in Cambodia are involved in capture fishing than in aquaculture. However, dependency on rice-field fisheries is not systematically recorded.

Most people living along the Mekong River in Lao PDR depend on fishery resources. Fisheries and aquaculture are a very important element of animal protein, hence a good sources of food security, nutrition and livelihoods. Fisheries and aquaculture have been greatly contributed to the Lao PDR economy. As expected, involvement varies by region largely due to differences in habitats (Table 5). Only around 8.3% to 8.7%of households are involved in aquaculture compared to 48.1% to 70.4% in capture fisheries. The number and proportion of households involved in aquaculture has not significantly changed over the 20 years between 1998/1999 and 2019/2020, but the number and proportion of those involved in capture fisheries decreased by 2019/2020 (Table 5).

Only 12.7% of households earned income from aquaculture, showing that it remains predominantly a subsistence activity in Lao PDR. Income from aquaculture was higher than

that from capture fisheries in households engaged in selling produce. Data from the Department of Livestock and Fisheries National Statistics (2021) also show that the prices for aquaculture fish are much lower than those from the capture fisheries.

Table 5. Number of households engaged in aquaculture and capture fishery, by region

Region	Number of farm households (HHs) ('000)			Number of HHs engaged in aquaculture ('000)			Number of HHs engaged in fishing ('000)		
	1998/99	2010/11	2019/20	1998/99	2010/11	2019/20	1998/99	2010/11	2019/20
North	238.4	288.9	236.7	28.6	28.9	13.7	153.2	187.3	86.4
Central	285.9	336.4	274.4	21.1	30.2	34.2	208.7	230.3	150.1
South	136	157.5	133.0	5.1	9.1	6.2	102.9	108.6	73.3
Total	**660.3**	**782.8**	**644.1**	**54.8**	**68.2**	**54.1**	**464.8**	**526.2**	**309.8**
% of farm households	**100**	**100**	**100**	**8.3**	**8.7**	**8.4**	**70.4**	**67.2**	**48.1**

Source: The 3rd Lao Agricultural Census 2019/2020

Out of the households engaged in the capture fisheries, on average only about 11.4% earned income from capture sales (Table 6); however, the amount of catch traded or bartered versus consumed in the household was not recorded. According to the Department of Livestock and Fisheries National Statistics (2021), fish prices from the capture fishery in Lao PDR are fairly high.

Table 6. Households engaged in capture fisheries and income received from capture sales by region 2019/20

Region	Number of farm households ('000)	Number of households engaged in capture fishing ('000)	Number of households that sold captured fish ('000)	Income from capture fishing ('000)	Percentage of fishing households earning income from captured fish
North	236.7	86.4	6.5	1633.1	7.5
Central	274.4	150.1	17.3	1782.2	11.5
South	133.0	73.3	11.7	2490.2	15.9
Total	644.1	309.8	35.5	-	11.4 (average)

Source: The 3rd Lao Agricultural Census 2019/2020

According to the Department of Fisheries (DoF, 2022), there were 90,596 registered fishing households in Thailand's Mekong River Basin in 2022, 95% of which engaged in fishing for household consumption, and the other 5%, for sale. There was a total of 416 registered fishery-related operators in the provinces along the Mekong River in Thailand (DoF, 2022), most of whom fishery product collectors (126 or 30%), followed by importers and exporters of aquatic animals (112, or 27%). The price of fish captured from the Mekong River in Thailand is generally high, ranging from $1.8 to $11.2 per kg (ONWR, 2022). There are around 300,000 registered aquaculture farms in provinces in the Mekong Basin of Thailand. Most of the farms

are small-scale aquaculture farms, which are mainly for household consumption and mostly managed by families.

In 2020, the Mekong Delta had an estimated population of 17.3 million, or around 4,794,200 households, i.e. an average household size of 3.61, slightly lower than the Viet Nam national average of 3.63. In 2016, around 22% of households were involved in the fisheries activities in the Mekong Delta, of which 10% were involved in fishing, followed by fish sellers (5-25%), fish processing (3.22%), fish traders (1.44%) and traders of fishing gears (0.44%) (Table 7). In general, fishing activity in the Delta is considered small-scale. Many households living near inland waters (estimated at 459,400 in 2020) are engaged in fishing, mostly part-time, but about 5% of these households' fish full-time. However, fishing (as opposed to fish processing and marketing, etc.) tended to be a secondary but important activity regarding household income (Table 8). The percentage of households engaged in fishing activities varied between zones, with the highest in the flooded zone (43.33% of households), followed by the rainfed zone (32.50%) and the brackish zone (17.50%) (Phan et al., 2016).

There are around a half of million full-time fishers both in freshwater and brackish water in the Mekong Delta. At present, an exact number of full-time fishers has not been inventoried but the part-time fishing group dominates in the Mekong Delta and is underestimated. Generally, the living conditions of full-time fishers in communities in the same locality are classified as average; however, they have many social limitations such as lack of schools and hospitals for their children (MARD, 2009). Controlling and managing the part-time group is very difficult because fishing is a temporary job and not registered (Phan *et al.*, 2015). There are also an estimated 726,900 fishery labourers in the Mekong Delta region. The fishery sector contributes significantly to the national economy in general, and to the Mekong Delta in particular (MARD, 2014). Fisheries not only provide an important source of protein and livelihoods for millions of people in the Delta, especially the rural poor, but also significantly contribute to exports; for capture fisheries, however, this is mainly from the marine fishery. Fish and other aquatic animals, together with rice, provide important and essential sources of animal protein in the population's diets, in particular in rural areas. Rural people or rural communities are usually poor and rely on the fisheries for food and income. For most locals, fishing and aquaculture have been their way of life for food and income. Both aquaculture and capture fisheries in the Mekong Delta are diverse and dynamic. Aquaculture, in particular, is increasing in both area and production, while the production of inland capture fisheries tends to decline over time (Mai and Phan, 2015).

Table 7. Percentage of households engaged in fishery activities in the Mekong Delta in Viet Nam

Occupation	Brackish zone (N=20)	Flood zone (N=20)	Rainfed zone (N=20)	All (N=60)
Other aquatic animals (OAAs) collectors	0.34	0.00	0.00	0.08
Fish processing	0.26	6.39	0.01	3.22
Fish selling by fisher household	9.58	4.57	2.43	5.25
Fish trading by middleman	2.26	1.51	0.54	1.44
Fishing	16.94	8.42	6.63	10.05
Making and repairing fishing gear	0.03	0.74	0.26	0.44

Source: Phan et al. (2016)

Table 8. The percentage of households that rely on economic activities, by order of importance and type of economic activities in the Mekong Delta in Viet Nam

Occupation	Income source	Brackish zone (N=20)	Flood zone (N=20)	Rainfed zone (N=20)	All (N=60)
Collecting other aquatic animals (OAAs)	Main source of household (HH) income	0.00	0.00	0.00	0.00
	Second source of HH income	0.00	0.00	0.00	0.00
	HH consumption use	100.00	0.00	0.00	100.00
Fish processing	Main source of HH income	52.63	72.38	100.00	72.02
	Second source of HH income	47.37	0.11	0.00	1.04
	HH consumption use	0.00	27.51	0.00	26.94
Fish selling by fisher HH	Main source of HH income	30.69	50.59	32.28	39.44
	Second source of HH income	69.31	48.96	67.72	60.37
	HH consumption use	0.00	0.44	0.00	0.19
Fish trading by middleman	Main source of HH income	80.24	97.76	73.81	88.66
	Second source of HH income	19.76	2.24	26.19	11.34
	HH consumption use	0.00	0.00	0.00	0.00
Fishing	Main source of HH income	23.12	27.45	12.04	23.02
	Second source of HH income	42.48	26.57	24.47	32.81
	HH consumption use	34.40	45.99	63.50	44.17
Making or repairing fishing gear	Main source of HH income	0.00	75.45	0.00	62.88
	Second source of HH income	100.00	15.45	0.00	14.39
	HH consumption use	0.00	9.09	100.00	22.73

Source: Phan et al. (2016)

There is a continuing shift in involvement in the capture fishery. Many more part-time fishing households quit than full-time fishing households. The reason may be that the main fishing habitats of part-time fishing households are reduced to cultivating the third rice crop and to low water levels in the flood season (Nguyen et al., 2016). In 2016, 120 types of fishing gear were identified, but by 2020, there were 25 commonly used fishing gears. Over a similar period, fish consumption increased from an average of 36.8 kg fish per person per year in 2000, to 51.6 kg in 2015, and to 77.0 kg in 2022. Inland capture fisheries contributed to this increase but by an unquantified amount. It is known that as fishing households catch fish with decreasing size and with decreasing economic value, they shift to using more of their own fish catches for their household's consumption than before. Fishing seasons have also changed: full-time fishers used to be mainly active in the flood season but have now shifted to unclear seasons, except for rivers and estuary areas.

These trends in participation in the capture fishery sector clearly reflect shifting socio-economic benefits from, and dependency on, the fishery as well as food security. But they also have implications for estimating overall production based on estimates of overall fishing activity (e.g. extrapolating catch per unit effort data). For example, in principle, it is possible for catches per fisher (or gear) to remain stable but overall production to decrease (or vice versa). These factors help explain some of the differences in estimates from various data and information sources. They also highlight the need to have a comprehensive, broad, approach to assessing overall productivity, and socio-economic benefits, and not to base estimates on single or limited datasets.

Data for the Mekong Delta confirm that most fishers are male, but the involvement of women can still be high, particularly for collecting OAAs, and their participation is higher than for aquaculture (Figure 8).

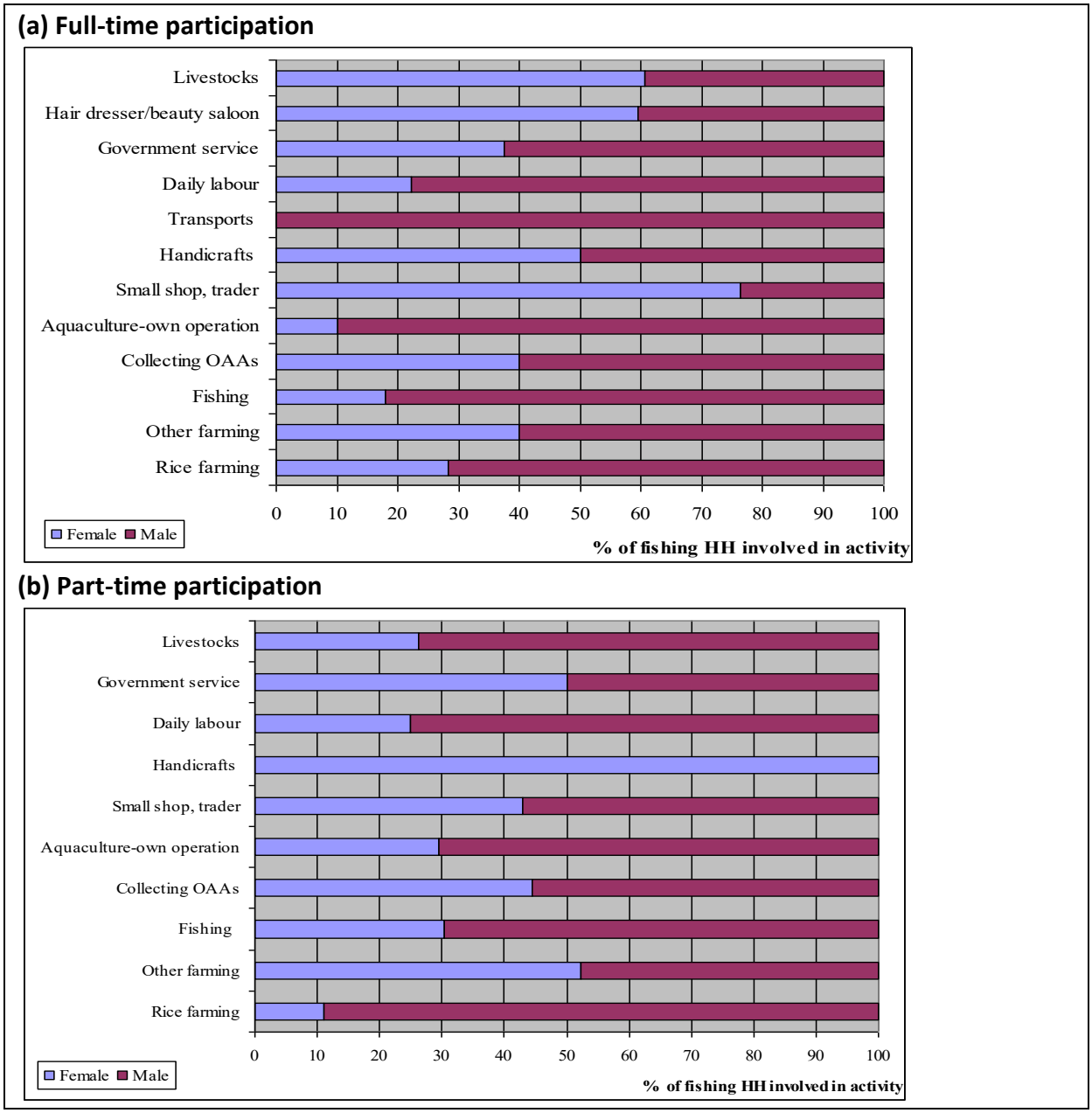


Figure 8. Participation in various activities by gender in the Mekong Basin in Viet Nam

Source: Phan et al. (2016)

Data on age distribution of fishers show that most were 40 to 60 years of age, with an average of 45 in Cambodia and 54 in Thailand (Figure 9). This ageing fishing population in all countries, except possibly for Cambodia, which has a higher proportion of younger fishers but also a younger population, has implications for the future of fisheries, including the sustainability of catches, and food and nutrition security. Urbanization, improved education and moving to

better paid, less onerous jobs may be the reasons for this aging population of fishers (MRC, 2023b).

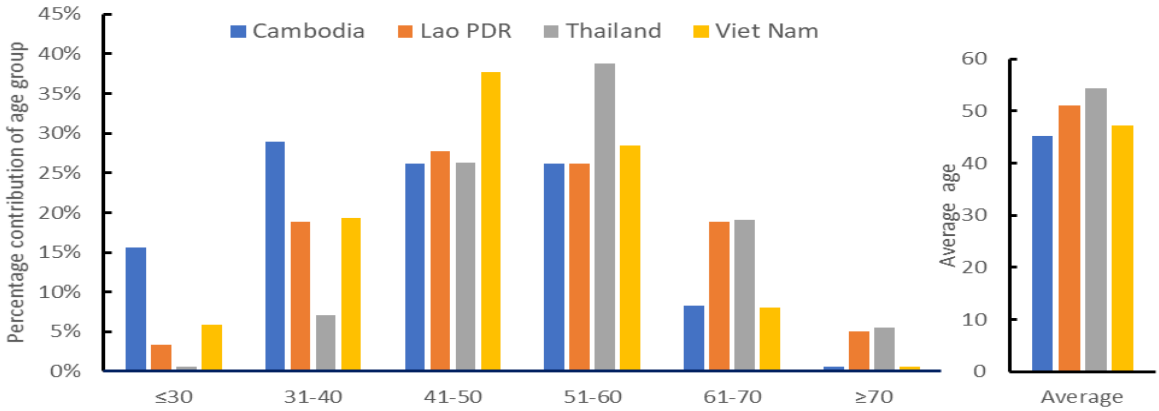


Figure 9. Age distribution and average age of fishers in villages surveyed in 2019–2020 household surveys

Source: MRC (2023b)

Other trends in demographics and socio-economic changes are also occurring. For example, in 2020 in Viet Nam, employment for those aged 15 years and above in the agriculture, forestry and fishery sector accounted for 33.1% of the workforce, an 8.5 % drop against that in 2016 (GSO, 2020). The total number agricultural, forestry and fishery production units were 9.23 million households, a decrease of 1.82% compared to 2016.

There are significant differences across the whole LMB in the social groups involved in capture fisheries versus aquaculture. In general, aquaculture tends to be taken up by agricultural households, although at the small scale, most households adopt mixed livelihoods strategies including capture fisheries. For example, "Decree 09/2000/NQ-CP" in Viet Nam provided for the transfer of low yield agricultural land to aquaculture production. In the Mekong Delta, rice farming in the coastal area was transferred to shrimp farming; fruit garden/orchards along river sides to striped catfish farming; and rice farming in the inland area to giant freshwater prawn farming (MARD, 2009). The total amount of agricultural land converted to shrimp culture was around 310,000 ha during the 1999–2005 period, of which 42% came from low-yield rice land conversion (ibid.). This illustrates that aquaculture is an option mainly for those with access to land. Cage culture in open waters requires limited land, but use rights for the area farmed. There is no clear shift from reliance on full-time professional capture fisheries to aquaculture.

Certainly, for Cambodia, Thailand and particularly Viet Nam, much of the aquaculture production is exported. Although this is an important economic benefit, this exported production does not directly support domestic food security. For example, most catfish production in the Mekong Delta in Viet Nam is exported, and farmers often sell their production directly to the pangasius processors. Catfish accounted for 73% of total production, and more than 95% of total catfish production was traded this way (Phan, 2014). Around 83% of the shrimp production was also exported (Vu et al., 2013). Aquaculture is also vulnerable to shifting market conditions. For example, in Viet Nam, the future of catfish

culture is uncertain because profits cannot keep up with the increase in input costs, especially costs for fish feed. Only those farmers who can run their farms effectively can adapt to survive as profit margins decline. Measures to adapt to climate change may lead to increases in production cost. Most inland capture fisheries production in the LMB supplies domestic consumption and is therefore more immune to international market fluctuations.

3.2 Trends in fish consumption

Fish consumption data can vary widely among studies largely due to sampling differences. Attention to this source of information on the capture fisheries and aquaculture in the LMB has improved in the last two decades following recognition of their value in providing good indications of overall fisheries production in an area, provided that sampling biases and imports and exports to a region (including local/domestic exports) are reasonably well understood.

Recent fish consumption data for the LMB confirm the low contribution of aquaculture to household consumption compared to capture fisheries (Table 9 and Figure 10), even despite the fact that aquaculture production is higher in Lao PDR, Thailand and Viet Nam, and approximately the same in Cambodia. This confirms that aquaculture plays a much less important role in local food security in the LMB than capture fisheries.

Table 9. Mean annual fish consumption rates of fish (excluding OAAs) and aquaculture products derived from the Social Impact Monitoring and Vulnerability Assessment -based and 2020 household surveys (kg/capita/year)

	Social Impact Monitoring and Vulnerability Assessment		**Household surveys**	
	Capture fisheries	**Aquaculture**	**Capture fisheries**	**Aquaculture**
Cambodia	21.10	0.54	35.32	5.58
Lao PDR	21.10	0.54	49.80	8.06
Thailand	76.61	1.43	96.61	31.04
Viet Nam Delta	36.12	5.50	78.29	15.63
Viet Nam Highlands	18.37	1.84	42.88	8.23

Source: MRC (2023b)

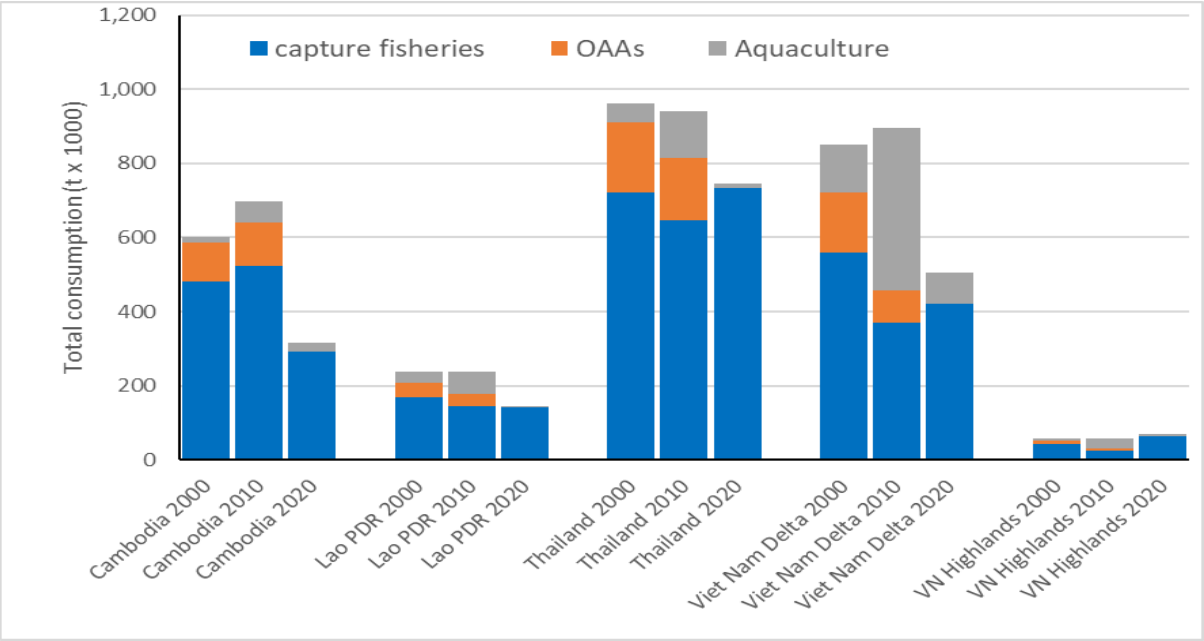


Figure 10. Comparison of total consumption of inland fish, OAAs and aquaculture products based on household consumption studies in the LMB, 2000, 2010 and 2020

Source: MRC (2023b)

Throughout the LMB, fish products remain the main source of animal protein consumption although the relative consumption varies according to local fishery resources availability. According to the five-year agriculture and forestry development plan 2016–2020, fish consumption in Lao PDR increased from 179,000 tonnes in 2016 to 229,000 tonnes in 2020. However, in 2016, fisheries and aquaculture production combined amounted to 114,802 tonnes compared to 179,000 tonnes consumed). This supports the view that capture production is grossly under-reported. Even considering the reported increase in aquaculture production, there is still a shortfall 27,300 tonnes between the amount consumed in 2019 and that produced.

Fish consumption is higher than meat consumption throughout Lao PDR, with no obvious trend in relative consumption between 2012/2013 and 2018/2019, but it is relatively higher in the central and southern regions where fishery resources are better (Table 10). According to the Department of Livestock and Fisheries National Statistics 2022, the average consumption of fish and OAAs was 28.8 kg per capita per year. However, these fish consumption data are based on purchased fish and own catch and aquaculture fish. As a result, these fish consumption estimates are low. MRC (2023b) provides an estimate of between 41.6 and 46.8 kg per capita per year for own fish catches for two provinces in Lao PDR based on more comprehensive assessments.

Table 10. Meat and fish consumption in Lao PDR, 2012/13 and 2018/19

Regions	2012/13		2018/19	
	Meat	Fish	Meat	Fish
North	21.5	19.7	20.2	19.2
Central	19.9	27.8	19.0	33.9
South	20.3	29.3	15.5	25.5
Lao PDR	20.6	25.6	18.3	26.2

Source: Lao Expenditure and Consumption Survey 2018–2019

In Thailand, most of inland aquaculture products are for domestic consumption (DoF, 2022). Data confirm that over 90% of freshwater fish production is consumed, and rest is consumed as salted, dried, steamed, smoked or fermented; only around 0.01% used as animal feed (Table 11).

Table 11. Use of freshwater fish products in Thailand

Year	Total	Fresh consumption	Salted or dried	Steamed or smoked	Fermented				Others	Animal feed
					Fish sauce	Fermented	Shrimp paste	Others		
2021	100	94.42	1.62	1.38	0.03	0.82	0.05	0.45	1.22	0.01
2020	100	93.97	1.32	1.3	0.03	1.22	0.03	0.8	1.33	-
2019	100	93.97	1.32	1.3	0.03	1.22	0.03	0.8	1.33	-
2018	100	94.15	1.66	1.12	0.08	1.34	0.06	1.03	0.56	-
2017	100	78.26	6.51	5.87	0.12	6.2	0.06	2.01	0.97	-

Source: DoF (2022)

The average per capita consumption of animal and aquatic foods has tended to increase rapidly in the last 10 years in Viet Nam (National Institute Nutrition, or NIN, 2022). The average per capita consumption of animal foods was around 1.8 kg/month (84.0 g/day) in 2010 and up to 2.3 kg/month (136.4 g/day) in 2020, and the average per capita consumption of fish/shrimp also increased from 1.2 kg/month in 2010, and to 1.4 kg/month in 2020. Aquatic foods in Viet Nam contributed to a greater share of animal protein intake, accounting for 28.1% of animal proteins and 11.5% of total protein (FAO, 2021).

Data for the Mekong Delta in Viet Nam, as expected, show that the areas that are more inland consume higher proportions of freshwater fish and those in coastal areas, more marine fish

(Table 12). Notably, inland areas consume little marine fish adding confidence to estimates of production based on local fish consumption data. There is also an increase in fish consumption with per capita consumption of fish and OAA protein estimated at 56.1 kg (Hortle, 2007), and then up to 74.4 kg in 2015 (Phan *et al.*, 2016).

Table 12. Consumption of fish and OAAs in five separate studies Viet Nam delta provinces

Items	Study 1: Tien Giang in 1998 in kg/capita/year	Study 2: An Giang in 1999 in kg/capita/year	Study 3: An Giang in 2000 in kg/capita/year	Study 4: Tra Vinh in 2001 in kg/capita/year	Study 5: An Giang/Tra Vinh in 2015 in kg/capita/year
Total inland fish	29.6	60.2	49.5	36.2	64.8
Fresh inland fish	29.6	48.1	36.8	22.7	51.6
Preserved fish	*	12.1	12.7	13.5	13.2
OAAs	*	*	12.1	7.6	9.5
Marine fish	*	0.1	*	9.9	*
Total fish and OAAs	**29.6**	**60.3**	**61.6**	**53.7**	**74.4**

Source: Hortle (2007); Phan et al. (2016); NIN (2022)

4. LMB FISHERIES AND CLIMATE CHANGE

4.1 Projected impacts of climate change on capture fisheries in the LMB

Capture fisheries in the LMB are vulnerable to changes in hydrology, which may be one of the more prominent impacts of climate change on the system (MRC, 2019). However, for the last ten years, no clear trend can be observed in the extent of flooding, possibly due to increased regulation. The range of impacts across the LMB have been simulated on hydrology, flood and drought behaviour, hydropower production, food production (crop yield, fisheries and aquaculture), ecosystem and biodiversity, as well as livelihoods (MRC, 2018). Also, there have been very significant changes in vegetation cover, forests, biodiversity and ecosystems across the LMB. Consequently, it is not possible to determine the extent to which climate change has contributed to the hydrological changes observed. It is possible to conclude that non-climate-related impacts (e.g. from water resources infrastructure) are the main drivers of change.

According to a global review of climate change and capture fisheries and aquaculture (Barange et al., 2018), the implications of climate change for individuals, communities and countries will depend on their exposure, sensitivity and adaptive capacity. Some of the main potential impacts of climate change on freshwater fishes and fisheries are listed in Table 13. In some cases, fish yields could increase, but the combination of climate change and other global change drivers will potentially reduce the quality and quantity of fishery yields, with subsequent impacts on those most vulnerable to the reduction in access to food supply. This highlights the need for effective incorporation of inland fisheries into development planning when examining the perceived and future impacts of climate change.

Table 13. Physiological and ecological impacts of climate change on freshwater fishes and fisheries at different levels of biological organization

Level of biological organization	Potential impact on fisheries
Individual/population level	
Phenotypic capacity	The capacity of an individual fish to respond to abiotic or biotic variation presented by short-term climate-related stressors.
Epigenetic effects	These are relatively short or rapid temperature-influenced gene responses resulting in phenotypic changes. This affects the capacity of fishery professionals to predict characteristics of the stock.
Physiological functions	Temperature and dissolved oxygen affects the fishes' performance and the capacity of an individual to thrive and to grow to a fishable size. Growth rate and body size. Linked to physiological function, this has a direct impact on fish yield. This is strongly influenced by temperature.
Metabolic rate and energetic requirements for growth and reproduction	As water temperatures fall outside of individual tolerances, fish have to devote increased energy to maintain their metabolic status, which reduces the amount of energy available for investment in somatic growth (that impacts potential yield) or for gonadal investment (that impacts the capacity of fish to replace themselves).

Level of biological organization	Potential impact on fisheries
Developmental time	The time taken for fish to fulfil their life cycle and to recruit to the fishery. Risk of larval mortality (and lack of supply to the fishery) if hatching does not coincide with abundant food or suitable conditions. This is linked to climate change through variations in timing of river flows, temperature and rainfall cues as well as seasonal fertility in water bodies.
Maturation, sex determination, reproductive investment and behaviour	The reproductive cycle and breeding behaviour of many fish are driven by predictable seasonal changes in temperature or water levels. Changes in these factors may affect the breeding and population dynamics of the fish stocks
Migration	Cues for migration are typically environmental (water level, flow, temperature), and if conditions shift following climate change, this may affect the timing and scale of migration in fish, or even form barriers to migration with consequences for reproduction, growth and yield.
Immune response, disease and parasitism	Changes in water temperature, flow and depth, etc. can affect the capacity of individual fish to withstand infection as well as the probability of encountering disease and parasites, with subsequent impacts on growth and potential yield.
Heat shock, hypoxia, UV and other stresses	Short-term impacts from extreme weather events (e.g. high or low temperature), which result in reduced individual growth and performance, even mortality, affecting the quality and size of the fishable stock.
Exposure to stressors and uptake of contaminants	Increased water temperatures and reduced flow/water levels can result in increased contaminant concentrations and uptake, reducing the quality or suitability of the catch for consumption.
Prey availability, foraging capacity and diet	Since freshwater fishes are poikilotherms, their metabolic demands scales with water temperature. Increased water temperatures result in increased food requirements and feeding rate. Changes in water levels and temperature can affect the availability and quality of prey. Together, these factors can impact the availability of sufficient food.
Mortality and predation risk	Fish mortality is related to water temperature – i.e. increases in water temperature will likely result in increased mortality and reduced potential fisheries yield. Changes in water temperature, flow and depth affect the probability that an individual fish will be consumed by a predator.
Habitat suitability and availability	Abiotic shifts following climate change may result in habitats not being suitable or available to fish stocks, affecting abundance and biomass, or even access for fishers.
Life history characteristics (size, age and sex structure), recruitment, population dynamics and potential fishery yield	Long-term changes in selective forces driven by climate change may result in fish stocks undergoing changes in key life history characteristics (e.g. age and size at maturity, maximum size, growth rate) with consequences for fisheries regarding regulations, gears used, catchability and yields, etc.
Distributional shifts, colonization, local extinction and population fragmentation	The suitability of individual habitats and ecosystems will vary following climate change and subsequent shifts in abiotic conditions. For some sensitive species, conditions will no longer be suitable and if possible, they will have to migrate to a suitable new habitat, which may mean that they are no longer accessible to local fishers (but may also provide be opportunities for fisheries in their new habitat). Some fishes or locally adapted genotypes will be unable to migrate and will become locally or even globally extinct. Other fishes that are currently limited by unsuitable conditions may gain habitat and widen their distribution and potential for exploitation

Level of biological organization	Potential impact on fisheries
Community level	
Interspecific interactions	Fishes exist in a complex biotic network interacting with other species (prey, predators, competitors, parasites, etc.), all of which will show different reactions to the impacts of climate change. This will affect the strength and form of ecological interactions between species, limiting the capacity to predict responses and associated ecosystem function, for example, multispecies fisheries yield.
Changes in fish community structure, loss of functional diversity and biotic homogenization	As species change their distribution in response to shifts in conditions, the species composition of freshwater ecosystems will change, including increased potential for non-native fishes to become established, if conditions are suitable. Species assemblages may be formed that are unique, making it difficult for fisheries scientists to provide guidance on fishery operations: conversely, they may represent significant opportunities for new fisheries Generally, warm-water adapted species become increasingly widespread, it is likely that fish communities will become more homogeneous over space and time. Although this is generally considered negative from an ecological viewpoint, it may be an opportunity for fishers as fishing gears and methods will be able to be standardized.
Capacity of protected areas or closed seasons to conserve fishes	Fishing is commonly prohibited during certain times of the year (spawning period) or areas (spawning habitats) in order to help conserve stocks. Due to climate change, these restrictions may no longer provide protection because of shifts in phenology or habitat suitability, and therefore provide little support for stock maintenance.

Source: Harrod et al. (2018b)

Cambodia and Lao PDR are among the countries with inland capture fisheries projected to be under current and future low stress from climate change, whereas inland capture fisheries in Thailand and Viet Nam are considered to be under medium current and future stress (Harrod et al., 2018a); however, for Thailand, this is a national assessment, and the LMB in Thailand may have similar vulnerability to Lao PDR. The same study concluded that freshwater aquaculture in Lao PDR and Viet Nam was estimated as among the most vulnerable to climate change in Asia. Thailand and Viet Nam are among the countries with highest vulnerabilities to climate change regarding brackish water aquaculture; however, in Thailand, this aquaculture is located outside the LMB.

The Mekong system has evolved against a background of predictable annual hydrological cycles. Even minor shifts in low flows or the timing of the wet season may affect the ecology of the river and the ecosystem services it provides to humans, including inland fisheries. The projected increases in flow during the wet season will likely result in increased flooding, for example, in Tonle Sap (MRC, 2018). This may be positive for fish, expanding spawning, nursery, and growth habitat, with likely bring positive effects for the fishery. Extreme flooding, however, may be catastrophic for human populations. The projected reductions in flow during the dry season (ibid.) are of more concern, as they will extend the period spent by fish in refuge pools, and the severity of conditions in the pools. MRC (2017c) projected that drier conditions in the LMB would reduce fish yields by at least 15%.

The indirect impacts of climate change on fisheries and aquaculture in the LMB from potential adaptation measures are likely to be more significant than direct impacts. The key factor determining the impacts of climate change on the fisheries will be how countries adapt to climate change. For example, any reductions in dry season precipitation will also lead to increased demands for water for irrigated rice, which grows during the dry season (Pech, 2013), with implications for fisheries. MRC (2017c) predicted that the fish populations would be reduced by between 25% and 40% due to run-of-river hydropower schemes in the mainstream Mekong. This does not include impacts of hydropower schemes constructed on major tributaries where modelling results indicate that the impact of 78 proposed tributary dams would further reduce the biomass of migratory fishes by 19% (Barlow et al., 2008; Ziv et al., 2012).

The direct impacts of climate change on capture fisheries will occur primarily through impacts on the fish stocks but they will lead to impacts on the fishery- and aquaculture-dependent communities, for example, through intensified competition for fishing areas, migration by fisherfolk, and increased production costs. There is a very high degree of uncertainty both about the actual climate change impacts on the ecosystems of the LMB and fish stocks, and subsequently, on capture fisheries and aquaculture. Consequently, it is not possible to conclude on the exact nature of changes that will occur. However, it is certain that changes will occur. Therefore, one necessary response is to build resilience to change in the capture fishery and aquaculture through adaptation measures.

Some national assessments of the predicted impacts of climate change on capture fisheries in the LMB have been carried out; for example, Ngor, Nam and Degen (2014) for the LMB, Halls (2009) for Cambodia and Viet Nam, and Bui et al. (2013) for the Mekong Delta in Viet Nam. The results are relatively consistent across the four MCs and essentially reflect many of the relevant impacts shown in Table 13. There are some differences among them due to their geographic location (e.g. impacts of sea-level rise will predominantly occur in the Delta). The main impacts arise from: expected higher temperatures; changes in precipitation and flows; extreme events (e.g. storms, severe drought); changes to water quality; and sea level rise and salinity. Some of these changes may be beneficial for capture fisheries in the LMB, but overall declines are predicted.

4.2 Capture fisheries in the LMB and climate change adaptation

4.2.1 Available general guidance on adaptation measures for inland capture fisheries

Adaptation to climate change is defined as the extent to which the community takes action to prepare and live with the effects of climate change; examples of measures for climate change adaptation identified from assessments on capture fisheries are shown in Table 14. Importantly, measures extend well beyond physical interventions (e.g. ecosystem restoration activities) and include adaptation of policy, legal frameworks, institutions, management, planning, livelihoods approaches and risk reduction.

Table 14. Examples of adaptation tools and measures in capture fisheries

INSTITUTIONS

Public policies

- Public investments (e.g. research, capacity building, sharing best practices and trials, communication)
- Implementation of climate change adaptation policies and plans that address fisheries
- Provision of incentives for fish product value addition and market development
- Removal of harmful incentives (e.g. for the expansion of fishing capacity)
- Mitigation of poverty and food insecurity, which systemically limits adaptation effectiveness

Legal frameworks

- Flexible access rights to fisheries resources in a changing climate
- Adaptive legal rules
- Dispute settlement arrangements
- Regulatory tools (e.g. adaptive control of fishing pressure; move away from time-dependent effort control)

Institutional frameworks

- Effective arrangements for stakeholders' engagement
- Awareness raising and capacity building to integrate climate change into research, management and policy rules

Management and planning

- Inclusion of climate change in management practices, e.g. Ecosystem Approach to Fisheries, including adaptive fisheries management and co-management
- Inclusion of climate change in integrated coastal zone management
- Improved water management to sustain fishery services (particularly inland)
- Flexible seasonal rights
- Temporal and spatial planning to permit stock recovery during periods when climate is favourable
- Transboundary stock management to consider changes in distribution
- Enhanced resilience by reducing other non-climate stressors (e.g. habitat destruction, pollution)
- Incorporation of traditional knowledge in management planning and advice for decision-making
- Management/protection of critical habitats for biodiversity and recruitment

LIVELIHOODS

Within sector

- Diversification of markets/fish products, access to high value markets, support to diversification of citizens' demands and preferences
- Improvement or change post-harvest techniques/practices and storage
- Improvement of product quality: eco-labelling, reduction of post-harvest losses, value addition
- Flexibility to enable seasonal migration (e.g. following stock migration)
- Diversification of patterns of fishing activities with respect to the species exploited, location of fishing grounds and gear used to enable greater flexibility
- Private investment in adapting fishing operations, and private research and development and investments in technologies, for example, to predict migration routes and the availability of commercial fish stocks
- Adaptation-oriented microfinance

Between sectors

- Livelihood diversification (e.g. switching among rice farming, tree crop farming and fishing in response to seasonal and interannual variations in fish availability)
- Exit strategies for fishers to abandon fishing

RISK REDUCTION AND MANAGEMENT FOR RESILIENCE

Risk pooling and transfer

- Risk insurance
- Personal savings
- Social protection and safety nets
- Improved financial security

Early warning

- Extreme weather and flow forecasting
- Early warning communication and response systems (e.g. food safety, approaching storms)

Monitoring climate change trends, threats and opportunities (e.g. monitoring of new and more abundant species)

Risk reduction

Risk assessment to identify risk points
Safety and vessel stability
Reinforced barriers to provide a natural first line of protection from storm surges and flooding
Climate-resilient infrastructure (e.g. protecting harbours and landing sites)
Underlying poverty and food insecurity problems addressed

Preparedness and response

Building back better in post-disaster recovery
Rehabilitation of ecosystems
Compensation (e.g. gear replacement schemes)

Source: Poulain et al. (2018)

4.2.2 Potential impacts and opportunities to fisheries from adaptation measures in other sectors

How other sectors adapt to climate change provides both challenges and opportunities to the inland fisheries sector. For example, adaptation measures in agriculture will likely target water resources availability in the dry season. However, there are other options available. Adopting more 'green' options, such as nature-based solutions or ecosystem-based approaches, through, for example, measures such as improving soil health, restoring land cover, reforesting catchments, and using more drought tolerant crops will likely be positive for fisheries. Increasing water use through increased reservoir storage will likely increase negative impacts on fisheries. Capturing the opportunities presented by climate change adaption in other sectors, and avoiding maladaptation will have a major bearing on outcomes for fisheries in the LMB. This highlights the need for integrated cross-sector planning and opportunities for the MRC to further promote integrated basin-wide planning.

There are many potential adaptation measures for each sector, with potential positive and negative impacts on inland fisheries. There are also additional measures that the fisheries sector might adopt to mitigate negative impacts, some of which are shown in Table 15. The table shows some of the potential benefits by adopting integrated climate change adaptation. Identifying and building on 'win-win' outcomes, or synergies among the sectors will be key to achieving sustainability in the face of multiple threats and pressures.

Table 15. Sectoral adaptation actions, potential loss/impact, opportunities and inland fishery adaptation

Sectoral adaptation actions	Potential loss/impact	Opportunity	Inland fishery adaptation
Urban and industrial areas			
Increased abstraction and storage of water to meet demand for potable drinking water.	Restrictions on access to fishing in water bodies.	Water bodies managed for water quality. Increased fish biodiversity. Potentially new food or recreational fisheries.	Develop and manage recreational and food fisheries in accordance with water body potential (e.g. potential fisheries enhancements).

Sectoral adaptation actions	Potential loss/impact	Opportunity	Inland fishery adaptation
Urban/industrial protection demands flood controls and river training	River flows regulated, and river course managed, leading to homogenization of the channel, and loss of essential habitat both in-channel and in the floodplain, for example, spawning, nursery and feeding areas. Reduced flooding and floodplain connectivity, which reduces productivity. Flood control to protect critical urban developments and agricultural areas.	Possibilities for win-win scenarios through holistic management of floods that preserves river dynamics and ecological flows.	Develop flood management plans that meet the requirements of water managers and the aquatic ecosystem.
Changes in emissions of pollutants in air and water to mitigate climate change.	Possible reduction in productivity thorough reduced nitrogen deposition from NOx. Potential shifts in fish community structure may affect catch structure	Improved quality of freshwater and fish.	Establish monitoring programme to provide managers, fishers and other stakeholders with relevant information.
Food and forestry production sector			
Changes in conditions (temperature, precipitation, CO_2 concentrations) drive changes in long-standing farming practices, for example, shifts from pastoral to arable farming, new crops, sowing periods, and the reduction of fallow periods.	Changes in disturbance and run-off patterns through the agricultural year. Increased exposure to agrichemicals. New crops change inputs of allochthonous materials into waterways.	With awareness and proper planning inland fisheries considerations can be built into development plans.	Develop catchment-level management plans to minimize impacts on receiving waters and allow for overall improved management of fisheries.
Changing precipitation demands increased agricultural irrigation and irrigated areas.	Increased abstractions for rivers and water bodies. Extreme removals dewater the environment and result in a loss of fisheries.	Increasing construction of water bodies for water storage and movement creates new habitat.	Initiate stocking programmes and stock management.
Construction of water storage ponds for irrigation.	Possible loss of natural standing waters to construct water storage ponds.	Increasing construction of water bodies for water storage and movement creates new habitat.	Initiate stocking programmes and stock management.

Sectoral adaptation actions	Potential loss/impact	Opportunity	Inland fishery adaptation
Flood proofing of roads, and conurbations	Partitioning of floodplains and loss of connectivity reduce fish productivity. Possible loss of natural standing waters to construct water storage ponds.	Include mitigation actions (to be identified in environmental impact assessments /EIAs) in infrastructure development projects at the planning stage.	Undertake mitigation actions through fish transparent weirs and culverts; restore refuges and habitats within systems; implement holistic, fish friendly water management and ensure minimum flows and water levels. Develop fisheries through enhancements/stocking.
Water and resource use efficiency drives the intensification of agricultural or livestock production.	When poorly managed, this leads to: increased run-off of nutrients, pesticides, sediment into water courses; increased water abstraction from rivers.		Implement stronger regulatory controls and environmental management measures to limit external impacts on water courses and water bodies. Implement payment for ecosystem services.
Climate-driven land use change – increases/decreases in agricultural or forested land.	Continued degradation of agricultural land, and associated fish habitat increases.	Minor changes to field boundaries and riparian zones can have major positive impacts.	Rehabilitate degraded land and increase land cover to reduce impacts of erosion and run-off. Implement catchment-based active management to minimize impacts and ensure the participation of the inland fisheries sector.
Farmland abandonment.	Loss of water management and managed wetland habitat (e.g. rice fields, water meadows).	Increased cover of mature vegetation and forest results in improved catchment integrity, improved water quality in run-off, and improved riparian habitat quality. These all benefit fish, and result in increased stocks.	Promote reforestation of abandoned farmland
Increased saline intrusion as a result of water abstraction from rivers or increased storage	Changes in the salinity regime may alter fish diversity and food webs in delta areas.	Possible extension of range in deltaic habitats and fisheries for euryhaline adapted species.	Develop new fisheries. Establish a monitoring programme to provide managers, fishers and other stakeholders with relevant information.
Energy sector			

Sectoral adaptation actions	Potential loss/impact	Opportunity	Inland fishery adaptation
Increased hydropower generation.	Impacts occur on riverine fisheries, flooding and flow. Loss of migratory routes. Changes in habitat from riverine to lacustrine habitats, which impact the largest and most iconic of freshwater species (e.g. sturgeons, giant Mekong catfish, pimelodid catfishes). Reduced sediment and nutrient supply downstream. Loss of nutrients upstream (spawning mortalities). Potential accumulation and liberation of heavy metals and other toxic substances in reservoirs	The inclusion of mitigation actions (to be identified in environmental impact assessments) in dam design and operation at the planning stage. New fish habitats become available. Potential to develop cage aquaculture in newly formed reservoir habitats.	improve fish passages and management of dams to sustain basic ecological flows to mitigate some impacts. Establish fisheries in the reservoirs created as a partial replacement of lost riverine and floodplain fisheries, which may require stocking and the introduction of new species.
Biofuel production.	Drainage of wetlands (e.g. peatlands drainage for palm oil leads to loss of fisheries). Loss of riparian habitats to biomass plantations and release of sediments and agrochemicals into the channel.	Few alternatives or opportunities beyond the construction of wetland refuges or management of areas to protect key floodplain or wetland habitats.	

Sectoral adaptation actions	Potential loss/impact	Opportunity	Inland fishery adaptation
Development of wind energy.	Habitat degradation, land use change and sediment mobilization during the construction phase, especially in upland areas. Changes in local microclimate (warming effect during the night and a cooling effect during the day).	Changes in air temperature may benefit production in some fish species.	Apply catchment-based active management to minimize impacts.
Development of floating solar farms on lakes and reservoirs	Loss of primary productivity and mixing as a result of shading and change in wind patterns	If the water surface is not totally covered, solar panels may represent a refuge from avian predation, increasing survivorship and fisheries yield	Develop management regulations taking into consideration that fish may aggregate under floating elements.
Nuclear energy.	Impacts of thermal discharge on receiving waters	Provision of improved rearing habitat for stocked fishes. Increased growth rates of fish from associated waters	Develop management regulations taking into consideration that fish may aggregate around the outflow of cooling water.
Installation and maintenance of energy-production infrastructure (e.g. pylons, service roads).	Short-term impacts: disturbance, habitat degradation, land-use change and sediment mobilization during the construction phase. Possible increased risk of negative impacts through extended road networks, e.g. construction of housing and the spread of invasive species.	Access to new areas for fisheries exploitation.	Develop management measures for new fishing areas.
Environmental restoration and rehabilitation management as part of flood control, carbon sequestration or rehabilitation of degraded land			

Sectoral adaptation actions	Potential loss/impact	Opportunity	Inland fishery adaptation
Reforestation and improved watershed management	Few or no anticipated negative impacts. Potential shifts in water flows. Possible acidification and browning of waters during initial phases of reforestation.	Reduced erosion and sedimentation. Possible improvement in dry season flow by maintaining higher baseflow; reduction in flash flooding. Stream temperature regulation, provision of structured habitats and allochthonous energy and nutrients	Ensure inland fisheries are consulted before making management decisions.
Wetland construction or rehabilitation (as part of flood control or restoration)	Few or no anticipated negative impacts.	Extension of fisheries habitat	Restore riparian habitat. Reconnect wetlands and rivers. Actively stock and/or enhance stocks to develop fisheries.
Restoration of contaminated land.	Possible release of contaminants into waterways during restoration works.	Improvements in habitat quality over the long-term and reduced risk of contamination. More benign conditions for inland fish.	Raise awareness among fishers regarding the dangers associated with the release of contaminants.

Source: Harrod et al. (2018a)

4.2.3 Available general guidance on pro-poor and food security focussed adaptation measures

The growing calls to focus on the adaptive capacity of communities to increase their resilience to climate change, to reduce poverty and to provide input on best adaptation practices are reflected in the Nairobi Programme under the UNFCCC (see Subsidiary Body for Scientific and Technological Advice (SBSTA) Draft Conclusions, FCCC/SBSTA/2017/L.7 of 16 May 2017). UNFCCC Technical Guidelines for National Adaptation Plans *(*NAPs) provide technical guidance on the integration of fisheries and aquaculture in the formulation and implementation of NAPs (Brugere and De Young, 2020). This serves as supplementary guidance to FAO's Addressing agriculture, forestry and fisheries in National Adaptation Plans – Supplementary guidelines (Karttunen et al., 2017). The fisheries and aquaculture NAP guidance aims to: assist fisheries and aquaculture institutions to integrate their knowledge into the climate change world and language, and articulate their needs; ensure that the visibility and specificities of fisheries and aquaculture are captured in the process to formulate and implement NAPs; support the mainstreaming of fisheries and aquaculture in the NAP implementation; and, more broadly, support adaptation planning within fisheries and aquaculture.

Kalikoski et al. (2018) provided general guidance on measures for and approaches to climate change adaptation in inland fisheries and aquaculture; the most relevant of them to the LMB, are as follows:

- Climate change affects communities and livelihoods in fisheries and aquaculture, and efforts to adapt to and mitigate climate change must be human-centred.
- Climate adaptation strategies must emphasize the need for poverty eradication and food security, in accordance with the Paris Agreement, the United Nations 2030 Agenda for Sustainable Development, and other international instruments, such as the Voluntary Guidelines for Securing Sustainable Small-Scale Fisheries in the Context of Food Security and Poverty Eradication (FAO, 2015).
- Measures to eradicate poverty and provide food security for people in fishing and aquaculture communities are also instrumental for climate change adaptation, and should be integrated in the formulation and implementation of national adaptation plans.
- Climate change adaptation for building resilience must be multi-dimensional and multi-sectoral to help people out of poverty and to prevent them from descending further into it.
- Capacity at the national, regional and local levels of governance should be mobilized to facilitate climate change adaptation for the poor and vulnerable.
- To address climate change vulnerability, management systems must create opportunities for fishers, fish farmers and fish workers in order to flexibly and sustainably utilize diverse livelihood opportunities.
- Climate change adaptation should empower local stakeholders to allow for meaningful participation of the poor and vulnerable, and safeguard their human rights.
- Climate change adaptation measures must address issues of power imbalances and inequity disadvantaging the poor, for example, those related to gender, labour conditions, tenure rights, market access, migration patterns and stakeholder conflicts.
- The impact of climate change and adaptation measures for the poor and vulnerable must be monitored at different scales and dimensions, focusing on achievements, best practices and on possible maladaptation.
- There is a need for the countries to put a stronger emphasis on poverty and food security in the context of fisheries and aquaculture within their nationally determined contributions (NDCs).

4.2.4 Adaptation measures identified among MCs in the LMB

General measures

In 2018, the MRC released the Mekong Climate Change Adaptation Strategy and Action Plan, which provides guidance on climate change mainstreaming and implementation adaptation measures across the LMB (MRC, 2018). Basin-wide climate change adaptation measures in general for the LMB have been reviewed (MRC, 2019). In general, the adaptation measures identified among MCs in the LMB include larger-scale, basin-wide, adaptation measures as well as localized interventions. Many of these measures, particularly those aimed at improving environmental conditions and resilience, can be expected to benefit capture fisheries. As

noted earlier, integrated approaches will be required to seize the opportunities that may benefit fisheries.

All MCs have developed policies, strategies and/or plans to respond to climate change, and have established both operational and oversight bodies to oversee adaptive actions. All MCs have ratified the United Nations Framework Convention on Climate Change (UNFCCC) and have submitted at least two National Communications to the Convention, acknowledging the importance of climate change adaptation and stressing the need for increased research to develop and implement effective response measures. In addition, all four countries are signatories to the Paris Agreement.

Specific measures for fisheries

Adaptation measures specifically for capture fisheries have been identified at basin-wide and national level. Ngor, Nam and Degen (2014) identified some climate change adaptation measures for the LMB.

As regards to Cambodia, under the Cambodia Climate Change Strategic Plan 2014–2023, the Ministry of Agriculture, Forestry and Fisheries developed and implemented the Climate Change Priority Action Plan 2016–2020 for Agriculture, Forestry and Fisheries, which provides some relevant implementation progress indicators and targets. The following are general adaptation measures and specific measures for capture fisheries identified by Cambodia:

1. General climate change adaptation measures:
    a. promoting systems that are more adaptive and resilient;
    b. building capacity;
    c. improving information, monitoring and knowledge management;
    d. adding value through the supply chain;
    e. strengthening capacities for risk reduction in the sector;
    f. enhancing fisheries related early warning systems;
    g. integrating disaster risk reduction and climate change adaptation measures into recovery and rehabilitation initiatives in the fisheries sector;
    h. promoting good postharvest practices via using renewable energy efficiency along fisheries value chains; and
    i. controlling invasive alien species.

2. Specifically for capture fisheries:
    a. managing and rehabilitating critical fisheries habitats to strengthen climate resilience, including ecosystem restoration (land cover restoration, maintaining or restoring connectivity, creating dry season refuges and protected areas, etc.); and
    b. promoting community-based fisheries management and co-management.

Cambodia' measures as above are less comprehensive than those recommended in Table 14. For example, policy, institutional and legal measures are not fully addressed. Many measures also refer to outcomes but do not identify actual measures required to achieve them. Importantly, these initial indications of adaptation measures need to be supplemented with a more detailed analysis of which measures deliver the best outcomes and which are the most

cost effective, although more detailed approaches are not in place in most countries world-wide.

The incorporation of inland capture fisheries into the NDC to the UNFCCC varies among the MCs. The Second NDC of Cambodia strongly focuses on the climate change adaptation of capture fisheries such as by promoting climate resilience in the capture fisheries sector and reducing fishing pressure, and through its programme on fishery management promoting climate resilience in the fisheries sector. The Cambodia Climate Change Strategic Plan 2014–2023 (Cambodia National Climate Change Committee, 2013) includes strategies to: increase productivity of fisheries; improve effective fisheries management; enhance community fisheries management; promote management and conservation of fisheries and aquaculture in a sustainable manner; and enhance capacity to understand climate change in the fisheries sector. The Cambodia national communication strategy for the NDC also has a section dedicated to fisheries (GSSD, 2018).

The NDCs for Lao PDR (UNFCCC, 2021) and Thailand (2022b) make no reference to capture fisheries.

The NDC of Viet Nam (UNFCCC, 2022b) mentions recently approved national strategies for fisheries development, the law on fisheries, and the master plan for the Mekong Delta, but without further details.

The Viet Nam Resolution No.120/NQ-CP of 17 November 2017 of the Government on sustainable and climate-resilient development of the Mekong River Delta), although general, it does focus on the interconnectedness of policy areas, for example:

> The transformation of the development model must be based on the ecosystem, ensuring conformity with natural conditions, biodiversity, culture, people and natural laws. This can be achieved by combining advanced and modern technology with traditional knowledge and experience, ensuring stability and livelihoods, in which fishers/farmers and businesses play a central role, the State plays a decisive role, guiding, leading and promoting innovation, creativity and supporting start-ups, accelerating the application of scientific and technological advances, especially achievements of the Fourth Industrial Revolution. The transition needs a long-term vision, prioritizing climate change adaptation, but also taking advantage of opportunities to develop a low-carbon economy, a green economy, and protect natural ecosystems.

Importantly, all the above measures that were identified in assessments in the LMB (mainly from global assessments and guidance) to adapt capture fisheries to climate change are the same as those needed to sustain the capture fishery in general, for example, restoring habitats, maintaining or restoring hydrology, reducing habitat fragmentation, managing fishing effort, and improving resilience. Hence, they are largely the same as the measures already required to respond to non-climate related drivers. This is because, in general, climate change exacerbates the drivers of change (threats) to the capture fishery. It essentially provides additional justification for general measures to support sustainability. In effect, climate change adaptation needs to justify increased investment in general fisheries

management and development. Since climate change is likely to have an increasing prominence in policies and investment, there will be an increasing need to more explicitly include climate-change adaptation in project and funding proposals for fisheries.

4.3 Greenhouse gas emissions from capture fisheries in the LMB

Measures for ensuring sustainability and international commitments, such as the Paris Agreement, have prompted increased attention to the significant role of food production systems in climate change mitigation; i.e. needs to reduce their GHG emissions. In capture fisheries, carbon intensity is defined as the amount of GHG emitted (in CO_2eq) per unit weight of fish produced at the point of landing (Mitchell and Cleveland, 1993). This essentially involves the emissions from fuel used to catch the fish. GHGs can also be released through non-fuel use processes in fish production and associated activities, such as the loss of refrigerants, and fuel used in transporting and processing the fish after landing. Using the GHG emissions up to the point of landing enables comparisons between fishing methods and fisheries. It also enables comparisons with alternative food production methods, in particular aquaculture and meat production, where GHG emissions are calculated based on emissions from inputs into production at the point of harvest or slaughter; however, for capture fisheries, also emissions from inputs after initial production.

For comparative purposes, in 2012, globally, fishing vessels emitted 172.3 million tonnes of CO_2eq, about 0.5% of total global CO_2 emissions that year (Barange et al., 2018). However, this calculation is based almost entirely on marine capture fisheries where fuel use in fish catching is the norm. In 2010, it was estimated that emissions from aquaculture doubled, i.e. 385 million tonnes of CO_2 equivalent, , around 1% of emissions in that year. Emissions from aquaculture amount to around 7% of those from agriculture (Hall et al., 2011). Most of the GHG emissions from aquaculture are caused primarily by the production of raw feed materials and, secondarily, with the transport of raw materials to the mills and finished feeds to the farms (Hasan and Soto, 2017; Robb et al., 2017). Overall, the energy use of protein production per unit mass of fish from marine fisheries and aquaculture is similar to that of chicken production, but is much less than that from other land-based systems such as pork and beef (Parker and Tyedmers, 2015).

In inland fisheries, static fishing gears dominate production; i.e. gears used do not require a fossil fuel driven engine or fuel use for their operation. Therefore, it can be assumed that GHG emissions from inland fisheries will be much lower overall than from marine fisheries. This is particularly obvious in the LMB. For Cambodia, Proclamation (Prakas) No. 630 of 24 November 2010 lists the kind of fishing gears allowed of these, only *Uon* (drag net) involves the use of engine power. The FADM in 2020 recorded catches from motorized gears in Cambodia were negligible (less than 1%). Lao PDR has a similarly large variety of fishing gears, with 108 types operating, all of which are static (FADM results for 2022). The SEAFDEC-Sweden Project: Mekong River Sub-region (2018) recorded 18 types of fishing gears operated in the Mekong River in Bokeo Province, none of which were motorized. Currently, there are over 150 types of fishing gear in use in the LMB in Thailand. Since most aquatic habitats cannot be fished efficiently with large gears, most of the catch is still taken by the small-scale family fisheries. The Office of National Water Resources (2022) reported the CPUE and species caught by various types of fishing gear in provinces along the Mekong River in Thailand in 2021. No active

(engine-driven) gears were recorded. Around 85 to 315 fishing boats were operating in each province on the Mekong River in Thailand, but almost all are not operating mobile (engine-driven) gears. The eight most commonly used fishing gears are gillnets, long line hooks, hooks, traps, cast nets, seine nets, funnel basket traps and dip nets (Office of National Water Resources, 2022).

Viet Nam is the only MC in the LMB in which there is a significant number of active engine-driven fishing gears are used. These are mostly used by small-scale trawling operations in the lower part of the Mekong Delta in Viet Nam as well as some industrial-scale operators. These operators fish in the brackish water transitional zones at sea where there is no clear demarcation of the LMB boundaries. Also, many motorized fishing operations catch fish in the coastal zone and land it at ports located inland in the LMB. Therefore, it can be difficult to disaggregate catches and catching methods by fishing location of fishing due to this lack of demarcation. For the inland areas of the LMB in Viet Nam, there are many and various fishing gears, which include both traditional and industrial, as well as individual and group operations (Nguyen et al., 2006). None of these qualify as active gear, that is being engine-driven. Part-time fishing households do not use any form of motorized fishing gear.

The NDCs of Cambodia (UNFCCC, 2020), Lao PDR (UNFCCC, 2021), Thailand (UNFCCC, 2022b) and Viet Nam (UNFCCC, 2022b) make no mention of inland capture fisheries and climate change mitigation, except for a general reference to improving fishing GHG efficiency in Viet Nam that applies mainly to engine use in the marine fishery. And yet they refer to emissions from land-use change, livestock and agriculture in general.

5. AVOIDED COSTS BY SUSTAINING THE PRODUCTION FROM CAPTURE FISHERIES

Given the importance of fish protein to human populations in the LMB, a key consideration to factor into planning and investment is not just the direct cost and impact of any potential losses in capture fisheries production, but also the costs and effects of replacing them; i.e. avoided costs by sustaining the fishery.

5.1 Water and land demands

It was calculated that the loss of fish production through the construction of mainstream dams by 2030, which were planned in 2012, would require a 4–7% increase overall in water use for the equivalent amount of food production. Estimates were much higher for countries located entirely within the Basin (Cambodia 29–64%, Lao PDR 12–24%). In addition, land demand would increase by 13–27% for the equivalent amount of food production (Orr et al., 2012). If considering the construction of tributary dams in the Basin by 2030, which were planned in 2012, and reservoir fisheries, projections were much higher: 6–17% for water use, and 19–63% for land demand. The considerable competition for land resources that this would create is of particular concern, and there are doubts as to whether this increased land demand can be met without undermining sustainability. Additional losses in production from the capture fisheries would also be expected from impacts other than from dams (e.g. land conversion, small-scale barriers, and basin fragmentation). This also does not factor in the nutrition benefits of fish and OAAs due to their high-quality protein and high micro-nutrient levels, compared to meat (e.g. Kawarazuka and Béné, 2010).

5.2 Greenhouse gas emissions when replacing losses in capture fisheries production

Much attention has been given to the GHG emissions from livestock production. Globally, livestock produce about 14.5% of total anthropogenic GHG emissions. They are highest for beef (almost 300 kg CO_2-eq per kg of protein produced), followed by meat and milk from small ruminants (165 and 112 kg CO_2-eq per kg, respectively). Cow milk, chicken products and pork have lower global average emission intensities, at around 100 CO_2-eq/kg (Gerber et al., 2013). As an approximate guide, the loss of 50% of LMB capture fisheries production (equal to about 1 million tonnes per annum, including OAAs) would produce between 100 to 300 million tonnes of CO_2-eq per annum depending on whether it was replaced by chicken or beef, respectively. For comparative purposes, this is an increase of 5.5–16 times the total national annual GHG emissions of Cambodia in 2020, 4.9–14.6 times the total national annual GHG emissions of Lao PDR in 2020, 36–108% of the total national annual GHG emissions of Thailand in 2020, 30.6–92% of the total national annual GHG emissions of Viet Nam in 2020, and 15.6–46.7% of the combined annual national emissions of the four LMB countries (comparative data from Ritchie et al., 2020).

Emissions resulting from replacing capture fisheries production through aquaculture depend on the aquaculture systems used. This has not yet been calculated for the LMB. Data from elsewhere (as above) suggest that overall emissions would be similar to that for chicken in the

above comparisons. Since this aspect is currently receiving limited attention in national and basin-wide policies in the LMB (and in most places elsewhere), there is clearly a need and opportunity to raise awareness of this issue among MCs. The impacts of losses in production from the capture fishery on increasing GHG emissions also present a very strong case for accessing climate change mitigation funding, nationally, and especially internationally.

6. CAPTURE FISHERIES AND AQUACULTURE IN THE LMB: INSTITUTIONS, LAWS, REGULATIONS, POLICIES, INVESTMENTS AND PRACTICES

A summary of the institutions, laws, regulations, policies, investments and practices regarding the fisheries sector in each of the four LMB countries is provided in the Annex. There is strong coherence among them, including:

- The current official policy in all four MCs is: to sustain, and in some cases, increase, capture fisheries production and its benefits including livelihoods, food security and contribution to the economy; to promote sustainable aquaculture and its contribution to improved livelihoods, food security and the economy; and to sustain, and in most cases, restore or rehabilitate the environment on which capture fisheries depend.
- There is no explicit policy of prioritizing aquaculture over capture fisheries or marine over inland capture fisheries at the level of overarching national policy; however:
  - in Thailand and Viet Nam, attention to capture fisheries is dominated by the marine sector and inland capture fisheries receive minimal attention by comparison;
  - all four MCs report that, in practice, aquaculture is prioritized over capture fisheries in the LMB in terms of investment and attention, although are differences in the level of prioritization among the MCs, which may be due to overarching government policy to develop export markets that, for example, influence the target species. In Thailand, this originates from recommendations made nearly a century ago by McCormick Smith (1925).

  In practice, capture fisheries and aquaculture are often seen as competing sub-sectors in terms of policy, investment and attention. Investments are often decided on the basis of capture versus culture, with aquaculture dominating budgets. However, investment would be more effective if decided on the basis of the contribution of each sub-sector to overall national sustainable development objectives, and not by comparing them within the fisheries sector and having them compete for the same budget.
- Although, sound policies for capture fisheries and aquaculture are usually in place, and accompanied by action plans, actual measures to achieve the stated outcomes are often either lacking or are inadequately funded.
- Investment in all four countries is driven largely by national policies to achieve economic development and industrialization. This is cited as the main driver of aquaculture development for export in the delta in Viet Nam, and a key driver of its environmental impacts. Hence, these sub-sectors that can contribute to increase production or contribution to GDP receive the most attention and investment. In these policies, there is limited attention to the need to sustain productivity and ensure food and nutrition security in order to achieve this economic progress; however, attitudes to this are changing, with an increasing recognition of the importance of sustainability.

- The identified challenges facing capture fisheries are common among the four MCs, albeit with some differences in the importance of each country's challenge.
- All four MCs recognize that, historically and today, management of inland capture fisheries is based on a top-down government-driven regulatory approach. There is universal agreement among the four MCs that this is approach is not effective enough. According to official policy, all four MCs have identified co-management as a complementary and usually better and more feasible approach:
    - Cambodia and Thailand rank it as highest in terms of relevance to the achievement of their fisheries policies; Lao PDR and Viet Nam rank it as 'medium' relevance.
    - The approach has been applied to different degrees in the MCs, with Cambodia and Viet Nam having instituted legal provisions to this effect. Cambodia is probably the most advanced in implementing co-management comprehensively for inland and coastal fisheries management. In Viet Nam, some successful cases of co-management are reported (Takahashi and Van Dujin, 2012). Thailand and Lao PDR also have co-management schemes albeit more limited in scope: in Thailand, no legal provisions have been promulgated specifically for co-management for fisheries, although recognition of the rights, roles and responsibilities of 'the people', 'communities' or 'citizens' in resources management (i.e. co-management) is enshrined in national law just as it is in the national law or constitutions (or their equivalent) of each MC; in Lao PDR legal provisions for co-management have only recently been introduced.
    - Co-management of fisheries has not become the mainstream approach in any MC.
- All four MCs recognize the need to closely cooperate in managing transboundary issues and challenges in the LMB.

Some relevant implications of the aforementioned policy landscape are:

- The issue with the LMB fisheries sector in each of the MCs is not only policy, but mainly priorities, investment and management approaches in practice. Therefore, a key way forward is to focus on reconnecting policy and practice, for example, by identifying interconnections, synergies and conflicts among policy areas and seeking ways forward that improve overall coherent policy delivery.
- There are considerable institutional challenges at play in influencing priorities and practice. There are also likely political constraints, but they were not assessed directly in national reviews.

7. DISPELLING MYTHS ABOUT CAPTURE FISHERIES IN THE LOWER MEKONG BASIN

Several misconceptions regarding the status and future of the capture fisheries in the LMB and associated response options continue to influence policies, planning and investment. These need to be rectified if policies, planning and investments are to improve.

7.1 Dispelling myths about the demise of capture fisheries and scope for increases in production

The demise of the capture fisheries of the LMB has long been predicted. McCormick Smith first referred to this demise in 1925, include Thailand, and recommended prioritizing aquaculture to compensate for this. A similar argument has limited investment in the capture fishery throughout the basin ever since. Although the fishery is showing signs of stress, and probable decline, it shows remarkable resilience given the pressures. Even in the Thai Mekong, important capture fisheries still exist.

A related and common assumption is that productivity in the capture fishery cannot be increased, which limits the appetite for investment when it is targeted at increasing economic output; however, it remains unclear as to why there is insufficient attention to the importance of maintaining outputs already in hand. This is another misperception. There are indeed significant opportunities to improve productivity of the fishery, principally through improved management of fishing effort and environmental restoration.

7.2 Dispelling the myth of how aquaculture can compensate for the loss of capture fisheries

A further myth is that losses in the capture fishery can be offset through gains in production from aquaculture. This is not the case. Aquaculture has different economic outcomes and equity implications for local communities. It generally requires capital investment, land or open water tenure, and access to relatively considerable financial resources due to the high costs of feed and seed. It can also be high risk, where crops can be lost, and along with them, returns on investment, both financial and labour. This mostly excludes rural people and fishers, who remain dependent on the wild fish and fisheries for their livelihoods and food. Consequently, social inequalities may be exacerbated by policies that seek to replace capture fisheries by aquaculture. Small-scale, family-based aquaculture certainly has an important role and is important for local food security in some areas. Although generating significant economic benefits, the bulk of aquaculture production from the LMB is exported, which contributes nothing to national or regional food security. Aquaculture can also cause significant environmental impacts, particularly with intensive aquaculture, including pollution, land-use change, and others. There are also significant differences regarding nutrition security where aquaculture products are typically larger specimens that are filleted or peeled and not eaten whole, in addition to creating waste. Much of the production from the capture fisheries is eaten whole, with limited waste, and can be more nutrient-rich.

Aquaculture is certainly an important sector in the LMB. It has already delivered significant benefits. Appropriate aquaculture development certainly has the potential to further contribute to sustainable development. However, rather than considering capture fisheries and aquaculture as competing sub-sectors, they should be considered separate. Currently, a significant issue is that the two often compete for the same investment resources.

7.3 Managing for future changes

Not only have the river conditions in the LMB significantly changed, but they will also continue to do so. The overall drivers of these changes are well documented and include national and regional economic development and population growth, and associated impacts, such as infrastructure development, water use, land-use change, pollution and climate change (including its direct effects and its impacts through adaptation strategies). A key challenge, therefore, is planning for future conditions, but accurate prediction is always unreliable due to many unknown factors. The development trajectory is also different among the four MCs. Significant economic progress in the LMB has been achieved, but the impacts of development on the environment of the LMB, and associated impacts on capture fisheries, have so far been mostly negative. However, one positive trend in the LMB is the increasing attention to sustainability, which should contribute towards achieving at least more balanced development. Pressures on capture fisheries continue to increase to meet growing demand of the population, given that population growth is slowing, in all four MCs. In addition, there is evidence that participation in capture fisheries is declining in some areas, partly due to declining catches, but also through the increasing availability of alternative livelihoods. A logical result is a slowing increase, or in some areas, a decrease in, the fishing population. Demand, however, is likely to continue to increase. These and other factors in longer-term basin development are assessed periodically in The State of the Basin Reports (e.g. MRC, 2019).

8. OPTIONS FOR INVESTMENTS AND ASSOCIATED MEASURES IDENTIFIED IN NATIONAL REVIEWS

The key challenges and drivers, current and recommended responses, and adaptive measures and needs were listed in each national review (Annex); these are combined and summarized in Table 16.

Table 16. Key challenges to sustainable fisheries management in the LMB and recommended options for investment and associated measures to address them identified in the four national reviews combined

Key challenge/driver	Recommended options and measures	Basin-wide and transboundary options and measures
Direct impacts of fishing		
Stock overexploitation from increasing fishing effort and unsustainable fishing, including illegal gear use. Contributing factors: • weak law enforcement; • weak communication and networking in fisheries conservation and management at the community levels to regional levels; • weak capacity of the fisheries staff and resources to tackle the problems of weak enforcement.	• Enhanced integrity of inland aquatic animal populations and biodiversity • Restored freshwater habitats and enhanced richness of fish populations • Restoration of rare Mekong fish species • Rehabilitation and restoration of inland fishery habitats and degraded freshwater ecosystems to be suitable for aquatic animals • Surveillance, control, monitoring and assessments of the status of aquatic animal resources, regulations and measures for inland fisheries management • Fish stocking programmes including restocking of endemic and high-economic value fish species in the Mekong tributaries • Provision of fishers with information on the challenges to sustainable fisheries. • Strengthening of the community fisheries by building the capacity of the Community Fisheries Committee and Community	• Establish a transboundary fisheries management body • Put in place a transboundary fisheries management plan. • Support/promote an alternative livelihood to community fisheries for reducing fishing pressures in the LMB. • Support the investment to enhance transboundary fisheries management in the LMB. • Restore and reconnect the critical fish habitats in the LMB. • Establish new fish conservation and protection areas in the LMB • Establish a joint fisheries monitoring programme

Key challenge/driver	Recommended options and measures	Basin-wide and transboundary options and measures
	Fisheries members on fisheries management, conservation and planning, to define gears use by zoning • Definition and list of all illegal gears' use by each village/ fishing area • Enhanced resilience of the fishing community • Promotion and establishment of alternative livelihoods for community fisheries members and fishers' families • Prohibition of fishing in the closed season and closed areas (conservation area, etc.) • Dissemination of knowledge on the negative impacts of mosquito nets and illegal fishing activities. • Strengthened patrol/surveillance activities • Strengthened law enforcement • Strengthened crackdown of illegal fishing activities • Promotion of livelihoods diversification, including aquaculture good practices, to ensure the sustainable use of fisheries resources, both for food security and the conservation of natural resources for future generations. In particular, the encouragement of the full engagement and participation of all stakeholders and community fisheries. • Formulation and implementation of a career change programme for fishers including organization models, job transfer models built and	• Jointly carry out conservation actions in dolphin zones and critical areas to be developed. • Encourage the full engagement and participation of stakeholders in transboundary fisheries management (cooperation and dialogue) and strengthen the research capacity and knowledge base. • Promote and strengthen transboundary inland fisheries management in bordering areas.

Key challenge/driver	Recommended options and measures	Basin-wide and transboundary options and measures
	deployed with the participation of the community • Strengthening of law enforcement • Enhanced awareness and dissemination on fisheries law and regulation to fisheries community • Strengthening of the capacity of fisheries' staff, both at the national and sub-national levels, and relevant stakeholders for coordinating workable fisheries management. • Establishment of the appropriate networking among community fisheries from villages and scaling up to the national and regional levels.	
Environmental degradation		
Local fisheries habitat degradation	• Application of the ecosystem approach to inland fisheries management • Rehabilitation, restoration, protection and enhancement of the productivity of inland fisheries habitats and inland aquatic ecosystems • Restoration of freshwater habitats and enhance the richness of fish populations • Ensured protection and management of natural fish habitats by all relevant stakeholders, especially community fishers (co-management) • A study conducted on possible new fish conservation and protection areas • Mapping of critical fish habitats for key species • Restoration and reconnection of the critical fish habitats	• Identify the existing fisheries habitats by each country and create the join action plan and programme for their protection and management.

Key challenge/driver	Recommended options and measures	Basin-wide and transboundary options and measures
	• The expansion by the State of the scope of application of water resource use rights, the subjects of application, and policies to support their implementation in inland waters and coastal estuarine areas when assigning water surface, fishing and conservation areas to the fishing communities. This aims to support co-management or community-based management approaches. • A review of fish passages design and operation for small-scale barriers. • Integration of fish migrations into related plans, especially irrigation and dyke planning and management, and implementation of construction and operation of small-scale fish passages. • Increased investment in the construction of fish passages through small-scale irrigation dams to contribute to improved fish migration routes, and contribute to the protection of aquatic resources and biodiversity. • Improved inter-ministerial cooperation and participation of local communities in small-scale fish passage design and operation. • Integration of issues on environmental protection and sustainable fisheries into community education programmes to raise awareness and enhance understanding by developing training programmes and implementing them	

Key challenge/driver	Recommended options and measures	Basin-wide and transboundary options and measures
	• Integration of issues regarding environmental protection and management, and sustainable fisheries into relevant laws and policies at the national and local levels	
Larger-scale impacts from water development in the mainstream and its tributaries	• Application of the ecosystem approach to inland fisheries management • Enhancement of the integrity of inland aquatic animal populations and biodiversity • Rehabilitation, restoration, protection and enhancement the productivity of inland fisheries habitats and inland aquatic ecosystems • A study conducted on the impacts that optimize energy-food trade-offs • Collaborative decisions on water development by applying relevant scientific and indigenous knowledge and incorporating fisheries and their social, economic and livelihood dimensions in the decision-making process • Monitoring and evaluation of the contribution of fisheries resources to national food security and nutrition carried out systematically to inform policies and decisions related to water development, land management, energy and food security • Maintenance of deep pools and their protection from sedimentation from upstream erosion areas • Review fish passages design and operation for larger-scale barriers	• Agree on the economic and social cost of habitat degradation or loss according to Mekong Agreement 1995 Principle 5: 'Principle of State Responsibility for Damages' (Art. 8).

Key challenge/driver	Recommended options and measures	Basin-wide and transboundary options and measures
	• Integration of fish migrations into related plans, especially irrigation and dyke planning and management, and construction and operation of larger-scale fish passages • Increased investment in the construction of fish passages on larger-scale barriers to contribute to improved fish migration routes, and to the protection of aquatic resources and biodiversity • Improved interministerial cooperation and participation of local communities in larger-scale fish passage design and operation • Integration of environmental protection and fisheries into community education programmes in order to raise awareness and enhance understanding by developing training programmes and implementing them • Integration of environmental protection and management and fisheries into relevant laws and policies at the national and local levels	
Land use change including deforestation and fisheries habitat conversion	• Rehabilitation of inundated forests of the Mekong mainstream and tributaries • Prevention and prohibition of cutting flooded forest for agriculture and other purposes • Improved inter-ministerial cooperation and participation of local communities in land use planning • Integration of environmental protection and fisheries into community education	

Key challenge/driver	Recommended options and measures	Basin-wide and transboundary options and measures
	programmes for land use planning to raise awareness and enhance understanding including by developing training programmes and implementing them • Integration of environmental protection and management and fisheries into relevant land use laws and policies at the national and local levels	
Climate change		
Climate change impacts on fisheries (climate change adaptation)	• Rehabilitation, restoration, protection and enhancement of the productivity of inland fisheries habitats and inland aquatic ecosystems • Enhancement of the integrity of inland aquatic animal populations and biodiversity • Rehabilitation of highly exploited aquatic animals to their maximum sustainable yield according to the potential of the water resources • Management and rehabilitation of critical fisheries' habitats in response to climate resilience • Identification of specific responses (solutions) for climate change adaptation • Conservation and protection of fishery resources • Building of resilience in the inland fisheries sector through environmental improvements and better management of fishing effort (co-management) • Strengthening of the capacity of fishers and communities to adapt to climate change	
Greenhouse gas emissions (climate change mitigation)	• Promotion of good post-harvest practices by using renewable	

Key challenge/driver	Recommended options and measures	Basin-wide and transboundary options and measures
	energy efficiency along fisheries value chains.	
Data and information needs		
Inadequate data and information lead to poor investment and management decision	• Development of knowledge, technology, innovation and a database for inland fishery management • Research, development, monitoring and assessments of the status of inland aquatic animals and inland fisheries to support effective management • Fish habitat assessment and development for the establishment of fish conservation zones • Strengthening of the capacity of local communities and networks for natural resource management for food security	• Develop and manage Mekong fisheries data and information-generation, sharing platform and feedback, with improved timely regional data and analysis • Update identification, mapping and demarcation of key habitats of the LMB ecosystem and rank key conservation areas, such as spawning grounds, in line with the medium- and long-term sustainability of the basin ecosystem • Conduct joint research to improve the knowledge and information about transboundary fisheries. • Improve the data information dissemination system and mechanism.
Disconnects between strategy areas, which leads to fragmented approaches and neglect of capture fisheries in key strategy areas	• Improved information on capture fisheries including assessments of values, status and trends • Strengthened incorporation of improved fisheries information into national planning • Strengthening of integrated national planning	• Strengthened integrated basin-wide planning

The following options and measures collectively identified, which are shown in Table 16, cover:

- data and information needs;
- overexploitation of the fishery resources by fishers, which leads to unsustainable use and declines in catches and adverse changes in catch composition; this essentially consists in managing fishing effort;
- environmental degradation and loss at the local scale due to small-scale local interventions, which undermines the sustainability of the fishery resources base; this usually involves restoration measures that can be potentially implemented by local communities and local stakeholders;
- environmental degradation and loss at the catchment scale arising through larger-scale developments (notably water use and water use infrastructure), which usually involves options and measures targeted at the catchment scale, and national and regional planning;
- miscellaneous specific measures; and
- climate change adaptation and mitigation.

The above options and measures are inter-related. For example: small-scale localized restoration measures can have a basin-wide impact if upscaled and they can also help mitigate the impacts of overexploitation by making fish stocks more resilient; data and information are a cross-cutting need. Information from national reviews (beyond listed specific options and measures) was also used to identify emerging opportunities and/or gaps in current attention.

The various drivers of declines in the capture fishery listed above (e.g. those pertaining to fishing effort and the environment) can usually reinforce each other. For example, environmental degradation reduces the resilience and productivity of fish stocks and hence increases the impacts of fishing pressure; and unsustainable fishing methods can contribute to environmental degradation. It is therefore challenging to assign some measures to specific drivers. The options and measures that address multiple drivers can often be the most efficient.

9. PRIORITY CONSOLIDATED OPTIONS FOR INVESTMENT AND ASSOCIATED MEASURES TO OPTIMIZE FISHERIES PRODUCTION UNDER CHANGED RIVER CONDITIONS

All the options outlined below are entirely consistent with current national policies across all four MCs. These options are designed to assist MCs implement current policies and make them more effective. Some options are necessarily broad in scope for each MC to identify specific actions in-line with national perspectives.

The options and measures identified cover:

- data, monitoring, information and integrated planning needs;
- drivers of overexploitation and environmental degradation of fishery resources; and
- climate change adaptation and mitigation.

9.1 Regional data, monitoring, information and integrated planning needs

The MRC already plays an important role in supporting national and regional capture fisheries data. This role remains a high priority. A priority is to maintain and enhance the MRC's role in regional fisheries data and monitoring. Specifically, it is essential to sustain FADM to better document longer-term trends in the fishery. There are identified needs to improve the programme with regard to the ability to compare catch-effort data between years. This work is already ongoing at the MRC in coordination with the four MCs.

To meet the immediate need to sustain these efforts, a regional project should be implemented to build capacities at the national level for fisheries assessment methodologies, based on datasets, which include data generated through the FADM and other sources. In addition, low-cost methods for improved data use should be identified such as:

- sharing of experiences and standardized approaches among the MCs;
- compiling and sharing experiences at the national level on the role of statistics and information in informing policies and investment; and
- identifying how to improve the integration of fisheries into relevant areas and investment.

Draft Project Proposal

Project 1: Regional capacity-building to improve national assessments synthesise capture fisheries-related datasets and information and how they are incorporated into national basin development policies, plans and investments

Background and rationale

According to all four MCs, in practice, inland capture fisheries are a low priority for investment nationally. There is a disconnect between the true value of inland capture fisheries and their contribution to local and national sustainable development, food and nutrition security and climate change mitigation and investment in their sustainability and development. A strong case can be made that raising attention to the importance of inland capture fisheries, and incorporating these into broader policy and planning are pre-requisites to sustaining longer-term investment in these fisheries. Therefore, the status of inland fisheries in national planning and investment is arguably the most influential factor in sustainability of investment.

Generating improved information is only part of a solution. In the short term, the need is for improved use of current information and its dissemination. In addition, there is a significant need is to better understand how information on capture fisheries is incorporated (or not) into broader development and investment planning, including the constraints to the information being properly considered, and ways and means to overcome them.

Investment for the future of the capture fishery requires good information to support wise choices. There are contradictions among the various datasets and information sources at the national level. Assessment approaches, reliability of available datasets, and how they are used vary considerably between MCs, and there is much experience in their compilation and use. MRC data and assessments (e.g. MRC 2023b) are often questioned or disregarded at the national level – yet always based on national data.

In all four MCs, the availability of data on OAAs and their inclusion in information systems vary. OAAs are known to be very important and contribute around 25% of total basin production. However, OAAs tend to be caught or collected mainly at the household or small-scale level. Therefore, there is a need to increase attention to OAAs in information systems.

Due to complexity and a wide range of fisheries, habitats and variables in play, no single data source can be relied on to reflect overall status or trends. Each MC has a different approach to assessing its fisheries. The best assessment methodology is one that draws together data and information from multiple sources, compares them, explains the differences among them and the factors in confidence in reliability and scope. This approach has been used since 2000 for the LMB (MRC, 2023b).

A high degree of accuracy is not essential to obtain information on the basic parameters of the fishery (e.g. estimated overall catches, socio-economic values etc.). But reliable catch-effort data are critical for assessing trends in fishery catches, composition and species. The FADM aims to assess data from 2000 and has assessed data from 2017. It is premature to conclusively assess longer-term trends, and currently, there are challenges to comparing catch-effort data between years because of the differences in catch efforts.

The MRC (2023b) was the source of much of the information presented in national reviews for the current review. It is not known if this information has an impact at the national level. Without a better understanding of how fisheries data are used, which fisheries data are currently available, which data and information are needed by policymakers, and options for

making improvements of and investments in current national statistics systems are high risk. Hence, in the short term, the priority is to invest in improving the use of existing data, connections between fisheries information and investment, and in sustaining and expanding current reliable fisheries monitoring activities (e.g. FADM). Efforts to improve data collection should be a longer-term option and based on a better understanding of the ways of compiling and using fisheries information and how this impacts investment.

There are significant risks in investing in trying to improve national inland fishery statistics. A review of inland fisheries statistics for South-East Asia by FAO (Coates, 2002), including for all four MCs, drew some relevant conclusions for the region as a whole:

- Official inland capture fishery statistics are neither a useful nor an accurate basis of determining the scale, importance or trends of the fisheries.
- There is limited evidence that official inland capture fishery statistics are trusted nationally.
- There are simple options for methods to improve the information (e.g. better use of local knowledge).
- National statistics are very difficult to change due to institutional resistance (e.g. an MRC project took over five years and significant investment to update the Cambodia national inland capture fisheries statistics in order to reflect catches more accurately during the late 1990s to the early 2000s).
- Returns on investment and potential sustainability of any improved information systems are key factors.

The short-term option is to better inform national agencies about how to interpret national statistics and how to combine different information sources to provide more reliable information to support management.

Integrating capture fisheries into basin-wide planning is already a core function of and high priority for the MRC Environment Division. Some current priorities, strategies, programmes and projects are listed in MRC (2021) and in MRC (2017c); sustaining and improving investment in them in the MRC remain a high priority even though these are not limited to fisheries. In terms of capture fisheries, the priority is to provide information to support the integration of fisheries into environmental and sustainable development planning. The following key information is required:

- the relevant values of capture fisheries such as total catches, catch composition, socio-economic benefits, contributions to food and nutrition security, GHG emissions, as well as its biodiversity;
- the inter-relationships between capture fisheries, its biodiversity and the environment;
- trends in the capture fishery and relationships with drivers of those trends;
- priority environmental management needs;
- conflicts and co-benefits among multiple strategy areas and objectives for sustainable basin development; and
- key response measures.

The MRC has already obtained most of this information at the basin scale, and some priority activities are being implemented (albeit within resource constraints). Other options for investments identified in the current document would also contribute to this ongoing work. The same needs for investments and associated measures apply equally at the national level, and many at the local level. Arguably, at the national level, it has been as or more important because basin-wide measures are determined by cumulative national action.

The most immediate and short-term need is a regional review of how inter-linkages between inland capture fisheries and environmental change are addressed in planning at the national level in order to understand:

- how investment is prioritized, with regard to capture fisheries and relevant environmental needs;
- how and if basin-wide information and measures influence national investment;
- key information gaps and needs;
- the ways and means to improve the integration of capture fisheries and relevant environmental needs into strategies and investment at the national level;
- the sharing of experiences among the four MCs and identification of mutual needs and opportunities;
- how basin-wide measures can have the best impact.

Objectives of the proposed project

- To improve national capacity for assessment and interpretation of multiple data and information sources on capture fisheries in the LMB in each MC;
- To better understand how data and information on inland capture fisheries are integrated (or not) into policies, planning and investments, and to identify constraints in the information-management interface and ways and means to overcome them.
- To improve national capacity for integrating inland capture fisheries into national basin development strategy, planning and investment.

Table 1. Outputs and activities

Output/activity	Description	Objectively verifiable indicators	Source of verification	Risk and assumption
Output 1: National capacity for assessing and synthesising national data and information sources on capture fisheries strengthened		Improved data and information on inland capture fisheries	Monitoring and evaluation (M&E) reports	Assumption: Sufficient funds and Secretariat and national staff capacity are available at both the regional and national levels.
Activity 1.1: Compile all relevant information sources	Compile information from national statistics, project data,			

	academic research, national surveys, etc. and all other relevant sources			
Activity 1.2: Document what each dataset refers to, and potential sources of error	For each, understand what the data and information refers to			
Activity 1.3: Compare all the data and information sources to obtain a robust overall combined assessment	Combine the available datasets and information to obtain a balanced conclusion			
Activity 1.4: Compare experiences among the four MCs to support regional capacity	Share best practices, experiences and solutions among the four MCs			
Activity 1.5: Identify low-cost means of repeating assessments to track relevant changes in the fishery	Identify what options are available for (i) using data and information sources; and (ii) low- cost, new data- and information-generation opportunities.			
Output 2: **Improved national capacity to integrate improved capture fisheries data and information into planning and investment**		Improved uptake of improved data and information into planning and investments relevant to inland capture fisheries	M&E reports	Assumptions: Sufficient funds and Secretariat and national staff capacity are available at both the regional and national levels. National agencies are willing to use improved data
Activity 2.1 Compile information at the national level on what information sources are used and	Obtain relevant details from relevant government agencies involved			

by whom, and how to inform planning and investments relevant to inland capture fisheries	in planning and investment			and information in planning and investment choices
Activity 2.2 Identify the key information needs of national planning and investment agencies				
Activity 2.3 Identify obstacles to integrating information on inland capture fisheries into national planning and investment and ways and means to overcome the.				
Activity 2.4: Share experiences among the four MCs to support strengthened regional capacity	Share best practices, experiences and solutions among the four MCs			

Timelines and milestones of proposed activities and deliverables

Milestones of proposed activities and deliverable are shown in Table 2.

Table 2. Anticipated deliverables and timeline of outputs and activities of the project

Output/activity	Deliverable	Timeline			
		Year 1			
		Q1	Q2	Q3	Q4
Output 1: National capacity for assessing and synthesising national data and information sources on capture fisheries strengthened	Capacity increased	x	x	x	x
Activity 1.1: Compile all relevant information sources	compilation	x	x		
Activity 1.2: Document what each respective dataset refers to, and potential sources of error	Documentation/review			x	
Activity 1.3: Compare all the data and information sources to obtain a robust overall combined assessment	Combined assessment			x	
Activity 1.4: Compare experiences among the four MCs to support regional capacity	Experiences shared			x	
Activity 1.5: Identify low-cost means of repeating assessments to track relevant changes in the fishery	Means identified			x	
Output 2: Improved national capacity to integrate improved capture fisheries data and information into planning and investment					
Activity 2.1 Compile information at the national level on what information sources are used, by whom, and how to inform planning and investments relevant to inland capture fisheries			x	x	
Activity 2.2 Identify the key information needs of national planning and investment agencies				x	
Activity 2.3 Identify obstacles to integrating information on inland capture fisheries into national planning and investment and ways and means to overcome the.				x	
Activity 2.4: Share experiences among the four MCs to support strengthened regional capacity					x

Proposed financial plan

The financial plan for achieving outputs and activities have been proposed in Table 3. Final budget allocation will be considered and decided after approval and securing financing of the project.

Table 3. Estimated budgets of each activity

Output/Activity	Year 1	Total (US$)
Output 1: The national capacity for assessing and synthesising national data and information sources on capture fisheries strengthened		50,000
Activity 1.1: Compile all relevant information sources		
Activity 1.2: Document what each respective dataset refers to, and potential sources of error		
Activity 1.3: Compare all the data and information sources to obtain a robust overall combined assessment		
Activity 1.4: Compare experiences among the four MCs to support regional capacity		
Activity 1.5: Identify low cost means of repeating assessments to track relevant changes in the fishery		
Output 2: **Improved national capacity to integrate improved capture fisheries data and information into planning and investment**		50,000
Activity 2.1 Compile information at the national level on what information sources are used and by whom, and how to inform planning and investments relevant to inland capture fisheries		
Activity 2.2 Identify the key information needs of national planning and investment agencies		
Activity 2.3 Identify obstacles to integrating information on inland capture fisheries into national planning and investment and ways and means to overcome the.		
Activity 2.4: Share experiences among the four MCs to support strengthened regional capacity (including workshops)		

Implementation arrangement

The project will be implemented in all MCs. Overall responsibility, budgetary oversight and M&E will be provided by MRC ED; technical responsibility will lie with the ED Environmental Management Expert Group/subgroup on fisheries.

9.2 Addressing drivers of overexploitation and environmental degradation of fisheries resources

Draft Project Proposal

Project 2: Regional capacity building for the co-management of fishing and the restoration of local habitats to address overexploitation of the fishery resources and local environmental degradation

Background and rationale

There is universal agreement among the MCs that basing the management of capture fisheries on a centralized (top-down) regulatory approach is not fully effective. Co-management as the alternative, or supplementary, approach is recognized in the policies of all four MCs. All MCs also have experience with co-management, some successful some less so, but all relevant and useful.

The term 'co-management' in the LMB context has been used for measures by two or more MCs to jointly manage a resource. Currently, 'co-management' means joint management undertaken by government and fishery dependent communities at the national or local level. Co-management, as a management strategy, offers a bottom-up approach and is broadly defined by the FAO as "a partnership arrangement between government and the local community of resource users, sometimes also connected with agents such as NGOs and research institutions, and other resource stakeholders, to share the responsibility and authority for management of a resource" (Pomeroy et al. 2022) The approach allows local communities to set in motion their co-management plans and develop local regulations. To implement and enforce local regulations, local communities can be supported by fisheries national laws, regulations, and policies. Well-structured inland fisheries co-management approaches can be effective because local communities have the knowledge, skills, and practices, developed over generations. Similarly, regulations that are developed by communities are more likely to be implemented and accepted. Through co-management arrangements, communities can oversee the productivity and harvest of defined aquatic ecosystems and their associated fish stocks so as to promote sustainability. A co-management approach can provide opportunities for adapting to changing conditions over time. Crucially, local communities are those with the highest stake in sustainability of local fisheries and, therefore, have the highest level of motivation.

The inland capture fisheries requires the sustainability of overall catches and the diversity of the fish fauna, and the sustainability or improvement of the habitats upon which the fishery resources depend.

Environmental changes in river conditions in the LMB are due to the following:

- larger-scale projects and impacts (e.g. larger dams); and
- small-scale impacts (e.g. localized habitat destruction, small-scale river/floodplain fragmentation, localized land-use change, localized water management measures).

Both causes can result in basin-wide impacts, including transboundary impacts. Historically, most of the MRC's attention to the environment has focused on larger-scale interventions, particularly dams. But smaller-scale impacts can also have a significant impact cumulatively at the regional scale. Addressing localized issues and opportunities can often be more feasible than taking on larger, and often politicized, environmental challenges.

There are considerable opportunities for improving fisheries through smaller-scale localized planning and management, particularly through ecosystem restoration of irrigation systems (i.e. improving their ecological health while maintaining their intended function) and localized habitat improvements (e.g. restoring fish refuges/sanctuaries). Combined with co-management of local fishing efforts, the approach offers the best opportunity for improving sustainability of the basin-wide fisheries, except for managing the impacts of large-scale infrastructure projects. If adopted across the LMB, these small-scale interventions can produce significant, cumulative basin-wide benefits for fisheries, livelihoods and the environment. All four MCs have some experience in restoring the environment, usually habitats, and capture fisheries.

These restoration activities would qualify as an important area for contributing to the United Nations Decade for Ecosystem Restoration 2021–2030 (www.decadeonrestoration.org). Although there is no specific funding mechanism for the Decade, it has an influence on many sources of donor funding. Opportunities for engaging with the decade regarding inland fisheries in developing countries were outlined by Coates (2023). This report also highlighted that world experience shows that significant local benefits can be achieved and quickly; for example, in some cases a doubling or more of fisheries production within two years.

A regional project to strengthen implementation of co-management approaches is proposed through:

Phase one (one year – output 1)

- Experiences will be shared among the MCs;
- Capacities of the MCs will be built, such as for government staff and local communities.

Phase two (five years – output 2)

- Pilot projects will implement co-management arrangements in selected local areas (or strengthen support to existing interventions);
- The adoption of measures to sustain diversity in the fishery sector will be strengthened through inclusion of management measures for specific threatened species or species groups and their critical habitats.

Logically, Phase one would contribute to and support Phase two (and any existing projects/activities in this area). Phase one can be implemented and budgeted separately from Phase two.

Some national reviews have identified needs and opportunities to restore rice-field fisheries (and associated irrigation networks). If required, this aspect can be included as the ecosystem or one of the ecosystems targeted for restoration.

Viet Nam noted that there were opportunities for co-management to improve capture fisheries in the Delta but that their efforts were constrained due to weak or non-existent water use rights of key stakeholders. Consideration of this issue would be included in the project.

The project aims to:

- focus on co-management approaches;
- share experiences among the four MCs;
- build capacities of the four MCs (such as capacity of other relevant ministries, for example, irrigation and/or agriculture);
- in the longer term, implement regional pilot projects or support ongoing ones, as well as introduce co-management practices for them.

Objectives of the proposed project

- To improve the national capacity for bringing fishing effort and practices within sustainable limits through strengthened inland capture fisheries co-management.
- To improve the national capacity for co-management to rehabilitate and/or restore local ecosystems to increase productivity and sustainability of inland capture fisheries.

Table 1. Outputs and activities

Output/Activity	Description	Objectively verifiable indicators	Source of verification	Risk and assumption
Output 1: National capacity for supporting co-management of fisheries and habitat strengthened		Level of national capacity	M&E reports	Assumption: Sufficient funds and Secretariat and national staff capacity are available at both the regional and national levels
Activity 1.1: Compile and review current and previous experiences in implementation of co-management	Information is drawn from government and non-government sources			
Activity 1.2: Hold national workshop on experiences with co-management (in each MC)	Government and non-government stakeholders from all relevant sectors (not limited to fisheries co-management) are included.	Workshop held		
Activity 1.3: Identify challenges to co-management and ways and means to overcome them	Based on experiences from all sectors, challenges and opportunities relevant to the inland capture fisheries sector are identified	Report produced		
Activity 1.4: Hold a regional workshop to share national experiences and lessons learned		Workshop held		

among the 4 MCs				
Output 2: Implementation of new, or strengthened existing, inland fisheries and habitat co-management project(s) to build local capacity for fisheries management		Implementation of co-management strengthened at the field level. Improved fisheries productivity and sustainability	M&E reports	Assumptions: Sufficient funds and Secretariat and national staff capacity are available at both the regional and national levels, respectively.
Activity 2.1: Identify priority field implementation sites and arrangements (in each MC).	Number of sites are determined by funding availability			
Activity 2.2: Engage with all relevant stakeholders at selected site(s)	The aim is to understand roles of stakeholders and build consensus			
Activity 2.3: Develop and agree on the co-management strategy and plan	The aim is to identify and agree on the roles and responsibilities of all stakeholders			
Activity 2.4: Implement a co-management plan		Plan implemented		

Timelines and milestones of proposed activities and deliverables

Milestones of proposed activities and deliverables are shown in Table 2.

Table 2. Anticipated deliverables and timeline of outputs and activities of the project

Output/activity	Deliverable	Timeline			
		Year 1			
		Q1	Q2	Q3	Q4
Output 1: **National capacity for supporting co-management of fisheries and habitat is strengthened**	Capacity increased	x	x	x	x
Activity 1.1: Compile and review current and previous experiences in implementation of co-management	Compilation	x	x		
Activity 1.2: Hold a national workshop on co-management experiences (in each MC)	Workshops held			x	
Activity 1.3: Identify challenges to co-management and ways and means to overcome them	Challenges and solutions identified			x	
Activity 1.4: Hold a regional workshop to share national experiences among the 4 MCs	Experiences shared				x

Output 2: **New inland fisheries co-management project(s) are implemented or existing ones are strengthened in order to build local capacity for fisheries management**	Yr1	Yr2	Yr3	Yr4	Yr5
	x	x	x	x	x
Activity 2.1: Identify priority field implementation sites and arrangements (in each MC).	x				

Activity 2.2: Engage with all relevant stakeholders at selected site(s)	x				
Activity 2.3: Develop and agree on the co-management strategy and plan	x				
Activity 2.4: Implementation of a co-management plan	x	x	x	x	x

Proposed financial plan

The financial plan for achieving outputs and activities for Phase One only have been proposed in Table 3. Final budget allocation will be considered and decided after approval and securing financing of the project.

Table 3. Estimated budget (Phase one only)

Output/Activity	Year 1	Total (US$)
Output 1: **Strengthened national capacity for supporting the co-management of fisheries and to restore local ecosystems to increase and sustain inland capture fisheries**		100,000
Activity 1.1: Compile and review current and previous experiences in the implementation of co-management for fisheries and small-scale/local ecosystem restoration		
Activity 1.2: Hold a national workshop on experiences with co-management (in each MC)		
Activity 1.3: Identify challenges to co-management and ways and means to overcome them		
Activity 1.4: Hold a regional workshop to share national experiences among the four MCs		

Implementation arrangement

The project will be implemented in all MCs. The overall responsibility, budgetary oversight and M&E will be provided by MRC ED. The technical responsibility will lie with the ED EMEG/subgroup on fisheries.

9.3 Climate change adaptation and mitigation

Draft Project Proposal

Project 3: Integrating the values of inland capture fisheries into national and regional climate change adaptation and mitigation strategies

Rationale and background

Overall, climate change exacerbates environment-related drivers of change to river conditions that impact capture fisheries. Most of the measures identified to adapt inland capture fisheries in the LMB to climate change are the same as those required to promote sustainability for other reasons than climate change. The impacts of climate change on fisheries in the LMB, although not insignificant, are likely much less than the impacts of direct human interventions (e.g. dams, other infrastructure, land-use change, pollution). Hence, adaptation to non-climate related changes requires the greatest attention.

Climate change adaptation needs, however, do increase the justification for investment in capture fisheries (required already for other reasons) and therefore should be incorporated into relevant proposals. This is important due to the current dominance of climate change in many forums and among many funding agencies.

There is limited inclusion of climate change adaptation measures for inland capture fisheries in the Nationally Declared Contributions of Lao PDR (UNFCCC, 2021), Thailand (UNFCCC, 2022a) and Viet Nam (UNFCCC, 2022b), with some inclusion in the NDC of Cambodia (UNFCCC, 2020). Climate change mitigation and inland capture fisheries are entirely missing from NDCs of all four countries. This highlights significant disconnects between strategy areas and opportunities to support improved integrated strategy and planning.

This review has identified the very significant linkages between capture fisheries of the LMB and climate change mitigation – i.e. reducing GHG emissions. Although the fisheries emit negligible levels of GHGs (an advantage), it is important to consider the emissions required from replacing lost production. This considerably increases the value of capture fisheries and significantly strengthens the justification for investing in their sustainability, if not making it essential. Additional impacts on water and land requirements are also relevant. There is a clear need to develop or strengthen an ‘avoided costs’ argument in climate change planning and investment; this is likely to be the most significant gap in the relevant policies and in attention in the LMB.

In addition, the link between fisheries in the LMB and climate change gives a very strong justification for access to climate change funding. Currently, very substantial resources are available globally for climate change, such as the Green Climate Fund (Box 1), and there are other potential sources.

Box 1: The Green Climate Fund

The Green Climate Fund (GCF) was established as an operating entity of the Financial Mechanism under the United Nations Framework Convention on Climate Change (UNFCCC) to assist developing countries in adaptation and mitigation practices to counter climate change. The objective of the GCF is to "support projects, programmes, policies and other activities in developing country Parties using thematic funding windows". There are billions of dollars in resources available.

The sustainability and sustainable development of capture fisheries in the LMB provide strong justification for appropriate funding through the GCF. Well-designed projects or programmes offer substantial opportunities to deliver on all four areas of the GCF approach:

- transformational planning and programming by promoting integrated strategies, planning and policymaking to maximize the co-benefits between mitigation, adaptation and sustainable development;
- catalysing climate innovation by investing in new technologies, business models, and practices to establish a proof of concept (in particular as the relationship between inland fisheries and climate change adaptation and mitigation (as identified briefly in this report) are not recognized in current climate change discourses;
- de-risking investment to mobilize finance at scale by using scarce public resources to improve the risk-reward profile of low-emission climate-resilient investment and crowd-in private finance, notably for adaptation and nature-based solutions in least developed countries;
- mainstreaming climate risks and opportunities into investment decision-making to align finance with sustainable development: by promoting methodologies, standards and practices that foster new norms and values.

A well-designed programme would also contribute to five of the eight areas of the GCF that cover both mitigation and adaptation: health, food and water security; livelihoods of people and communities; ecosystems and ecosystem services; and forests and land use.

Source: Green Climate Fund. https://www.greenclimate.fund

The short-term priority is a regional support project to:

- refine national estimates (aggregated regionally) of GHG emissions from capture fisheries and the emissions from alternative food production systems under plausible scenarios for losses in capture fisheries production in each MC and basin-wide; and
- assess the current incorporation of capture fisheries in the LMB into national climate change adaptation and mitigation policies, plans and investment, including identification of needs and opportunities to align policies and investments commensurate with the importance and value of capture fisheries.

In the longer term, there is an opportunity to design a significant regional project to access international climate change funding in order to support the sustainability of capture fisheries in the LMB as a contribution of MCs to climate change mitigation obligations.

Objectives of the proposed project

- To improve national capacity for identifying the values of inland capture fisheries and ways and means to integrate them into national and regional policies, plans and investments for climate change adaptation and mitigation.
- To design a regional project to invest in the sustainability of inland capture fisheries in the LMB as a contribution of the MCs' obligations to climate change mitigation targets.

Table 1. Outputs and activities

Output/activity	Description	Objectively verifiable indicators	Source of verification	Risk and assumption
Output 1: Strengthened national capacity for identifying the values of inland capture fisheries and incorporating them into national and regional climate change policies, planning and investments		Level of national capacity	Monitoring and evaluation (M&E) reports	Assumption: Sufficient funds and Secretariat and national staff capacity are available at the regional and national levels.
Activity 1.1: Identify national values of inland capture fisheries regarding climate change mitigation	Avoided costs correspond to avoided greenhouse gas (GHG) emissions identified as well as to reduced requirements for water and land use at the national scale through alternative food production to compensate for losses from capture fisheries			
Activity 1.2: Hold a national workshop estimating of values and avoided costs	Government and non-government stakeholders are included and from all relevant sectors (not limited to fisheries)	Workshop held		

Activity 1.3: Identify the current values of land capture fisheries that are incorporated into current national policies, planning and investments for climate change adaptation and mitigation; identification of constraints to the recognition of values, and ways and means to overcome them	Based on experiences from all sectors, challenges and opportunities relevant to the inland capture fisheries sector are identified	Report produced		
Activity 1.4: Hold a regional workshop to share national experiences among the four MCs to assess the extent to which inland capture fisheries values are incorporated into regional planning and investments in climate change adaptation and mitigation		Workshop held		
Activity 1.5: Develop and implement strategies and work plans to integrate values into planning and investments in climate change adaptation and mitigation.		Strategies produced and implemented		

Output 2: Development of a major project to invest in sustaining inland capture fisheries in the LMB in order to meet climate change mitigation obligations of MCs	To be based on the priorities, programmes and projects identified in the Basin-wide Fisheries Management and Development Strategy 2018–2022 and its Project-based Action Plan (as subsequently revised), taking into account ongoing and pipeline projects and investments secured.	Project developed	M&E reports	Assumptions: Sufficient funds and Secretariat and national staff capacity are available at both at the regional and national levels.

Milestones of proposed activities and deliverables

The milestones of planned activities and deliverables are shown in Table 2.

Table 2. Planned deliverables and timeline of outputs and activities of the project

Output/activity	Deliverable	Timeline							
		Year 1				Year 2			
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Output 1: Strengthened national capacity for identifying the values of inland capture fisheries and incorporating them into national and regional climate change policies, planning and investments	Capacity increased	x	x	x	x	x	x	x	x
Activity 1.1: Identify national values of inland capture fisheries regarding climate change mitigation	Values calculated	x	x						
Activity 1.2: Hold a national workshop on estimates of values and avoided costs	Workshops held				x				
Activity 1.3: Identify the current values of inland capture fisheries that are incorporated into current national policies, planning and investments for climate change adaptation and mitigation; identify constraints in the uptake	Challenges and solutions are identified					x			

of values, and ways and means to overcome them									
Activity 1.4: Hold a regional workshop to share national experiences among the four MCs and assess the uptake of values into regional planning and investments in climate change adaptation and mitigation	Experiences shared						x		
Activity 1.5: Develop and implement strategies and work plans to integrate values into planning and investments in climate change adaptation and mitigation								x	
Output 2: **Development of a major project to invest in sustaining inland capture fisheries in the LMB in order to meet climate change mitigation obligations of MCs**				x	x	x	x		

Proposed financial plan

The inception, duration, timelines and financial plan for achieving outputs and activities are proposed in Table 2. The final budget allocation will be considered and decided on following approval and the securing of project financing.

Table 3. Estimated budgets of each activity

Output/activity	Year 1	Year 2	Total (US$)
Output 1: **Strengthened national capacity for identifying the values of inland capture fisheries and incorporating them into national and regional climate change policies, planning and investments**			
Activity 1.1: Identify national values of inland capture fisheries regarding climate change mitigation			
Activity 1.2: Hold a national workshop on estimates of values and avoided costs			
Activity 1.3: Identify the current values of inland capture fisheries that are incorporated into current national policies, planning and investments for climate change adaptation and mitigation; identify constraints in the uptake of values, and ways and means to overcome them			100,000
Activity 1.4: Hold a regional workshop to share national experiences among the four MCs and assess the uptake of values into regional planning and investments in climate change adaptation and mitigation			
Activity 1.5: Develop and implement strategies and work plans to integrate values into planning and investments in climate change adaptation and mitigation.			
Output 2: **A major project is developed to invest in sustaining inland capture fisheries in the LMB in order to meet climate change mitigation obligations of the MCs**			50,000

Implementation arrangement

The project will be implemented in all MCs. Overall responsibility, budgetary oversight and M&E will be ensured by MRC ED. Technical responsibility will lie with the ED EMEG/subgroup on fisheries.

9.4 How the options support the Project Based Action Plan to Implement the Basin-wide Fisheries Management and Development Strategy 2018–2022

The projects (options) proposed here are aligned with and complementary to the projects listed in the PBAP. None are duplicating the activities in the PBAP that are currently funded or ongoing. Details of how the projects (options) listed here contribute to and support the PBAP are provided in Table 17.

The options listed here will help inform and complement the eventual updating of the PBAP.

Table 17. The contribution of the projects proposed here to those proposed in the Project Based Action Plan (PBAP) for the Basin-Wide Fisheries Management and Development Strategy 2018–2022

Project proposal in this document	Relevant project proposal in the PBAP	How the project proposed in this document contributes to the PBAP Projects
Project (1): Regional capacity-building to improve national assessments and synthesis of capture fisheries related datasets and information and their incorporation into national basin development policies, plans and investments	All	It will provide a better assessment of the values of the inland capture fishery in the LMB to justify increased investment in sustainability.
	Project (1) title: Improvement of fisheries monitoring for supporting water development and management to sustainable inland fisheries	Project 1 of the PBAP deals with improving data collection and monitoring. Project 1 proposed here supplements this work by improving the way in which data are assessed and integrated into policy, planning and investments.
	Project (4) title: The development of standard methodology and technical guidance to manage interaction and interdependency of water development and fisheries	It initially strengthens capacity as an input into the much larger-scale proposed PBAP Project 4.

Project proposal in this document	Relevant project proposal in the PBAP	How the project proposed in this document contributes to the PBAP Projects
Project (2): Regional capacity-building for co-management of fishing and restoration of local habitats to address overexploitation of the fishery resources and local environmental degradation	Project (2) title: Transboundary fisheries and key habitat management in the Lower Mekong Basin	Project strengthens capacity for co-management of resources which is one basis for implementation of PBAP Project 2.
	Project (5) title: Support and promote fish-friendly irrigation and agriculture to link with national and regional organizations	Project 5 (PBAP) would also entail the implementation of Project (proposed here) as applied specifically to irrigation systems (where most actions involve some form of restoration and cooperation among relevant stakeholders, i.e. 'co-management'
Project (3): Integrating the values of inland capture fisheries into national and regional climate change adaptation and mitigation strategies	All	By providing a better assessment of the values of the inland capture fishery in the LMB to justify increased investment in sustainability. Justifying access to climate funding to support sustainability of the inland capture fisheries of the LMB
	Project (6) title: Strengthening capacity in fisheries and aquaculture for sustainability to be resilient to climate change in the Lower Mekong Basin.	Climate change mitigation (GHG emissions) is absent from the Basin-Wide Fisheries Management and Development Strategy 2018–2022 (BFMDS) and the PBAP (Project 6). Project 5 (proposed here) helps fill this gap.

Source: MRC (2017a).

10. REFERENCES

Arias, M.E., Cochrane, T.A., Piman, T., Kummu, M., Caruso, B.S., & Killeen, T.J. (2012). Quantifying changes in flooding and habitats in the Tonle Sap Lake (Cambodia) caused by water infrastructure development and climate change in the Mekong Basin. *J. Environ. Manage,* 112, 53–66. https://doi.org/10.1016/j.jenvman.2012.07.003

Baran, E., Baird, I.G., & Cans, G. (2005). Fisheries bioecology at the Khone Falls (Mekong River, Southern Lao PDR). *WorldFish Center*. 84 pp.

Barange, M., Bahri, T., Beveridge, M.C.M., Cochrane, K.L., Funge-Smith, S. & Poulain, F., eds. (2018). Impacts of climate change on fisheries and aquaculture: synthesis of current knowledge, adaptation, and mitigation options. *FAO Fisheries and Aquaculture Technical Paper* 627. Rome, FAO. 628 pp.

Barlow, C., Baran, E., Halls, A.S. & Kshatriya, M. (2008). How much of the Mekong fish catch is at risk from mainstream dam development? *Catch and Culture*, 14(3): 16–21. (also available at http://www.mrcmekong.org/assets/Publications/Catch-and-Culture/CatchCulturevol14.3.pdf

Brugere, C. & De Young, C. (2020). Addressing fisheries and aquaculture in National Adaptation Plans. *Supplement to the UNFCCC NAP Technical Guidelines*. Rome, FAO. https://www.fao.org/documents/card/en/c/ca2215en

Bui, L., Nguyen, S.H., Nguyen, M.H., Tong, P.H.S., Nguyen, T.K.L., Pham, M.T., & Nguyen, X.V. (2013). Scientific basic of the Mekong Delta to adapt with climate change and sea level rise. Ho Chi Minh, Agriculture Publishers.

Cambodia National Climate Change Committee (2013). *Cambodia Climate Change Strategic Plan* 2014–2023.

Campbell, T., Ngor, P.B., Chan, B., Eschenroeder, J.C., Everest, E., Chandra, S., Chea, S., Pin, K., Chhuoy, S., Chhorn, S., Soem, S., Sup, M., Phen, C., Sreynov, H., Somony, T., Chhut, C., & Hogan, Z.S. (2022). Dispersal and Survival of Captive-Reared Threatened Fishes in a Tonle Sap Lake Reserve. *Water (Switzerland) 14*, 1–13. https://doi.org/10.3390/w14192995

Chea, R., Pool, T.K., Chevalier, M., Ngor, P., So, N., Winemiller, K.O., Lek, S., & Grenouillet, G., (2020). Impact of seasonal hydrological variation on tropical fish assemblages: abrupt shift following an extreme flood event. *Ecosphere 11*. https://doi.org/10.1002/ecs2.3303

Chevalier, M., et al. (2023). Long-term data show alarming decline of majority of fish species in a Lower Mekong Basin fishery. *Science of the Total Environment.* https://doi.org/10.1016/j.scitotenv.2023.164624

CCPAP (Climate Change Priorities Action Plan) (2016–2020). Ministry of Agriculture, Forestry and Fishery Cambodia. Royal Government of Cambodia.

CCCSP (Climate Change Strategic Plan) 2014–2023 (2013). Royal Government of Cambodia.

Coates D., Ouch Poeu, Ubolratana Suntornratana, N. Thanh Tung & Sinthavong Viravong. (2003). Biodiversity and fisheries in the Lower Mekong Basin. *Mekong Development Series No. 2.* Phnom Penh, Mekong River Commission.

Coates, D. (2002). Inland capture fishery statistics for South-east Asia: current status and information needs. Food and Agriculture Organization of the United Nations, Regional Office for Asia-Pacific, Bangkok, *Thailand*. RAP Publication 2002/11.

Coates, D. (2023). Ecosystem restoration and inland food fisheries in developing countries – opportunities for the United Nations Decade on Ecosystem Restoration (2021–2030). *FAO Fisheries and Aquaculture Circular No. 1231*. Rome, FAO. https://doi.org/10.4060/cc7082en.

DoF (Department of Fisheries) Thailand (2021). Inland Fisheries Development Plan 2023-2030. Inland Fisheries Research and Development Division, Department of Fisheries, Ministry of Agriculture and Cooperatives.

DoF (2022). Sustainable Fisheries Development Plan in the Mekong River Basin of Thailand 2023–2030. *Ministry of Agriculture and Cooperatives*.

Le Duc Trung, L.D.T., Nguyen Anh Duc, N.A.D., Linh Thu Nguyen, L.T.N., Tran Hong Thai, T.H.T., Khan, A., Rautenstrauch, K. and Schmidt, C., 2020. Assessing cumulative impacts of the proposed Lower Mekong Basin hydropower cascade on the Mekong River floodplains and Delta-overview of integrated modeling methods and results.

FAO (Food and Agriculture Organization of t4he United Nations) (2015). Voluntary Guidelines for Securing Sustainable Small-Scale Fisheries in the Context of Food Security and Poverty Eradication. Rome.

FAO (2021). FAO Yearbook. Fishery and Aquaculture Statistics 2019/FAO annuaire. Statistiques des pêches et de l'aquaculture 2019/FAO anuario. *Estadísticas de pesca y acuicultura 2019.* Rome. https://doi.org/10.4060/cb7874t

FAO & IUCN (International Union for Conservation of Nature). (2017). Identification of spatial priorities for the re-opening of wetlands to maintain the water flow required for ecological functioning, biological connectivity, and habitat maintenance. *Xe Champhone Ramsar Site, Lao PDR*. CAWA Project, December 2017. http://www.fao.org/3/I8804EN/i8804en.pdf

FAO, WorldFish and IWMI (International Water Management Institute) (2020). Increasing the benefits and sustainability of irrigation through the integration of fisheries - A guide for water planners, managers, and engineers. Colombo. https://doi.org/10.4060/cb2025en

FiA (Fisheries Administration) (2021). Fisheries Statistics. Phnom Penh.

Funge-Smith, S.J. (2018). Review of the state of world fishery resources: inland fisheries. *FAO Fisheries and Aquaculture Circular No. C942 Rev.3*. Rome. 397 pp.

Gerber, P.J., Steinfeld, H., Henderson, B., Mottet, A., Opio, C., Dijkman, J., Falcucci, A. & Tempio, G. (2013). Tackling climate change through livestock – A global assessment of emissions and mitigation opportunities. Food and Agriculture Organization of the United Nations, Rome.

Gray, T.N.E., Phommachak, A., Vannachomchan, K., Guegan, F. (2017). Using local ecological knowledge to monitor threatened Mekong megafauna in Lao PDR. *PLoS One 12*, 1–12. https://doi.org/10.5061/dryad.f18q0.Funding

GSO (General Statistics Office)(2020). Completed results of the 2019 Viet Nam: Population and housing census. Statistical publishing house (842 pp).

GSO (2021). Statistical Yearbook of Vietnam 2020. Statistical publishing house (1056 pp).

GSSD (General Secretariat) (2018). Cambodia's National Adaptation Plan: Communication Strategy. General Secretariat of the National Council for Sustainable Development. Ministry of Environment. Phnom Penh.

Hall, S.J., Delaporte, A., Phillips, M.J., Beveridge, M.C.M., & O'Keefe, M. (2011). Blue frontiers: managing the environmental costs of aquaculture. *Penang, Malaysia, WorldFish Centre* (93 pp). http://pubs.iclarm.net/resource_centre/WF_2818.pdf

Halls, A.S. (2009). Addressing fisheries in the Climate Change and Adaptation Initiative. *Catch and Culture: Fisheries Research and Development in the Mekong Region*, 15(1), 12–16.

Harrod, C., Ramírez, A., Valbo-Jørgensen, J., & S. Funge-Smith (2018a). How climate change impacts inland fisheries. pp 375–392 In: M. Barange, T. Bahri, M.C.M. Beveridge, K.L. Cochrane, S. Funge-Smith, & F. Poulain (Eds.), Impacts of climate change on fisheries and aquaculture: synthesis of current knowledge, adaptation, and mitigation options. *FAO Fisheries and Aquaculture Technical Paper No. 627*. Rome, FAO.

Harrod, C., Ramírez, A., Valbo-Jørgensen, J., & S. Funge-Smith (2018b). Current anthropogenic stress and projected effect of climate change on global inland fisheries (pp 393–448). In: M. Barange, T. Bahri, M.C.M. Beveridge, K.L. Cochrane, S. Funge-Smith, & F. Poulain (Eds.), Impacts of climate change on fisheries and aquaculture: synthesis of current

knowledge, adaptation, and mitigation options. FAO Fisheries and Aquaculture Technical Paper No. 627. Rome, FAO.

Harrod, C., Simmance, F., Funge-Smith, S., & Valbo-Jorgensen, J. (2018c). Options and opportunities for supporting inland fisheries to cope with climate change adaptation in other sectors (pp 567–584). In: M. Barange, T. Bahri, M.C.M. Beveridge, K.L. Cochrane, S. Funge-Smith, & F. Poulain (Eds.), Impacts of climate change on fisheries and aquaculture: synthesis of current knowledge, adaptation, and mitigation options. FAO Fisheries and Aquaculture Technical Paper No. 627. Rome, FAO.

Hasan, M.R. & Soto, D. (2017). Improving feed conversion ratio and its impact on reducing greenhouse gas emissions in aquaculture. FAO Non-Serial Publication. Rome, FAO. 33 pp. (also available at http://www.fao.org/3/a-i7688e.pdf).

He, F., Thieme, M., Zarfl, C., Grill, G., Lehner, B., Hogan, Z., Tockner, K., & Jähnig, S.C. (2021). Impacts of loss of free-flowing rivers on global freshwater megafauna. *Biol. Conserv*. 263. https://doi.org/10.1016/j.biocon.2021.109335

Heilpern, S.A., Sethi, S.A., Barthem, R.B., Da Silva Batista, V., Doria, C.R.C., Duponchelle, F., Vasquez, A.G., Goulding, M., Isaac, V., Naeem, S., & Flecker, A.S. (2022). Biodiversity underpins fisheries resilience to exploitation in the Amazon river basin. *Proc. R. Soc. B. Biol. Sci. 289*. https://doi.org/10.1098/rspb.2022.0726

Heng, K., Chevalier, M., Laffaille, P., & Lek, S. (2017). Spatio-temporal variation of fish taxonomic composition in a South-East Asian flood-pulse system. *PLoS One 12*, 1–16. https://doi.org/10.1371/journal.pone.0174582

Hortle, K. (2007). Consumption and the yield of fish and other aquatic animals from the Lower Mekong Basin. MRC Technical Paper No. 16. Mekong River Commission, Vientiane.

IFReDI (2016). M-IWRM Transboundary Project: Transboundary Fisheries Management on the Mekong and Sekong Rivers in Cambodia and Lao PDR.

Januchowski-Hartley, S.R., McIntyre, P.B., Diebel, M., Doran, P.J., Infante, D.M., Joseph, C. & Allan, J.D. (2013). Restoring aquatic ecosystem connectivity requires expanding inventories of both dams and road crossings. *Frontiers in Ecology and the Environment*, 11(4), pp.211–217.

Joshua. L. (2013). Mekong Dams Threaten Extinction of Giant Catfish. Rfa, https://www.rfa.org/english/news/laos/dams-06192013184629.html

Kalikoski, D.C., Jentoft, S., Herrera, D.S., Cook, K., Béné, C., & Allison, E.H. (2018). Understanding the impacts of climate change for fisheries and aquaculture: applying a poverty lens (pp. 19–40). In: M. Barange, T. Bahri, M.C.M. Beveridge, K.L. Cochrane, S. Funge-Smith, & F. Poulain (Eds.), Impacts of climate change on fisheries and aquaculture: synthesis of current knowledge, adaptation, and mitigation options. FAO Fisheries and Aquaculture Technical Paper No. 627. Rome, FAO.

Karttunen, K., Wolf, J., Garcia, C., & Meybeck, A. (2017). Addressing agriculture, forestry, and fisheries in National Adaptation Plans. *Supplementary guidelines*. Rome, FAO. 101 pp. http://www.fao.org/3/a-i6714e.pdf

Kawarazuka, N. & Béné C. (2010). Linking small-scale fisheries and aquaculture to household nutritional security: an overview. *Food Security 2,* 343–357

Lam, N.C., Nguyen, N. Du, & Nguyen, V.P. (2011). Impacts of hydropower dams to dynamic of fish larvae composition species of Mekong delta. *J. Mekong Fish*. 437–446.

Lebel, P., Whangchai, N., Chitmanat, C. Promya, P., Chaibu, P., Sriyasak, P., & Lebel, L. (2013). River-based cage aquaculture of Tilapia in northern Thailand: Sustainability of rearing and business practices. *Natural Resources*, Vol.4 No.5(2013), Article ID:37174,12. pp. 410–421. https://idl-bnc-idrc.dspacedirect.org/items/dbabf900-b511-4118-add7-d4e18d215712

Mai, Y.D., & Phan, L. (2015). An Introduction to the Fisheries and Aquaculture in the Lower Mekong River Basin of Viet Nam. *Technical report, Fisheries Programme - MRC*.

MARD (Ministry of Agriculture and Rural Development) (2009). Strategies for fisheries development of Vietnam up to 2020 (in Vietnamese).

MARD (2014). Restructure of fisheries sector towards sustainable development and increasing of value added products (in Vietnamese).

McCormick Smith, H. (1925). A Review of the Aquatic Resources and Fisheries of Siam: With Plans and Recommendations for their Administration, Conservation, and Development.

Mitchell, C. & Cleveland, C.J. (1993). Resource scarcity, energy use and environmental impact: a case study of the New Bedford, *Massachusetts, USA, fisheries*. Environmental management, 17(3): 305–317.

MRC (2017a). Mekong Basin-wide Fisheries Management and development Strategy 2018–2022. Vientiane, Lao PDR.

MRC (2017b). Biological Resources Assessment for the Council Study on the sustainable management and development of the Mekong River, including impacts of mainstream hydropower projects. Specialist's Technical Report Vol. 1. Vientiane, Lao PDR.

MRC (2017c). Summary of the basin-wide assessments of climate change impacts on water and water-related resources in the Lower Mekong Basin. Climate Change and Adaptation Initiative (24 pp.). https://www.mrcmekong.org/assets/Uploads/Summary-of-basin-wide-impact-assessments.pdf

MRC (2018). Mekong Climate Change Adaptation Strategy and Action Plan. Vientiane, Lao PDR (44 pp).

MRC. (2019). Mekong River Commission. State of the Basin Report 2018. Vientiane, Mekong River Commission Secretariat. https://www.mrcmekong.org/assets/Publications/SOBR-v8_Final-for-web.pdf. 274pp.

MRC. (2021). Project-based Action Plan for Implementing the Strategy for Basin-wide Environmental Management for Environmental Assets of Regional Importance 2021–2025. Vientiane, MRC Secretariat. https://www.mrcmekong.org/resource/qx5ynx

MRC. (2023a). Mekong River Commission. Brief for options for Investment and Associated Measures to Optimize Fisheries Production under Changed River Conditions. Vientiane, MRC Secretariat.

MRC. (2023b). Mekong River Commission. Fisheries Yield Assessment by Habitat Type at the Landscape Scale in the Lower Mekong River Basin 2020. Vientiane, Mekong River Commission Secretariat. https://www.mrcmekong.org/resource/bivw7w#:~:text=The%20assessments%20conducted%20in%202020,OAA)%20is%20approximately%20443%2C000%20tons

Ngor, P.B., Nam, S., & Degen, P. (2014). Potential Impacts of Climate Change on Fisheries in LMB. 2nd Mekong Climate Change Forum Adaptation to Climate Change in the Transboundary Context. *SiemReap,* Cambodia, 6–8 October 2014.

Ngor, P.B., Oberdorff, T., Phen, C., Baehr, C., Grenouillet, G., & Lek, S. (2018a). Fish assemblage responses to flow seasonality and predictability in a tropical flood pulse system. *Ecosphere 9*. https://doi.org/10.1002/ecs2.2366

Ngor, P.B., Legendre, P., Oberdorff, T., & Lek, S. (2018b). Flow alterations by dams shaped fish assemblage dynamics in the complex Mekong-3S River system. *Ecol. Indic. 88*, 103–114. https://doi.org/10.1016/j.ecolind.2018.01.023

Nguyen, N. D., Smallwood, C., Nguyen, V.H., Nguyen, X.T., & Nguyen, T.T. (2006). Collection Atlas on the inland fishing gears in the Mekong Delta. Ho Chi Minh, Research Institute for Aquaculture 2 and MRC.

Nguyen, N.D., Phan, T.L., Vu, V.A., Nguyen, V.P., Doan, V.T., Doan, V.B., & Nguyen, V.T. (2016). Impact Assessment of Proposed Saline Intrusion Prevention Sluice Gate Construction Project on Fisheries Resources in Bến Tre province. Technical report. Research Institute for Aquaculture 2 (RIA2).

ONWR (Office of the National Water Resources). (2022). Final Report: A study of the impact and monitoring of transboundary environmental impact assessment of hydropower projects on the Mekong mainstream 2021 (628 pp.).

Orr, S., Pittock, J., Chapagain, A., & Dumaresq, D. (2012). Dams on the Mekong River: lost fish protein and the implications for land and water resources. *Global Environmental Change*, 22(4): 925–932. https://doi.org/10.1016/j.gloenvcha.2012.06.002

Parker, R.W., & Tyedmers, P.H. (2015). Fuel consumption of global fishing fleets: current understanding and knowledge gaps. *Fish and Fisheries*, 16(4): 684–696 https://doi.org/10.1111/faf.12087

Pech, S. (2013). Water sector analysis. In: A. Smajgl & J. Ward (Eds). The water-food-energy nexus in the Mekong region, (pp. 19–60). New York, Springer. https://doi.org/10.1007/978-1-4614-6120-3

Phan, L.T. (2014). Sustainable development: key issues for striped catfish and shrimp industries in Vietnam. Stirling, Institute of Aquaculture, University of Stirling.

Phan, T.L., Doan, V.B., Nguyen, T.D., Nguyen, H.S., Peter, D., So, N., & Hortle, K.G. (2016). Survey of fisheries yield at landscape scale in the Mekong River Delta, Viet Nam. *Technical report.* Research Institute for Aquaculture No. 2.

Phan, T.L., & Pham, M.P. (2002). Assessment of inland fisheries resources in An Giang province based on the fisher surveys. *J. Mekong Fish*. 22–37.

Phan, T.L., & Pham, M.P. (2003). Some approaches for aquatic resources assessments of Inland waters of Mekong delta. *J. Mekong Fish*. Special issue, 23–37.

Phan, T.L., Nguyen, N.D., Doan, V.B., & Nguyen, V.P. (2015). Study on socio-economic impacts and social implications from reduced capture fisheries in the Mekong River Delta. Technical report. Research Institute for Aquaculture No. 2.

Phan, T.L., Pham, M.P., Visser, T., Sjorslev, J.G., & Hortle, K.G. (2003). Inland fisheries activities and fish consumption in Tra Vinh Province, Viet Nam. In: 5th Technical Symposium on Mekong Fisheries, 11 December 2002, Khon Kaen. Series 4:127–139.

Pomeroy, R.S., Oh, K., Martone, E., Westlund, L., Josupeit, H. & Son, Y. 2022. Guidebook for evaluating fisheries co-management effectiveness. Rome, FAO. https://doi.org/10.4060/cc2228en

Poulain, F., Himes-Cornell, A. & Shelton, C. (2018). Methods and tools for climate change adaptation in fisheries and aquaculture (pp. 535–566). In: M. Barange, T. Bahri, M.C.M. Beveridge, K.L. Cochrane, S. Funge-Smith, & F. Poulain (Eds.), Impacts of climate change on fisheries and aquaculture: synthesis of current knowledge, adaptation and mitigation options. FAO Fisheries and Aquaculture Technical Paper No. 627. Rome, FAO.

Ritchie, H., Roser, M., & Rosado, P. (2020). "CO_2 and Greenhouse Gas Emissions". *OurWorldInData.org*. https://ourworldindata.org/co2-and-greenhouse-gas-emissions

Robb, D.H.F., MacLeod, M., Hasan, M.R., & Soto, D. (2017). Greenhouse gas emissions from aquaculture: a life cycle assessment of three Asian systems. *FAO Fisheries and Aquaculture Technical Paper No. 609.* Rome, FAO.

Sjorslev, J.G. (2002). An Giang Fisheries Survey. An Giang Province - Viet Nam. AMFC of MRC Fisheries Programme. Vientiane.

Takahashi, B., & Van Duijn, A.P. (2012). Operationalizing fisheries co-management: Lessons learned from lagoon fisheries co-management in Thua Thien Hue Province, Viet Nam. *FAO Regional Office for Asia and the Pacific, Bangkok*. RAP Publication 2012/02 (131 pp.).

UNFCCC (United Nations Framework Convention on Climate Change) (2020). Cambodia's Updated Nationally Determined Contribution (NDC).Bonn.

UNFCCC (2021). Lao PDR Updated Nationally Determined Contribution (NDC). 9 March 2021. Bonn.

UNFCCC. (2022b). Thailand's Second Updated Nationally Determined Contribution (NDC). Bonn.

UNFCCC. (2022a). Viet Nam's Nationally Determined Contribution (NDC) Updated. Bonn.

Van Zalinge N., Thuok N., & Nuov S. (2016). Status of the Cambodia inland capture fisheries sector with special reference to the Tonle Sap Great Lake. http://info.mrcmekong.org/assets/midocs/0002802-biota-status-of-the-cambodian-inland-capture-fisheries-sector-with-special-reference-to-the-tonle-sap-great-lake.pdf

Vu, A.V. et al. (2014). Study on the impacts of mainstream hydropower on the Mekong River: Research study to gather additional data for fishery resource impact assessment. Research Institute for Aquaculture No. 2. Ho Chi Minh.

Vu, V.A., Doan, V.T., Pun, N.P., Nguyen, H.S., & Nam, S. (2013). Exotic species in southern Viet Nam. *Catch Cult*. 19, 18–23.

Welcomme, R., & Vidthayanom, C. (2003). The impacts of introductions and stocking of exotic species in the Mekong Basin and policies for their control (38 pp.). MRC Technical Paper No. 9. Phnom Penh, Mekong River Commission.

WWF (2016). Lao-Thai fisheries co-management: improving fish stocks and livelihoods in the middle Mekong. Project introduction document (9 pp.).

Yoshida, Y., Lee, H.S., Trung, B.H., Tran, H.D., Lall, M.K., Kakar, K. and Xuan, T.D., 2020. Impacts of mainstream hydropower dams on fisheries and agriculture in lower Mekong Basin. Sustainability, 12(6), p.2408.

Ziv, G., Baran, E., Nam, S., Rodríguez-Iturbe, I., & Levin, S.A. (2012). Trading-off fish biodiversity, food security, and hydropower in the Mekong River Basin. *Proc. Natl. Acad. Sci. U.S.A.* 109, 5609–5614. https://doi.org/10.1073/pnas.1201423109

ANNEX: FISHERIES SECTOR IN THE FOUR LOWER MEKONG BASIN COUNTRIES: INSTITUTIONS, LAWS, REGULATIONS, POLICIES, INVESTMENTS AND PRACTICES

Cambodia

The sector policy framework for the management and development of the fisheries sector outlined in the Strategic Planning Framework 2015–2024 (SPF) for Fisheries aims to ensure that fisheries resources and ecosystems maintain sustainable livelihoods and contribute to national economic development. It is based on the 2005 National Fisheries Sector Policy and Cambodia's Rectangular Strategy, which is the Government's economic policy agenda. The Framework was developed to support the achievement of Cambodian Millennium Development Goals in compliance with Chapter 4 of the Law on Fisheries, which states that the Fisheries Administration shall develop a national fisheries management plan based on the national fisheries policy. The law stipulates that the management plan should reflect the following principles:

1. Fisheries and aquaculture should contribute to national prosperity.
2. Fisheries and aquaculture should improve livelihoods.
3. Fishery domains and their resources should be maintained in healthy and resilient condition, and sustainably managed.
4. Fish should remain a plentiful, healthy and valuable source of food.
5. Fishing should be profitable, sustainable and responsible.
6. There should be close cooperation with neighbouring countries to manage, develop and conserve the fisheries.
7. The sector's policy, regulatory and support environment should be sufficient, appropriate and enabling.

In 2014, the Fisheries Administration (FiA) developed an annual fisheries action plan in compliance with the Framework's goals, indicators and targets. It listed nine sub-programmes:

- Community fisheries development
- Management of the fisheries domain
- Rural aquaculture development
- Human-resources development and fisheries-resource protection
- Research in support of sustainable fisheries
- Improvement of post-harvest fisheries for better quality and safety
- Fisheries protection and conservation of fisheries resources
- Fisheries policy, planning and monitoring and evaluation
- Sustainable marine-fisheries resource development.

In 2016, IFReDI led a focus group discussion, which identified the challenges to sustainable fisheries management as follows:

- the lack of fisheries staff;

- the lack of awareness of the importance of fisheries in some parts of society and government;
- seasonal and annual variation in supply, leading to gluts, shortages and overexploitation of any species;
- weak enforcement and cooperation/coordination;
- limited skills, standards, and guidance material;
- shortage of funding, including for investment in infrastructure;
- shortage of resources and knowledge to support aquaculture;
- limited quality control and disease management facilities;
- the lack of scientific research and data in many areas;
- the loss of breeding habitat and declining wild stocks due to:
  - climate change, leading to changes in water levels, flow rates and flooding patterns;
  - environmental degradation from pollution and increased mining sediment.
  - damming, land conversion and deforestation;
  - increased pressure on the resource due to economic and population growth factors;
  - increased international trade competition and more stringent import regulations;
  - uncontrolled, illegal and destructive fishing, leading to conflict.
  - disease, especially in aquaculture;
  - loss of land for fisheries due to weaknesses in land management;
- the lack of a detailed agreement between border villages and the district over regulations;
- increased use of more efficient modern fishing gears by commercial fishers, which means less small fish for dolphins to eat;
- poverty of local people;
- no alternative livelihood to fishing activities;
- no benefits from tourism services;
- the use of chemical fertilizers; and
- weak cooperation and coordination among relevant stakeholders.

IFReDI (2016) showed that fisheries management had been facing challenges and issues that were causing the resources to decline and constraining management (Table 18). The three top challenges were: lack of funds, materials and equipment to implement activities; illegal fishing gears/activities; and lack of cooperation.

Table 18. The challenges/issues in fisheries management in Cambodia

No	Challenge in fisheries management	Percentage
1	Lack of funds, materials and equipment for the activities (lack of boats, depletion of funds of non-governmental organizations, lack of income of CFis)	37.5
2	Illegal fishing gears/activities (e.g. flooded forest clearing)	35.72
3	Lack of cooperation/coordination (between the authorities of multiple countries)	8.93
4	Hydropower dam construction	7.14
5	Limited awareness and dissemination of fisheries law	5.37
6	Weak law enforcement	5.36

Source: IFReDI, 2016.

Based on findings from a discussion during a workshop in Stung Treng on 19 January 2016 and a workshop in Phnom Penh on 22 January 2016, the transboundary fisheries management challenges/issues were identified as follows:

- changes in river water levels and water quality due to large-scale development and climate change;
- weak cooperation and coordination among relevant stakeholders;
- the lack of definitive studies on the size and type of fishing gears to the appropriate areas;
- the lack of mutual information systems (radio, television, radio, microphone and Facebook, etc.);
- limited knowledge of local institutions, non-governmental organizations (NGOs) and local authorities;
- export of fisheries products to Lao PDR for free without permission;
- the building of Don Sahong dam, which substantially affects fisheries, e.g. by reducing flooding and and making the Mekong River shallower; and
- lack of basic data on the economic, social and biodiversity aspects.

A summary of key challenges, recommended responses, integrated/transboundary adaptive measures, and approximate investment costs for capture fisheries in Cambodia is provided in Table 19.

Table 19. Key challenges, recommended response, integrated transboundary adaptive measures and approximate investment costs for capture fisheries in Cambodia

Key challenges	Recommended response	Integrated/transboundary adaptive measures	Investment needs (2024–2030) (US$)
Increasing fishing effort	1. Educate fishers on the challenges to sustainable fisheries is very important. One of the aims is to strengthen the Community Fisheries (CFi) by building the capacity of the Community Fisheries Committee (CFiC), Community Fisheries members on fisheries management, conservation and planning, to define gear use by zoning 2. Enhance the resilience of the fishing community 3. Promote and establish alternative livelihoods for CFi members and fishers' families	• Establish a transboundary fisheries management body. • Implement a transboundary fisheries management plan. • Support/promote alternative livelihoods to community fisheries for reducing fishing pressures in the Lower Mekong Basin (LMB). • Support the investment to enhance transboundary fisheries management in the LMB. • Restore and reconnect the critical fish habitats in the LMB.	500,000
Illegal gear use	1. Strengthen low enforcement 2. Define and list all illegal gears' use by each CFi villages/fishing area 3. Support/promote an alternative livelihood to Community Fishers. 4. Strengthen crackdown illegal fishing activities.		400,000

	5. Promote livelihoods diversification, including aquaculture good practices, in order to ensure the sustainable use of fisheries resources, both for food security and conservation of natural resources for future generation. In particular, encourage the full engagement and participation of all stakeholders and CFis.	• Establish new fish conservation and protection areas in the LMB. • Establish a joint fisheries monitoring programme. • Conduct joint research to improve the knowledge and information about transboundary fisheries. • Improve the data information dissemination system and mechanism. • Joint conservation action in the dolphin zones and critical areas to be developed. • Encourage the full engagement and participation of stakeholders in transboundary fisheries management (cooperation and dialogue) and strengthen the research capacity and knowledge base.	
Declining catches, fish abundance and fish size	1. Support/promote an alternative livelihood to community fishers. 2. Responsibly protect and manage natural fish habitats jointly with all relevant stakeholders, especially Cfi. 3. Prohibit fishing in the closed season and closed area (conservation area, etc.). 4. Disseminate information on the negative impacts of mosquito net and illegal fishing activities. 5. Strengthen patrol activities.		300,000
Weak law enforcement	1. Strengthen law enforcement. 2. Enhance awareness on and dissemination of fisheries laws and regulations to fisheries community. 3. Build the capacities of the fisheries staff and increase resources to tackle the problems of weak enforcement.		300,000
Weak communication and networking between the community to regional levels regarding fisheries conservation and management	1. Ensure that the Fisheries Administration (FiA) plays an important role in coordinating with relevant stakeholders such as NGOs, local authorities and others line departments/ministries to manage fisheries resources 2. Ensure that fisheries staff both at the national and sub-national levels and relevant stakeholders strengthen management capacity for coordinating functional fisheries management. 3. Establish the appropriate networking among CFis from the village level and scale up to the national and regional levels.		400,000
Fisheries habitat degradation	1. Identify the fisheries habitats by country and design the joint action plan and programme to efficiently protected and manage them. 2. Study possible new fish conservation and protection areas.		300,000

	3. Map the critical fish habitats for key species. 4. Restore and reconnect the critical fish habitats. 5. Prevent or stop cutting flooded forest for agriculture and other purposes with permission or legal activities. 6. Maintain or prevent sand and sediment deposits from upstream erosion areas in deep pools that would make them shallow.		
Water development in the mainstream and its tributaries	1. Conduct a study on the impacts that optimize the energy-food trade-off. 2. Apply the relevant scientific and indigenous knowledge on water development and incorporate fisheries and their social, economic and livelihood dimensions into the decision-making process in a collaborative manner. 3. Monitor and evaluate the contribution of fisheries resources to national food security and nutrition should be carried out systematically to inform policies and decisions related to water development, land management, energy and food security.		500,000
Climate change impacts on fisheries	Follow the three proposed actions by the Fisheries Administration in its CCPAP 2021–2030. These three actions consist of 17 sub-activities for climate actions that have both adaptation and mitigation components and include climate-tolerant seeds, stock enhancement, protection of critical fisheries habitat, good post-harvest practices, good aquaculture practices, and capacity development for community fisheries; 1. Improve climate-tolerant seed and brood stock for aquaculture and stock enhancement (5 sub-activities) 2. Manage and rehabilitate critical fisheries habitats in response to climate resilience (6 sub-activities). 3. Promote good post-harvest practices by using renewable energy efficiency along fisheries value chains.		500,000

Broad categories of policy areas and strategy elements of Cambodia's fishery sector

The relationships and priorities among various key instruments and policies for capture fisheries in Cambodia are indicated in Table 20.

Table 20. Broad categories of policy areas and strategy elements of Cambodia's fishery sector

Categories	Relevance Estimated at High (3), Medium (2), Low (1) Not listed (0)			
	NFP 2005	Fish. Law 2007	SPF 2010–2019	Action Plan
Contribution to economic (GDP) growth, including by value chain and post-harvest improvements	3	2	3	3
Contribution to sustainable livelihoods	3	3	3	3
Contribution to food security	1	2	2	0
Responsible fisheries	2	3	3	3
Fisheries enhancement, including rice-field fisheries	1	2	2	2
Responsible aquaculture	2	3	2	2
Environmental and ecosystem/habitat protection and restoration	2	3	3	3
Co-management, including public-sector institutional strengthening and capacity building	3	3	3	3
Research, including monitoring and generation of data and information	1	1	1	2
Basin-wide cooperation in fisheries management and development	0	1	2	0
Regional/international cooperation	0	1	2	0

Lao PDR

The Review of National Fisheries Plans, Strategies and Policies for Lao PDR provides a summary of the state of fisheries management and development in Lao PDR. Its findings are based on the National Strategy for Fisheries from the present to 2020, Action Plan from 2006 to 2010 and on the legal and regulatory framework governing the sector, in particular, the 2009 Fisheries Law (Lao PDR, 2009). In addition, FAO's Fisheries and Aquaculture in Lao PDR – a Legislative Review was consulted for the findings presented below.

The review recognizes the important contribution of fisheries and aquaculture to national food security and livelihoods, especially in rural areas. It also acknowledges that developments in other sectors, such as irrigated agriculture, hydroelectricity, domestic water supply and wastewater disposal, threaten this contribution. Regarding sector management and development, it recommends the following:

> The development of aquatic resources should be recognized by the Government in its development planning, as it is a key component in improving food security for many rural people, as well as providing them with additional income and employment opportunities. Two interlinked strategic frameworks of resource assessment and the management of capture fisheries should be developed, in concert with the promotion of the sustainability of aquaculture (FAO's Fisheries and Aquaculture in the Lao PDR – a Legislative Review).

The National Strategy for Fisheries discusses issues that are pertinent to the sector, but does not explicitly outline strategies, plans and road maps. No explicit reference is made to regional cooperation. Since it refers to the planning period of 2006–2010, it may have been superseded by more recent planning efforts, although no documents were provided for this review.

The FAO's legislative review analysed the fisheries and aquaculture legal framework in place prior to the 2009 Fisheries Law, including relevant legislation that impacts fisheries and aquaculture.

Major findings of the analysis were:

- "Fisheries regulations are scattered throughout several laws and regulations, particularly in the Forestry Law, Agriculture Law and MAF rules and instructions, and are, to a large extent, redundant, dealing mainly with protected and managed species, prohibited fishing gears and methods and closed seasons.
- Aquaculture activities are virtually unregulated.
- There is a need to clarify the extent of the powers conferred by the Local Administration Law 2003 upon local authorities with respect to fisheries and aquaculture at each level of government (province, district and village).
- Signs of overfishing have been reported in certain areas, indicating that there may be a need to introduce legal mechanisms to restrict or limit access to such areas.
- Existing regulations are poorly enforced, if at all" (FAO's Fisheries and Aquaculture in the Lao PDR – a Legislative Review).

The following findings emerged from FAO's review:

- "It was proposed to introduce co-management mechanisms drawing on co-management initiatives by the Living Aquatic Resources Research Center (LARReC), the Mekong River Commission (MRC) and WWF for the management of fisheries at the local level.
- It [was] recognized that a significant amount of fish is produced in rice-field fisheries and that rules of access to such fisheries need to be clarified.
- To facilitate the orderly development of commercial aquaculture and control the conduct of such activities, it was suggested to introduce a licensing system.
- There [was] a need to reassess the procedure and objective of fishing concessions, as, so far, fishing concessions that have been granted are marketing concessions.
- Provide for enforcement mechanisms (e.g. designation of enforcement officers, specification of enforcement officers' powers).
- There (was) no offences and penalties scheme for fisheries and aquaculture."

The 2009 Fisheries Law provides the basic principles of fisheries in Article 6:

Principle 1
Engagement in aquaculture, conservation, protection, development and expansion of the species of fish and other aquatic fauna in a sustainable manner shall be work in which all people participate.

Principle 2
Engagement in aquaculture, conservation, protection, development and expansion of the species of fish and other aquatic fauna shall be the important tasks in the management of fisheries of fish and other aquatic fauna.

Principle 3
Exploitation of aquatic fauna shall be in accordance with laws and regulations, effective and sustainable without creating negative impact on environment, society or nature.

Principle 4
Establishment and protection of conservation zones for aquatic species and of their habitats, and food sources are to create the best conditions for their growth and proliferation and are aimed at maintaining the ecosystem balance.

Principle 5
Conservation, protection, development, exploitation of aquatic fauna, the management and inspection of fisheries shall be in conformity with international treaties to which the Lao PDR is a party.

Article 23 covers the protection of habitats and ecosystems:
"The protection of habitats and ecosystems means the conservation and protection of the habitats of fish and other aquatic fauna, and of the ecosystems of the bodies of water including the conservation of natural fish breeding areas, the food sources and other protected areas to ensure the sustainability and abundance of biodiversity. At the same time, protection measures against any man-made or natural destruction or attack shall be issued."

The law provides for participatory resource management in several articles, including roles of community-based fisheries management committees. Several participatory management schemes are being implemented, some with external support, for example, management of stretches of the Kading River supported by WWF. The Guidelines on Fisheries Co-management (in Lao PDR) was developed by the Department of Livestock and Fisheries with support from World Wildlife Fund (WWF)-Lao PDR in 2009.

Since all consulted documents were either in draft, outdated or not intended as policy/strategy documents, the following valuation of policy areas and strategy elements (Table 21) is largely based on the consultant's interpretation.

Table 21. Broad categories of policy areas and strategy elements of Lao PDR's fishery sector

Broad categories of policy areas and strategy elements	Relevance Estimated at High (3), Medium (2), Low (1) and Not Listed (0)	
	2006–2010 National Strategy	2009 Fisheries Law
Contribution to economic GDP growth, including by value chain and post-harvest improvements	3	2
Contribution to sustainable livelihoods	2	2
Contribution to food security	2	2
Responsible fisheries	3	3
Fisheries enhancement, including rice-field fisheries	2	2
Responsible aquaculture	3	2
Environmental and ecosystem/habitat protection and restoration	2	3
Co-management, including public-sector institutional strengthening and capacity building	1	2
Research, including monitoring and generation of data and information	2	2
Basin-wide cooperation in fisheries management and development	1	1
Regional/international cooperation	1	1

Thailand

The Department of Fisheries formulated the following mission:

- promoting and encouraging increase of aquaculture production in all stages;
- promoting and developing the quality of aquaculture production and fishery products throughout the entire chain in compliance with Thai and international standards;
- regulating and controlling fisheries resources for the sustainable utilization and maintenance of diversity by, *inter alia*, involving fisheries communities and people engaged in fisheries resources management;
- promoting and encouraging study and research on all areas of fisheries, and developing and transferring new research-based fisheries technologies towards creative and value-added innovation; and
- promoting capacity building to enhance responsible knowledge and expertise, and by reorganizing the organizational structure so that it is appropriate for the new mission.

Vision

Developing and managing changes in order to become a fisheries leader and to ensure food security through sustainable development.

Strategies

Five fisheries strategy issues are highlighted:

- Enhancement of aquaculture production
- Quality development of aquaculture production and fishery products
- Fisheries resources management for sustainability and diversity
- Research and technical development including fisheries technologies
- Human resources and organization development.

The following objectives are as follows:

- Ensure that aquaculture production is efficient, and the quality of products is acceptable, support the country's food security and enhance competitiveness.
- Ensure that farmers have secure income to maintain suitable living conditions and increase competitive potential.
- Improve the quality of aquatic animal and fisheries products to increase consumer confidence in export markets.
- Balance aquatic animal production and exploitation.
- Ensure research-based sustainable development.
- Build individual capacities.

Public participation and co-management

The Royal Ordinance contains a provision encouraging public participation at many levels.
The Inland Fisheries Development Action Plan 2023–2030, based on a review and analysis of issues pertinent to inland fisheries in Thailand, and the Sustainable Fisheries Development

Plan in the Mekong Basin 2023–2030 based on a review and analysis of issues pertinent to inland fisheries in the Mekong Basin Thailand.

The Inland Fisheries Development Action Plan 2023–2030

The Inland Fisheries Development Action Plan 2023–2030 was developed in recognition that inland fisheries production is decreasing, the freshwater ecosystem is deteriorating, the demand for freshwater fish is increasing, and the lack of participation in the management of inland fisheries resources are high-priority issues for threats to the sustainable management of inland fisheries in Thailand:

Vision

"Committed to the development of participatory inland fisheries management for maintaining the abundance and diversity of aquatic animals and for sustainable use."

Mission

1. Manage inland fisheries resources and maintain freshwater ecosystems across the country.
2. Increase inland fisheries productivity and restore freshwater aquatic animal resources in natural water bodies and community water bodies across the country;
3. Restoring, protecting, and enhancing inland fisheries habitats in an ecological and environmentally friendly way.
4. Eliminate and control illegal fishing.
5. Develop research and technology in inland fisheries management and sustainable utilization of freshwater fishery resources.

To achieve the objectives and goals under the vision and mission, the Inland Fisheries Development Action Plan 2023–2030 was formulated with five goals and 18 objectives:

Action Plan 1: Enhance the integrity of inland aquatic animal populations and biodiversity.
Objective 1: Rehabilitate highly exploited aquatic animals to return to their maximum sustainable yield according to the potential of the water resources.
Objective 2: Improve the population structure of aquatic animals to be more effective in increasing fishery production.
Objective 3: Enhance populations of economically important and valuable fish species to increase their production.
Objective 4: Restore, protect and conserve rare and threatened fish species to maintain their abundance and diversity.
Objective 5: Eliminate, control and prevent invasive alien species and genetically modified aquatic animals to preserve the biodiversity of native aquatic animals.

Action Plan 2: Rehabilitate, restore, protect and enhance the productivity of inland fisheries habitats and inland aquatic ecosystems.
Objective 1: Monitor and protect inland fishery habitats to retain the potential for aquatic animal production.
Objective 2: Rehabilitate and restore inland fishery habitats and degraded freshwater ecosystems to be suitable for aquatic animals.

Objective 3: Enhance and develop inland fishery habitats to increase their potential for inland fishery production.

Action Plan 3: Enhance awareness, integration and evaluation of participatory approaches into inland fisheries management.
Objective 1: Enhance awareness of participatory inland fisheries management in target communities.
Objective 2: Enhance the and integration of the participation of all stakeholders in inland fisheries management.
Objective 3: Carry out surveillance, control, monitoring and assessments of aquatic animal resources with community participation.

Action Plan 4: Promote and strengthen transboundary inland fisheries management in bordering areas.
Objective 1: Restore habitats and enhance the fertility of aquatic animal populations in water resources
Objective 2: Promote and integrate efficient participatory inland fisheries management into water resources management
Objective 3: Integrate cooperation with regional and international organizations for inland fisheries management in water resources management

Action Plan 5: Develop knowledge, technology, innovation and a database for inland fishery management.
Objective 1: Conduct research and development, monitoring and assessments of the status of inland aquatic animals and inland fisheries are necessary to support the efficient management of inland fisheries.
Objective 2: Enhance and develop knowledge databases and learning resources to increase the efficiency of inland fisheries management.
Objective 3: Promote and develop the DOF's official capacity to have knowledge and skills for effective inland fishery management.
Objective 4: Promote and integrate academic cooperation with national agencies and international organizations.

Although well formulated and targeted, the Inland Fisheries Development Action Plan 2023–2030 does not have measures or activities that mitigate the direct negative impacts of water resources development on blocking the migration routes of fishes. This indicates that there are issues regarding policy development, planning and the implementation of the inland fisheries development and management policy. In addition, implementation of the Action Plan is hampered by limited resources availability due to the prioritization of aquaculture management and development.

The Sustainable Fisheries Development Plan in the Mekong Basin 2023–2030

The Sustainable Fisheries Development Plan in the Mekong Basin 2023–2030 was initiated by local communities along the Mekong River and civil society organizations through the Ministry of Agriculture and Cooperatives. It was developed in recognition that the aquatic animal resources in the Mekong Basin, which are important food sources and livelihoods for

communities along the Mekong River in both Thailand and other countries, have significantly decreased and has undergone fluctuations due to changing ecological conditions as well as development projects in the Mekong River.

Vision

"Fisheries and aquaculture resources in the Mekong Basin of Thailand are participatory, sustainably developed, and responsive to change."

Mission

1. Enhance farmers' potential in aquaculture, processing, marketing, and resilience to ecosystem change.
2. Improve the quality, safety and added value of fishery products in the Mekong River Basin of Thailand to meet market demands.
3. Promote stakeholder participation in aquaculture management.
4. Manage aquatic animal resources for sustainable use, biodiversity, and protection from the impacts arising from ecosystem changes.
5. Promote stakeholder engagement in the management of fishery resources and aquaculture.

To achieve the objectives and goals under the vision and mission, the Sustainable Fisheries Development Plan in the Mekong Basin 2023–2030 was formulated, consisting of two strategic priorities, eight goals and 11 objectives:

Strategic priority 1: Improve the efficiency of production and strengthen the capacity of farmers in the Mekong Basin of Thailand.

- Goal 1: Enhance knowledge to increase the capacity of farmers to produce environmentally friendly products that are suitable for the living area and freshwater ecosystem.
    - Objective 1: Ensure that farmers have the capacity to produce environmentally friendly products that are suitable for the conditions of the area and the freshwater ecosystem.
- Goal 2: Strengthen farmers' and farmer groups' capacity to improve production quality and management systems throughout the supply chain to meet the standards and needs of the market.
    - Objective 2: Support small-scale farmers to become certified to meet aquaculture standards.
    - Objective 3: Strengthen capacity of farmers for processing and fishery product development to meet market needs throughout the supply chain.
- Goal 3: Promote participatory aquaculture management in the Mekong River Basin of Thailand.
    - Objective 4: Ensure that farmers are involved in the management of aquaculture.
- Goal 4: Develop knowledge, technology, innovation and a database for inland aquaculture management.
    - Objective 5: Provide farmers with knowledge, technology and a database system for aquaculture management.

Strategic Priority 2: Sustainably manage the fisheries and aquatic animal resources for fisheries abundance and diversity in the Mekong Basin.

- Goal 1: Restore freshwater habitats and enhance the richness of fish populations
  - Objective 1: Fully rehabilitate and enhance fish habitats and fish populations as well as their health.
- Goal 2: Promote and integrate effective participatory inland fisheries management of freshwater fisheries.
  - Objective 2: Encourage stakeholders to participate in inland fisheries resources management.
- Goal 3: Conduct surveillance, control, monitoring and assessments of the status of aquatic animal resources, regulations and measures for inland fisheries management.
  - Objective 3: Conduct surveys and control and monitor fishing activities in the targeted areas in accordance with the prescribed regulations and measures.
  - Objective 4: Monitor and assess the aquatic resources and inland fisheries in order to review and improve inland fishery management measures.
  - Objective 5: Review and update fisheries management regulations and measures to increase efficiency.
- Goal 4: Develop knowledge, technology, innovation and databases for inland fishery management.
  - Objective 6: Provide fisheries communities with knowledge, technology and innovation, and a database for aquatic animal resources management.

Although well formulated through a participatory approach, the implementation of the Sustainable Fisheries Development Plan in the Mekong Basin 2023–2030 is hampered by limited resources availability due to the prioritization of aquaculture management and development.

Current fisheries management and development activities

In 2023, the DOF implemented the fishery resource management project to promote participatory management of inland fisheries, involving all stakeholders in:

- Fishery reform (reorganization): The aim of this activity is to seek scientific evidence to set up measures for controlling fishing activities according to the Royal Ordinance on Fisheries and related rules and regulations; this would ensure the sustainable use of fisheries resources.
- The rehabilitation of native, rare and endangered aquatic animals: This activity aims to increase and conserve native, rare and endangered fish species as well as their biodiversity using area-based approach.
- Fishery resources monitoring and assessment: This activity aims to monitor the fisheries status and collect fisheries data and information in order determine the CPUE and maximum sustainable yield (MSY) to be used as a reference for fisheries management.

Fisheries co-management activities

The new fisheries law of Thailand, Section 9, promotes the participation and support of local fishing communities to management, maintenance, conservation, restoration and sustainable use of aquatic resources within the fishery in coastal fisheries or Inland Fisheries.

In 2023, the DOF implemented a project on strengthening the capacity of fisher groups, which aims to promote and support local fishers in establishing and registering as local fisher groups. This would promote the participation of local fishers in fisheries management, raise awareness among youth of participatory fisheries management, and build networks between government agencies and community leaders to disseminate fisheries management measures and illegal fisheries surveillance.

Further, WWF also implemented a project, Lao-Thai fisheries co-management: improving fish stocks and livelihoods in the middle Mekong (2016–2019), which aimed to improve transboundary freshwater natural resources management by creating fish conservation zones (FCZs) and fisheries management committees and ensuring village patrols in order to jointly improve the management of the Mekong River's rich natural resources. The project also supported local livelihoods and developed alternative sources of income to reduce pressure on freshwater natural resources. In addition, the project sought to raise awareness of communities to better understand the benefits of fish conservation and fisheries management. The project covered 15 villages each between Thailand and Lao PDR.

The production and restocking of fish fingerlings into natural water bodies is the major activity that has been conducted over the last 10 years. However, the number of fingerlings produced has been significantly reduced, from 1,330 million in 2013 to 371 million in 2022. This is probably because DOF has changed its focus from enhancing inland capture fisheries to promoting aquaculture and food safety. Also, DOF has continued to monitor the status of fisheries resources in natural water bodies during this period. Every year, the CPUE of 7 to 25 large rivers and reservoirs is monitored and reported as the Key Performance Indicator for the restocking programme. From this monitoring, the CPUE has slightly increased from 583 in 2013 to 1,000 g/100 m^2 gillnet per night in 2022. Several activities have been conducted since the implementation of the new Royal Fisheries Ordinance in 2015. For example, the community-based aquaculture promotion project began in 2018. Monitoring the abundance and diversity of fish in the Mekong River started in 2021 after the operation of Xayaburi hydropower project. Further, the inland fishery reform project started in 2022 with the aim of using scientific data for the establishment of fisheries rules and regulations.

The 12th National Economic and Social Development Plan (2017–2021)

Strategy 4: ***Strategy for Environmentally Friendly Growth for Sustainable Development:*** Key development approaches are: (i) conserving and restoring natural resources as well as creating a balance between conservation and sustainable usage in an equitable manner; (ii) increasing efficiency in water resource management to achieve security, balance and sustainability; (iii) solving the critical problem of environmental pollution; (iv) promoting sustainable consumption and production; (v) promoting GHG reduction and increasing adaptive capacity to climate change; (vi) managing disaster risk reduction; (vii) developing management systems

and conflict resolution mechanisms for natural resource and environmental issues; and (viii) fostering international environmental collaboration.

Data and information needs and gaps

In order to support sustainable capture fisheries, data and information must inform the following:

- evidence to establish measures and regulations to sustainably manage inland fisheries, especially on critical habitats, stock (population, abundance and diversity), some biological aspects of key species, migration behaviour, and more accurate and reliable statistics; and
- transboundary fisheries management plans, especially in the Mekong River where Thailand and Lao PDF use the same fisheries resources.

Challenges, current policies and management

The DOF (2021 and 2022) identified key challenges facing inland capture fisheries in Thailand as follows:

- climate change;
- excessive encroachment and exploitation of water resources;
- difficulty in collecting data, and controlling and managing inland capture fisheries since they are mainly for subsistence, and inland water bodies are scattered;
- decreasing fisheries productivity due to environmental degradation;
- the demand for aquatic animal resources exceeding the natural production capacity;
- development projects such as dams, barriers, reservoirs, and irrigation systems that affect the spawning and nursing grounds of fish;
- lack of effective fisheries management guidelines and control, protection and conservation of critical habitats; and
- insufficient scientific data and information for fisheries management.

The problem in Thailand may not be the fisheries sector per se, but rather the policy of the Government that aims to promote the nation's economy through modern agriculture and aquaculture. This is because inland capture fisheries are mainly subsistence fisheries, and their socio-economic benefits to fishers, families and communities are not well documented, while aquaculture has long been promoted and proven to contribute a huge economic value to Thailand, especially in the marine shrimp aquaculture industry. This is the reason that the Government invests more financially into inland aquaculture than inland capture fisheries.

Fisheries development in Thailand complied with the recommendations from McCormick Smith (1925) that aquaculture was the future of state intervention in fisheries. Since then, aquaculture has been more rigorously adopted by the DOF and provided the basis for fisheries development in Thailand. This is reflected in both the Twenty Year Agriculture and Cooperative Strategy (2017–2036) of the Ministry of Agriculture and Cooperatives, and the Department of Fisheries Strategy 2017–2021, which focus mainly on aquaculture and food safety.

Furthermore, since the EU issued a yellow card regarding the country's illegal, unreported and unregulated (IUU) fishing practices, the DOF has made significant efforts in developing and managing marine fisheries resources. Among the four strategies of the DOF, only one focuses on the sustainable management of fisheries and fisheries resources, and on the maintenance of fishery biodiversity. However, under this strategy, much effort is mainly focused on marine capture fisheries, while inland capture fisheries are of less concern. Although there are two specific plans for inland fisheries, the Inland Fisheries Development Action Plan 2023–2030 and the Sustainable Fisheries Development Plan in the Mekong Basin 2023–2030, the budget for implementing these plans is very limited, with only around 5% of the total 2023 budget of the DOF.

Moreover, though the DOF realizes that climate change, water resource development projects, and blockage of migration routes are key threats to inland fisheries, both the Inland Fisheries Development Action Plan 2023–2030 and the Sustainable Fisheries Development Plan in the Mekong Basin 2023–2030 lack measures and activities that mitigate the direct negative impacts of these threats. This indicates that there are some problems in the processes of policy development, planning and implementation of the inland fisheries development and management policy.

The DOF (2021 and 2022) implemented the Inland Fisheries Management Plan 2023–2030 and the Sustainable Fisheries Development Plan in the Mekong River Basin of Thailand 2023–2030, which provide policy direction to address inland fisheries challenges in Thailand. These policy recommendations are summarized in Table 22.

Table 22. Main challenges and policy recommendations for capture fisheries in the Mekong basin of Thailand

No	Challenges	Policy recommendations
1	Climate change	1. Rehabilitate, restore, protect, and enhance the productivity of inland fisheries habitats and inland aquatic ecosystems
		2. Enhance the integrity of inland aquatic animal populations and biodiversity
		3. Rehabilitate highly exploited aquatic animals to return to their maximum sustainable yield according to the potential of the water resources
2	Excessive encroachment and exploitation of water resources	1. Enhance the integrity of inland aquatic animal populations and biodiversity
		2. Restore freshwater habitats and enhance the richness of fish populations
		3. Rehabilitate and restore inland fishery habitats and degraded freshwater ecosystems to be suitable for aquatic animals
3	Inadequate data and information	1.Develop knowledge, technology, innovation and a database for inland fishery management.
		2.Conduct research and development, monitoring and assessments of the status of inland aquatic animals and inland fisheries are necessary to support the efficient management of inland fisheries
4	Fisheries productivity is decreasing due to environment degradation	1.Rehabilitate, restore, protect and enhance the productivity of inland fisheries habitats and inland aquatic ecosystems
		2. Restore freshwater habitats and enhance the richness of fish populations

No	Challenges	Policies recommendations
5	The demand for aquatic animal resources exceeds the natural production capacity	1. Improve production efficiency and build the capacities of fish farmers in sustainable aquaculture in the Mekong Basin of Thailand
		2. Promote participatory aquaculture management in the Mekong River Basin of Thailand
6	Since inland fisheries are mainly for subsistence and inland water bodies are scattered, it is difficult to collect data, control and manage them	1. Develop knowledge, technology, innovation and a database for inland fishery management.
7	Development projects such as dams, barriers, reservoirs, and irrigation systems affect the spawning and nursing grounds of fish	1. Enhance the integrity of inland aquatic animal populations and biodiversity.
		2.Rehabilitate, restore, protect and enhance the productivity of inland fisheries habitats and inland aquatic ecosystems.
8	Lack of effective fisheries management guidelines and control, protection, and conservation of critical habitats	1. Ensure the sustainable management of fisheries and aquatic animal resources for fisheries abundance and diversity in the Mekong Basin.
		2. Promote and strengthen transboundary inland fisheries management in bordering areas.
		3. Conduct surveillance, control, monitoring and assessments of the status of aquatic animal resources, regulations and measures for inland fisheries management.

Source: The DoF (2021 and 2022)

Both the Inland Fisheries Development Action Plan 2023–2030 and the Sustainable Fisheries Development Plan in the Mekong Basin 2023–2030 address the lack of data and information on inland fisheries as the key challenge and propose action plans to address it. However, the DOF's Five-Year Action Plan (2023–2027) fails to address this challenge as a key priority; thus, the budget for implementing these plans may be insufficient and thus a major constraint for inland capture fisheries development. Moreover, a minor constraint may be the technical capacity of DOF's staff, which needs to be urgently strengthened.

In order to prioritize inland capture fisheries, it is necessary to have more precise, reliable and timely data and information on the production, value and socio-economic benefits of inland capture fisheries. The current national fisheries statistics collected and analysed by DOF do not fully provide these data and information.

Synergy between fisheries and other policy domains

The Department of Water Resources is responsible for the development and management of wetlands in Thailand. One of the key strategic priorities of the Twenty-Year Action Plan (2021–2037) of the Department of Water Resources and the Five-Year Plan is to regulate, control, conserve and develop natural water resources and wetlands.

In the Mekong tributary, WWF Thailand developed the strategic plan for the management of the Lower Songkhram River (2017–2021). The strategy not only covers the management of the Lower Songkhram River, but also the conservation and rehabilitation of the fisheries resources in the Lower Songkhram River (WWF, 2016). However, there is no report on the implementation and the outcomes of this strategy.

Areas of conflict between fisheries and other policy domains

One major challenge to inland capture fisheries in the Mekong Basin of Thailand are the proposed 'megaprojects' on water development, i.e. to use Mekong River's food waters during the flood season to irrigate farmland in the Mekong Basin of Thailand. Under the project, a number of dams, irrigation canals and pumping stations will be set up in tributaries of the Mekong to feed floodwaters into local rivers and thus store water for the dry season. The project has been proposed by the Royal Irrigation Department and is being considered by the National Environmental Board. If approved and budgeted, several dams and irrigation canals will be constructed, which will eventually block the natural migration routes of fish in the Mekong Basin of Thailand.

Since the project is being reviewed, it is necessary to ensure that it has already included fisheries as one of the main concerns and has also incorporated the concept of 'fish-friendly structures' to mitigate impacts of developments.

Ongoing and new projects

At the regional scale, at the moment, MRC is working with the International Union for Conservation of Nature (IUCN) to formulate a project on enhancing transboundary fisheries management in the LMB. The project aims to address barriers in the LMB through dialogue and engagement, enhance the resilience of fishing communities, and strengthen research capacity and knowledge bases. The project will also provide a new understanding of mechanisms, processes and linkages between environmental degradation, climate change, fisheries and livelihoods. The project has been agreed upon by four MRC MCs and is now seeking support of US$12 million from the Global Environment Facility- (GEF) 8, which includes US$2 million from GEF's System for Transparent Allocation of Resources (STAR) from the MCs.

In addition, the Mekong Basin-wide Fisheries Management and Development Strategy 2018–2022 and its Project-based Action Plan to implement the Basin-wide Fisheries Management and Development Strategy, which has never been intensively implemented due to a limited budget, contain several important priority actions that are still valid in the current situation and need to be implemented, as follows:

1. Develop and manage Mekong fisheries data and information-generation and sharing platform, and feedback regional data and analysis in a timely manner.
2. Update identification, mapping and demarcation of key habitats of the LMB ecosystem and rank key conservation areas, including spawning ground, in line with the medium- and long-term sustainability of the basin ecosystem.
3. Agree on the economic and social cost of habitat degradation or loss according to Mekong Agreement 1995 Principle 5, 'Principle of State Responsibility for Damages' (Art. 8).

The Project-based Action Plan to implement the Basin-wide Fisheries Management and Development Strategy requires around US$ 7.225 million during its five-year implementation

period, and the MRC is now seeking financial support from Development Partners and other international financial mechanisms.

The Sustainable Fisheries Development Plan in the Mekong Basin 2023–2030 was initiated by local communities along the Mekong River and CSOs through the Ministry of Agriculture and Cooperatives. All related stakeholders were involved in all phases of the planning process. However, the implementation of the plan relies on DOF and the budget allocated to the DOF. If the Government still maintains its policy of using aquaculture as the key mitigation to address the decrease in inland capture fisheries production, it will be the biggest challenge to inland fisheries development.

At the national scale, DOF has identified several key projects under the Inland Fisheries Development Action Plan 2023–2030 and the Sustainable Fisheries Development Plan in the Mekong Basin 2023–2030, but to date, these projects have not yet been budgeted nor are on the priority list. These projects are shown in Table 23.

Table 23. Key projects identified under the key projects under the Inland Fisheries Development Action Plan 2023–2030 and the Sustainable Fisheries Development Plan in the Mekong Basin 2023–2030

Projects	Proposed budget (million THB)
Fish restocking programme in key water bodies using mobile hatcheries	55
Fish habitat assessment and development for the establishment of fish conservation zones	173.25
Inland fisheries management using an ecosystem approach to fisheries management	30
Enhancement of fish conservation zones in the transboundary rivers of Thailand	7.5
Surveillance and control of fisheries in important and ecologically sensitive fish habitats	16.45
Fisheries resource enhancement in the Mekong River	250
Raising of awareness on and inform perceptions of the conservation of critical fish habitats in the Mekong and transboundary rivers	7.5
Community fish bank project in small water bodies in the Mekong River Basin of Thailand	56
Strengthening of the capacity of fishers and communities to respond to climate change in the Mekong Basin of Thailand	7.5
Strengthening of the capacity of local communities to respond to climate change in the Mekong River Basin	3.9
Rehabilitation of inundated forests of the Mekong mainstream and its tributaries	25
Restocking of endemic and high-economic-value fish species in the Mekong tributaries of Thailand	5
Restoration of rare Mekong fish species	125

Major challenges facing sustainable aquaculture

The major challenges facing sustainable aquaculture in Thailand are as follows:

- Lack of good quality seed
- High production cost, especially the cost for fish feed
- Fish disease
- Water supply and water quality issues
- Impacts of exotic species
- Market constraints.

Broad categories of policy areas and strategy elements of the Thai fishery sector

The relationships between and priorities of various key instruments and policies for capture fisheries in Thailand are indicated in Table 24.

Table 24. Broad categories of policy areas and strategy elements of the Thai fishery sector

Categories	Relevance Estimated at High (3), Medium (2), Low (1) Not Listed (0)		
	Royal Ordinance on Fisheries 2015	Inland Fisheries Development Action Plan 2023–2030	Sustainable Fisheries Development Plan in the Mekong Basin 2023–2030
Contribution to economic (GDP) growth, including by value chain and post-harvest improvements	3	3	3
Contribution to sustainable livelihoods	3	3	3
Contribution to food security	3	3	3
Responsible fisheries	3	3	3
Fisheries enhancement, including rice-field fisheries	3	3	3
Responsible aquaculture	3	0	3
Environment and ecosystem/habitat protection and restoration	3	3	3
Co-management including public sector institutional strengthening and capacity building	3	3	3
Research, including monitoring and generation of data and information	3	3	3
Basin-wide cooperation in fisheries management and development	3	3	3
Regional/international cooperation	3	3	3

Viet Nam

Fisheries administration

The Ministry of Agriculture and Rural Development (MARD) is a governmental agency that performs state management functions in the fields of agriculture, forestry, salt production, fishery, irrigation/water services and rural development nationwide. It also performs state management functions with regard to the delivery of public services in line with legal requirements(Figure 11).

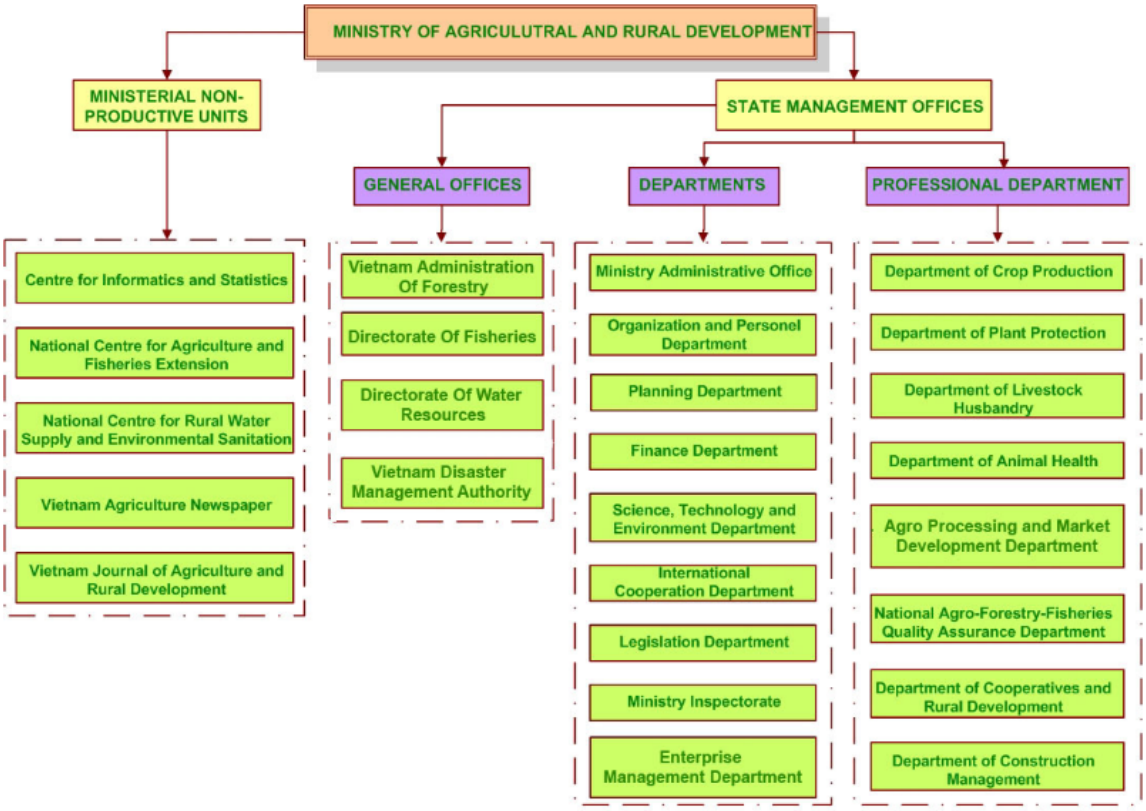


Figure 11. The organizational structure of the Ministry of Agriculture and Rural Development

Policy

Decision No. 339/QD-TTg, dated 11 March 2021, of the Prime Minister approving the Strategy for the Development of the Fisheries of Viet Nam until 2030, with Vision to 2045 highlights that the fisheries strongly need to become industrialized and modernized thus becoming a market-oriented, environment-friendly industry, that: protects, restores and develops its fishery resources and conserve biodiversity; adapts to climate change; protects aquatic animals from epidemics, and ensures their biological safety; and guarantees the populations' social security.

Additionally, Decision of the Prime Minister 911/QD-Ttg (29 July 2022) on approving the scheme for environmental protection in the fisheries sector in the 2021–2030 period also states that the aim is to: control and prevent pollution in fisheries activities; prevent or

address environmental events; protect and develop aquatic resources and the living environment; contribute to preventing biodiversity loss; improve the capacity to adapt to climate change; reduce GHG emissions; build and develop models of the circular economy and the green economy in fisheries activities to protect the environment and sustainably develop the fishery industry. Regarding the Mekong River Delta, the scheme places a strong emphasis on aquaculture while ensuring that local fisheries are maintained in harmony with environmental protection, regeneration and the development of aquatic resources.

Development of capture fisheries

The planning for the development of capture fisheries is focused mainly on marine capture fisheries rather than on inland capture fisheries because the production of the latter was limited compared to that of the former. Nevertheless, it can be deduced that the planning for the development of inland capture fisheries is based on the General Fisheries Development Plan applied throughout the entire country.

There are several policy documents related to the planning on the conservation of fish and OAAs species and aquatic ecosystems. Two decisions address the need to protect and conserve the environment and regional cooperation. The first decision describes the need to:

> create a system of protected areas to protect, restore, regenerate fisheries resources, especially aquatic species that are rare, and have economic value and high science value. The system will aid in protecting aquatic ecosystems in inland waters, and encourage community participation in the management, exploitation, and rational use of resources. This is to ensure ecological balance, preserving biodiversity of inland waters.

Regarding international cooperation, the second decision highlights the need to:

> strengthen international cooperation to conduct surveys, carry out research on aquatic resources (marine and inland), *manage* migratory species and manage marine-protected areas. Also, the need to build international relations to help protect transnational inland protected areas, as well as prevent illegal fishing activities from outsiders within the Mekong Delta.

Current policies for the inland fisheries sector

Some forms of inland fisheries development, such as stocking in reservoirs or small-scale water storage schemes within irrigated areas, may have potential for further development. Inland fisheries production may benefit from the establishment of sanctuaries to protect critical natural habits, appropriate gear, and closed fishing seasons during the main spawning periods in selected areas (Ronald et al., 2005). Steps to ensure the sustainability and livelihoods of people dependent on inland aquatic resources consist of:

- further assessment of the importance to the national economy and local farmers and poor inland fishers in reference to the trade-offs, particularly of flood control for agriculture.
- identification of appropriate management measures such as appropriate gear and closed fishing seasons in selected areas; and
- establishment of sanctuaries to protect key breeding and nurturing habitats in order to sustain or improve productivity and biodiversity conservation.

As a starting point for future interventions, a review on inland fisheries should be prepared, with specific emphasis on its importance to the national economy and to local farmers and poor inland fishers, biodiversity. It should also focus on trade-offs, particularly of flood control for agriculture, and implementation of the new Wetland Decree as applied to inland wetlands.

Management tools in the inland capture fisheries sector

The legal framework as well as the institutional framework is in place for implementing a fisheries management system, but coordination and clear demarcation between authorities, as well as the necessary scientific basis are not yet fully developed, and investment funds are scarce. For the protection of the fisheries resource base, fisheries management can recur to regulations that are in place such as gear restrictions, closed seasons and the protection of breeding grounds and juveniles; however, the state of implementation of these regulations is not known or is limited and less effective. Several fisheries regulations have been promulgated; however, few fishers comply with them. In addition, although some destructive gears and practices such as mosquito nets and electric fishing have been prohibited, they are still popular. The Mekong Delta fishery is a small-scale fishery; it is difficult to control or enforce fishing regulations. Moreover, official fisheries statistics are less reliable and seriously underestimate production. As a result, the fisheries have been undervalued by decision-makers and fisheries managers although they play an important role for local people as important sources of protein and employment.

Fisheries management in Viet Nam may be viewed as a two-tier system where part of the responsibility lies with the provincial authorities and part with the former Ministry of Fisheries. To date, Viet Nam's management and monitoring, control and surveillance (MCS) capability focus only on the coastal areas, with the offshore areas being monitored mainly for border incursions *and not for sustainable management purposes*. The areas of greatest need and interest in Viet Nam are training in sustainable management and MCS techniques and supporting legislation.

Current fisheries management and development activities that area most relevant to inland capture fisheries

The network and environmental monitoring activities serving the management of the fisheries sector (soil, water, sediment monitoring) have been effectively deployed; conservation, protection and development of aquatic resources, protection of aquatic habitats, and restoration of important ecosystems for aquatic resources (mangroves, seagrass beds, coral reefs, etc.) are effectively implemented, contributing to the prevention of biodiversity loss.

The circular economy models, green economy models in the seafood value chain has been researched, applied and gradually replicated.

Implementation of several specific solutions such as raising awareness and understanding about environmental protection in fisheries activities for stakeholders; and conducting a study on mechanisms and policies to encourage exploitation and use of investment, the maintenance and development of aquatic natural capital, and to mobilize resources in aquatic environment protection.

The fisheries must develop towards industrialization and modernization so that it becomes a market-oriented, environment-friendly industry, protection/restoration and development of fishery resources, and conserve biodiversity; adaptation to climate changes; ensure aquatic animal epidemic safety, biological safety, and social security. Developing fisheries in collaboration with improving people's livelihood, building new rural areas.

Science and technology are key activities and can provide important solutions to increasing productivity, reducing costs, increasing the value of fishing, aquaculture and fish processing activities.

The fisheries strategy has mainly focused on training and capacity building, such as by: (i) training, educating, retraining and developing human resources with strong expertise and high skills, including human resources for the protection and development of aquatic resources, fishery production, aquaculture and fish processing; (ii) training fisheries management staff to meet international integration requirements, enabling them to apply advanced management and administration technologies; and providing them with training in corporate governance, commerce, and market development for seafood businesses; (iii) attracting international resources in cooperation, training and development of high-quality human resources for the fisheries sector; (iv) building links and connections between training institutions, research institutes and enterprises in training and developing human resources to meet the needs of the labour market; and (v) investing in increasing the capacities of the Fisheries Research Institute, , the Institute of Fisheries Economics and Planning, the Department of Fisheries – Viet Nam Academy of Agriculture, the Institute of Fisheries Science and Technology – Nha Trang University, the Faculty of Fisheries – Can Tho University and Colleges of Economics, Technology and Fisheries and the Aquaculture Research Institutes I, II and III. This investment will allow them to become institutions for scientific, technological research, training and development of high-quality fisheries human resources

Resolution No. 120/NQ-CP on sustainable and climate-resilient development of the Mekong Delta states the following:

i. By 2010, the Mekong Delta will sustainably, safely and prosperously develop, on the basis of high-quality agriculture in combination with services, ecological tourism and industry, focusing on processing industry. Transform and improve the value and competitiveness of agricultural products; the infrastructure system is planned and developed synchronously and modernly in the direction of being proactive, intelligent, adaptive to climate change, certainly safe from geniuses; natural resources are used rationally; biodiversity and cultural and historical traditions are maintained and embellished, the material and spiritual life of the nation is enhanced; and

ii. The policy and strategic direction for the development of the Mekong Delta are as follows:

   a. Ensure that the development model of the Mekong Delta is people-centred, serving the people, reducing the gap between the rich and the poor, focused on quality rather than quantity, shifting from breadth to depth, taking a proactive and flexible approach in the context of rapid, increasingly extreme climate change and the impact of resource exploitation and water resource use with large-scale and high-intensity water use and operation in the upper stream of the Mekong River. Change the development model to improve economic efficiency and focus on preserving the cultural, historical, biodiversity and ecological values of the region.

   b. Identify climate change and sea level rise as an inevitable trend; we must live together and suitable adaptation with climate change events and must turn challenges into opportunities. Take water resources as a core factor and a basis for strategic planning, policies and regional development planning, which needs to be managed in an integrated manner throughout the Mekong Delta Basin. In addition to freshwater resources, brackish water and salt water should be considered natural resources for economic development. Strengthen management, and ensure the efficient and sustainable use of water, land and other resources in the region. Recognize the importance to the development of the coastal zone, the exclusive economic zone and the geopolitical position of the Mekong Delta, while focusing on mitigating damage caused by natural disasters, responding to the most adverse scenarios that may occur.

   c. Base the transformation of the development model on the ecosystem, ensuring alignment with natural conditions, biodiversity, culture, people and natural laws, combining advanced and modern technology with traditional knowledge and experience, and ensuring stability and people's livelihoods. Here, fishers/farmers and businesses will play a central role and the State will play a decisive role, guiding, leading and promoting innovation and creativity, and supporting start-ups, accelerating the application of scientific and technological advances, especially achievements of the fourth industrial revolution. The transition needs a long-term vision, prioritizing climate change adaptation, and also taking advantage of opportunities to develop a low-carbon economy and a green economy, and to protect natural ecosystems.

   d. Use a comprehensive and integrated approach to socio-economic development of the entire Mekong Delta region; strengthen cooperation and development

between localities in the region, between the region and Ho Chi Minh City, the provinces of the Southeast and other regions of the country, between the Southwest and the Southeast, between Viet Nam and other countries, above all in the Mekong Sub-region.

e. Uniformly coordinate all investment activities, ensuring inter-regional, intersectoral, focused, key and reasonable roadmap, in which immediate priority is given to urgent works, works of motivational nature, promoting the economic development of the whole region, essential works serving people's life. The Programme must focus on and mainly apply non-structural solutions while implementing structural solutions.
f. Develop socio-cultural fields to keep pace with the common ground of the whole country. Development needs to link economic development with social development, poverty reduction, job creation, social security assurance and environmental protection. Bring into play potentials, strengthen defence and security capabilities, maintain political stability, national sovereignty and social order, and consider safety.
g. Actively integrate_____ into the global world activities, strengthen cooperation with the countries of the Mekong Sub-region on the basis of mutual benefits through regional cooperation initiatives and bilateral cooperation in order to jointly use effectively and sustainably water and related resources in the whole Mekong River Basin.

Key drivers of the trends

Five driving factors are identified and their predicted impacts on fisheries presented in Table 25. Changes in river flow regimes, sediment and nutrient transport, and water quality that could occur as a result of the proposed hydropower developments would directly affect fish habitat, fish populations and communities, foraging and breeding behaviours, species interactions and ecosystem functioning, and migration triggers. In addition, the construction of large dams across the main river channel will physically obstruct fish migration routes and spawn distribution, as well as downstream drift of larval and juvenile fishes, therefore disrupting population recruitment. All of these changes could impact capture fishery yields and aquaculture production.

Table 25. Relationship between impact drivers and impacts on fisheries in the Mekong Delta

Impact drivers	Factors that impact fisheries	Example of impacts
Changes in river system flows and velocities	Variations in timing, amplitude, and duration of seasonal flows	• Loss of freshwater fish habitat and/or changes in fish habitat quality • Disruption in fish migration cues
	Changes in river and floodplain inundation depths and extent	• Loss of freshwater fish habitat and/or changes in fish habitat quality • Loss of spawning habitats • Changes in habitat connectivity

Impact drivers	Factors that impact fisheries	Example of impacts
		• Interruption of migration routes
	Changes in the extent and timing of the annual floods	• Interruptions in fish migration patterns and spawning distribution
	Changes in the extent and timing of salinity incursions	• Loss of freshwater fish habitat with accompanying increase in estuarine fish habitat • Increased mortality rate and recruitment • Changes in habitat quality for capture fisheries and aquaculture sectors
	Changes in flows in dry season alter connectivity	• Changes in habitat quality for capture fisheries and aquaculture sectors
Changes in river sediment flows	Changes in riverbank morphology	• Changes in riparian habitat quality with impacts on fish foraging and breeding • Decreased deposition and increased bank instability and erosion
	River channel morphology	• Changes in fish habitat quality leading to impacts on foraging, breeding, and migration routes
	Riverbed morphology	• Possible impacts on mainstream deep pools, which are critical habitat especially in the dry season
	Floodplain sedimentation	• Reduced floodplain nutrient loading affecting primary and secondary production and fishery productivity
	Coastal sediment plume	• Changes in coastal nutrient loading affecting primary and secondary production and fishery productivity in and near the sediment plume
	Coastal erosion	• Loss of marine fish habitat and mangroves, with possible changes in fish community composition and loss of recruitment
Changes in river water quality	Ecosystem productivity	• Changes in primary, secondary and fishery productivity
Changes in river obstructions	Dams acting as physical barriers	• Disruption of migration pathways, interruptions in migration patterns and spawn distribution, and fish mortality • Disruption of downstream drift of larval and juvenile life stages, and population recruitment • Flooding of spawning habitat
	Elevated mortality rates from passage	• Reduction in fish recruitment and production resulting in reduced fish biomass

Impact drivers	Factors that impact fisheries	Example of impacts
	through turbines and over spillways	

The key divers of the trends presented in Table 26.

Table 26. Status, trends of inland fisheries development and key drivers in the Mekong River Delta

ices	Trends	Reasons of trends		Dr
		General reasons	Specific reasons	
tonnes tonnes	✓ Inland capture fisheries production decrease over time	✓ The fishing area is fragmented due to an increase of protected/defence flood structures, e.g. increase of dikes and flood control irrigation systems. ✓ Low-lying areas are gradually shrinking to be used for agricultural production, for example: increasing 3rd crop rice production, reducing wetlands due to development of other industries and urbanization. ✓ Low water level, short flood season and low level of flooding. ✓ intrusion inland damages the habitat of many freshwater fish species. ✓ Decrease in stocks due to broodstock exploitation, and a high ratio of by-catch. ✓ Using fishing gears with small mesh-size, electrical pulses, chemicals in the fishing activities. ✓ The introduction of exotic fish causes competition for food and habitats. ✓ Increased use of pesticides in agricultural production.	✓ Statistics are not included for all fishery species, possibly because current statistics focus mainly on the synthesis of fish catches and the collection of other aquatic animal data not on an annual basis and mainly based on estimates from national censuses conducted every five years.	
hold (hh)	✓ Inland capture fisheries production decrease over time			
ing gear were 020 there were g gears	✓ A downward trend in the number of fishing gears used. Fishing gears are mainly small fishing gear types and there are still many destructive fishing gears		✓ Inland capture fisheries production decreased, and production value also decreased due to a large reduction in the size of fish caught. ✓ People changed jobs, for example, to work in seafood factories or take up other jobs with more stable income.	✓ Changes i between activities. ✓ Changes i resource for ration ✓ Changes i sustainab fishing ma
4–68% of d in mining, of art-time; ached 31% and	✓ The percentage of fishing households participating in fishing tends to decrease, especially in the part-time households.			
7 stations: caught was 155 ounted to 14.0 2021. ht of most ounted to 6.5 uaries; and 80 nes decreased r time (2017–	✓ Size of caught fish decreased. ✓ Number of large-size fish species caught deceased. ✓ Production of large-size fish decreased and number of species caught decreased. ✓ Fish catches decrease in almost habitats, excluding coastal estuaries. ✓ Inland capture fisheries' production of the black fish group decreased, while the white fish group fluctuated but tended to decrease; in contrast, the group of marine fish and estuarine fish increased. ✓ The group of imported/exotic fish tended to increase, while the group of native fish remained unchanged. Some species have disappeared (*Aaptosyax grypus; Pangasianodon gigas; Probarbus jullieni; Catlocarpio siamensis)*		✓ Fixed monitoring of fishing areas, however, the decreasing trend is due to: (i) low water level and the short flood season; (ii) the structure of species and the small size of caught species, as well as an abundance of introduced species such as glass cleaner-crayfish (iii) the use of chemicals in agricultural production affects black fish species; and (iv) sand mining, abnormal climate change (e.g. salt water intrusion), which change the fish habitats.	✓ Changes i organizati fishing co ✓ Changes i projects s fish passa dams, the developm conservat spawning waters ✓ Solutions implemer adaptatio condition upstream developm ✓ There is a sustainab responsib reduced e
ns: t was 198 in caught in 2017 , and 700	✓ Number of species caught decreased ✓ The density of fry/juvelines caught also decreased.		✓ Fixed monitoring of fishing areas, however, is constrained due to low water levels and the short flood season, as well as the fact that fish are mainly from upstream to the Mekong Delta; however, the decrease may be due to the impact of flood control works and irrigation development in the upstream, which separates the	

			spawning area of fish connected to the Mekong River flow.	
on/year on/year on/year	✓ Consumption of aquatic animal foods still tends to increase over time. Part-time households tend to use their own fish catches for their household's consumption, which increases over time		✓ Aquatic animal food still accounts for a large proportion due to the increasing source of products from aquaculture. ✓ Fishing households that are catchingsmaller fish do not earn high economic value, so they use more their own fish catches for their household's consumption than before.	
groups or ainly leading to ds leaving the	✓ Households still engage in fishing activities at a small scale, operating independently; income from fishing activities tends to decrease, and many households leave the profession due to financial difficulties.		✓ The way production is set up is not efficient. Currently, there is no model of community management, or if present, it is in the form of cooperative groups whose operation is ineffective; the	
season was on took place ar. stuary areas, efined as the o June in 2015	✓ The fishing season with full-time fishers tends to fluctuate seasonally, except in rivers and estuary areas.		✓ The flow mode changes. ✓ There is low water level and a short flood season. ✓ The system of irrigation works to control floods gives priority to agricultural development. ✓ The amount of water and hydrological situation in the Mekong Delta have been affected and changed from previous years.	

The main challenges facing inland capture fisheries in the Mekong Delta and responses required to them are listed in Table 27.

Table 27. The challenges facing in inland capture fisheries and their responses

Key challenges	Current challenge facing inland capture fisheries	How to deal with the challenges *(Policy responses include integrated/transboundary adaptive measures, cooperation, investment needs)*
Changes in land use and effects of deforestation and agricultural development	These changes in land use have often been beneficial but at times also harmful such as (i) the destruction of mangrove forests and melaleuca forests for the expansion of agricultural areas and urban constructions; and (ii) the construction of dykes to prevent effects of floods and tides. The consequences of these operations have led to negative impacts on important lifecycle habitats of wild aquatic species, such as fishes, shrimps and crabs.	*Responses:* (i) All households who have a demand for, and an ability to using, land for establishing a farm, the Government shall allocated or rent land, as well as provide land-use right certification for a 20–50 year period. People who are directly involved in agriculture, sericulture or aquaculture farming in the region can acquire land to expand their farm. In addition to the portion of land that has been equally provided, the required land areas would be considered by the local government for rental of land. In order to better and more effectively manage the land, the households can transfer or lend their land-use right to other individuals, households or organizations. (ii) According to the fishery law, all people in the coastal and sea areas can access seawater just as inland people access lands, i.e. the water areas will be allotted or rented with certification from the Government. Households, individuals and organizations can freely use their products from provided water areas. Similar to land-use rights, the allocated water area is considered a property, which can be inherited as other properties, as permitted by the Government. However, utilization of these water areas must follow the framework and regulations defined under the law; and (ii) the effective implementation of the Law on Planning 2017 focuses on “integrated planning” and “national land use planning” approaches. “Integrated planning” integrates fields and sectors related to infrastructure, the use of natural resources and environmental protection in a uniform manner in accordance with the plans relating to a defined territory towards achieving balanced, harmonious, effective and sustainable development. “National land use planning” refers to national plans aimed at implementing national comprehensive plans for allocating and zoning of land used by fields, sectors and areas on the basis of land potential. *Investment needs:* The State should allocate budget to implement the Law on Planning 2017 focusing on “integrated planning” and “national land use planning”.

Effects of construction of dams and dykes	Mekong Delta has rapidly developed dyke construction to prevent water flooding in the inland areas and protect from salinity intrusion in the coastal areas. The consequences of these activities are harmful for the aquatic animals and fish, which has led to increased fragmentation of their habitats and, thus, interrupting the migration pathways of fish/aquatic animals during the season, among others.	*Responses:* (i) Effective implementation of the Law on Planning 2017 focusing on "integrated planning" approaches, with some master plans such as for: natural disaster prevention and control and irrigation; water resources; forestry; the protection and exploitation of aquatic resources; biodiversity conservation; environmental protection; the protection, exploitation and use of inter-country water sources; and irrigation and dykes. *Investment needs:* The State should allocate budget to implement the master planning, such as for: natural disaster prevention and control and irrigation; water resources; forestry; the protection and exploitation of aquatic resources; biodiversity conservation; environmental protection; the protection, exploitation and use of inter-country water sources; and for irrigation and dykes
Water pollution	The main reasons for water pollution are identified as follows: (i) urbanization and rapid industrialization without pollution treatments; (ii) wastewater treatment technology and control that does not keep up with growth of human population; and (iii) increased usage of pesticides, herbicides, and inorganic fertilizers in the agriculture sector.	*Responses:* (i) Effectively develop an aquatic environmental monitoring network and services (including soil, water and sediment monitoring); and build and integrate the aquatic environmental monitoring database into the ministerial and national environmental databases; (ii) effectively carry out conservation, protection and development of aquatic resources; protection of living environment for aquatic species and restoration of important ecosystems for aquatic resources such as mangrove forests, seagrasses, coral reefs), which will contribute to the prevention of biodiversity loss; formulate and promulgate at least two actions plans for the conservation, protection and regeneration of certain aquatic species that are prioritized for protection; and (iii) implement several specific solutions such as raising awareness among stakeholders, implementing environmental protection in fisheries activities; and conducting a study on the mechanisms and policies to encourage the exploitation and use of investment into, and the maintenance and development of aquatic natural capital; and mobilize and socialize resources in aquatic environment protection (*Decision of the Prime Minister 911/QD-Ttg (29/7/2022) on approving the scheme for environmental protection in the fisheries sector in the 2021–2030 period).*

		Investment needs: The State should allocate the budget to implement the priority project and tasks of the Decision of the Prime Minister of Viet Nam 911/QD-Ttg. Provincial governments shall consider allocating funding from their local government budgets and mobilizing other lawful sources of funding for implementing environmental protection in the fishery sector in their provinces as prescribed.
Illegal exploitation of aquatic resources	Aquatic fish resources are being overexploited, and there is illegal fishing in different areas of the Mekong Delta. The issues are considered the most important causes for the decrease in natural fisheries resources. To date, the current legislation on sustainable fishery exploitation issued by the Viet Nam Government is adequate. However, the enforcement of the laws and regulations, and management are still weak. This is a governance issue that needs to be addressed urgently.	*Responses:* (i) Inland fisheries production could likely benefit from the establishment of sanctuaries or conservation of fish and OAAs species and aquatic ecosystems to protect critical natural habits; (ii) Appropriate management measures such as appropriate gear and closed fishing seasons during the main spawning periods in selected areas should be identified. (iii) Regarding international cooperation, the legislation highlights the need to strengthen international cooperation in order to conduct surveys, carry out research on aquatic resources, and manage migratory species and protected areas. Also, there is need to build international relations to help protect transnational inland protected areas, as well as prevent illegal fishing activities from outsiders within the Mekong Delta. (iii) Research should be conducted, and proposals developed for the competent authorities to identify and issue appropriate incentives and support policies, with an open, public and transparent mechanism to ensure that individuals and organizations have faster access to policies. Reviewing, amending, supplementing and refining the legal system in the field of fishing (Decision No. 1090/QD-TTg of the Prime Minister of 19 July 2022 on the Approval for the national development programme on efficient and sustainable fishing in the 2022–2025 period). *Investment needs:* The State should allocate a budget to implement Decision No. 1479/QD-TTg of 2 May 1994 on the Approval of the planning on the system of inland water conservation zones by 2020, Decision No. 188/QD-TTg of 13 February 2012 on the Approval of the Programme on protection and development of aquatic resources by 2020, and Decision No. 1090/QD-TTg of the

		Prime Minister of 19 September 2022 on the Approval of the National Programme to develop effective and sustainable fisheries for the 2022–2025 period with a vision to 2030.
Effects of alien, exotic and invasive species	There are 18 aquatic alien species listed in the Mekong Delta, among which three are considered invasive: *Pterygophichthys pardalis*, *Pomacea canaliculata* and *Trachemys scripta elegans*. It should be noted that in the Mekong Delta, many fish and OAA species farmed are not native species; therefore, their impacts on the natural environment and ecosystem should be evaluated and monitored over time.	Responses: Effective implementation of Circular No. 53/2009/TT-BNNPTNT (21/8/2009) of the Ministry of Agriculture and Rural Development on t*he* management of alien aquatic species in Viet Nam. This Circular sets out how to manage aquatic species that are intentionally or unintentionally imported from abroad to the Vietnamese territory for intentional or unintentional purposes; these species have been released in the natural environment or are being raised in a controlled natural environment. This Circular applies to domestic and foreign organizations and individuals engaged in the management of alien aquatic organisms in Viet Nam. Investment needs: Funds for the management of alien aquatic organisms shall be allocated from budget for non-business environmental activities (under 29n December 2006 Joint Circular No. 114/2006/TTLT-BTC-TNMT of the Ministry of Finance and the Ministry of Natural Resources and Environment, guiding the management of funds for non-business environmental activities). Additionally, the Ministry of Agriculture and Rural Development shall allocate funds for the Aquatic Resource Exploitation and Protection Department to examine, supervise, direct and guide the management of alien aquatic organisms, and reserve funds to assess impacts on biodiversity and aquatic resources, and isolate and kill harmful alien aquatic organisms spreading in the aquatic environment nationwide.
Effects of climate change	Aquatic species in the Mekong Delta are exposed to the harmful effects by extreme and more frequent weather conditions (e.g. sea water level rise, temperature increases and disasters). By 2100, around 40% of the Mekong Delta will be submerged under the sea water if the sea level rises to	*Responses:* (i) climate change and sea level rise should be considered an inevitable trend; hence, suitable adaptation to climate change events is needed in order to turn challenges into opportunities. Water resources must be managed in an integrated manner throughout the Mekong Delta basin and should be at the core of strategic planning, policies and regional development planning. In addition to freshwater resources, brackish water and salt water should be considered natural resources for economic development.

	1 m. Additionally, the fisheries sector in Viet Nam and Cambodia was predictably highly vulnerable to climate change conditions due to the following factors: (i) climate warming; (ii) more unpredictable water flow in the flood season; and (iii) an increase in sea water intrusion in the dry season. The different aquatic ecosystems in the Mekong Delta, such as intertidal, estuarine, mangrove forests, as well as melaleuca forest ecosystems will be strongly affected by climate change conditions.	Management, and efficient and sustainable use of water, land and other resources should be strengthened in the region. To highlight the importance to the development of the coastal zone, the exclusive economic zone and the geopolitical position of the Mekong Delta, at the same time, focus should be placed on mitigating damage caused by natural disasters, responding to the most adverse scenarios that may occur*;* and (ii) actively integrate into the global world activities, strengthen cooperation with the countries of the Greater Mekong Sub-region on the basis of mutual benefits through regional cooperation initiatives and bilateral cooperation in order to jointly use effectively and sustainably water and related resources in the entire Mekong River Basin. *Investment needs:* All investment activities must be coordinated, ensuring an inter-regional, intersectoral focused approach and roadmap, in which immediate priority is given to urgent works, including increasing motivations, promoting economic development of the entire region, essential works serving people's life. Programmes must focus on and mainly apply non-structural solutions while effectively implementing structural solutions (Resolution No. 120/NQQ-CP of 17 November 2017 on the sustainable and climate-resilient development of the Mekong River Delta.
Relationships between Viet Nam and other countries of the Mekong River Basin on land use and water resources management.	The Mekong River Basin is shared by six countries. Therefore, all riparian countries should follow the same rationale for land use and water resources management while using them and benefiting from their sustainable development. Since water resources play an important role in socio-economic development, the challenges of transboundary water management must be adequately addressed.	*Responses:* Become an official member or actively cooperate with fisheries management organizations in and outside the region to fulfil Viet Nam's commitment to these organizations in complying with management regulations in order to sustainable fisheries development goals (Decision No. 1090/QD-TTg of the Prime Minister of 19 July 2022 on the Approval for the national development programme on efficient and sustainable fishing in the 2022–2025 period). *Investment needs:* Capitalize on funding sources from governments, international development organizations and agencies to provide financial and technical support towards the sustainable fisheries management and development.

The challenges facing the inland capture fisheries sector in Viet Nam also depend on broader policy challenges and the approaches to address them (Table 28).

Table 28. The challenges facing inland capture fisheries and the broader policy challenges and the approaches to address them

Key challenges	How to address the challenges	
	Current status of the responses to address the challenges	Better broader policy changes and approaches to address them
Changes in land use and effects of deforestation and agricultural development	(i) All households who have demand on and ability to used land for farm establishment would be provided or rented land by government as well as land use right certification provided for a 20–50 year period. People who are directly engaged in agriculture, sericulture or aquaculture farming in the region can acquire land to expand their farm. In addition to the portion of land that has been equally allotted, the required land areas would be considered by the local government for land rental. For better and more effective land management, the households can transfer or lend their land-use rights to other individuals, households or organizations; (ii) according to the fishery law, all people in the coastal and sea areas can access seawater just as inland people access lands; i.e. the water areas will be provided or rented with certification from the Government. Households, individuals and organizations can freely use their products from provided water areas. Similar to land use right, the provided water area is considered a property, which can be inherited as other properties as long as government allowed. However, utilization of the allowed water areas must follow framework and regulation defined in the law. (ii) Effective implementation of the Law on Planning 2017, with a focus on "integrated planning" and "national land use planning" approaches, in which "integrated planning" integrates fields and sectors related to infrastructure, the use of natural resources and environmental protection in a uniform manner following the formulation of the planning in a define	*What measures must be taken for better coordination:* The decline in inland fishery resources and catches is a clear trend, one of the main reasons is the increase in agricultural production such as triple rice cropping, cultivation and aquaculture development. The current policy focuses more on serving agricultural production than on inland fisheries. Therefore, the Government should aim to better balance the benefits for sustainable development in all fields, including inland fisheries. There should be more specific policies for inland fisheries; for example, for water resource use rights, the State needs to expand the scope of application, subjects of application, and policies to support implementation for inland waters and coastal estuaries areas. *What broader policy changes are likely to work?* Changes in land-use and inland water use will be more comprehensive and will contribute to better management of small-scale and dispersed inland fisheries. *Are broader policy changes feasible and practical?* The

	territory in order to achieve balanced, harmonious, effective and sustainable development. "National land use planning" refers to national plans aimed at implementing national comprehensive plans for allocating and zoning of land used by fields, sectors and areas on the basis of land potential.	changes are now feasible and practical.
Effects of the construction of dams and dykes	(a) Effectively implement the Law on Planning 2017 focusing on "integrated planning" approaches, with some master plans such as for: natural disaster prevention and control and irrigation; water resources; forestry; the protection and exploitation of aquatic resources; biodiversity conservation; environmental protection; the protection, exploitation and use of inter-country water sources; and for irrigation and dykes	*What measures must be taken for better coordination:* The master plans are developed and approved; however, the implementation of the plans and the roadmap is carried out inadequately, and the capital to implement the plans is often insufficient or not allocated in a timely manner, which greatly reduces the effectiveness of the plans. The Government needs to address this in order to avoid the spread of investments that would otherwise lead to low investment efficiency. The impact assessments upon whih investment in irrigation works such as dams currently neglects any conflicts that may arise from any measures to protect the aquatic resources, such as the blocking of fishways. Hence, the Government should consider adding more public funds for fishways when planning irrigation dams, funding the creation of aquatic resources protection zones in deep water pools and inland conservation areas. *What broader policy changes are likely to work?* Changes in irrigation planning to inter-connect inland fisheries field will be more comprehensive and will contribute to protect the fisheries resources and

		better management of small-scale and dispersed inland fisheries. *Are broader policy changes feasible and practical?* The changes are now feasible and practical.
Water pollution	(i) Effectively develop aquatic environmental monitoring network and services (e.g. soil, water and sediment monitoring); build and integrate aquatic environmental monitoring database into ministerial and national environmental database. (ii) Effectively carry out conservation, protection and development of aquatic resources; protection of living environment for aquatic species and restoration of important ecosystems for aquatic resources (mangrove forests, seagrasses, coral reefs, etc.), which will make contribution to prevention of biodiversity loss; formulate and promulgate at least two actions plans for conservation, protection and regeneration of certain aquatic species which are given priority for protection; and (iii) Implement several specific solutions such as raising awareness and understanding about environmental protection in fisheries activities for stakeholders; and conducting a study on mechanisms and policies to encourage exploitation and use of investment, maintenance and development of aquatic natural capital; mobilize and socialize resources in aquatic environment protection. (*Decision of the Prime Minister 911/QD-Ttg (29/7/2022) on approving the scheme for environmental protection in the fisheries sector in the 2021–2030 period).*	*What measures must be taken for better coordination*: the effectiveness of the implementation of Decision of the Prime Minister 911/QD-Ttg of 29 July 2022 is limited due to the lack of coordinated implementation and poor scheduling, limited funding for implementation compared to the proposed plan. The Government needs to more effectively regulate and integrate it into community education programmes to raise awareness and enhance understanding about environmental protection in fisheries activities for stakeholders. What broader policy changes are likely to work? Changes focusing on raising awareness and understanding about environmental protection in fisheries activities for stakeholders into community education programmes will be effective. Are broader policy changes feasible and practical? The changes are now feasible and practical.
Illegal exploitation of aquatic resources	(i) Inland fisheries production could likely benefit from the establishment of sanctuaries or the *conservation of fish and OAAs species and aquatic ecosystems* to protect critical natural habits. (ii) Appropriate management measures should be identified such as appropriate gear and closed fishing seasons	*What measures must be taken for better coordination: Due to the lack of effective coordinated implementation effective implementation of* Decision No. 1090/QD-TTg of the Prime Minister of 19

	during the main spawning periods in selected areas. (iii) Regarding international cooperation, the Decision highlights the need to "strengthen international cooperation in order to conduct surveys, carry out research on aquatic resources, *manage* migratory species and manage protected areas. Also, there is need to build international relations to help protect transnational inland protected areas, as well as prevent illegal fishing activities from outsiders within the Mekong Delta; (iii) Proposals should be researched and developed for competent authorities to issue appropriate incentives and support policies, with an open, public and transparent mechanism to ensure that individuals and organizations have faster access to policies. Reviewing, amending, supplementing and perfecting the legal system in the field of fishing (Decision No. 1090/QD-TTg of the Prime Minister of 19 September 2022 *on the* Approval of the National Programme to develop effective and sustainable fisheries for the 2022– 2025 period with a vision to 2030	September 2022) *and limited consideration of inland capture fisheries,* the Government needs to supplement the current content on the Decision, which the mainly focuses marine capture fisheries with content on inland capture fisheries. *What broader policy changes are likely to work?* Changes focusing on *inland capture fisheries field* will be effective. *Are broader policy changes feasible and practical?* The changes are now feasible and practical.
Effects of alien, exotic and invasive species	Effective implementation of Circular No. 53/2009/TT-BNNPTNT (21 August 2009) *of Ministry of Agriculture and Rural Development on the management of alien aquatic species in Viet Nam. This Circular sets out how to manage aquatic species that are intentionally or unintentionally imported from abroad to the Vietnamese territory and that have been released in the natural environment or that are being raised in the natural environment are controlled.* This Circular applies to domestic and foreign organizations and individuals engaged in the management of alien aquatic organisms in Viet Nam.	*What measures must be taken for better coordination: Effectiveness of the* Circular No. 53/2009/TT-BNNPTNT (21/8/2009) of *Ministry of Agriculture and Rural Development on management of alien aquatic species in Viet Nam is limited due to the lack of coordinated implementation, and limited funding for implementation compared to the proposed plan. The Government needs to more effectively regulate and integrates it into community education programmes to* raise awareness and enhance understanding about environmental protection in

		fisheries activities for stakeholders. *What broader policy changes are likely to work?* Any policy changes that focus on raising awareness and enhancing understanding about integrating environmental protection in fisheries activities by stakeholders into community education programmes will be effective. *Are broader policy changes feasible and practical?* The changes are now feasible and practical.
Effects of climate change	(i) Identify climate change and sea level rise as an inevitable trend; we must live together and suitable adaptation with climate change events and must turn challenges into opportunities. Take water resources as a core factor and a basis for strategic planning, policies and regional development planning, which needs to be managed in an integrated manner throughout the Mekong Delta basin. In addition to freshwater resources, brackish water and salt water should be considered as natural resources for economic development. Strengthen management, efficient and sustainable use of water, land and other resources in the region. To valorize the development of the coastal zone, the exclusive economic zone and the geopolitical position of the Mekong Delta, at the same time, focus must be placed on mitigating damage caused by natural disasters, responding to the most adverse scenarios that may occur*; and* (ii) cooperation among the countries of the Mekong Sub-region in global activities must be strengthened based on mutual benefits through regional cooperation initiatives and bilateral cooperation. The aim is to jointly, effectively and sustainably use water and related resources of entire Mekong River Basin.	*What measures must be taken for better coordination:* Continue to effectively implement the Resolution on sustainable development of Mekong River Delta responsibilities to the climate change (Resolution No. 120/NQQ-CP (17/11/2017). The programme must focus and mainly apply non-structural solutions, at the same time well implement structural solutions; and implement specific solution for climate change adaptation and mitigating damage in case of inland fisheries field. *What broader policy changes are likely to work?* Changes focusing on implementing specific solution in case of inland fisheries field will be effective. *Are broader policy changes feasible and practical?* The changes are now feasible and practical.

Relationships between Viet Nam and other countries of the Mekong River Basin on land use and water resources management	Actively participate in becoming an official member or cooperate with fisheries management organizations in and outside the region to fulfil Viet Nam's commitment to these organizations in complying with management regulations in order to sustainable fisheries development goals (Decision No. 1090/QD-TTg of the Prime Minister of 19 September 2022).	*What measures must be taken for better coordination:* Continue to effectively implement Decision No. 1090/QD-TTg of the Prime Minister of 19 September 2022 on the Approval of the National Programme to develop effective and sustainable fisheries for the 2022– 2025 period with a vision to 2030. However, the Government needs to supplement the content on inland fishing as the main focus of this decision is currently on marine capture fisheries. In addition the coordinating well with the MRC countries is to implement the related activities in Viet Nam, especially the Mekong Delta region. *What broader policy changes are likely to work?* Changes that focus on *inland capture fisheries* and good coordination with the MRC countries in implementing the related activities in Viet Nam will be effective. *Are broader policy changes feasible and practical?* The changes are now feasible and practical.

The synergies and conflicts between fisheries policy with other policy areas in Viet Nam are presented in Table 29.

Table 29. Information on the synergies and conflicts between fisheries policy with other policy areas

Related policy document	Common interests or barriers/conflicts of interest	How it can be improved or solved
I. Main areas of synergy between fisheries and other policy domains		
(i) Decision of the Prime Minister 911/QD-Ttg (29/7/2022) on approving the scheme for environmental protection in the fisheries sector in the 2021–2030 period; (ii) Planning the protection and exploitation of aquatic resources; (iii) master plan on biodiversity conservation; (iv) environmental protection planning; (v) planning on protection, exploitation and use of inter-country water sources; and (vi) Decision No.1090/QD-TTg of the Prime Minister of 19 September *2022* on the 19 September 2022 on the Approval of the National Programme to develop effective and sustainable fisheries for the 2022– 2025 period with a vision to 2030	These documents all support responsible production and sustainable development. The strengthen of these documents is that policy areas reinforce each other and increase mutual benefits. If these policy areas are aligned through implementation, it will contribute to promoting sustainability and identifying joint funding activities and cost sharing.	In order to improve the effectiveness of the alignment of these policy documents, the Government needs to coordinate among stakeholders for developing a viable implementation plan. The Government also needs to allocate capital to implement these policy documents to achieve their objectives.
II. Main areas of conflict between fisheries and other policy domains		
(i) National land use planning; (ii) irrigation planning; (iii) dyke planning; (iv) Decision of the Prime Minister 911/QD-Ttg of 29 July 2022 on approving the scheme for environmental protection in the fisheries sector in the 2021–2030 period; and (v) Decision No. 1090/QD-TTg of the Prime Minister of 19 July 2022 on the Approval for the national development programme on	The social and economic benefits of inland capture fisheries have been consistently undervalued, due in part to lack of reliable data on fish catch and nutrition, resulting in little attention to water-food-energy trade-offs. Conversely, the economic benefits of dams, irrigation systems and other capital-intensive projects are easy	Effective implementation of the law on planning 2017 focusing on "integrated planning" approaches, with some master plans such as for: natural disaster prevention and control and irrigation; water resources; forestry; the protection and exploitation of aquatic resources; biodiversity

efficient and sustainable fishing in the 2022–2025 period.	to quantify and can be quickly realized. This has arguably resulted in an overinvestment in energy and agricultural projects that often conflict with countries' commitments to biodiversity, environment and sustainable development goals. For example, there was a steady increase in both rice farming area and rice production over the 1995–2021 period, corresponding with a reported decline in fish catches. In particular, large proportions of land were also dyked and converted to triple crop rice farming area, accompanied by a flood-control system for agriculture, which caused habitat loss for fishes during the flood season in the Mekong Delta. Moreover, agricultural activities also negatively impact fishery resources such as causing pollution from fertilizers/pesticides and the loss of refugee habitats during the dry season. There was a significant increase in rice farming area, but inland capture yield declined dramatically in the Mekong Delta.	conservation; environmental protection; the protection, exploitation and use of inter-country water sources; and irrigation and dykes. The Government also needs to allocate capital to properly implement the master plans to ensure their effectiveness However, the Government should consider adding more public funds for fishways when planning irrigation dams, investing in creating aquatic resources protection zones in deep water pools and inland conservation areas. The State allocated water surface, fishing and conservation areas to the fishing community, which will be managed through co-management or community-based management approaches.

The priorities for new policies, measures, cooperation and financing for inland capture fisheries in Viet Nam are presented in Table 30.

Table 30. The priorities for introducing new policies, and measures, cooperation and financing for capture fisheries in the Lower Mekong Basin in Viet Nam

Potential new needs and opportunities	**Priority ranking** (High, 1; Medium, 2; Low, 3)	**Expected impacts, measures, cooperation and financing needs**
Water resource use rights: the State needs to expand the scope of application, subjects of application and policies to support implementation for inland waters and coastal estuaries areas	1	*Expected impacts:* Supplementing regulations and policies on the right to use water surface in the inland region will contribute to delegating management rights to the fishing community, raising awareness on the protection of aquatic resources and fishing activities responsibly and in a sustainable manner, and on sustainable development. *Measures:* The State assigns water surface, fishing and conservation areas to the fishing communities so that they may manage these areas jointly or use a community-based approach. *Cooperation:* This consists of applying co-management or community-based management approaches for the implementation phase. *Financing needs:* The State invests in the local community by building community houses, providing boats for inspection, ensuring supervision and providing training. The fishing community invests in equipment for the community's production.
Public investment items for fish ways through irrigation dams, investing in aquatic resources protection zones in deep water pools and inland conservation areas	2	*Expected impacts:* Additional investment in the construction of fish passages through irrigation dams will contribute to reducing fish migration routes into areas of growth, habitation and spawning, and also contribute to the protection of aquatic resources and biodiversity. *Measures:* The State reviews and supplements fish passages design in related plans, especially irrigation planning and dyke planning, and ensures the construction and operation of fish passages. *Cooperation:* This consists of ensuring close coordination between relevant units of the Ministry of Agriculture and Rural Development, especially the Department of Fisheries and the Department of Water Resources. In addition, during the operation phase of the fish passages, the participation of the local community is essential. *Financing needs:* The State invests in the construction of fish passages, and trains on the operation of fish passages.
The programme on environmental protection in	3	*Expected impacts:* The activities of *Environmental protection on fisheries operation* programme are integrated *into community*

fisheries operations should integrate its activities into community education programmes in order to raise awareness and enhance understanding about environmental protection in fisheries activities for stakeholders.		*education programme* activities *and community education programmes to* raise awareness and enhance understanding about environmental protection in fisheries activities for stakeholders, and also to contribute to the protection of aquatic resources and biodiversity. *Measures:* This consists in developing training programmes and implementing them. Local specialized units are mainly responsible for training to raise awareness and enhance understanding about environmental protection in legal activities for stakeholders. *Cooperation:* This consists in close coordination between relevant units of the Ministry of Agriculture and Rural Development, the Ministry of Education and Training, and the Ministry of Invalids and Social Affairs to develop training programmes and implement them. *Financing needs:* The State invests funds to implement the training programme.
Supplement Decision No. 1090/QD-TTg of the Prime Minister of 19 July 2022 with inland fisheries content, and then move quickly to the implementation phase.	2	*Expected impacts*: Supplement Decision No. 1090/QD-TTg of the Prime Minister of 19 July 2022 with inland fisheries content and move quickly to the implementation phase contributing to the protection of aquatic resources and fishing activities responsibly and in a sustainable manner, and on sustainable development. Measures: Decision No. 1090/QD-TTg of the Prime Minister of 19 July 2022 with inland fisheries content, and then move quickly to the implementation phase. *Cooperation:* Coordinating implementation from the national to local levels according to Decision No. 1090/QD-TTg of the Prime Minister of 19 September 2022 and its Supplement. *Financing needs:* The State invests in construction items, non-construction parts mobilized from community sources and other sources (e.g. financial sources from international organizations, businesses and fishing communities).
Implement specific solution for climate change adaptation and mitigating damage in case of inland fisheries field	3	*Expected Outcomes:* Specific solutions are developed and implemented for climate change adaptation and for mitigating damage of inland fisheries (Resolution No.120/NQQ-CP of 17 November 2017 on sustainable and climate resilience development of Mekong River Delta). They also contribute to the protection of aquatic resources and fishing activities responsibly and in a sustainable manner, and on sustainable development. *Measures:* Feasible and practical adaptation solutions are developed and implemented with community participation throughout the process. *Cooperation:* This consists in coordinating implementation from the national to local levels according to the additionally adjusted Resolution No. 120/NQQ-CP (17/11/2017). *Financing needs:* The State invests in construction items, non-construction parts mobilized from community sources and other sources (e.g. financial sources from international organizations, businesses and fishing communities).

Formulate and implement an alternative livelihood programme for fishers, and organize production for the community	2	*Expected impacts:* A career change programme for fishers is formulated and implemented, and production is organized for the community, which *contributes to* the protection of aquatic resources and fishing activities responsibly and in a sustainable manner, and on sustainable development. *Measures:* These consist in feasible and practical production organization models, and job transfer models built and deployed with the participation of the community throughout the process. *Cooperation:* Co-management or community-based management approaches are followed for the implementing phase. *Financing needs:* The State invests in construction items, non-construction parts mobilized from community sources and other sources (e.g. financial sources from international organizations, businesses and fishing communities).

Interrelationships between Viet Nam and other countries of the Mekong River Basin on land use and water resources management

The Mekong River Basin is shared by six countries (China, Myanmar, Lao PDR, Thailand, Cambodia and Viet Nam). Therefore, it is recommended that all the riparian countries share the same approach for land use and water resources management while using and benefiting from their sustainable development. The MRC was established with the aim of effectively managing water resources and land uses in the Mekong River Basin. However, the MRC has not included all riparian countries, and the Commission's operations are also limited for many different reasons. Bearing in mind the important roles of water resources for the socio-economic development, these challenges must be adequately addressed.

Broad categories of policy areas and strategy elements of Viet Nam's fishery sector

The relationships and priorities among various key instruments and policies for capture fisheries in Viet Nam are indicated in Table 31.

Table 31. Broad categories of policy areas and strategy elements of Viet Nam's fishery sector

Broad categories of policy areas and strategic elements	Relevance Estimated at High (3), Medium (2), Low (1) and Not Listed (0)	
	Viet Nam Fisheries Development Strategy by 2020	Master Plan for the Mekong River Delta Region by 2020
Contribution to economic (GDP) growth, including by value chain and post-harvest improvements	3	3
Contribution to sustainable livelihoods	2	2
Contribution to food security	3	2
Responsible fisheries	2	2
Fisheries enhancement, including rice-field fisheries	2	1
Responsible aquaculture	3	3
Environmental and ecosystem/habitat protection and restoration	2	2
Co-management, including public-sector institutional strengthening and capacity building	2	2
Monitoring and generation of data and information and research	3	3
Basin-wide cooperation in fisheries management and development	2	2
Regional/international cooperation	2	3

Mekong River Commission Secretariat

P. O. Box 6101, 184 Fa Ngoum Road, Unit 18 Ban Sithane Neua, Sikhottabong District,
Vientiane 01000, Lao PDR

Tel: +856 21 263 263| Fax: +856 21 263 264 www.mrcmekong.org

© Mekong River Commission 2022