Mekong River Commission
For Sustainable Development

MEKONG RIVER BASIN 2023 STATE OF THE BASIN REPORT

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, Luxembourg, the Netherlands, New Zealand, Sweden,Switzerland, and the United States of America.

First published (2024)

State of the Basin Report 2023

Mekong River Commission

Basin development; basin conditions and trends; social, economic, environment, climatic change, cooperation

For bibliographic purposes, this volume may be cited as:
State of the Basin Report 2023/The Mekong River Commission/Vientiane/Lao PDR (2023)

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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

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ACRONYMS AND ABBREVIATIONS

ACMECS	Ayeyarwady-Chao Phraya-Mekong Economic Cooperation Strategy
ADB	Asian Development Bank
ASEAN	Association of South-East Asian Nations
ATSPT	Average Tolerance Score Per Taxon
BAU	Business as usual
BDS	Mekong River Basin Development Strategy
BDS SP	Basin Development Strategy Strategic Priority
BioRA	Biological Resources Assessment
CDD	Consecutive dry days
CLMV	Cambodia-Lao PDR-Myanmar-Viet Nam
CPUE	Catch per unit effort
CSO	Civil society organization
CSO	Central Statistical Organization
CWD	Consecutive wet days
DAGAP	Data Acquisition and Generation Action Plan
DO	Dissolved oxygen
DSMP	Discharge and Sediment Monitoring Project
EC	Electrical conductivity
FADM	Fish Abundance and Diversity Monitoring
FAO	Food and Agriculture Organization of the United Nations
FAOSTAT	Food and Agriculture Organization Corporate Statistical Database
GDP	Gross domestic product
GEF	Global Environment Facility
GIZ	Gesellschaft für Internationale Zusammenarbeit
GMS	Greater Mekong Subregion initiative
GPI	Gender Parity Index
ILO	International Labour Organization
IUCN	International Union for Conservation of Nature
IWRM	Integrated Water Resources Management
IWT	Inland Waterway Transport
JCCCN	Joint Committee on Coordination of Commercial Navigation
JRC	Joint Research Centre

LMB	Lower Mekong River Basin
LMC/MLC	Lancang-Mekong Cooperation/Mekong-Lancang Cooperation
LMCWRCC	Lancang-Mekong Water Resources Cooperation Center
LU/LC	Land Use/Land Cover
MLC Water	Mekong-Lancang cooperation on water resources
MRB-IF	Mekong River Basin Indicator Framework
MoU	Memorandum of Understanding
MRC	Mekong River Commission
MRC SP	Mekong River Commission Strategic Plan
MRCS	Mekong River Commission Secretariat
MW	Megawatts
NDC	Nationally Determined Contribution
NGO	Non-government organization
NIP	National Indicative Plan
NPV	Net present value
OAA	Other aquatic animal
OAAs/Ps	Other aquatic animals/plants
PMFM	Procedures for the Maintenance of Flow on the Mainstream
PNPCA	Procedures for Notification, Prior Consultation and Agreement
PPP	Purchasing power parity
PWQ	Procedures for Water Quality
SDG	Sustainable Development Goal
SIMVA	Social Impact Monitoring and Vulnerability Assessment
SOBR	State of the Basin Report
SPI	Standardized Precipitation Index
SRI	Standardized Runoff Index
TEV	Total economic value
UMB	Upper Mekong River Basin
UNEP	United Nations Environment Programme
UNESCO	United Nations Education Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
USD	United States dollar
WHO	World Health Organization
WTTC	World Travel and Tourism Council

FOREWORD

It is my pleasure to present to you the 2023 Mekong State of the Basin Report (SOBR). The SOBR is a flagship product of the Mekong River Commission (MRC), representing the first and critical step in our strategic planning and implementation cycle. The timing of this current report is especially important because it informs the MRC's implementation of a more proactive regional planning approach, now underway with our Member Countries, in order to identify supplementary development options that go beyond the national plans. This will help us address some of the significant water resources challenges faced by the Mekong River Basin, as outlined in this report.

The results presented in this SOBR are the most comprehensive to date information, with data and analysis from over 50 assessment indicators. For the first time, social and economic data at the basin level are derived from subnational data provided by Member Countries, rather than solely reflecting national-level results. This approach provides us with a far better understanding of conditions and trends impacting people living in the Basin, rather than just those across the basin countries.

As I highlighted in my 3rd State of the Mekong Address (SOMA) on Mekong Day, on 5 April 2023, this year's SOBR highlights the rapid economic growth that has occurred across the Basin over recent decades, bringing benefits and poverty reduction. The vital contribution of water-related sectors to the basin economy is now valued at around USD 63 billion per year, driving considerable improvements in the living conditions and well-being of basin communities, particularly in terms of household water, food and energy security.

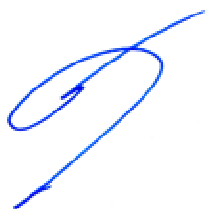
The social and economic gains have nevertheless come at a cost to the environment with changing river conditions exacerbated by a run of recent dry years. Changes in the flow regime, reduced sediment transport, reductions in fish yields at the Tonle Sap, and salinity intrusion in the delta are all of significant concern to basin countries. These trends demand our collective and intensified response to ensure progress towards the objectives set in the Basin Development Strategy (BDS) 2021–2030 and the Sustainable Development Goals (SDGs) by 2030.

Our approach to addressing these challenges has been to actively promote cooperation based on the 'One Mekong, One Spirit' concept. We facilitate considering alternative development options, work with all six basin countries to identify adaptation measures to changing river conditions, coordinate the implementation of Joint Action Plans to improve the design and operation of mainstream hydropower, and help improve national impact assessment processes and the information available to communities on floods and droughts, just to mention a few.

Beyond the additional measures that the MRC will implement as recommended in this report, the SOBR also provides guidance to other stakeholders working on water-related matters in the Mekong River Basin on what steps can be taken to increase the likelihood of meeting the BDS outcomes.

The Mekong region is undergoing tremendous transformation. To ensure that the Mekong River region remains prosperous, just and resilient, we must work together, fostering a culture of mutual understanding, recognition of each other's concerns, and collaboration.

As we move forward, I invite all stakeholders to join us in embracing the spirit of cooperation and shared responsibility. As you read through this report, I encourage you to think about the role we all play in preserving the Mekong River's vitality and supporting its communities. Let this report serve as a call to action, reminding us that our collective efforts can make a difference. I look forward to continuing our work together for a sustainable Mekong.



Dr. Anoulak Kittihoun

Chief Executive Officer
Mekong River Commission Secretariat

EXECUTIVE SUMMARY

The Mekong State of the Basin Report (SOBR) provides an overall picture of the status of the Mekong River Basin in terms of its ecological health, the social and economic circumstance of its people, the changing climate, and the degree to which cooperation between basin countries is enhancing these conditions, as envisaged under the 1995 Mekong Agreement. The SOBR is an integral part of the basin planning cycle since it is the first step in a five-yearly process of adaptive management to guide basin stakeholders in reviewing and refining their implementation of the 10-year Basin Development Strategy (BDS).

The SOBR is structured around the Mekong River Basin Indicator Framework (MRB-IF), consisting of 15 strategic indicators and 53 assessment indicators across five dimensions:

1. Environment
2. Social
3. Economic
4. Climate Change
5. Cooperation.

The strategic indicators seek to inform high-level decision-makers and basin stakeholders on key issues related to the development, utilization, conservation and management of the Mekong River Basin.

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- Waterquality and sedimentconditions
- A Status of environmental assets
- Overallenvironmentcondition

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Strategic Indicators
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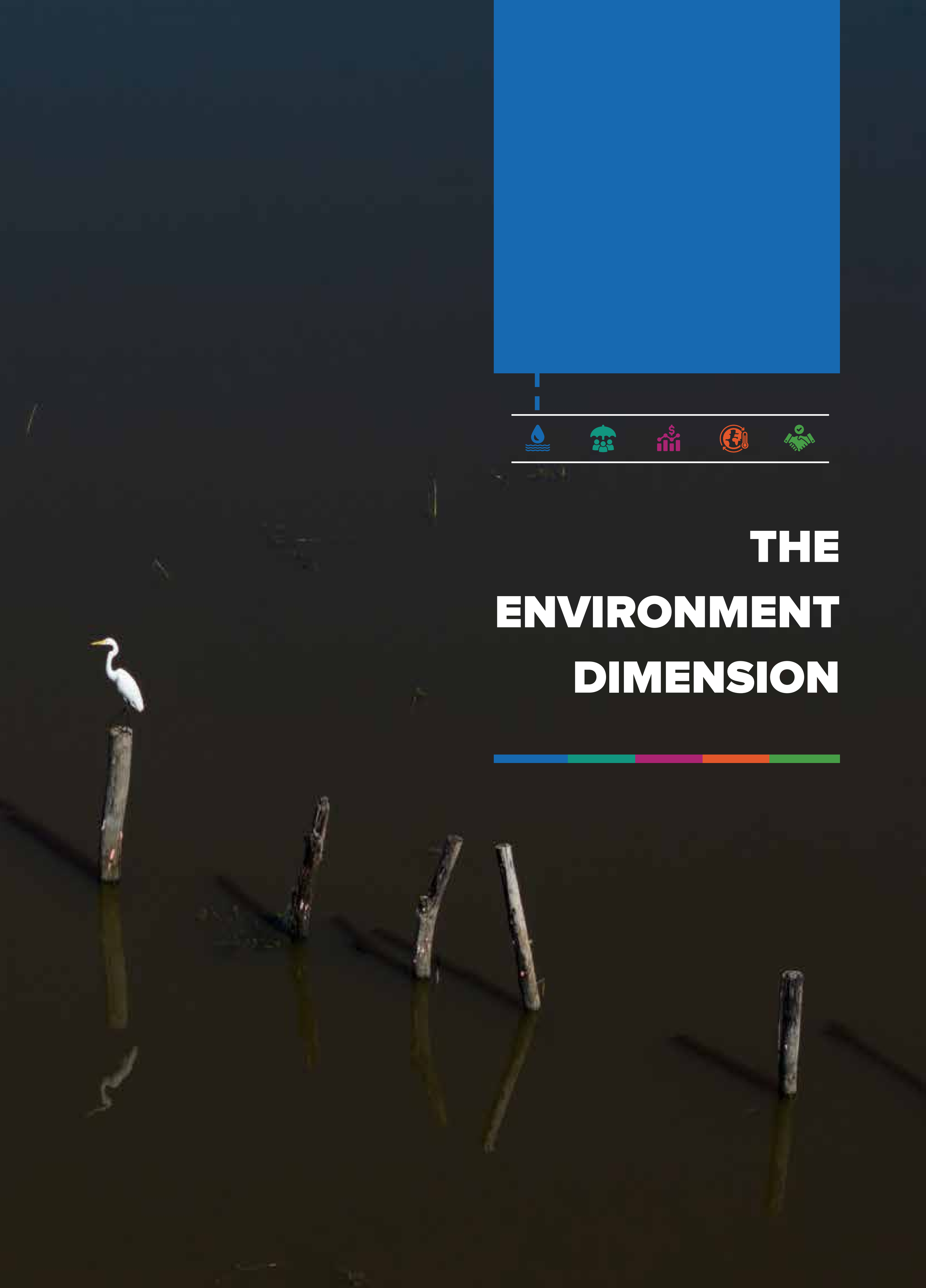
- Self-finance of the MRC
- Benefits derived from cooperation
- Equity of benefits derived from the Mekong River system

The 2023 SOBR provides a rating for each strategic and assessment indicator consistent with the Mekong River Commission (MRC) technical guidelines and with the monitoring and evaluation framework of the BDS 2021–2030. Commentary explaining the rationale for the ratings for each indicator, the trends and likely causes of change in each of the underpinning monitoring parameters, and the interlinkages between different indicators and monitoring parameters is also provided to tease out potential responses to identified issues that basin stakeholders may wish to consider. The report describes initial progress against the BDS 2021–2030 Outcomes in each dimension and identifies recommendations for consideration in the further implementation of the strategy over the remainder of the current period to help improve the chances that the outcomes will be met. This 2023 SOBR also makes some suggestions for improving future SOBRs.

Just like the 2018 SOBR, this 2023 edition also presents information on the conditions and trends in both the Upper and Lower Mekong River Basins. However, unlike in 2018, both parts of the Basin are now consolidated into a holistic assessment for relevant indicators. Data and information from all six basin countries are presented together within each chapter to the extent that they are available and that it is appropriate to do so. This approach follows the emphasis of the BDS 2021–2030 on more integrated management of the entire Mekong River Basin by providing a more complete picture of current conditions and trends as an input to planning and decision-making by all basin countries.

Addressing issues identified in this SOBR is a responsibility of all basin actors involved in Mekong water-related issues. While the Mekong River Commission (MRC) plays a critical role in providing leadership and facilitating dialogue between its Member Countries, with its Dialogue Partners and in cooperation with its Development and other Partners, it is only through the coordinated action of all relevant local, national and regional parties working on Mekong water-related matters that the BDS Outcomes can be achieved.



THE ENVIRONMENT DIMENSION

Water flow conditions

There has been a clear and significant change in the flow regime of the Mekong River Basin over the last decade. Dry season flows are higher, and flood season flows lower than in the past (Figure E1). The changed flow regime is evident along the length of the river where the proportional impact is greatest in the upper parts of the Basin and the overall volumetric impact is greatest downstream, likely reflecting the cumulative impacts of development throughout the Basin and recent climatic conditions, especially lower annual precipitation. The MRC-MLC Water Joint Study demonstrates a shift in the proportion of the annual flow occurring in the dry season compared to the flood season, for example, from 20% of annual flows in the dry season and 80% in the flood season during the 2000–2009 period at Chiang Saen, to 40% of flow in the dry season and 60% in the flood season during the 2010–2020 period. The average change across nine mainstream stations shows a shift between the two periods from 18% to 28% of annual flow in the dry season.

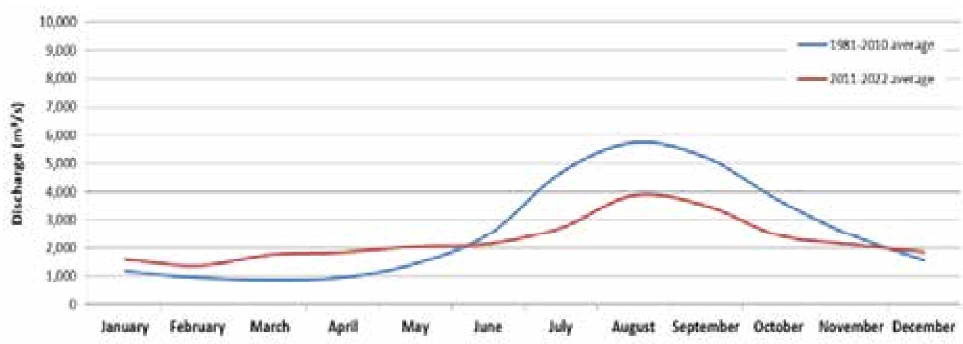


Figure E1 The change in the annual hydrograph at Chiang Saen

Note: The higher dry season flows and lower flood season flows over the last decade are compared to the 30 years prior.

With regard to the Procedures for Monitoring Flows on the Mainstream (PMFM), although dry season flows have become more stable in recent years at some stations (e.g. at Chiang Saen) with potential benefits for some agriculture and aquaculture activities, at other stations, flows and water levels (e.g. at Tan Chau) appear to be more unstable, reflecting that, especially in dry years, unstable and even severe conditions still occur despite the increased regulation of flow. When unstable conditions occur, it is mostly in the early part of the dry season from December to February, although at some locations in recent years, these unstable and severe conditions are extending into March.

Lower flood season flows are causing reduced reverse flows at Tonle Sap, especially when compared to the period prior to 2009 (Figure E2), which is of significant concern given the importance of this hydrological mechanism to wetland areas, fisheries and other aquatic animals (OAAs), recession agriculture and rural livelihoods – not only around Tonle Sap, but also throughout the Mekong Delta. Over the 2008–2022 period, there was a statistically significant trend in the number of days where the flow was outside the PMFM thresholds, increasing from 0 days to almost 100 days per year. As reflected in the MRC-LMC Joint Study, reduced accumulated reverse flow volumes also indicate lower outflows to the delta in the early dry season, which is a likely contributing factor (in conjunction with sea-level rise and other local influences) to high riverine salinity concentrations, well above levels that would have severe consequences for agriculture and some aquaculture (e.g. striped catfish) if control measures were not in place. Reduced Tonle Sap reverse flows over the last decade are driven by both reduced wet season rainfall and increased storage and water withdrawal in the whole Basin.

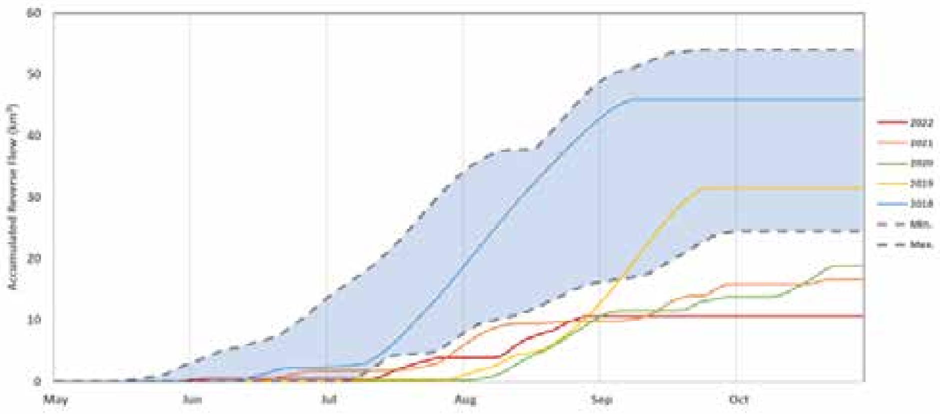


Figure E2 Accumulated Tonle Sap Reverse flows annually, compared to the maximum and minimum PMFM reference levels, 2018–2022

There has also been a change in the timing of the onset of flood season flows, with a delayed start and shorter flood season over the last decade compared to the 30 years prior (Figure E3). Taken together, the delay in the start of the flood season and the earlier end to the flood season indicate that, on average, the length of the flood season has decreased in the 2011–2022 period compared to the 1981–2010 period by 22 days (16%) at Vientiane, and 11 days (8%) at Kratie. Similar results emerge at all mainstream stations. The delayed onset to the flood season also means a delay in the onset of reverse flows to Tonle Sap, as illustrated above. Further investigation of the factors influencing the flow of the Tonle Sap Lake will be undertaken in a subsequent phase of the MRC-MLC Water Joint Study.

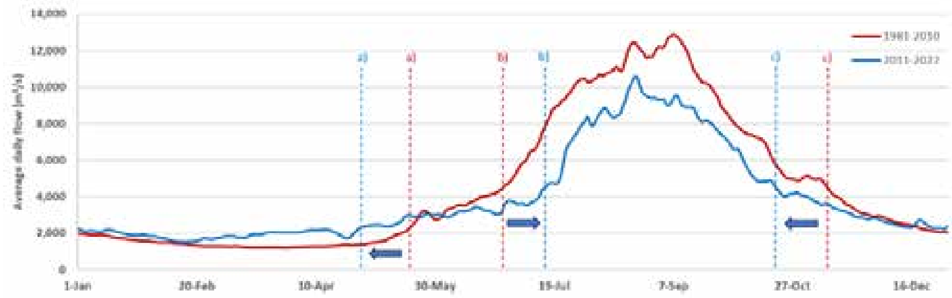


Figure E3 Change in the timing of the onset of flood season flows and the first and second transition season, Vientiane, over the last decade compared to the 30 years prior

Water quality and sediment conditions

Water quality in the Mekong River Basin generally meets the requirements of the MRC Procedures for Water Quality (PWQ), with Indices for Human Health, Aquatic Life, and Agricultural Use rated as ‘Good’ at almost all mainstream stations. However, there are some concerning trends in individual water quality parameters that warrant closer inspection to better understand what is causing the changes and whether any actions can be and should be taken. Of particular concern is the increase in water temperature by around 1.8 °C between 2010 and 2021 (or 0.16°C per year), which may be linked to climate change or reduced flows at certain times of year. Over the same period, mainstream total suspended solids decreased by around 40%, and average median nitrogen concentrations increased across LMB stations by around 30%.

Ecological stress is evident by high Average Tolerance Score Per Taxa (ATSPT) values and increasing trends for biological markers at many sites across the Basin. The threshold values for the ATSPT were exceeded in 2021 for littoral macroinvertebrates at all stations, for benthic macroinvertebrates at 28 stations, for diatoms at 29 stations, and for zooplankton at 15 stations. There is also a large amount of plastic waste pollution in the Mekong River system. It is estimated the Mekong contributes between 17.4 tonnes/day and 101 tonnes/day of plastic debris to the ocean, which is the 10th largest amount contributed by rivers globally. In the Upper Mekong River Basin (UMB), local water quality issues occur due to, *inter alia*, contamination with heavy metals through mining wastewater, pesticides and fertilizers through agricultural wastewater.

There has been a substantial decline in sediment transport throughout the Basin over the last two decades. The drop in sediment from the upper to the lower basin from around 2009 has been reported in previous SOBRs, although, as evident at Chiang Saen, largely appears to have stabilized, albeit at a much lower level. Further downstream sediment loads continue to fall with statistically significant decreasing trends at five of 15 stations, likely due to ongoing development throughout the Basin. The average annual daily load from the measured samples across all stations dropped by around half over the 2012–2022 decade, which is generally consistent with previous MRC analysis suggesting that the reduction relative to historic sediment loads is continuing. The potential impacts of a loss of sediment include increased riverbank, riverbed and coastal erosion, reduced nutrient deposition on the floodplain, and an exacerbation of land subsidence issues in the delta, especially in combination with sand mining.

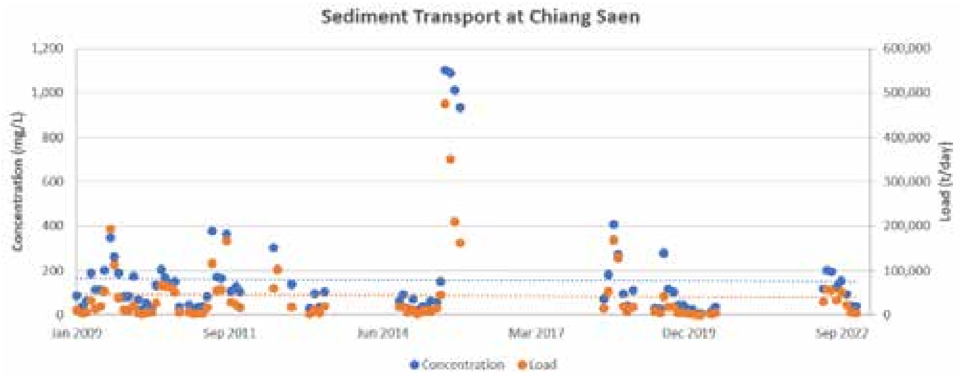


Figure E4 Sediment concentrations and sediment loads recorded at Chiang Saen, 2009-2022

Note: This figure shows that there is no significant change over this time period.

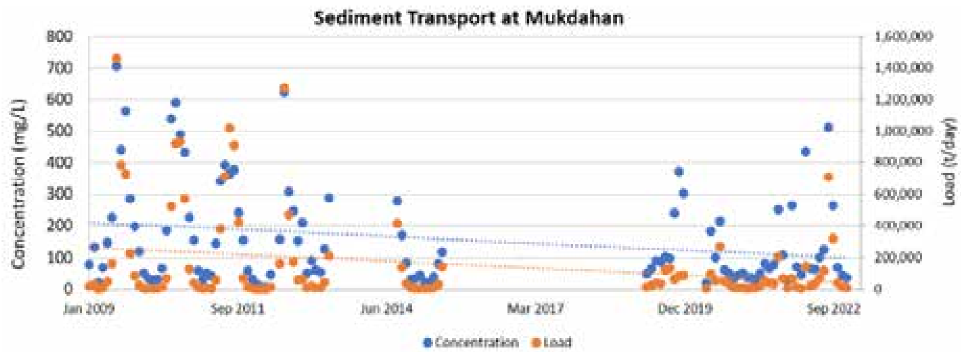


Figure E5 Sediment concentrations and sediment loads recorded at Mukdahan, 2009–2022

Note: The figure shows that there is no statistically significant declining trend over this time period.

The length of the Mekong River affected by salinity intrusion is highly variable from year to year. Some high results in recent years may be due to lower flow conditions upstream (see summary of water flow conditions above), which are leading to reduced Tonle Sap outflows early in the dry season, along with sea-level rise and other local factors. Further investigation of this issue may be warranted to identify whether the current controls in place to mitigate the impacts of riverine salinity on agriculture and other activities are adequate, or if other suitable measures need to be considered to mitigate the potential impacts.

Status of environmental assets

The loss of wetlands and pressure on fish populations remains mostly as reported in the 2018 SOBR. Total fish catch across the LMB is lower in recent years, mostly driven by declines in the catch from Tonle Sap Lake. Over the last five years, total fish catch generally declined in six ecological zones, was stable in three zones, and increased in one. There is evidence, albeit inconclusive, that fish caught are of a greater diversity and smaller size than in the past. There have also been declines in catch-per-unit-effort (CPUE) at some locations and increases at others, and a large number of fish species listed as threatened. Reduced flood season flows, including due to drier overall conditions contributing to less flooded habitat, have led to a lower estimate in this SOBR compared to 2018 of the overall economic value of basin capture fisheries, which are highly dependent on the annual flood pulse. This lower estimate of USD 7.1 to USD 8.4 billion per year is also due to a change in methodology to take better account of the variable amount of flooded habitat within the assessment time period.

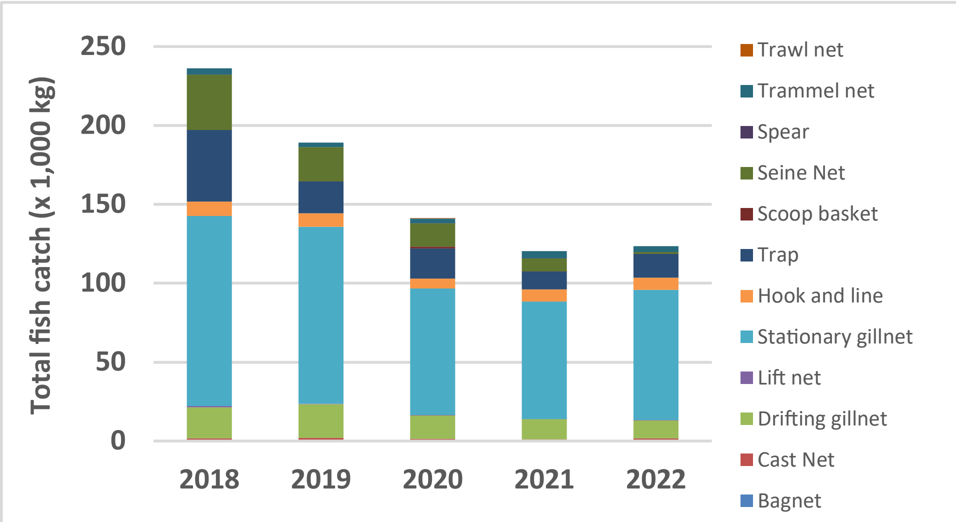


Figure E6 Total fish catch across all ecological zones in the Lower Mekong River Basin, 2018–2022, by different type of fishing gear from the MRC's Fish Abundance and Diversity Monitoring

While areas of natural wetland are known from previous SOBRs to have declined significantly in the past, more recent changes are difficult to quantify due to changes in assessment methodologies and classification definitions in land cover mapping. However, a particular concern is the ongoing decline in mangrove areas in the delta of around 30% from 2010 to 2020 (Figure E7), which is evident both from MRC Land Cover assessments and from Mekong SERVIR products. Mangroves play an important role in buffering coastal areas affected by sea-level rise and typhoon-induced storm surge. Insufficient information is available for this SOBR to report on changes in areas of riparian vegetation, sandy habitats, riverbank erosion, and tree loss in protected areas using data sources approved and ground-truthed by Member Countries. Ongoing methodology development and testing at the MRC seeks to change this for future SOBR assessments.

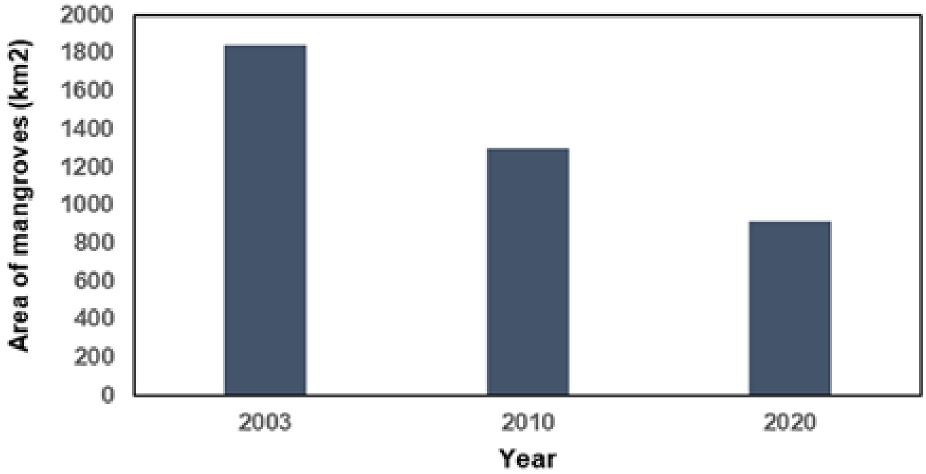


Figure E7 Total area of mangrove in the Mekong River Basin from land cover mapping, 2003–2020

There have been impressive efforts by basin countries to put in place protected areas of varying categories, now covering around 20% of the total basin area. Further action will be required to continually improve management and enforce conservation measures in these areas in order to protect and conserve Mekong River Basin ecosystems and biodiversity.

THE SOCIAL DIMENSION

Living conditions and wellbeing

Water, food and energy security of basin communities have strengthened significantly over the past two decades, as indicated by measures such as access to improved water sources, basic sanitation, dietary energy supply, and access to electricity (Figure E8). All LMB countries have experienced increased access to improved drinking water sources, to basic sanitation, and to electricity (around 70– 100% of households had access in 2020), as well as lower rates of water-related disease (less than 1 case of malaria per 10,000 in Cambodia, Thailand and Viet Nam). Food availability has improved, and rates of malnutrition have dropped.

Progress, however, is slowing in some countries. For instance, despite earlier gains, at a national level, the proportion of the population undernourished has been relatively consistent, at around 5–10% in four of six basin countries since 2015. This indicates the possibility that some groups in society are especially hard to reach with public services and through economic engagement; they may be experiencing entrenched disadvantages due to multiple, intersecting dimensions of vulnerability. Household access to improved water sources is still below 80% in the basin areas of two of the four LMB countries, and the proportion of cropped areas in drought-prone regions equipped with irrigation is only 9% on average across the LMB, indicating significant potential for water stress regarding farming.

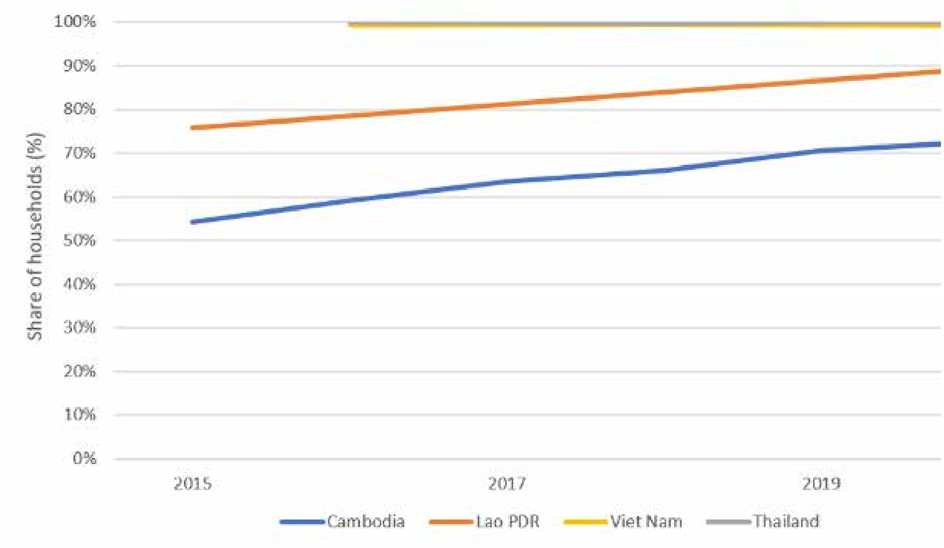


Figure E8 Proportion of basin households with access to electricity in each Lower Mekong Basin country, 2015–2020

Although more than enough food is produced in the Basin to meet the dietary energy needs of the population, the prevalence of undernourishment and of wasting and stunting in children suggests that, despite recent improvements, there are persistent barriers to affordable, nutritious meals in some sections of society.

There are also some large differences in access to basic services in basin populations between countries, for example, in access to water supplies from improved water sources, which recent trends suggest may take a long time to narrow. Considerable effort will be needed in some countries to close the remaining gap towards achieving universal access by 2030 in order to achieve the SDGs.

Livelihoods and employment in water-related sectors

Employment in water-related sectors is falling but remains relatively high, at between 25% and 60% across all basin countries (Figure E9) given the importance of sectors such as agriculture and fisheries to livelihoods within the Basin. The reduction in employment in these sectors (from around 50–80% in 2000) likely reflects the broader economic transition underway in basin countries as productivity improvements in agriculture and the growth of higher value-add sectors such as manufacturing and services attract workers, including to urban areas outside the Basin. Employment in sectors such as tourism exhibits strong growth.

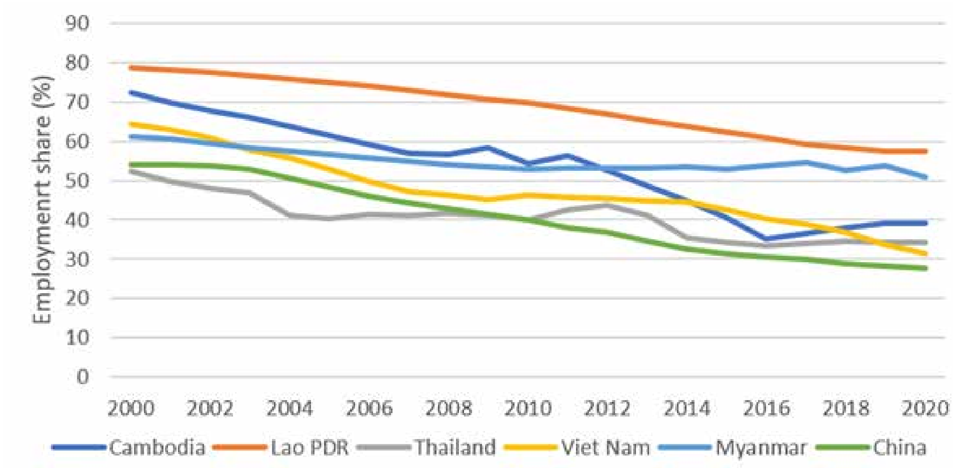


Figure E9 Employment share in agriculture, fisheries and forestry sectors in Mekong River Basin countries, 2000–2020

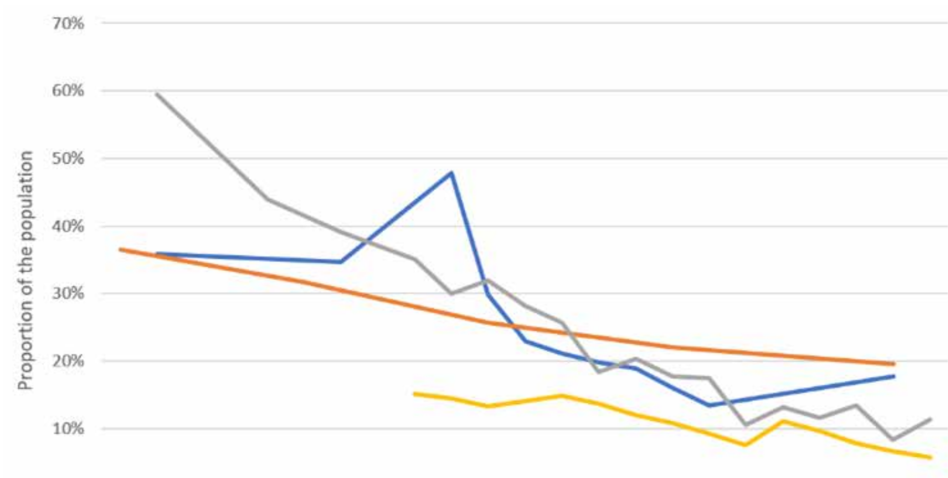


Figure E10 Percentage of the population below the national poverty line in each Lower Mekong River Basin country, 1999–2020

These broader trends are undoubtedly contributing to the significant reduction in poverty that has occurred in all basin countries over the past 20 years. The reduced poverty is evident as measured both against international benchmarks and national poverty levels determined by each country. However, the reduction in poverty appears to be slowing, and apparent chronic levels of poverty persist in certain geographic regions, with higher rates in rural areas and among farming households. In Cambodia and Lao PDR, close to one-fifth of the population is still below the national poverty line. An analysis of poverty data by the World Bank in Cambodia, Lao PDR and Viet Nam suggests that a significant portion of the population remains economically vulnerable. Rates of land ownership also remain very low in some countries, especially Cambodia and Viet Nam.

Expenditure rates, and by implication income, have generally increased over recent years, reflecting improvements in economic conditions. However, these national-level improvements can mask important differences between different groups in society. The available data are not sufficiently delineated to ascertain the extent to which vulnerable people who are dependent on river and wetland resources have had their economic circumstances improved.

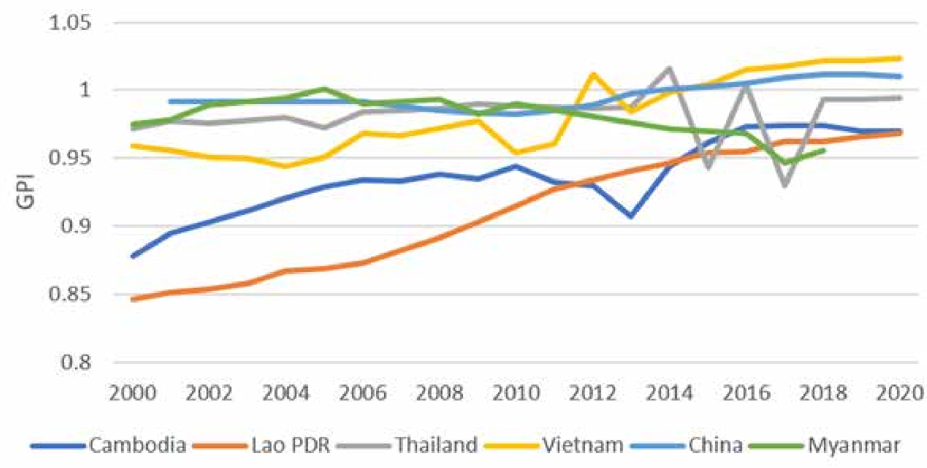


Figure E11 Gender Parity Index (ratio of girls to boys enrolled in primary school) in each Mekong River Basin country, 2000–2020

As indicated by the share of employment in water-related sectors by gender and the Gender Parity Index (GPI) for enrolment in primary (Figure E11) and secondary education, overall gender equality would appear to be improving across Mekong River Basin countries; however, there is some slowing of progress or decline in the indicators of gender equality related to employment and education in some countries, and an ongoing lack of gender-disaggregated data for a broader set of indicators to inform a more complete assessment. It should be noted that there are multiple aspects to gender equality not captured in the data available for this SOBR due to the mixed results by basin country based on equality of access to employment in water-related sectors and the GPI. These indicators based on national data also do not pick up subnational differences or additional drivers of inequality, such as differing roles and levels of pay, or other conditions of employment that occur within sectors. Ongoing work at the MRC to improve the information base on gender and vulnerability will inform future SOBRs.

THE ECONOMIC DIMENSION

Contribution to the basin economy

In 2019/20, total gross domestic product (GDP) in the Mekong River Basin was estimated at around USD 187.4 billion (excluding Myanmar), of which USD 133.7 billion (71%) was from the LMB. Around 30% of basin GDP came from Thailand, 29% from China, and 22% from Viet Nam.

The Basin's water-related sectors make an important contribution to basin, national and regional economies. Rice and fisheries sectors in particular contribute a large share of national production in the LMB countries. The contribution of LMB rice production to the total national production of the four LMB countries is around 54%, and the contribution of LMB fisheries (including aquaculture) is around 49% of national production. Hydropower in Lao PDR is essentially produced from within the Mekong River Basin, with much of it exported to other countries.

The relative importance of different water-related sectors in the Basin to national economies is obviously different for different countries, with the economic value of rice production from the Basin proportionately contributing the most to the national economic value in Cambodia and Lao PDR, and the economic value of fish production proportionately contributing the most to national production in Lao PDR, since almost the entire area of Lao PDR is within the Basin, albeit at a much lower volume than in Cambodia, Thailand and Viet Nam. Despite a relatively low contribution to national production compared to other LMB countries, the total economic value of basin production is still highest in Viet Nam for the rice and fisheries sectors, with the latter mostly due to aquaculture production. Hydropower from Lao PDR contributes almost 60% of the total gross economic value from this sector in the LMB.

Economic performance of water-related sectors

The economic performance across water-related sectors in the Mekong River Basin is generally strong, with a partial estimate of total gross annual economic value of around USD 63 billion. Sectors such as hydropower, rice production and tourism have seen substantial growth over recent decades, especially in Cambodia and Lao PDR. Similarly, aquaculture (Figure E12) and navigation in the Mekong Delta continue their rapid rise. Estimates of the value of capture fisheries and wetlands over time have not been possible due to changes in assessment methodologies and lack of consistent time-series data, but the most recent estimates put their value at around USD 8 billion and USD 30 billion, respectively, while noting that the value of ecosystem services from wetlands also includes provisioning services such as fish production.

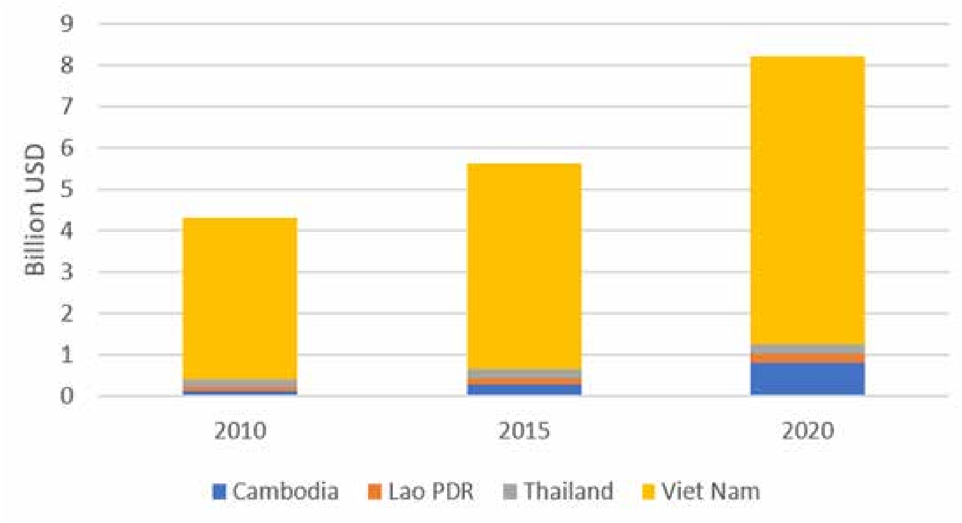
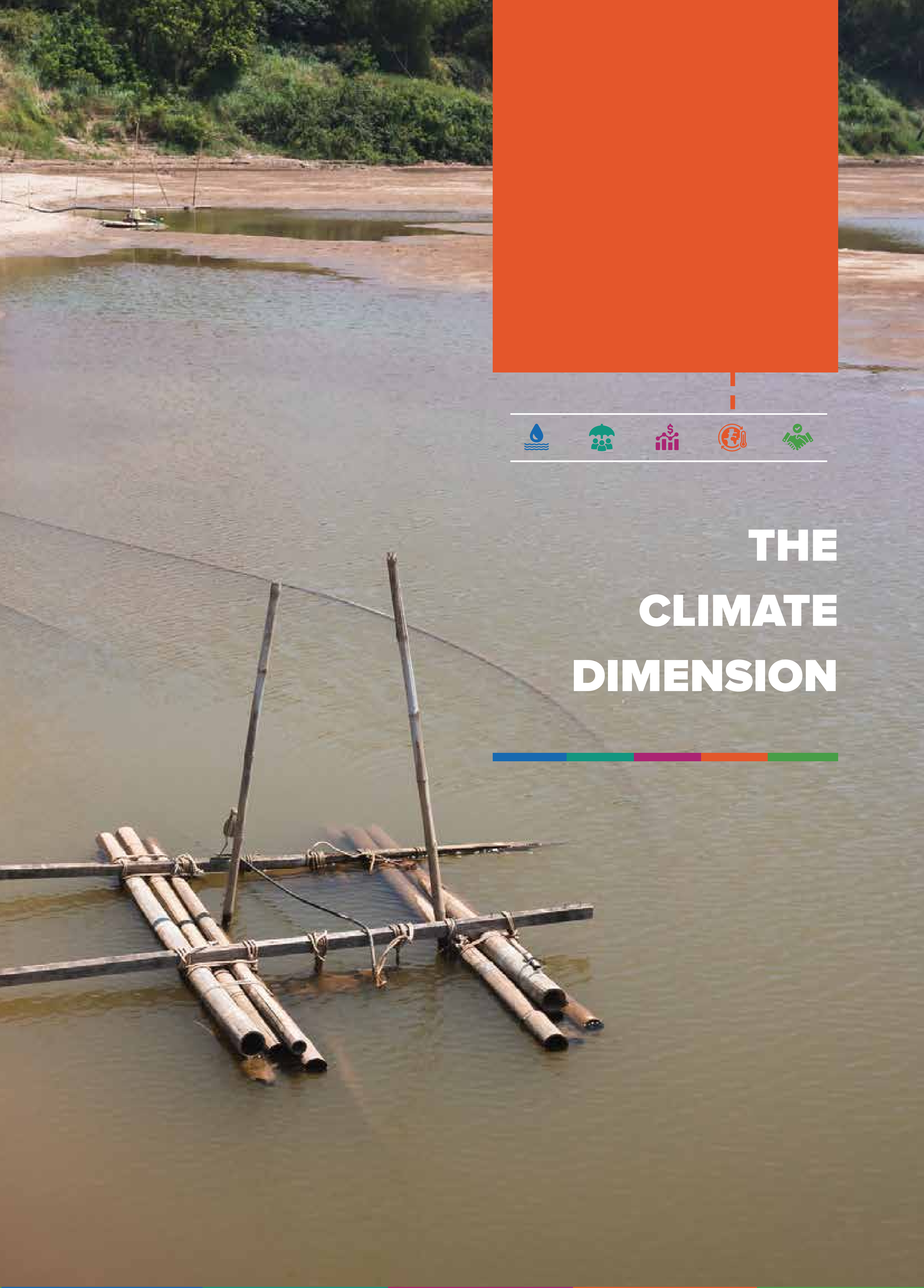


Figure E12 Gross annual economic value of aquaculture across the Lower Mekong River Basin countries, 2010–2020

In addition to these improvements, based on reporting by MRC Member Countries, there is no discernible trend in flood damages at the basin scale over the last decade or so, likely due to drier conditions across the Basin, lower flows (as reflected in the MRC-MLC Water Joint Study) and therefore less severe flood events. Despite no systematic reporting or monitoring of impacts of droughts on multiple sectors in the Mekong River Basin, due to their relative frequency and severity (especially over the last ten years), the average annual costs of droughts have probably been larger than flood damages. The agriculture and fisheries sectors are the most vulnerable to droughts and crucial for ensuring food security and income generation for basin communities.

Although strong overall economic growth and growth in water-related sectors are evident, the assessment of conditions in the Environment Dimension suggests that significant challenges remain before economic growth can be considered sustainable. Further information is also needed on the extent to which the benefits of economic growth are inclusively shared among basin communities. Some of the indicators in the Social Dimension where progress is slowing suggest that there remain groups within society that are not sharing equally in the economic success of recent decades. Additional disaggregated data on gender and vulnerability are needed to properly consider these issues, and their collection remains a work in progress.



THE CLIMATE DIMENSION

Greenhouse gas emissions

Greenhouse gas emissions from the Mekong River Basin are estimated to make a relatively small contribution to global emissions, with carbon dioxide, methane and nitrous oxide emissions each contributing around 0.85% of the total global emissions, roughly equivalent to the Basin's share of the global population. However, this is the case for most areas around the world, and emissions from the Basin, especially from the energy sector, are rising in every country: the estimated basin emissions are highest in Thailand's part of the Basin, followed by Viet Nam, Cambodia, China, Lao PDR and Myanmar. There has been strong investment in recent years in renewable energy, especially hydropower, but further investment in a broader range of renewable technologies will be important for countries to meet their Nationally Determined Contributions (NDCs) under the Paris Agreement.

Climate change trends and extremes

There is strong evidence of climate change within the Mekong River Basin through increases in temperature and sea-level rise. across the Basin, both minimum and maximum daily temperatures have increased over the past 50 years by around 1.4 °C, and extreme temperatures are occurring more frequently than before. Total annual precipitation across the Basin is declining. Since 1970, the number of hot days and hot nights per year has increased by more than 15 days and 25 days, respectively. The sea level along the Viet Nam coast is rising by around 4 mm per year.

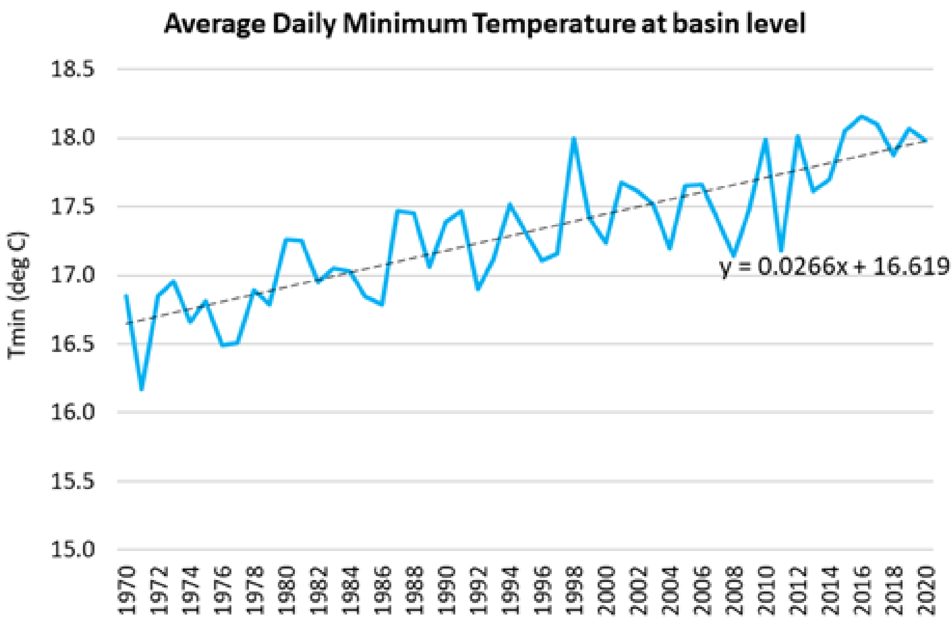


Figure E13 Increase in average daily minimum temperatures across the Mekong River Basin, 1970–2020

There has been a decrease in the frequency of typhoon formation in the Western Pacific Ocean over the past 30 years and no change in the number or intensity of typhoons that cross into the Basin. There has also been a reduction in the number of heavy (>100 mm) and very heavy (>150 mm) rainfall days annually in the LMB, but no apparent trend to date in the frequency or severity of floods or droughts due to climate change. Although areas of the Basin affected by meteorological, hydrological and agricultural drought are larger over the last decade (2011–2022) than the decade before (2001–2010), as confirmed by the Joint Study, they are smaller than the 1991–2000 decade. Continued hydrometeorological and drought monitoring will be important to assess whether drier conditions are becoming more prevalent and to inform the identification and implementation of adaptation options as considered through the Joint Study and the MRC's proactive regional planning.

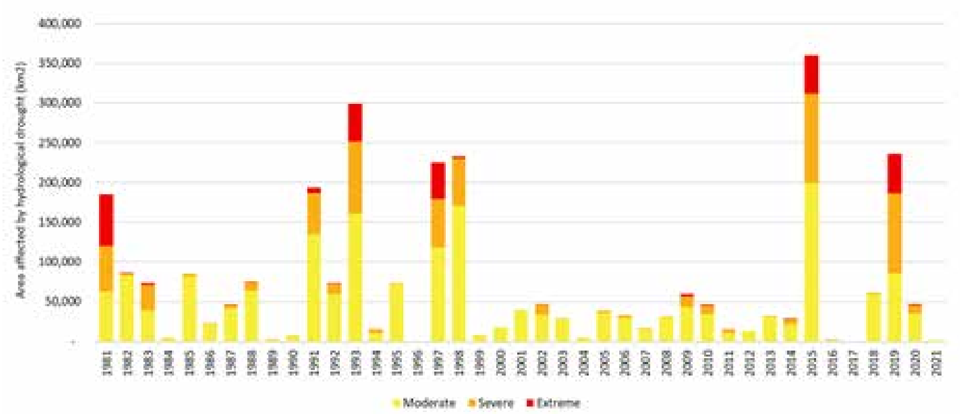


Figure E14 Area of the Lower Mekong River Basin annually affected by moderate, severe and extreme hydrological drought, 1981-2021

The rising sea level is of significant concern to the Mekong Delta due to the potential for higher storm surge and the compounding effects of land subsidence and increased coastal erosion. Reversing the decline in the area of mangroves is likely to be one of the most cost-effective ways to improve resilience in these areas, and as a nature-based solution is widely recognized to have significant co-benefits including for coastal and marine fisheries.

Although a long-term trend in the frequency or severity of floods and droughts is not yet confirmed, it is important that mitigating the impacts of the most extreme events remain a priority for regional planning activities and joint projects. Extreme events under current flood and drought conditions, as experienced over the last decade especially for droughts, already cause significant economic losses for basin communities, including for vulnerable people who are more directly dependent on water-related resources.

Adaptation to climate change

Although progress in climate change adaptation is generally good in that all basin countries recognize the seriousness of the issue, have developed plans and priorities for action, and put in place institutional arrangements to manage the response, it is unlikely to be anywhere near sufficient given the scale of the likely future change to the climate and the impacts that this will have on basin water and related resources. This is illustrated in the gaps some countries have identified in their NDCs for their adaptation financing needs.

More information than is available for this SOBR is needed on the extent to which basin communities are prepared for changing river conditions or for undertaking better disaster management in response to floods and droughts needs. For instance, no time series information was available on flood protection measures that have been put in place in basin countries. Drought protection, as indicated by the level of irrigation in the Basin, has increased in both Lao PDR and Viet Nam. However, the proportion of irrigable land in the basin provinces likely still leaves many provinces that are drought-prone without sufficient protection.

No significant joint investment projects between two or more countries to manage transboundary flood and drought risks have yet been identified or implemented on a scale that is likely to make a material difference. It will therefore be important for the basin countries to focus on this issue through the proactive regional planning activity that is now underway and through climate change adaptation measures to be identified in the MRC-MLC Water Joint Study.

THE COOPERATION DIMENSION

Self-financing of the MRC

The strengthening of the MRC is on track with regard to the increased financial contribution and commitments made by Member Countries to the financial sustainability and riparianization of the organization. Countries have met all targets to date for increasing their financial contributions to the MRC, and projections to 2030 suggest that 100% financing of core river basin management functions by Member Countries by that year is achievable. There is also an increasing proportion of the MRC's budget delivered through the basket fund, rather than being earmarked for specific activities by Development Partners, which puts the MRC in the driver's seat and provides more flexibility in relation to meeting riparian country priorities at the regional level.

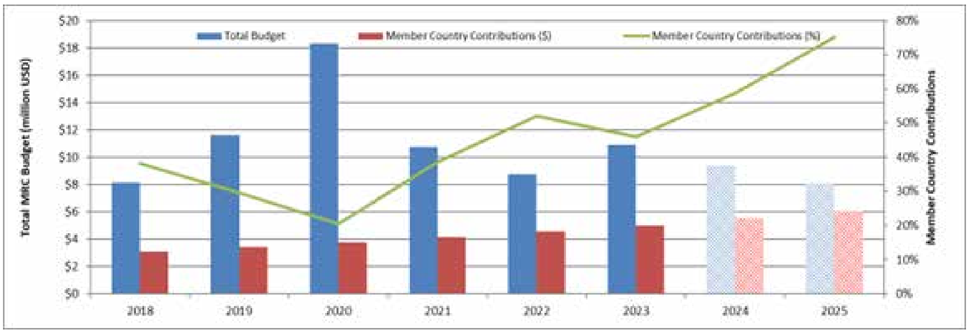


Figure E15 Total MRC budget and total proportional contributions from MRC Member Countries

Nevertheless, the full financing of the MRC by Member Countries remains a challenge as substantial further increases still need to be made. The public finances of all countries were negatively impacted by the COVID-19 pandemic and the policy responses to it, which led to difficult trade-offs to be made in national budgets over the coming years.

Benefits derived from cooperation

All basin countries derive benefit from cooperation on water resources management and development in the Mekong River Basin, and there are strong statements of commitment to further cooperation from the highest levels of government. Much of the cooperation activity entails working together on projects of basin-wide significance, including joint or transboundary (non-infrastructure) projects, and on consultation processes under the PNPCA (Figure E16). While there has been an increase in project activity, progress has been slow on mobilizing financial resources and developing and implementing joint and transboundary projects between Member Countries through the MRC.

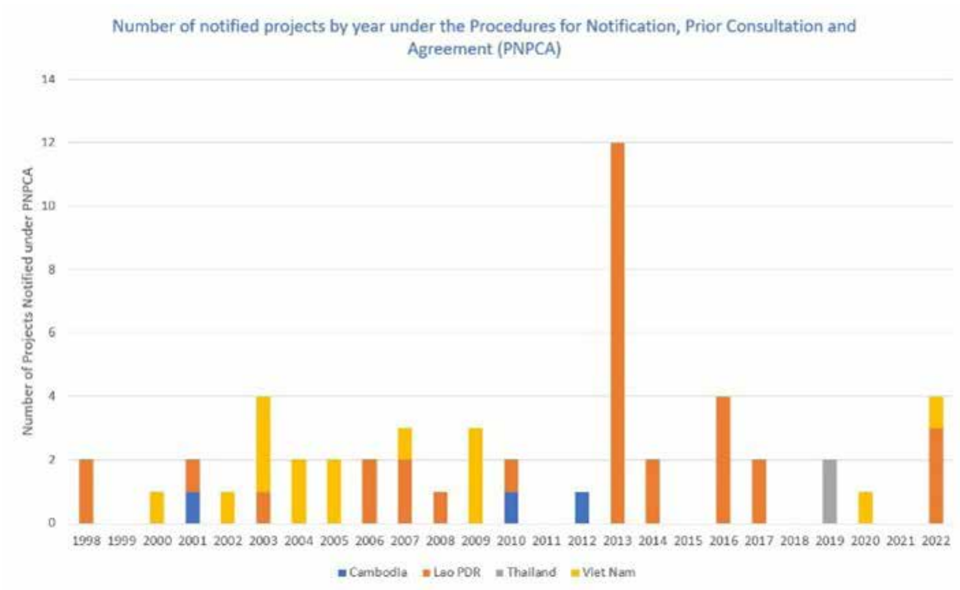


Figure E16 Number of projects by country notified under the PNPCA, 1998–2022

The MRC has made considerable efforts to facilitate improved consultation processes and engage stakeholders in the PNPCA process, resulting in the post-consultation mechanism of the Joint Action Plan. After a slow start, Joint Action Plan implementation for mainstream dams saw more dialogue, and data- and information sharing in 2023. However, the challenge in reaching an agreement or compromise on proceeding with some proposed projects notified under the PNPCA reflects an inability to reach an optimal solution and identify development pathways that are acceptable to all countries. Nevertheless, the concerned countries remained in dialogue, demonstrating the value of 'One Mekong, One Spirit' characteristic of MRC cooperation.

Knowledge-sharing and partnership activities at the MRC are proceeding positively. Due to a shift in approach under the BDS where the MRC plays more of an enabling and facilitation role for other parties to contribute to the BDS Outcomes, a more proactive outreach effort and direct access to data and information provision are becoming increasingly important. This is supported by an active partnership building effort by the MRC and deeper engagement with strategic partners such as MRC Development Partners, MRC Dialogue Partners, the private sector, non-government organizations (NGOs), civil society organizations (CSOs), research institutions and other river basin organizations.

Equity of benefits derived from the Mekong River system

Each basin country has a different endowment of resources and capabilities to exploit them for social and economic gain, as well as different priorities for development. Each country is also affected differently through impacts on the environment and social conditions from water resources development and management. Even where there are common challenges experienced, the implications for people and livelihoods will often be different due to different socio-economic contexts both within and between countries.

As regards the environment, the conditions for some indicators have deteriorated throughout the Basin due to a range of factors (e.g. changes in flow conditions, loss of wetlands including mangroves, reduction in sediment transport, extensive salinity intrusion). In particular, significant changes have been increasingly evident in downstream areas, including in Tonle Sap and the Mekong Delta. This is because, as with all river basins around the world, the lower reaches of the river are often subject to the cumulative effects of changes upstream combined with the effects of past and present developments within the downstream areas.

As regards social conditions, all basin countries have achieved significant gains over recent decades in living conditions, wellbeing and livelihoods. Progress in some countries, however, is slowing for some indicators, likely reflecting challenges in reaching more vulnerable groups in the community.

As regards economic conditions, all basin countries derived substantial aggregate benefits from the Basin's water-related sectors. Different countries enjoy greater or lesser benefit in different sectors depending on their endowment of resources, technological and human capabilities, and supporting infrastructure. Based on the available data at the basin level, all LMB countries except for Lao PDR derive the most economic benefit in terms of absolute economic value from rice production, fisheries (capture fisheries or aquaculture) and wetlands. Lao PDR derives greater economic benefit from hydropower than from fisheries.

Viet Nam derives a higher benefit than other countries from rice production and aquaculture, Thailand from capture fisheries, Cambodia from wetland ecosystem services, and Lao PDR from hydropower and forestry. Based on a partial assessment from water-related sectors, the gross economic benefits generated per capita are roughly similar for Cambodia, Lao PDR and Viet Nam, i.e. between USD 1,207 and USD 1,574, but are significantly lower for Thailand, at around USD 452 per person. The lower figure for Thailand reflects both its higher basin population and possibly a more diverse economic base, which includes manufacturing, services and value-added industries such as food processing, which are not captured in this partial assessment.

Progress towards achieving the Sustainable Development Goals

Progress is being made within the Basin towards the United Nations Sustainable Development Goals (SDGs). Most indicators across the 12 SDGs considered the most relevant for water resources management and development in the Mekong River Basin demonstrate improvements, i.e. 16 indicators show substantial progress that, if continued or only moderately accelerated, would put the SDGs within reach. However, five indicators show progress that is unlikely to be sufficient to meet the SDGs. Different aspects of five indicators show some improvement and some decline, making the achievement of the SDGs increasingly difficult to achieve.

Regarding SDG 6, Ensure availability and sustainable management of water and sanitation for all, there has been good progress in access to safe water supplies and sanitation, and the targets for Integrated Water Resources Management (IWRM) and transboundary water management have largely been met. However, some concerning trends in some water quality parameters and the decline in the extent of some water-related ecosystems suggest that some aspects of this goal may be increasingly difficult to achieve by 2030 (Table E1).

The SDGs largely focus on universal and equitable access to conditions of human wellbeing and security, and in this respect, addressing vulnerabilities of different groups in the community for all goals and indicators becomes important. Strong progress is being made across the Basin in several major intersectional dimensions of vulnerability related to water resources, such as poverty, gender and livelihood . The trends are all heading in the right direction. However, as reflected in the assessment of conditions and trends in the Social Dimension, progress in some countries is slowing, and there are indicators of potentially chronic levels of food insecurity (e.g. child malnutrition) and of disadvantage (e.g. access to clean water and sanitation), even if it is not yet shown exactly which groups are affected and where they are located.

Although poverty has declined in the Basin, it remains relatively high in some countries. Overall, these indicators suggest that more efforts are needed to support people who are vulnerable to changes in river conditions throughout the Basin and to ensure that they share in the economic benefits derived from the sustainable utilization of basin water resources.

Table E1 Summary of progress in the Mekong River Basin towards SDG 6, 'Clean water and sanitation'

SDG 6: Ensure availability and sustainable management of water and sanitation for all		
Targets		**Current status**
By 2030, achieve universal and equitable access to safe and affordable drinking water for all	↗	Access to improved water sources is increasing in the Basin. However, the rate of improvement is not fast enough to achieve universal access by 2030, especially since progress in some countries is slowing, the causes of which need to be investigated and urgently addressed. [Section 4.2.2]
By 2030, achieve access to adequate and equitable sanitation and hygiene for all and end open defecation, paying special attention to the needs of women and girls and those in vulnerable situations	↗	Access to basic sanitation is increasing in the Basin, and universal access by 2030 is within reach if some moderate improvement in the rate of progress can be achieved. However, progress in some countries is slowing, the causes of which need to be investigated and urgently addressed. [Section 4.2.4]
By 2030, improve water quality by reducing pollution, eliminating dumping and minimising release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally	→	Although water quality is generally rated as good in accordance with the Procedures for Water Quality (PWQ), trends of some key parameters suggest deteriorating conditions, and there is insufficient information on changes in important pollutants, including heavy metals, pesticides and other toxic substances, which have not been assessed since 2011. [Section 3.3.2]
By 2030, implement Integrated Water Resources Management (IWRM) at all levels, including through transboundary cooperation as appropriate	↗	There is a high degree of IWRM awareness and implementation throughout the Basin, including at national levels, although further effort may be warranted in transboundary areas of key sub-basins including in the transition zone from the Upper to the Lower Mekong River Basin, tributary areas of Tonle Sap, the 3-S sub-basin, and the Mekong Delta. [Section 7.3.2]
	↗	The Mekong River Basin is covered by the 1995 Mekong Agreement, and there are cooperation arrangements among all basin states. Strengthening cooperation between Member Countries and non-Member Countries is a critical focus of the Basin Development Strategy 2021–2030, and progress is being made through joint studies, additional data sharing and other engagement. [Section 7.3.4]
Protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers and lakes	→	The Mekong River Basin has a high proportion of areas under some form of protection. However, the challenges are often much bigger than the management of individual sites, leading to declines in the extent of water-related ecosystems over time, especially wetlands. The rate of decline may have slowed in some cases, although further effort will be required for restoration. [Section 3.4.2]

Progress towards the Outcomes of the Basin Development Strategy 2021–2030

An assessment of progress towards the BDS 2021–2030 Outcomes was undertaken as a basis for identifying recommendations to guide the refinement of BDS implementation over the remainder of the planning period. Given the early stage of implementation, it will take time before the BDS 2021–2030 has a material effect on conditions and trends in key indicators across the Basin. Much of the data collected for the SOBR is in any case only available up to 2020 or even earlier, prior to the agreed BDS 2021–2030. As a result, the focus of the assessment in this 2023 SOBR is on the current conditions and trends in key strategic indicators aligned with the BDS 2021–2030 Outcomes and the extent to which the achievement of the outcomes is drawing closer or further out of reach (i.e. more or less challenging to achieve), considering data and information that were not available at the time that the BDS 2021–2030 was prepared.

The assessment shows that based on recent trends, achieving the BDS Outcomes for one outcome is likely (Table E2), i.e. Outcome 5.1, *Strengthening the Mekong River Commission for more effective implementation of the Mekong Agreement*. The basis for this assessment is the continued progress that Member Countries are making towards self-financing of the MRC. However, the progress is slow in implementing some joint transboundary projects, and in improvements in the implementation of MRC Procedures, particularly the PNPCA.

For three other BDS Outcomes, progress being made is essential to achieving the outcome, although it may take more sustained efforts and actions to be realized by 2030 due to the considerable challenges ahead and the timeframes needed to actually change conditions on the ground. These three outcomes are: Outcome 3.1, *Increased economic growth of all basin countries from more proactive regional planning*; Outcome 4.1, *Better informed and prepared basin communities against changing river conditions, and more frequent and severe floods and droughts*; and Outcome 5.2, *Increased joint efforts and partnerships for more integrated management of the entire river basin*.

Each of these outcomes has significant activities underway that will provide the basis for achieving the outcome, including the MRC's proactive regional planning initiative and the MRC-MLC Water Joint Study on changing river conditions in the Lancang-Mekong. However, the outputs from these activities will still need to be negotiated and agreed between the countries and then implemented before any change in conditions can be expected. Much depends on the ability to identify and agree on supplementary joint investment projects and adaptation measures that will increase benefits and reduce costs between countries from water resources development and management, including in response to climate change. The positive engagement between the MRC and LMC Water and the enhanced data sharing from China are encouraging signs towards achieving Outcome 5.2.

No or only slight improvements have been identified for three BDS outcomes, and there is insufficient information on which to make a judgment for three other BDS outcomes. The outcomes where only slight or no progress was identified, i.e. they were likely to be no closer to or were further away from being achieved, were Outcome 1.2, *Sediment transport managed to mitigate bank erosion,* Outcome 1.3 *Ecosystem services from wetlands and watersheds ensured*, and Outcome 2.1 *Strengthened water, food and energy security for basin wellbeing*. For each of these outcomes, the rating for aligned strategic indicators has not significantly changed since the agreement of the BDS 2021–2030.

For Outcome 1.2, no regional sediment management plan has yet been developed, and sediment transport continues to decline at some stations along the length of the river. There was insufficient information on trends in riverbank erosion for this SOBR. For Outcome 1.3, the loss of wetlands and risks to fish populations remain largely as reported in the 2018 SOBR. For Outcome 2.1, recent trends show a slowing of progress within some basin countries, with some indicators pointing to possible chronic problems, for example, in food security among some vulnerable groups.

Outcome 1.1, *Adequate water flow and quality for a healthy environment and productive communities*, is the BDS outcome where progress is the furthest away than at the start of the BDS period. This assessment is based on the significant reduction in Tonle Sap reverse flows, dry season flows being often unstable or severe for prolonged periods at some stations despite increased flow regulation, and some concerning negative trends in individual water quality parameters, all of which are results not reported in the previous SOBR. There is also evidence of some potential negative flow-on effects associated with these conditions, for example, high levels of salinity intrusion, which may be at least partly related to the reduced Tonle Sap reverse flows, and subsequent outflows from the lake in the early dry season, together with the impacts of sea-level rise.

Table E2 Summary of progress towards the BDS Outcomes 2021–2030

Strategic indicators		Condition	Status and key issues
● (green)	No immediate concerns	↑	On track. The gap towards achieving the outcome is decreasing
● (yellow)	Some concerns to address	↗	Moderate improvement, but unlikely to be sufficient
● (red)	Significant concerns to address	→	No or only slight improvement, likely well short of requirements
		↓	Gap towards achieving the BDS Outcome is increasing, becoming more challenging
		●●●	Insufficient information on progress towards BDS Outcome

BDS Outcomes	Strategic indicators	Condition	Status and key issues	BDS progress
1.1 Adequate water flow and quality for a healthy environment and productive communities	Water flow conditions	🟡	Dry season flows unstable or severe in some areas for extended periods in the early dry season Reduced Tonle Sap reverse flows	↓
1.2 Sediment transport managed to mitigate bank erosion and maintain wetland and floodplain productivity	Water quality and sediment conditions	🔴	Declining water quality for some parameters Continued reduction in sediment transport at multiple stations along the river	→
1.3 Ecosystem services from wetlands and watersheds ensured	Status of environmental assets	🔴	Significant loss of natural wetlands Risks to wild fish populations with declining total catch in recent years	→

BDS Outcomes	Strategic indicators	Condition	Status and key issues	BDS progress
2.1 Strengthened water, food and energy security for basin community wellbeing	Living conditions and wellbeing	🟡	Improved access to water, sanitation, electricity and food in all countries Inequality of access including potential chronic food insecurity in some vulnerable groups Slowing of gains in some countries over recent years and significant gaps remaining between countries	→

2.2 Increased employment and reduced poverty among vulnerable people dependent on river and wetland resources	Livelihoods and employment in water-related sectors	●	Significant poverty reduction in all countries Managing a transition from employment in water-related sectors to more productive economic activities Supporting vulnerable groups to access employment opportunities in growth sectors	• • •

BDS Outcomes	Strategic indicators	Condition	Status and key issues	BDS progress
3.1 Increased economic growth of all basin countries from more proactive regional planning	Contribution to the basin economy	●	Strong economic growth, especially in the hydropower, rice and tourism sectors Enabling increased basin benefits and reduced costs of development for all countries Identifying net economic benefits within sectors and accounting for externalities	↗
3.2 Enhanced inclusive growth and sustainability in irrigated agriculture, hydropower, navigation, environment and fisheries sectors	Economic performance of water-related sectors	●	Ensuring inclusive growth and sustainability considering the impacts of development on the environment and the livelihoods of vulnerable people	• • •

BDS Outcomes	Strategic indicators	Condition	Status and key issues	BDS progress
4.1 Basin communities are better informed of, and prepared against, changing river conditions, and more frequent and severe floods and droughts	Greenhouse gas emissions	●	Emissions are rising even if basin emissions are only a small proportion of the global total	↗
	Climate change trends and extremes	●	Temperature increases Potential decrease in annual precipitation, but needs further investigation with ground- truthing Sea-level rise at the delta Potential for more severe floods and droughts in future	

4.2 Better disaster management and adaptation to water resources development and climate risks	Adaptation to climate change	●	More comprehensive and integrated investment in adaptation needed to match the scale of the challenge	•••

BDS Outcomes	Strategic indicators	Condition	Status and key issues	BDS progress
5.1 A strengthened Mekong River Commission for a more effective implementation of the Mekong Agreement	Self-finance of the MRC	●	Increased financial contribution by MRC member countries National budget pressures post- COVID-19	↑
	Benefits derived from cooperation	●	Benefits derived from and high commitment demonstrated for Mekong cooperation Challenges in evaluating and communicating the benefits of cooperation and joint projects Coordination of project activities across the Basin Identifying, financing and implementing joint investment projects that increase benefits and reduce costs for all basin countries	
5.2 Increased joint efforts and partnerships for more integrated management of the entire river basin	Equity of benefits from the Mekong River system	●	The need for joint investment and associated cost- and benefit-sharing mechanisms between countries	↗

Recommendations to refine the implementation of the BDS 2021–2030

The BDS 2021–2030 was agreed by Member Countries of the MRC in 2020, and implementation began in 2021. Progress in achieving the BDS Outcomes is at an early stage, with mixed results to date. There is a need for further negotiation, agreement and implementation beyond the investigative and planning activities underway, and the long lag time before changes in basin conditions will become evident as a result of actions undertaken. The most important recommendation with regard to the BDS 2021–2030, therefore, is to continue to fully implement it on time. Given the issues identified in this SOBR, the Strategic Priorities, Outcomes and Outputs remain as relevant today as they were two years ago.

The assessment of the strategic and assessment indicators aligned with BDS Outcomes has nevertheless identified several areas where refinement of implementation by relevant basin stakeholders may be warranted. These are summarized in the following tables, together with reference to the relevant BDS 2021–2030 Outputs. The recommendations do not change the overall priorities, outcomes and outputs of the BDS 2021–2030, but are intended to inform relevant parties about opportunities for them to shape how the Outcomes and Outputs are achieved, including through updates to their plans over the remainder of the BDS 2021–2030 period, for example, through the development of the MRC Strategic Plan 2026–2030, national strategies and plans, and the strategies and plans of other actors involved in water resources management and development in the Basin.

The recommendations are divided into three categories: (i) short-term actions for implementation over the remainder of the MRC Strategic Plan 2021–2025; (ii) medium-term recommendations for consideration by the MRC and Member Countries in the preparation of the MRC Strategic Plan 2026–2030; and (ii) recommendations for consideration by other stakeholders working on Mekong water-related matters to support the implementation of the BDS 2021–2030.

Recommendations for MRC* to support achievement of BDS 2021–2030 Outcomes		
	Short-Term Actions for the MRC Work Plans 2024–2025	**Medium-Term Recommendations for the MRC SP 2026–2030**
Environment Dimension	**Action 1:** Strengthen the capacity of Member Countries to: (i) monitor riverine micro- and macroplastic for potential integration into routine Water Quality Monitoring; and (ii) implement Chapter 4 on Water Quality Emergency Response Management under the Technical Guidelines of the Procedures for Water Quality (PWQ).. [SP Activity 1.1.1.4] **Action 2:** Support the use of MRC fisheries monitoring data and assessment findings for the integration of inland capture fisheries into national basin development policies, plans and investments. [SP Activity 3.2.5.2] **Action 3:** Identify and assess supplementary water resources development options through proactive regional planning, which includes minimizing further environmental impacts from water resources development. [SP Activity 3.1.1.1, 3.1.1.2, 3.1.1.3] **Action 4:** Continue to monitor sediment transport throughout the Basin including by implementing the updated Core River Monitoring Network; undertake a study on sediment trapping and extraction activities, and the extent and distribution of bank erosion, as part of the Proactive Regional Planning and in cooperation with partners; and prepare a basin-wide sediment management plan to address the loss of sediment. [SP Activity 1.2.1.1] **Action 5:** Identify additional hydrological limits of change for key wetland assets and river flows as part of the Proactive Regional Planning to support sustainable development pathways that protect against the further loss of wetlands and their ecosystem functions, and consider updates to the PMFM flow thresholds including potentially with additional stations. [SP Activities 1.3.1.1, 3.1.1.2] **Action 6:** Review institutional, governance and regulatory arrangements, and undertake a gap analysis for the further development of a regional management framework for the protection of key regional watersheds of priority regional environmental assets. [SP Activities 1.3.1.2, 3.2.4.1]	**Recommendation 1:** Further assess water quality conditions in the mainstream including by: (i) investigating the causes and possible solutions to concerning trends in some key water quality parameters; (ii) updating the regional study on heavy metals and pollutants; and (iii) if necessary, re-evaluating the calculation of indices in the PWQ (considering current international standards), if these are shown not to be adequately identifying changing water quality conditions in underlying parameters. [BDS Outputs 1.1.1 and 5.1.1] **Recommendation 2:** Implement a holistic plan and concrete measures based on results of the proactive regional planning and of the Joint Study phase 2 for addressing environmental challenges at Tonle Sap. This encompasses transboundary issues arising from changes in water flow and sediment conditions, and the intersection with national and local management, as well as the combined impacts on wetlands, recession agriculture and capture fisheries. [BDS Outputs 1.3.1 and 1.1.2] **Recommendation 3:** Implement updated flow framework and thresholds (identified under the MRC SP 2021–2025) with agreed response protocols to help countries minimize any significant adverse environmental impacts of an increase in dry season flows and a reduction in flood season flows, and consider the implications for reduced flood season flows on the accumulated volume and timing of Tonle Sap reverse flows. [BDS Output 1.3.1] **Recommendation 4:** Use priority regional environmental assets as exemplar sites to extend improved management and further protections to other regionally important sites and hotspots throughout the Basin, especially those affected by water resources development and climate change. [BDS Outputs 1.3.1 and 1.3.2]

Social Dimension	**Action 7:** Enhance national disaggregated data collection and mapping on gender and vulnerability within the Data Acquisition and Generation Action Plan, including to inform SDG reporting. (SP Activity 2.1.4.2) Action 8: Formulate measures for improving equity for vulnerable groups, including recommended measures for regional and national plans. (SP Activity: 2.1.4.3)	**Recommendation 5:** Building on the MRC's review of gender and vulnerability data available across the Lower Mekong River Basin, implement concrete measures and action plans with each country to improve equity and access for vulnerable groups. Also, continue collecting and analysing agreed relevant national and subnational data disaggregated by gender and other dimensions of vulnerability at the national level through basin countries' existing national survey, and data collection systems and processing mechanisms, and update the MRB-IF accordingly. [BDS Outputs 2.1.4, 4.1.2, 4.1.4 and 4.1.5]
Economic Dimension	**Action 9:** Formulate the initial adaptive basin plan under Proactive Regional Planning by identifying joint investment projects and enabling activities to optimize water, food and energy security considering climate change impacts using alternative development scenarios. (SP Activities: 3.1.1.1, 3.1.1.2, 3.1.1.3)	**Recommendation 6:** Coordinate transboundary social, economic and environmental impact assessments of any proposed joint investment projects and adaptation measures identified through proactive regional planning and the MRC-MLC Water Joint Study. Also, facilitate the consideration of and agreement on joint projects by basin countries including to support inclusive growth among vulnerable communities. [BDS Outputs 3.1.1 and 5.2.3] Recommendation 7: Engage potential funding agencies and the private sector early in the assessment of any proposed joint investment projects and adaptation measures, and in discussions between countries to build support for potential investment decisions. [BDS Outputs 3.1.1] **Recommendation 8:** Implement a process to identify and collect data on input costs for water-related sectors to enable a proper assessment of economic value and changes over time including in response to water resources development, possibly through a regional study identifying standard or benchmark rates in each basin country that are occasionally updated. [BDS Outputs 3.1.1 and 4.1.5]

Climate Change Dimension

Action 10: Continue supporting the implementation of the joint project on flood and drought management for sub-area 9C-9T, working with Development Partners to seek additional support to implement other joint projects (including for the Mekong Delta and Sekong, Sesan and Srepok [3S]). Also, facilitate the implementation of transboundary projects on climate change adaptation and water resources management including joint National Indicative Plan (NIP) projects to improve knowledge, management, systems and cooperation in response to increased floods and droughts. [SP Activities: 4.2.2.5]

Action 11: Continue work on cooperation arrangements and mechanisms for data and information sharing for dam operations, and for water-related emergencies. [SP Activities: 4.2.1.1, 4.2.1.2, 4.2.1.3, 4.2.1.4)

Action 12: Finalize and implement the upgraded Decision Support Framework, providing countries and stakeholders with timely, better and integrated data, information and analysis on river conditions, dam operations, and flood and drought forecasting. [SP Activities: 4.1.4.2, 4.1.4.3]

Action 13: Support the implementation of the Drought Management Strategy including by implementing the drought adaptation guidelines. [SP Activity 4.2.2.3]

Action 14: Identify and evaluate adaptation strategies for the changing hydrological conditions for the sustainable management and development of the LMB under the Joint Study phase 2 with MLC Water, in line with strategic assessments under proactive regional planning. [SP Activity 5.2.3.1]

Action 15: Conduct Phase II of the regional study to assess the conditions and trends in riverine, estuarine and coastal habitats, salinity intrusion, flood and drought extent and severity, and ecologically significant assets by ground-truthing activities with Member Countries' involvement. [SP Activity 4.1.5.1]

Recommendation 9: Building on the MRC-MLC Water Joint Study, periodically undertake a comprehensive scientific assessment of the impact of climate change on any long-term trends in floods and droughts in the Basin, and any change in damages as a result. Ensure that the methodology can be used to monitor change and impacts over time, including to account for variability between representative locations across the Basin with appropriate ground-truthing of global datasets. [BDS Output 4.2.2]

Recommendation 10: Continue to enhance data sharing, monitoring and forecasting capabilities for floods and droughts at multiple scales (from the regional to the community level), and strengthen the links and ongoing cooperation with national monitoring, forecasting and early warning systems. [BDS Output 4.1.4]

Recommendation 11: Implement agreed flood and drought solutions (including nature-based solutions and coordinated infrastructure operations) identified in regional proactive planning to enable resilience to potential future climatic conditions, and cooperate on progressing large-scale regional projects that contribute to climate change resilience with the support of a regional Mekong Fund and other funding sources. [BDS Outputs 4.2.2 and 5.2.3]

Recommendation 12: Implement remaining periodic regional studies from the Data Acquisition and Generation Action Plan (DAGAP), particularly: (i) a drought risk assessment of water security (in all relevant dimensions); (ii) a multi-media contaminants assessment; and (iii) a review of threatened water-dependent species [BDS Output 4.1.5]

Cooperation Dimension		
	Action 16: Implement and enhance partnerships between the MRC and Dialogue Partners (China and Myanmar) as well as the Mekong-Lancang cooperation on water, including year-round data sharing on river flows and dam operations through updated agreement and the Information-Sharing Platform. [SP Activity 5.2.3.2] **Action 17:** Implement the MRC organization development plan following the recommendations of the Mid-Term Review. [SP Activity 5.2.1.1] **Action 18:** Implement and enhance partnerships towards BDS Strategic Priorities between the MRC and all other relevant partners, including Development Partners, Association of Southeast Asian Nations (ASEAN) and other Mekong regional cooperation frameworks, relevant international organizations, river basin organizations, research institutes and universities, non-governmental organizations and the private sector. [SP Activity 5.2.3.3] **Action 19:** Facilitate the consideration of proposed joint investment projects and measures, and national projects of basin-wide significance including through discussions on trade-offs and benefit-sharing, and by comparing benefits and costs of existing national water-related development plans (SP Activity 5.2.2.1). In addition, support the preparation of agreed significant joint investment projects and national projects of basin-wide significance. [SP Activity 5.2.2.2)	**Recommendation 13:** Increase cooperation with MRC Dialogue Partners and Mekong-Lancang Cooperation on Water in order to align efforts and work towards common objectives throughout the Mekong River Basin through, *inter alia*, operational data sharing, joint studies and surveys, joint expert groups and information-sharing platforms, coordinated operation of water-related infrastructures, and joint development of basin-wide flood and drought management strategy for the Mekong-Lancang River Basin with infrastructure and non-infrastructure measures, with a particular focus on transboundary cooperation needs. [BDS Output 5.2.3] **Recommendation 14:** Prioritize partnership activities through, *inter alia*, improved approaches to measure and evaluate the benefits of cooperation so that effort can be targeted where it is most effective and achieve tangible benefits for riparian countries. [BDS Outputs 5.2.1 and 4.1.5] **Recommendation 15:** Develop and trial benefit-sharing models to facilitate joint investments between countries in order to, *inter alia*, share the benefits derived from wetlands and their ecosystem services.. [BDS Output 5.2.2] **Recommendation 16:** Implement and further raise funds for the Mekong Fund for all agreed purposes and windows.

Note: * MRC Member Countries with the facilitation and support of the MRC Secretariat.

Other stakeholders* in partnership with the MRC and/or basin countries to support the achievement of BDS 2021–2030 Outcomes	
Environment Dimension	**Recommendation 17:** Partners, International financial institutions and private sector investors should promote increased investment in renewable energy and supporting grid infrastructure in basin countries based on optimizing water-energy solutions that take sustainable development objectives for aquatic ecosystems into account and help them meet the commitments in their Nationally Determined Contributions. [BDS Output 3.1.1] **Recommendation 18:** Partners must provide further technical and financial support, and work with basin countries to protect and restore key environmental assets at regional and national levels through ongoing capacity building, systems and tools, as well as policy development and implementation assistance. [BDS Output 1.3.1]
Social Dimension	**Recommendation 19:** Partners should provide technical and financial support to national governments to enhance data collection mechanisms that enable disaggregated and spatially explicit data on gender and other aspects of vulnerability to be identified, filling gaps identified in the MRC's review of gender and vulnerability data. [BDS Output 2.1.4] **Recommendation 20:** Partners, international financial institutions, private sector investors and civil society organizations should identify, trial and promote alternative livelihood strategies that are sustainable and resilient to climate change for people affected by changes in river and other aquatic environments. [BDS Output 2.2.1]
Economic Dimension	**Recommendation 21:** Partners should contribute technical and financial support to develop joint projects between two or more countries in key transboundary locations, including the Mekong Delta, 3S sub-basin, transboundary Tonle Sap tributaries, and other border areas between countries. [BDS Outputs 3.1.1, 4.2.2, 5.2.3] **Recommendation 22:** International financial institutions and private sector investors should evaluate projects and measures identified through proactive regional planning and the MRC-MLC Water Joint Study for inclusion in regional and national investment plans, and project investment pipelines. [BDS Output 5.2.2] **Recommendation 23:** Financial institutions, lenders, private sector investors, developers and operators should integrate and apply MRC procedures, guidelines and data in the planning, design, monitoring and operation of water-related projects of transboundary significance.
Climate Change Dimension	**Recommendation 24:** Project developers and operators, and MRC Dialogue Partners should continue to enhance data cooperation and sharing and other parties including to support and supplement the MRC's Core River Monitoring Network. [BDS Output 4.1.2] **Recommendation 25:** Partners should continue to enhance systems and tools for monitoring, forecasting and early warning capabilities for floods and droughts at the national level, and to enhance mechanisms for data and information sharing and dissemination from the regional to the community levels, including by strengthening the links with upgraded MRC/regional monitoring and forecasting systems. [BDS Output 4.1.4] **Recommendation 26:** Partners should identify and support countries in mangrove protection and restoration (and other nature-based climate change solutions) as a cost-effective measure to buffer against rising sea levels and storm surge risks at the delta coast with co-benefits for fisheries and biodiversity. [BDS Output 4.2.2] **Recommendation 27:** Partners, international financial institutions and private sector investors should enhance the identification of and support to concrete climate change adaptation investment projects and measures at the national and local levels that change conditions on the ground by putting the MRC/regional and national policies and strategies into action. [BDS Output 4.2.2]
Cooperation Dimension	**Recommendation 28:** Partners should support the uptake and mainstreaming of MRC strategies, procedures, plans and guidelines in their regional and bilateral development cooperation programmes in countries. **Recommendation 29:** MRC Dialogue Partners, academic institutes, non-governmental organizations and civil society organizations should identify opportunities for collaboration and contribute to joint studies, publications and partnership approaches with the MRC and other water-related platforms. [BDS Output 5.2.3] **Recommendation 30:** International financial institutions and accredited entities should work with the basin countries, the MRC and other parties to progress opportunities through global and regional environment and climate change funds in support of transboundary and joint investment projects between two or more countries. [BDS Outputs 4.2.2 and 5.2.3] **Recommendation 31:** Partners, international financial institutions and private sector investors should consider opportunities to help capitalize on, or work in partnership through, coordinated investment with the Mekong Fund. [BDS Output 5.2.3]

Note: *These include Development Partners, Dialogue Partners, other water-related platforms, project developers and operators, lenders, non-governmental organizations, and public and private investors.

In addition to these recommendations to refine the implementation of the BDS 2021–2030 over the remainder of the BDS period, recommendations have also been made in Chapter Eight for improving future State of the Basin Reports (SOBRs).

CHAPTER 1
INTRODUCTION

CHAPTER 1: INTRODUCTION

1.1. Purpose and scope

The Mekong State of the Basin Report (SOBR) aims to provide an overall picture of the state of the Mekong River Basin in terms of its ecological health, the social and economic circumstances of its people, the changing climate, and the degree to which cooperation between basin countries is enhancing these conditions as envisaged under the 1995 Mekong Agreement.

The SOBR forms an integral part of the basin planning cycle, being the first step in a quinquennial process of adaptive management to review and refine the implementation of the 10-year Basin Development Strategy (BDS) (Figure 1.1).

The SOBR reflects on the aims and commitments of the *1995 Mekong Agreement* in presenting an evaluation of the status of conditions and trends relevant to water resources management and development. In doing so, it describes progress towards achieving the BDS Outcomes and identifies issues for basin countries and water-related stakeholders to consider as they update their respective strategies and plans, and refine implementation approaches at regional and national levels. This adaptive management approach aims to increase the likelihood that the BDS Outcomes will be met, and ultimately that the Mekong River Basin vision will be realized.

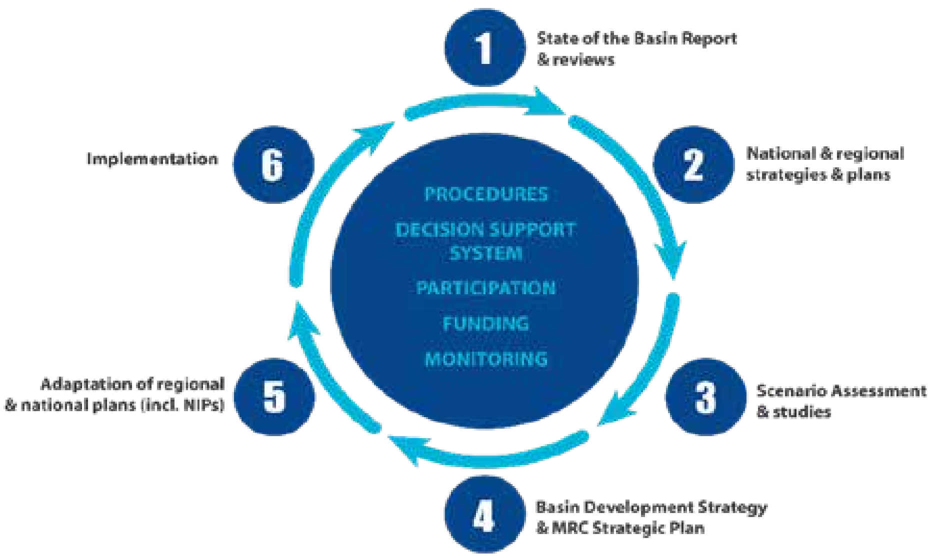


Figure 1.1. The Mekong River Basin strategic planning cycle

Addressing issues identified in the SOBR is a responsibility of all basin actors involved in Mekong water-related issues. While the Mekong River Commission (MRC) plays a critical role by providing leadership and facilitating dialogue between its Member Countries, with its Dialogue Partners, and in partnership with Development Partners, it is only through the coordinated action of all relevant parties that the BDS Outcomes can be achieved. Coordinated action at the regional level occurs through several water-related cooperation platforms, as described in the BDS 2021–2030 and in Section 2.1.2 of this SOBR. Regional cooperation is essential to ensuring that transboundary water-related issues and concerns are identified, investigated, mitigated and/or managed, that the benefits of development are maximized, and that costs are minimized.

Regional cooperation platforms provide a mechanism for dialogue through which technical investigations and water diplomacy can be applied to identify solutions to common challenges. Ultimately, however, it is through the national policies and management decisions of basin countries, and through political and administrative decisions by governments and national agencies working in partnership with others, such as local and foreign investors, where the results of regional cooperation come to affect the lives and livelihoods of basin communities. The key messages of the SOBR are therefore aimed at a broad audience of actors working at all levels and on all Mekong water-related issues.

The issues identified and guidance provided in the SOBR should be pursued both through regional cooperation between countries and by actors working at the national level where transboundary impacts and concerns may result from the implementation of policies, programmes and projects related to water resources management and development. As such, the SOBR is a technical report that can be used for a range of purposes, for example:

- to record and evaluate the positive and negative development impacts within the Mekong River Basin as a measure of the effectiveness of the implementation of the BDS and the cooperation aimed at sustainable development envisaged by the 1995 Mekong Agreement;
- to highlight the sustainable development opportunities and issues arising from such development, which need to be addressed in updates to the BDS, or through the review and refinement of the strategic plans and activities of actors working on Mekong water-related issues;
- to provide decision makers with concise information on the issues they consider relevant to progressing opportunities for cooperation that will maximize benefits and minimize costs; and
- to provide information to stakeholders on progress towards the Mekong River Basin Vision of *an economically prosperous, socially just, environmentally sound and climate resilient Mekong River Basin* and the progress within the Basin towards achieving the relevant Sustainable Development Goals (SDGs).

This 2023 edition of the SOBR continues the approach presented in the 2018 SOBR. The assessment of conditions and trends is based on the hierarchical structure of the Mekong River Basin Indicator Framework (MRB-IF) across five dimensions:

- Environment
- Social
- Economic
- Climate Change
- Cooperation.

As outlined in Section 1.2, these five dimensions inform the structure of the report. Across these five dimensions, the SOBR adopts an evidence-based approach to the assessment of conditions and trends, using quantifiable monitoring parameters to underpin the strategic and assessment indicators of the MRB-IF. As with the 2018 SOBR, this 2023 edition identifies 13 strategic questions to be addressed through the assessment (Table 1.1). The strategic questions have been updated since 2018 to align with the intended Outcomes of the BDS 2021–2030. They are used to consolidate the findings of this report, presented in the *Conclusions and Recommendations* in Chapter Eight.

Just like the 2018 SOBR, this 2023 edition presents information on the status and trends in both the Upper Mekong River Basin (UMB) and the Lower Mekong River Basin (LMB). However, unlike in 2018, both parts of the Basin are now consolidated into a holistic assessment for relevant indicators. Data and information from all six basin countries are presented together within each chapter to the extent that they are available and that it is appropriate to do so. This approach follows the emphasis of the BDS 2021–2030 on more integrated management of the entire Mekong River Basin (Figure 1.2) as being essential to the sustainable development and management of the Mekong's shared waters and related resources.

Table 1.1. The strategic questions in each MRB-IF dimension aligned with the intended Outcomes of the BDS 2021–2030

MRB-IF Dimension	Key strategic questions aligned with the BDS Outcomes 2021–2030
Environment	✓ Is the water flow in the Mekong mainstream adequate for maintaining the ecological function of the Mekong River Basin? ✓ Are the water quality and sediment transport in the Mekong mainstream adequate for maintaining the ecological function of the Mekong River Basin? ✓ Are key environmental assets in the Mekong River Basin adequately protected and conserved to maintain the provision of ecosystem services?
Social	✓ Is the utilization of the Mekong's water and related resources strengthening the water, food and energy security of basin communities? ✓ Are the livelihoods and employment conditions of basin communities helping to increase economic security and reduce poverty among vulnerable people?
Economic	✓ How important are the Basin's water-related sectors to the basin, national and regional economies? ✓ To what extent are water-related sectors contributing to the optimal and sustainable development of the Mekong River Basin?
Climate Change	✓ To what extent are greenhouse gas emissions from the Mekong River Basin contributing to global emissions? ✓ What is the evidence of climate change within the Basin, and has there been a change in the frequency and severity of floods and droughts? ✓ Are basin communities adequately informed and prepared for changing river conditions, and are they adapting to climate risks?
Cooperation	✓ Is the strengthening of the MRC on track according to the commitments made by its Member Countries? ✓ What are the benefits derived from cooperation between basin countries? ✓ Do the basin countries derive equitable benefits from the utilization of the Basin's water and related resources?

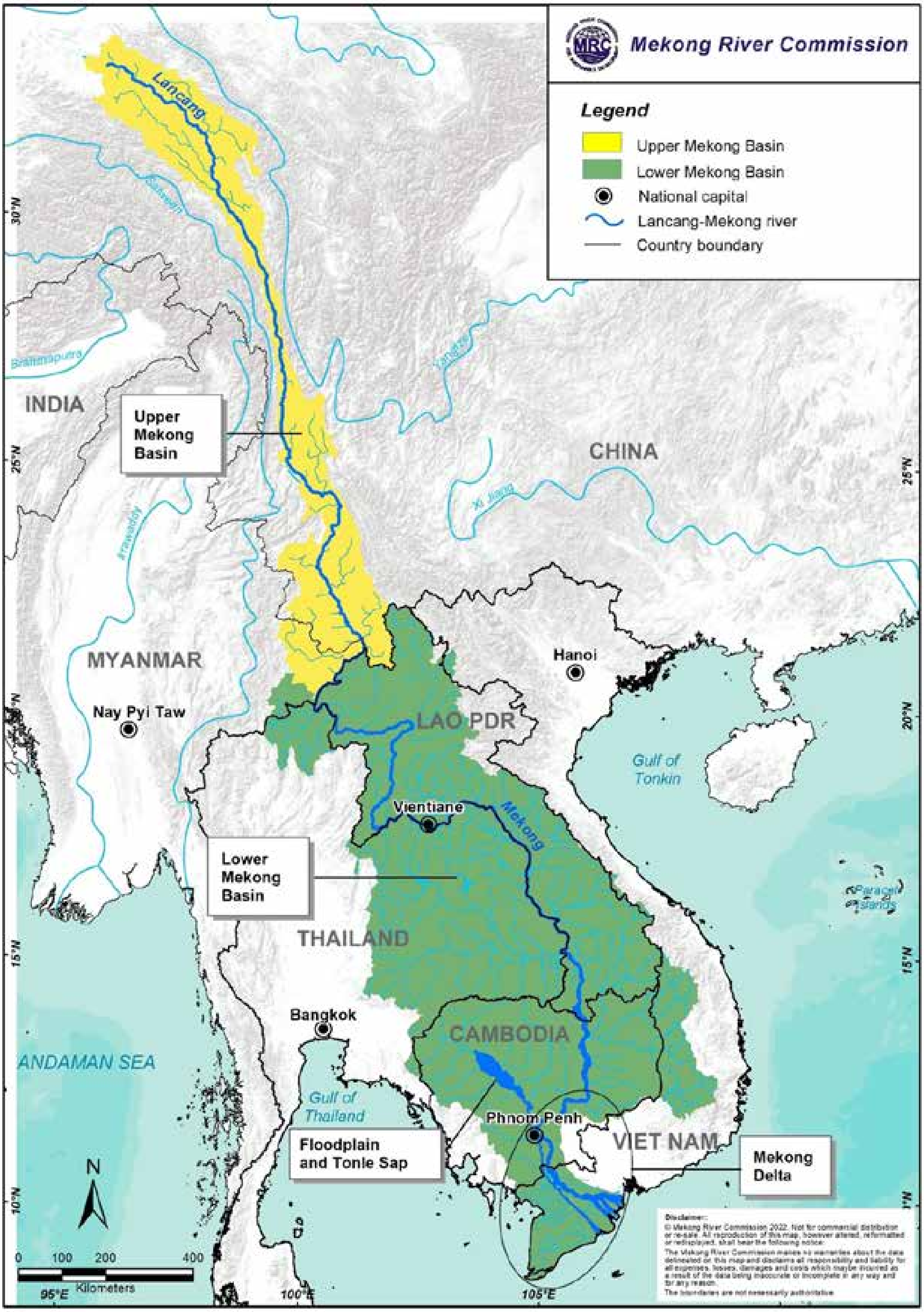


Figure 1.2. The Mekong River Basin

Note: This map shows t he Upper and Lower Mekong Basins, major tributaries, basin countries, national capitals, administrative boundaries and some key physiographic features.

1.2. Structure

The SOBR 2023 is structured according to the MRB-IF and largely follows the structure of previous reports.

Chapter 1	Chapter One provides an introduction, which discusses the purpose and scope of the report and provides an overview of the approach and methodology employed in evaluating conditions and trends across the Basin. It introduces the MRB-IF, the approach to evaluating progress towards achieving the BDS 2021–2030 Outcomes, and how the contribution to relevant water-related Sustainable Development Goals (SDGs) is considered. The overall assessment approach and methodology are described in more detail within each assessment chapter as they relate to each dimension of the MRB-IF.
Chapter 2	Chapter Two describes the setting and context underlying the assessment of conditions and trends in each dimension. Its purpose is to support an understanding of the relevance and meaning of the assessment within the particular physiographic, socio-economic and institutional setting of the Mekong River Basin. The setting and context do not change dramatically from one five-year assessment report to another, and mostly represent baseline factors that influence and affect water resources management and development within the Basin but that are only indirectly affected by changes in the conditions of water and related resources.
Chapter 3-7	Chapters Three to Seven correspond to the five dimensions of the MRB-IF (Environment, Social, Economic, Climate Change and Cooperation), with one chapter for each dimension providing the status and trends of selected water-related indicators and monitoring parameters. Sections and sub-sections correspond to the strategic and assessment indicators of the MRB-IF, respectively, with an introductory section to explain the specific approach and methodology employed for the dimension, and a conclusions section that describes the progress towards the relevant BDS 2021–2030 Outcomes that align with that dimension. Contributions to each BDS outcome are reflected in multiple strategic and assessment indicators across the five dimensions of the MRB-IF since there is rarely a one-to-one alignment.
Chapter 8	Chapter Eight draws together conclusions on the state of the Basin based on the assessments of each MRB-IF dimension in Chapters Three to Seven, reflects on the impact that they have on the SDGs, and makes recommendations for consideration in further implementation of the BDS for the remainder of the 2021–2030 period. The recommendations provided are necessarily high-level to enable further consideration by basin countries, Development Partners, relevant water-related regional cooperation platforms and other stakeholders throughout the Mekong River Basin on how they can best respond through the updating and implementation of their own strategies and plans over the coming years, including for Member Countries through the MRC Strategic Plan 2026–2030.

1.3. Approach and methodology

1.3.1. The Mekong River Basin Indicator Framework

The MRB-IF (MRC, 2019a) provides a unified and integrated approach to assessing how well the MRC and its Member Countries are progressing towards the aims of the 1995 Mekong Agreement, as part of the 10-year basin planning cycle. The Framework seeks to reflect Member Countries' commitments under the Preamble of the 1995 Mekong Agreement:

to cooperate and promote in a constructive and mutually beneficial manner in the sustainable development, utilization, conservation and management of the Mekong River Basin water and related resources for navigational and non-navigational purposes, for social and economic development and the well-being of all riparian States, consistent with the needs to protect, preserve, enhance and manage the environmental and aquatic conditions and maintenance of the ecological balance exceptional to this river basin.

The MRB-IF is hierarchical (Figure 1.3) and consists of: (i) 15 strategic indicators, selected to inform high-level decision-makers and stakeholders on key issues related to the development, utilization, conservation and management of the Mekong River Basin; (ii) 53 assessment indicators, intended to provide the basis for evaluating the strategic indicators, and to provide planners with the capacity to assess alternative development scenarios; and (iii) 185 monitoring parameters, intended to provide the basis for relevant and quality assured data sets from which assessment and strategic indicators can be evaluated, and support regional studies and assessments.

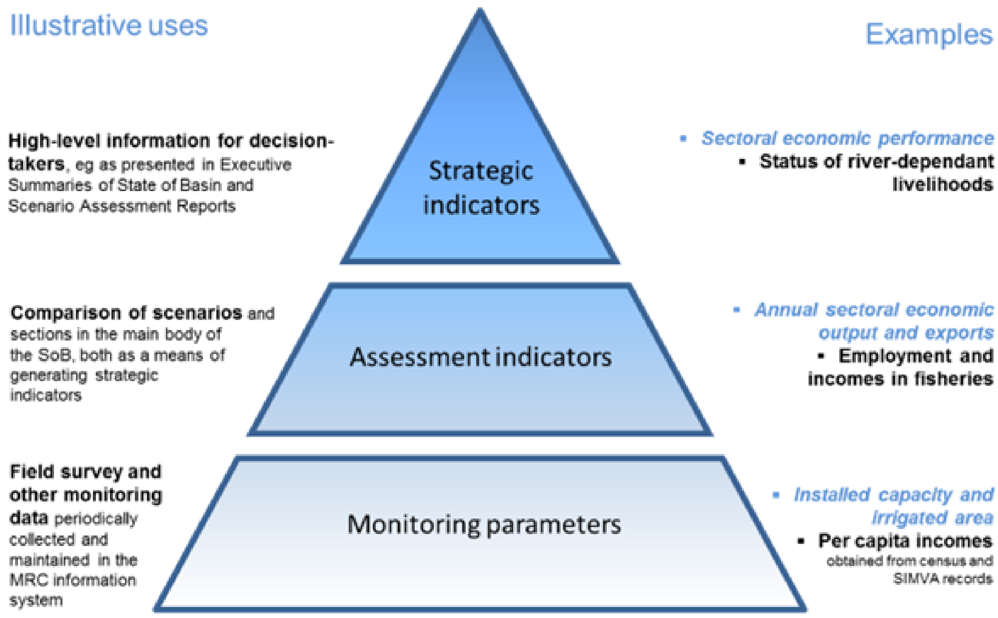


Figure 1.3. Three levels of the Mekong River Basin Indicator Framework

The MRB-IF is intended to support basin development and management over the long term. The use of a consistent indicator framework for each SOBR supports the evaluation of long-term trends in basin conditions. These evaluations facilitate the identification of key opportunities and challenges that are explored through scenario assessments and that the BDS seeks to address.

The MRB-IF was largely designed to draw on datasets already available or understood to be reasonably accessible or generated from routine MRC monitoring, periodic regional studies and assessments, national monitoring and survey efforts, or from supplementary international and regional datasets considered acceptable to MRC Member Countries. However, in some cases, data gaps remain, and it is evident after multiple editions of the SOBR that suitable data sources for these indicators or monitoring parameters may not exist or be readily accessible to the MRC. As a result, some recommendations at the conclusion of this report include options to refine the MRB-IF for future SOBRs while maintaining its core capacity to support the evaluation of long-term trends.

1.3.2. Assessment approach and methodology

The SOBR assessment approach and methodology are informed by the completeness of the data available to undertake the assessment. Data and information for the SOBR were collected in line with the MRC Data Acquisition and Generation Action Plan (DAGAP) (MRC, 2021a) and draw on the following sources:

- MRC routine river monitoring activities (i.e. hydrology, sediment, water quality, ecological health and fisheries);
- periodic regional studies undertaken by the MRC by the Mekong River Commission Secretariat (MRCS) and Member Countries;
- national monitoring and survey data collected by national agencies in the ordinary course of business (e.g. national census; wellbeing surveys) and transmitted to the MRCS according to work agreements signed between the MRCS and Member Countries; and
- international and regional organizations such as the World Bank, Asian Development Bank (ADB) and United Nations agencies.

For the Upper Mekong River Basin (UMB), data and information were collected from publicly available sources such as national statistics office websites, relevant scientific literature and reports, and some whole-of-basin spatial analysis using international and regional datasets. As much as possible, this was performed in alignment with the MRB-IF, although the data available are clearly more limited than for the Lower Mekong River Basin (LMB). This is consistent with the approach taken in the 2018 SOBR, although, as noted above, these additional data and information no longer appear in a separate chapter.

The assessment approach is informed by the MRB-IF Technical Guidelines (MRC, 2021b) and involves providing a rating for each strategic and assessment indicator according to the Figure 1.4.

Assessment Indicators

Very Good	Good	Of Concern	Requires Action	Requires Urgent Action
Substantial improvement in conditions for most monitoring parameters and/or agreed thresholds always met	Improved conditions for most monitoring parameters and/or agreed thresholds mostly met, and with conditions otherwise generally stable	Decline in conditions for one or more monitoring parameters and/or with conditions sometimes unstable	Decline in conditions for one or more monitoring parameters and/or agreed thresholds sometimes not met, with conditions often unstable	Substantial decline in conditions for most monitoring parameters and/or agreed thresholds frequently not met

Implications for achieving BDS 2021–2030 Outcomes

Strategic Indicators

No immediate concerns	Some concerns to address	Significant concerns to address
If all assessment indicators corresponding to the strategic indicator are rated as at least 'Good'	All Strategic indicators not otherwise rated as 'No immediate concerns' or 'Significant concerns to address'	If any assessment indicators corresponding to the strategic indicator are rated as 'Requires Urgent Action' or all assessment indicators are rated as 'Requires Action'

Trends

↗ = Improvement in conditions	↔ = Some improvement and some decline in conditions or uncertain	↘ = Decline in conditions

Figure 1.4. Assessment framework for ratings and trends applied to Strategic and Assessment Indicators of the MRB-IF

The ratings presented here are essentially a communications device to draw the attention of the reader to particular issues that may warrant further investigation and/or analysis, and to encourage conversation among relevant water-related stakeholders on the need to respond or not to potential issues of basin-wide significance, and if so, in what way. The ratings for the assessment indicators are provided mainly for a more technical audience targeted at particularly disciplinary expertise. The ratings for the strategic indicators are provided mainly for consideration in policy, strategic planning and decision-making, hence, the alignment of the strategic indicator scale to the BDS 2021–2030 monitoring system.

The MRB-IF Technical Guidelines are not prescriptive with regard to the methodology and how the rating is determined for each indicator; rather, they are intended to be implemented flexibly, as necessary given the data limitations and objectives of the relevant study. Where data requirements are not currently available, the methodology is only partially implemented based on the remaining data available for the relevant indicator. In implementing this approach, it is important to note the following points:

- Where possible, the spatial unit for assessment is the basin scale, with conditions and trends identified within each country's part of the Basin rather than at the whole-country level. Where subnational data were not available, national-level data were used, but in appropriate cases, combined with other spatially explicit datasets to generate an estimate of the relevant value for the Basin. This is especially the case for China, Myanmar, Thailand and Viet Nam, where national conditions and trends may not accurately reflect the conditions and trends in the relatively smaller portion of each country that occurs within the boundaries of the Mekong River Basin.
- In the Social and Economic Dimensions, national- and provincial-level data were adjusted (where indicated), based on the estimated proportion of the total population or total area within the boundaries of the Basin (see Annex A). This provides an improved estimate of conditions within the Basin with respect to what has been made in earlier SOBRs. Where average basin conditions for particular indicators are provided, they were weighted relative to provincial population within the Basin in order not to give undue weight to provinces with small populations.
- Methods to enable a degree of consistency between countries with data at different spatial and temporal scales are outlined in the DAGAP and include interpolation between time periods to allow comparison for the same years.
- The water-related sectors referred to throughout this report are: (i) agriculture (especially irrigated agriculture); (ii) fisheries (including aquaculture); (iii) forestry; (iv) navigation; (v) hydropower; (vi) sand mining; and (vii) tourism.
- The economic value calculated for indicators in the Economic Dimension is, for the most part, the gross economic value. Calculation of net economic value requires data on input prices and volumes, in addition to output prices and volumes, and these data have generally not been available.
- Where relevant, the assessment thresholds used in assigning a rating to each indicator are those that have already been agreed by MRC Member Countries, for example, with regard to the PMFM or the PWQ. Where thresholds have not yet been agreed by the MRC Member Countries, an objective judgment has been made by the MRCS by considering the relative number of monitoring parameters for each indicator showing positive or negative conditions, and the magnitude and direction of the trend over recent years, either positive or negative.
- All matters of importance as identified in the strategic indicators, the assessment indicators and the monitoring parameters have by default been weighted equally.

As noted above, each of the chapters from 3 to 7 cover a single dimension of the MRB-IF and is structured in a consistent manner, demonstrating the approach and methodology used in compiling the report on that dimension. Each chapter includes the following:

- **Introduction to the dimension** – This describes the relevance of the dimension to the 1995 Mekong Agreement and sets out the assessment framework within that dimension.
- **Each strategic indicator** – For each strategic indicator, a brief description is provided of how that strategic indicator is evaluated based on the findings for each related assessment indicator. The section then discusses in detail the evaluation of each assessment indicator and concludes with an evaluation and rating of the strategic indicator, including commentary on differences between countries or other geographic areas, where appropriate.
- **Each assessment indicator** – For each assessment indicator within each strategic indicator above, the sub-section starts with a description of the methodology used for the evaluation of each assessment indicator, then reports on the status of select monitoring parameter, and finally, sets out the evaluation and rating of each assessment indicator based on the conditions and trends in the monitoring parameters.
- **Progress towards BDS Outcomes** – In each chapter, an assessment is made of the overall conditions within the Basin by referencing the assessment of each strategic indicator within the dimension and what it reflects about progress towards the BDS 2021–2030 Outcomes, as described in Section 1.3.3. Where indicators suggest that conditions should be highlighted, these indicators are set out with commentary tracing the likely cause of these conditions back through assessment indicators to the monitoring parameters.

1.3.3. Evaluating progress towards the Basin Development Strategy 2021–2030 Outcomes

The SOBR 2023 evaluates and reports on progress towards the 11 Outcomes of the BDS 2021–2030 through basin impact monitoring against the 15 strategic indicators and 53 assessment indicators of the MRB-IF. Given the early stage of implementation, it is unlikely the BDS 2021–2030 has had any material effect on conditions and trends in key indicators across the Basin to date. Much of the data collected for the SOBR are only available up to 2020 or even earlier, prior to the agreed on BDS 2021–2030. As a result, the focus of the assessment in this 2023 SOBR is on the current conditions and trends in key strategic indicators as aligned with the BDS 2021–2030 Outcomes, and the extent to which the outcomes have been achieved, considering data and information that were not available at the time that the BDS 2021–2030 was prepared (Table 1.2). Generally, this indicates that data and information are not available for the 2018 SOBR.

Table 1.2. Indicators and descriptive guidance for evaluating progress towards BDS Outcomes in each dimension of the MRB-IF

Indicator of progress towards achieving BDS Outcomes	Descriptive evaluation guidance
↑	On track. The gap in achieving the 2030 Outcome is decreasing based on recent conditions and trends over the last few years. The effort required to close the gap towards achieving the outcome is becoming less challenging.
↗	Moderate improvement. The gap is closing, but likely there is insufficient progress to attain the BDS Outcome. Challenges remain to achieve the outcome.
→	No or only slight improvement. Progress is well short of requirements to achieve the BDS outcome and significant challenges remain.
↓	The gap in achieving the 2030 Outcome is increasing based on recent conditions and trends over the last few years. The effort required to close it is becoming more challenging.
●●●	Insufficient information on progress. There is no reliable indication that the effort required to close the gap towards achieving the outcome is becoming more or less challenging due to, *inter alia*, a lack of updated data appropriately reflecting the outcome.

The alignment of strategic and assessment indicators with BDS 2021–2030 Outcomes is not always a one-to-one relationship. In many cases, the indicators provide relevant information to evaluate progress towards more than one BDS Outcome (Table 1.3). Where this is the case, commentary cross-referencing the results of evaluation against assessment indicators in other dimensions or for other strategic indicators is provided.

Table 1.3. Alignment of MRB-IF strategic and assessment indicators in each dimension with the BDS Outcomes 2021–2030

	BDS Outcomes 2021–2030	MRB-IF strategic indicators	MRB-IF assessment indicators
ENVIRONMENT DIMENSION	1.1 Adequate water flow and quality for a healthy environment and productive communities	S1. Water flow conditions	A1. Compliance of dry season flows with the PMFM
			A2. Compliance of flood season peak flows with the PMFM
			A3. Compliance of Tonle Sap reverse flows with the PMFM
			A4. Change in the timing of onset of flood season flows
		S2. Water quality and sediment conditions	A5. Ecological health, and compliance of water quality with the PWQ
			A6. Extent of salinity intrusion in the delta
			A7. Changes in sediment transport
			A8. Condition of riverine, estuarine and coastal habitats
	1.3 *Ecosystem services from wetlands and watersheds ensured*	S3. Status of environmental assets	A9. Extent of wetland area
			A10. Condition and status of fisheries and other aquatic habitats
			A11. Condition and status of ecologically significant areas
	-	S4. Overall environmental conditions	

	BDS Outcomes 2021–2030	MRB-IF strategic indicators	MRB-IF assessment indicators
SOCIAL DIMENSION	2.1 Strengthened water, food and energy security for basin community well-being	S5. Living conditions and well-being	A12. Water security
			A13. Food security
			A14. Water-related health security
			A15. Access to electricity
			A16. Gender equality in employment and economic engagement
	2.2 Increased employment and reduced poverty among vulnerable people dependent on river and wetland resources	S6. Livelihoods and employment in water-related sectors	A17. Employment in water-related sectors
			A18. Economic security
			A8. Condition of riverine, estuarine and coastal habitats
	-	S7. Overall social conditions	

	BDS Outcomes 2021–2030	MRB-IF strategic indicators	MRB-IF assessment indicators
ECONOMIC DIMENSION	3.1 Increased economic growth of all basin countries from more proactive regional planning	S8. Contribution to the basin economy	A31. Contribution of water-related sectors to basin, national and regional GDP
			A32. Contribution to food grain supply
			A33. Contribution to protein supply
			A34. Contribution to power supply
		S9. Economic performance of water-related sectors	A22. Economic value of sand mining
			A25. Economic value of aquaculture
			A26. Economic value of forestry
			A27. Economic value of tourism and recreation
	3.2 Enhanced inclusive growth and sustainability in irrigated agriculture, hydropower, navigation, the environment and fisheries sectors		A19. Economic value of agriculture
			A20. Economic value of hydropower
			A21. Economic value of navigation
			A23. Economic value of wetlands
			A24. Economic value of capture fisheries

BDS Outcomes 2021–2030		MRB-IF strategic indicators	MRB-IF assessment indicators
CLIMATE CHANGE DIMENSION	4.1 Better informed and prepared basin communities against changing river conditions, and more frequent and severe floods and droughts	S10. Greenhouse gas emissions	A35. Greenhouse gas emissions from water-related sectors
			A36. Relative contribution to global emissions
		S11. Climate change trends and extremes	A37. Changes in tropical storm frequency and intensity, and storm surge risk
			A38. Changes in temperature
			A39. Changes in precipitation
			A40. Extent and severity of flooding
			A41. Extent and severity of drought
		S12. Adaptation to climate change	A42. Institutional response to the effects of climate change
	4.2 Better disaster management and adaptation to water resources development and climate risks		A43. Flood protection measures
			A44. Drought protection measures
			A45. Vulnerability to floods, droughts and storms

	BDS Outcomes 2021–2030	MRB-IF strategic indicators	MRB-IF assessment indicators
COOPERATION DIMENSION	5.1 Strengthened Mekong River Commission for more effective implementation of the Mekong Agreement	S13. Self-finance of the MRC	A46. Proportion of MRC budget funded by national contributions during the current period
		S14. Benefits derived from cooperation	A47. Joint efforts on projects of basin-wide significance that have potential transboundary impacts
			A48. Extent of knowledge-sharing activities
	5.2 Increased joint efforts and partnerships for more integrated management of the entire river basin		A49. Partnerships between the MRC and other parties
			A50. Proportion of benefits derived from cooperation to total net economic value of all water-related sectors
		S15. Equity of benefits from the Mekong River system	A51. Overall environment benefits derived in each country's part of the Basin
			A52. Overall social benefits derived in each country's part of the Basin
			A53. Aggregate economic benefits derived from each water-related sector in each country's part of the Basin
			A43. Flood protection measures
			A44. Drought protection measures
			A45. Vulnerability to floods, droughts and storms

1.4. Contribution to the Sustainable Development Goals

The strategic priorities and the outcomes of the BDS 2021–2030 are aligned with relevant water-related SDGs to which all basin countries have committed to achieving. Although SDG 6, *'Clean Water and Sanitation*, has the strongest connection to the BDS Outcomes, 12 of the 17 SDGs are identified in the BDS results chain as being related to some extent to transboundary water resources management and development in the Mekong River Basin (Figure 1.5). Each of the SDGs and targets has a set of indicators determined by the United Nations by which to measure progress. These indicators are focused mainly on reporting at the national and global levels but can also apply at other scales, including regional levels, provided that sufficient and appropriate data are available at that scale. Not all of the targets and indicators for each goal are relevant to water resources management and development in the Mekong River Basin, and even where relevant, it is not always possible to source data or disaggregate existing national data at the basin scale.

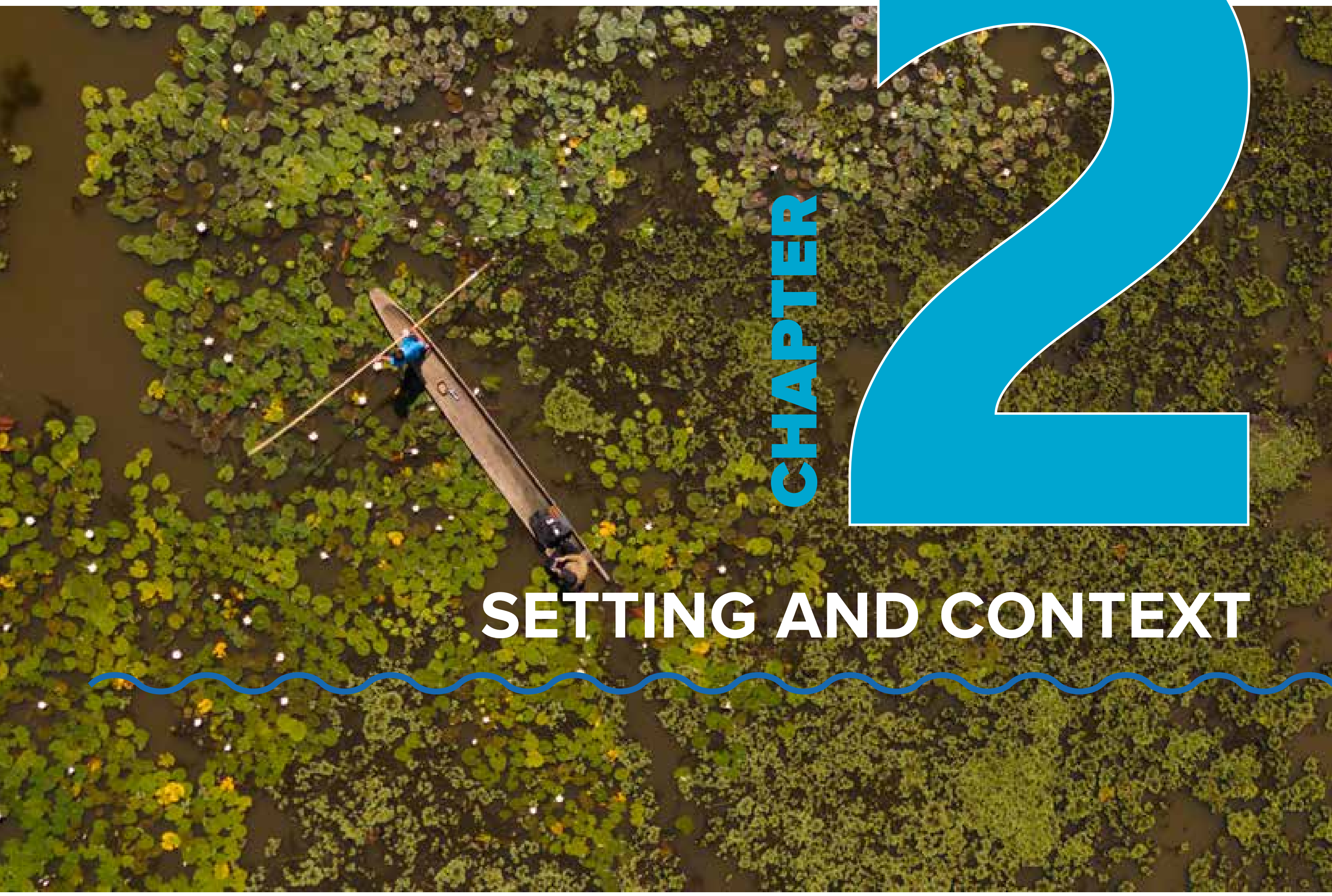
To evaluate progress within the Mekong River Basin towards to the SDGs, a subset of indicators has been selected from the SDG Indicator Framework (updated by the United Nations General Assembly in 2023) that align with those from the MRB-IF and for which sufficient data are available. The select number of SDG indicators in each dimension inform the summary of the contribution to the SDGs provided in Chapter Eight, together with a more general narrative evaluation and commentary based on related indicators from the MRB-IF for the relevant SDG and targets. The number of SDG targets and indicators reported in this SOBR has been narrowed down since the 2018 SOBR in order to reflect the strongest connections to the BDS 2021–2030 Outcomes, as indicated in Figure 1.4.

Figure 1.5. Overview of the Basin Development Plan results chain linking the achievement of the BDS Outcomes to the relevant Sustainable Development Goals

Source: MRC (2020a)

CHAPTER 2

SETTING AND CONTEXT



CHAPTER 2: SETTING AND CONTEXT

2.1. Overview of the Mekong River Basin

2.1.1. Development setting

The Mekong River rises in the Himalayas at an elevation of about 5,000 m. It is the world's 12th longest river, flowing for almost 4,800 km through China, where it is known as the Lancang River, and then around 2,500 km further through Myanmar, Lao PDR, Thailand and Cambodia, and into the sea from Viet Nam. The Mekong has the world's 8th largest flow, with a long-term mean annual discharge of approximately 446 km^3 per year. The Mekong River Basin is the world's 21st largest by area, draining 810,000 km^2.

The hydrology of the Basin is characterized by very high inter-annual variability, with discharge over the wet season on average 5–10 times greater than over the dry season. Snowmelt off the Tibetan Plateau in summer dominates dry season discharge north of Vientiane. Between June and October, the Southwest Monsoon delivers a discharge pulse from the Mekong tributaries when the monsoonal winds meet the Annamite range along Lao PDR, Cambodia and Viet Nam. Together with tropical storms moving in from the sea, this can contribute to extensive flooding in parts of Thailand and Lao PDR, and especially in the Mekong Delta in Cambodia and Viet Nam. These wet season peak flows also cause the large flow reversal up the Tonle Sap River to the Great Lake in Cambodia, triggering fish movement and delivering a pulse of sediment and nutrients to the floodplain, which supports fish and other biodiversity, and enables recession rice agriculture around the lake and downstream to the delta.

The annual cycle of flooding is the basis of water resources productivity within the Basin, benefiting the local inhabitants for centuries through abundant fisheries and fertile floodplains. The magnitude of the annual flood has led to the concept of 'living with floods', which recognizes the valuable role that flooding plays in the economy and society of the region, and the need to work in harmony with this cycle while seeking to mitigate the destructive nature of the most extreme events.

The Mekong River supports the livelihoods of millions of people, both within the Basin and beyond. Riparian countries are harnessing the Mekong's water resources principally for domestic consumption and for food and energy production, and the pace of development has gathered momentum over recent decades. Irrigation and hydropower have been the two major users of Mekong water resources to date (Figure 2.1).

As described in the BDS 2021–2030, Viet Nam first invested in navigation and improved drainage in the fertile Mekong Delta, and by the 1960s began to construct intensive canal systems, pumps and other means of irrigating the floodplain. Its approach to agricultural development has been extraordinarily successful because the delta is currently supporting three rice crops per year. The last 20 years or so have also seen substantial development of aquaculture in the Mekong Delta and the construction of 14 hydropower dams on tributaries in the Central Highlands.

Thailand has long focused on improving water security in its north-eastern provinces with the construction of barrages, weirs and irrigation schemes within the Chi-Mun River basin and areas draining to the Mekong. In addition to rice, the paddy fields and connected canals and streams support a productive capture fisheries sector, which helps diversify income for much of the population. Thailand constructed seven hydropower projects on Mekong tributaries from the mid-1960s onwards, although only two had an installed capacity of more than 100 megawatts (MW). The current focus in Thailand is on modernizing and improving the efficiency of much of its water resources infrastructure.

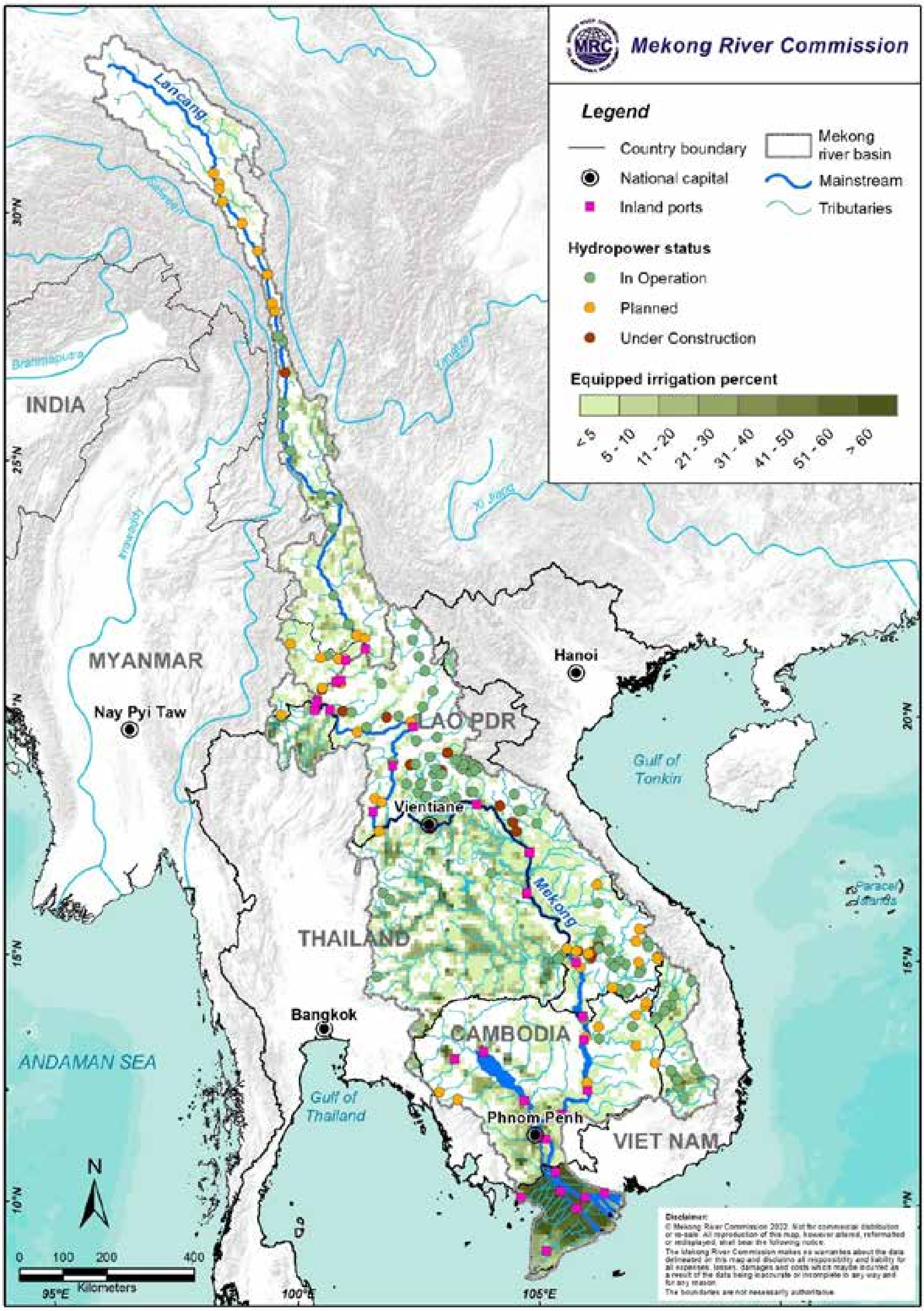


Figure 2.1. The existing and planned hydropower projects and areas of equipped irrigation across the Mekong River Basin

Data source: MRC Information System and FAO irrigation data

Development in Cambodia and Lao PDR was delayed for several decades in the latter part of the 20th century and is only now coming to fruition. Lao PDR has commenced construction of the lower Mekong hydropower cascade, including the recently built Xayaburi and Don Sahong developments and the Luang Prabang hydropower project, which is under construction. These dams are among more than 100 projects either built or planned on the tributaries and mainstream within Lao PDR that aim to help meet national and regional energy demand.

Cambodia is also intensifying the development of its water resources. This includes irrigation development, drainage works, and flood management around Tonle Sap and between Phnom Penh and the border with Viet Nam. Hydropower investments have been investigated on the mainstream and commenced in the tributaries, including the Lower Sesan II, built in the 3S sub-basin. In 2020, the Royal Government of Cambodia announced that no mainstream hydropower development would occur until at least 2030.

China has constructed 12 hydropower dams (of which two are large storage dams) along the mainstream with another 10, each greater than 100 MW, either being constructed or planned. The installed hydropower capacity in China is 22,750 MW, and the total is planned to rise to 31,605 MW. Only a small proportion of China's part of the Mekong River Basin is irrigated due to the narrow, steep- sided gorges that dominate there.

In Myanmar, the Mekong River Basin is relatively undeveloped compared to the other countries. The first dam on its Mekong tributaries was commissioned in 2017 and there are plans for at least six more small storage dams. Less than 1,000 km^2 of Myanmar's basin area is currently irrigated.

These cumulative developments across all basin countries have resulted in current active water storage from hydropower developments amounting to around 22% of the Basin's long-term mean annual runoff (MAR) and 27% of the MAR over the last decade due to the drier conditions that have prevailed (MRC-LMCWRCC, 2023). The volume of water storage across the Basin increased by more than five times in the 2010–2020 decade (Figure 2.2).

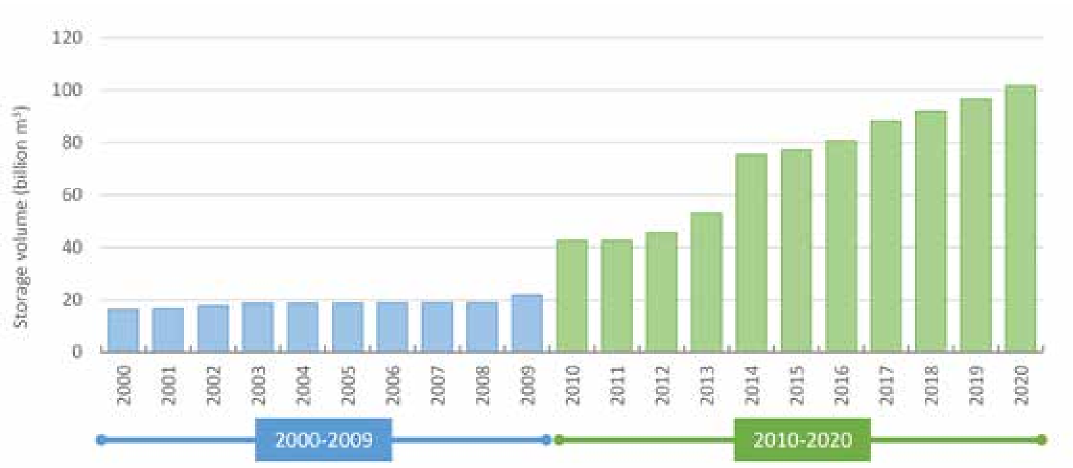


Figure 2.2. Cumulative storage capacity of hydropower on the mainstream and tributaries of the Mekong River Basin, illustrating the significant increase in active water storage since 2010

Source: MRC-LMC Water, 2023

Increased hydropower in the Basin does not consume much water. However, it does contribute to changes in hydrological conditions, in particular, lower flows in the flood season as reservoirs are being filled, and higher flows in the dry season to support year-round electricity generation. This change has significant implications for basin ecosystems and biodiversity. The 2018 SOBR (MRC, 2019b) identified significant reductions in the transport of sediment from the UMB to the LMB, and further instream barriers including in the tributaries are expected to exacerbate this problem (MRC, 2017a). The reduction in sediments may cause increased erosion and riverbank failure, potentially less productive fisheries and floodplains, and reduced replenishment of the delta, which is also affected by land subsidence and sea-level rise. In-stream barriers also significantly reduce fish migration, which has detrimental impacts on spawning and recruitment of fish to subsequent generations. Different fish species and ecosystems will be affected to a greater or lesser extent by the changing flow regime and in-stream barriers depending on their ecological requirements (MRC, 2017a).

In addition to hydropower, irrigation expansion is identified as a priority for some basin countries, and if current plans go ahead this will increase the demand for the Basin's water resources. Irrigation is currently the largest consumptive water user in the Basin, with water withdrawals for irrigation estimated at 56 billion m3 (from total water withdrawals of 62 billion m3), or 12% of the river's mean annual discharge (MRC-LMCWRCC, 2023), not accounting for return flows. While return flows from agriculture can be an important contributor to overall river flows, especially in the dry season, water quality including eutrophication of receiving waters high in nutrients can often be a problem.

As reflected in the BDS 2021–2030, groundwater use has been relatively modest in most parts of the Mekong River Basin. Thailand and Viet Nam both use groundwater to irrigate crops, yet due to the lack of extensive transboundary aquifers outside the Mekong Delta, there is limited need for regional engagement on transboundary issues. Nevertheless, several significant projects including with funding from the Global Environment Facility (GEF) are investigating this issue further, which may lead to future directions for cooperation between relevant basin countries. Groundwater extraction in the Mekong Delta, especially for urban and industrial uses, has been identified as a major contributor to the significant land subsidence problems there.

Data and information on domestic and industrial water use in the Basin are limited. The total industrial water demand was estimated at approximately 232 million m3 in 2007 (MRC, 2017b). Domestic water demand is projected to increase across the LMB by around 76% by 2040, and industrial demand to increase by around 192% in line with population growth and further industrialization of national economies (MRC, 2017b). Nevertheless, domestic and industrial demand for water in the Mekong River Basin will likely remain relatively small compared to other sectors.

2.1.2. Institutional setting

As described in the BDS 2021–2030, national sovereignty, customs and administrative systems are the foundation for planning, decision-making and management of water resources within the Mekong River Basin. However, due to transboundary concerns with the development and utilization of basin resources, these national systems are under a regional cooperation framework consisting of the 1995 Mekong Agreement between the four LMB countries, and complemented more recently by the Mekong-Lancang Cooperation (MLC) mechanism encompassing the six riparian nations.

For over 25 years, the four Lower Mekong riparian States have been working with the MRC, based on the 1995 Mekong Agreement, building on a long history of cooperation dating back to 1957 when the Mekong Committee was under the United Nations Economic and Social Commission for Asia and the Pacific (then known as the Economic Commission for Asia and the Far East). The Upper Mekong states of China and Myanmar have been Dialogue Partners of the MRC since 1996, cooperating in hydrological data and information sharing, technical exchanges, joint studies and policy dialogues.

The 1995 Mekong Agreement

establishes the goals, objectives and underlying principles by which the four Member Countries intend to cooperate, and to which this Strategy responds. These may be summarised as:

- To cooperate in all fields of sustainable development, utilisation, management and conservation of the water and related resources of the Mekong River Basin, in a manner to optimise multiple uses and mutual benefits ... including, but not limited to irrigation, hydro-power, navigation, flood control, fisheries, timber floating, recreation and tourism (Article 1);
- To promote the development of the full potential of sustainable benefits and to prevent wasteful use with an emphasis and preference on joint and/or basin-wide development projects and basin programs through the formulation of a basin development plan (Article 2);
- To protect the environment, natural resources, aquatic life and conditions, and ecological balance (Articles 3 and 7-10);
- To utilize the waters of the Mekong River system in a reasonable and equitable manner (Articles 4-6).

Figure 2.3. Summary of the goals, objectives and underlying principles of the 1995 Mekong Agreement to which the BDS 2021–2030 seeks to respond

Source: MRC (2020a)

The MRC is presided over by a Council made up of ministerial representation from each Member Country. The Council is supported by a Joint Committee that normally meets four times a year to oversee and direct the activities of the MRC. National Mekong Committees (NMCs) have been established by each Member Country to coordinate national inputs to the MRC. The Mekong River Commission Secretariat (MRCS) provides technical support to the Joint Committee. The MRC is financed by its Member Countries and contributions from Development Partners.

The MRC remains the only treaty-based intergovernmental river basin organization with a clear mandate and core functions, which focuses on principles of IWRM, common procedures, strategies, guidelines and tools to support the sustainable and equitable use of water and related resources, and joint actions to address transboundary issues. As a regional knowledge hub and water diplomacy platform, its core functions have been defined to include: data acquisition, exchange and monitoring; analysis, modelling and assessment; basin planning support; forecasting, warning and emergency response; implementation of the five MRC procedures for basin management; and dialogue and facilitation.

Since 2010, the Prime Ministers of the four Member Countries of the MRC have held summits approximately every four years. The first was held in Hua Hin (Thailand) in 2010; the second in Ho Chi Minh City (Viet

Nam) in 2014; the third in Siem Reap (Cambodia) in 2018; and the most recent, in Vientiane (Lao PDR) in 2023. The declarations by the Prime Ministers have evolved over time according to the most pressing issues and challenges identified for discussion among the countries and reflecting the ongoing commitment to regional cooperation captured by the slogan, '*One Mekong, One Spirit*' (Table 2.1).

The MLC, established through the Sanya Declaration in 2016, has a broad scope with water resources: management is one of five priority areas, which also include connectivity, production capacity, cross-border economic cooperation, and agriculture and poverty reduction through project-based initiatives. Mekong-Lancang Cooperation on water resources (MLC Water) not only focuses on the Mekong River Basin, but also on regional, national and local water issues across the six countries.

MLC Water is managed through a Joint Working Group (JWG) of water and related line agencies in the six countries supported by the Lancang-Mekong Water Resources Cooperation Center (LMC Water Center) in Beijing. The Center is a platform for technical exchange, research, information sharing and capacity building. The MRCS being granted observer status at JWG meetings and the agreement to a Memorandum of Understanding (MoU) between the MRCS and LMC Water Center are evidence of the willingness of both cooperation platforms to work more closely together. Increasing engagement between the MRC and MLC Water builds on the strong positive trajectory of cooperation between the MRC and UMB countries through the Dialogue Partner arrangement.

Table 2.1. The four Mekong River Commission Summits held since 2010 and the themes of the corresponding declarations by Prime Ministers

Summit	Theme of Summit Declaration
Hua Hin, Thailand, 2010	"Meeting the Needs, Keeping the Balance"
Ho Chi Minh, Viet Nam, 2014	"Water, Energy and Food Security in the Context of Climate Change"
Siem Reap, Cambodia, 2018	"Joint Efforts and Partnerships towards Achievement of the Sustainable Development Goals in the Mekong River Basin"
Vientiane, Lao PDR, 2023	"Innovation and Cooperation for a Water Secure and Sustainable Mekong"

Beyond the principal water resources cooperation platforms of the MRC and MLC Water, other key cooperation mechanisms involved in Mekong water resources-related issues include the Association of South-East Asian Nations (ASEAN), the Greater Mekong Subregion (GMS) initiative, the Lower Mekong Initiative (LMI)/Mekong-US Partnership, the Ayeyarwady-

Chao Phraya-Mekong Economic Cooperation Strategy (ACMECS) and the Mekong Initiatives of Japan and the Republic of Korea, among others. Further information on the strategic priories of each of these cooperation mechanisms is provided in the BDS 2021–2030.

2.2. Key physiographic and environmental features

2.2.1. Physiographic features

The Mekong River rises from the Tibetan Plateau. It flows southeast and enters Yunnan Province as one of three parallel rivers in the Hengduan Mountains, with the Yangtze River to its east and the Salween River to its west. Here, the river is typically associated with strongly incised gorges, fed by tributaries and gullies draining hilly fields with steep slopes. The river flows through China and along the border with Myanmar before entering northern Lao PDR, with elevation in the LMB ranging from just over 2,800 m above mean sea level to zero at the coast of Viet Nam. Four key physiographic regions are described in the Planning Atlas of the LMB (MRC, 2011a): the Northern Highlands, the Khorat Plateau, the Tonle Sap Basin and the Mekong Delta.

The Northern Highlands include the upland areas of northern Lao PDR and northern Thailand. In this region, the Mekong River as well as its major tributaries are constrained in steep-sided valleys. In isolated places, such as near Chiang Saen and Huay Xai, the Mekong and its tributaries broaden and have developed floodplains. The Khorat Plateau is a basin that has been uplifted and tilted such that it now lays perched at an elevation of about 300 m above sea level.

The Plateau is bounded by mountains on all sides, and the Phu Phan Uplift divides it into two sub-basins: the Sakhon Nakhon/Savannakhet Basin to the north, and the Min/Chi Basin to the south. Most of the central region of the Khorat Plateau, however, is flat or gently folded. The major rivers draining this area (Songkhram, Chi and Mun Rivers) have low gradients and wide floodplains.

The Tonle Sap Basin is a “large dome-like geological structure that has been ‘unroofed’ through erosion, leaving a rim of hills standing above the alluvial plains in the centre of the Basin” (MRC, 2010). The western and central parts of the Basin are characterized by a low gradient and low-relief landscape. The Tonle Sap Basin is bounded in the north by the ridge that forms the southern edge of the Khorat Plateau and the Cardamon Range in the southwest.

The Mekong Delta plain covers an area of 62,520 **km²**. The delta begins below Kratie around upper Kampong Cham province, and at Phnom Penh, the Mekong River splits into two main distributary channels: the Mekong and Bassac Rivers, which further downstream split into nine smaller channels that discharge into the sea. The delta plain can be divided into two regions: the inner delta plain located upstream and dominated by fluvial (river) processes, and the outer delta plain located nearer the sea and subject to marine processes such as the influence of tides, waves and ocean currents (Nguyen et al., 2000; Ta et al., 2002). The outer delta is of slightly higher elevation than the inner delta due to the formation of sand dunes and ridges near the coast.

2.2.2. Climate

Over the 1901–2010 period, average annual temperatures across the LMB ranged from a minimum of 22.3˚C in northern Lao PDR to a maximum of 27.6˚C in the Mekong Delta (MRC, 2015). This meridional, north-to-south temperature gradient is unsurprising given that northerly parts of Lao PDR have elevations that are 1,000 metres higher than in the southern regions. It is these same thermal contrasts, particularly across the Tibetan Plateau, that drive the monsoon circulation. Average maximum and minimum temperatures are similarly affected by elevation.

Over the 1901–2010 period, average annual rainfall across the LMB ranged from a minimum of 1,291 mm per year in the Mun/Chi River Basin to a maximum of 1,992 mm per year in the Mekong delta. These values are calculated by averaging rainfall across each of the 10 sub-areas (MRC, 2015). When considering localized rainfall maxima, the variability is much larger. Rainfall quantities as low as 1,000 mm per year are observed in northeastern Thailand, while more than 3,000 mm per year is received close to the Gulf of Thailand. Wet season rainfall contributes approximately 80% of the average annual rainfall. It therefore shows a similar spatial pattern to that of annual rainfall. Dry season rainfall exhibits limited spatial variability, with a basin-wide average accumulation of 362 mm over the period of record. The largest accumulations are again constrained to mountainous and coastal regions, with the delta receiving an average of 463 mm per year.

Within the UMB, the north is classified as tundra climate by the Köppen-Geiger classification, and transitions in a downstream direction to a monsoon-influenced subarctic climate, a subtropical highland climate downstream of Chamdo Prefecture, and a monsoon-influenced humid subtropical climate in the Weiyuan Jiang and Nam Loi sub-basins. The average monthly rainfall and temperature patterns for two weather stations in the UMB in China illustrate that at 535 mm per year, annual rainfall at Chamdo is around one-third the average yearly total of 1,572 mm per year at Pu'er in the south of the UMB. Similarly, substantial differences in temperatures are observed, with annual averages of 8.1 ºC and 19.2 ºC at

Chamdo and Pu'er, respectively. Where monthly average temperatures at Pu'er are all within a range of 10 ºC, the difference between minimum and maximum is much larger in Chamdo, with average temperatures of -1.2 ºC in January and 16.5 ºC in July.

2.2.3. Land cover

Land cover in the Mekong River Basin is classified into more than 20 types (Table 2.2 and Figure 2.4), depending on the classification applied in each part of the Basin. In the UMB, the dominant land cover is grassland, covering around 40% of the area, with alpine meadows giving way to pine and broadleaved forests as the river flows downstream. In the LMB, broad-leaved deciduous and evergreen forests cover around 40% of the Basin with paddy rice and annual crops together covering a similar proportion (MRC, 2021c). Other than orchards, industrial plantations, urban areas and water bodies, all other types of land cover in the LMB each cover less than 2% of the basin area (Table 2.2).

Table 2.2. Area of land cover types in the Lower Mekong River Basin, by country

	2020 Land Cover Area by Country (km^2)					
	Cambodia	Lao PDR	Thailand	Viet Nam	LMB	% LMB
Annual Crop	29,104	18,070	37,765	7,808	92,747	15.0%
Aquaculture	229	215	1,070	8,397	9,911	1.6%
Bamboo Forest	124	3,127	83	182	3,516	0.6%
Bare Soil	982	481	606	166	2,235	0.4%
Coniferous Forest	14	753		2,103	2,870	0.5%
Deciduous Forest	28,836	23,384	17,160	5,644	75,024	12.1%
Evergreen Forest	27,599	114,108	23,029	9,074	173,810	28.1%
Flooded Forest	9,075	12	2	1,105	10,194	1.6%
Forest Plantation	3	10	208	1	222	0.0%
Grassland	287	3,249	727	602	4,865	0.8%
Industrial Plantation	3,718	1,774	9,599	2,873	17,964	2.9%
Mangrove	0	0	0	915	915	0.1%
Marsh/Swamp Area	2,627	2,843	1,776	1,814	9,060	1.5%
Orchard	4,963	19,687	4,774	5,336	34,760	5.6%
Others	1,637	2,847	1,125	1,325	6,934	1.1%
Paddy Rice	38,712	10,847	73,807	15,119	138,485	22.4%
Shrubland	1,322	1,491	2,633	863	6,309	1.0%
Urban Area	1,961	932	10,107	1,193	14,193	2.3%
Water Body	5,203	3,396	3,287	2,412	14,298	2.3%
Total:	**156,396**	**207,226**	**187,758**	**66,932**	**618,312**	
Total Forested Land Area (Natural)	65,648	141,384	40,274	19,023	266,329	83.4%
Total Forested Land Area (Plantation)	8,684	21,471	14,581	8,210	52,946	16.6%
Total:	**74,332**	**162,855**	**54,855**	**27,233**	**319,275**	

Data source: MRC (2021c)

Monitoring of land cover change, which can be an indirect indicator of human use, provides insight into landscape-level dynamics. Over time, due to changes in definitions and methodological approaches, it has not been possible to directly evaluate changes in land cover types since the last SOBR. However, some ongoing dynamics supplemented with other evidence (see Chapter 3) remain clear. For example, the reduction in mangrove areas along the delta coast continues and coincides with an increase in aquaculture ponds and evidence from other sources (e.g. Mekong-SERVIR). There has also been a reduction in grassland and shrubland areas and an increase in areas of orchards and other plantations. Another notable trend over several land cover assessments since at least 2003 is an increase in annual crops, not including paddy rice.

The areas of broadleaved evergreen and deciduous forests in the LMB are particularly difficult to classify: the deciduous forests increased substantially from 2003 to 2010 before retreating again in 2020, and the evergreen forests substantially decreased (MRC, 2021c). Nevertheless, taken together, both categories cover close to 40% of the basin area, just as they did in 2010, which is a reduction from around 50% in 2003 for these two land cover categories. This trend of an overall reduction in forest cover to 2010 before an apparent stabilization, and indeed increase in some areas, was previously reported in the 2018 SOBR.

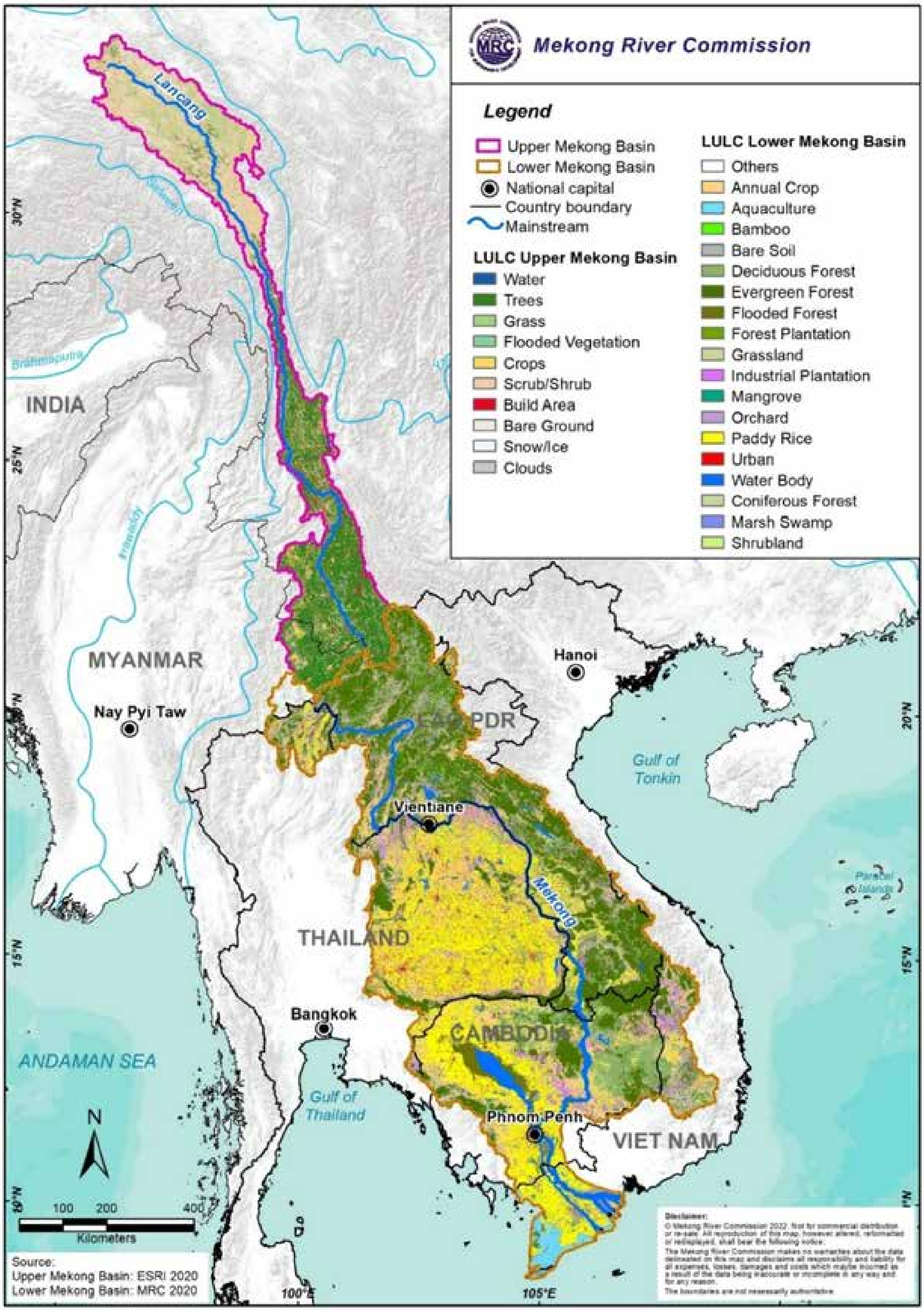


Figure 2.4. Land cover map of the Mekong River Basin

Data source: MRC (2021c)

2.2.4. Key environmental features

The Mekong River Basin is one of the most biodiverse regions on earth. Its ecosystems and the services they provide are of immense importance to the people currently living in the Basin and to future generations. The Basin comprises a wide range of environmental assets with a multitude of habitat types ranging from forested mountains to lowland swamps, plains, floodplains, and coastal areas, among others. These different ecosystems offer extensive provisioning, regulating, supporting and cultural ecosystem services, especially for people in vulnerable situations who depend more directly on natural resources for their livelihoods and wellbeing.

The Biological Resources Assessment (BioRA) of the Lower Mekong Basin, which informed the MRC Council Study (MRC, 2017a), divides the Mekong mainstream into eight key zones (Figure 2.5a). The zones reflect important biological features, such as fish migration routes (Figure 2.5b), differences in aquatic habitats across the river system, and the links between potential ecosystem changes and their impacts on people and livelihoods, and build on earlier hydrogeomorphic zones (e.g. MRC, 2005; Adamson, 2001; Carling, 2009; and Gupta, 2004). The use of these zones for condition and impact assessments recognizes important differences in environmental features and associated ecological processes in different parts of the river system, as well as the nature and extent of the socio-economic impacts from water resources development experienced by different countries.

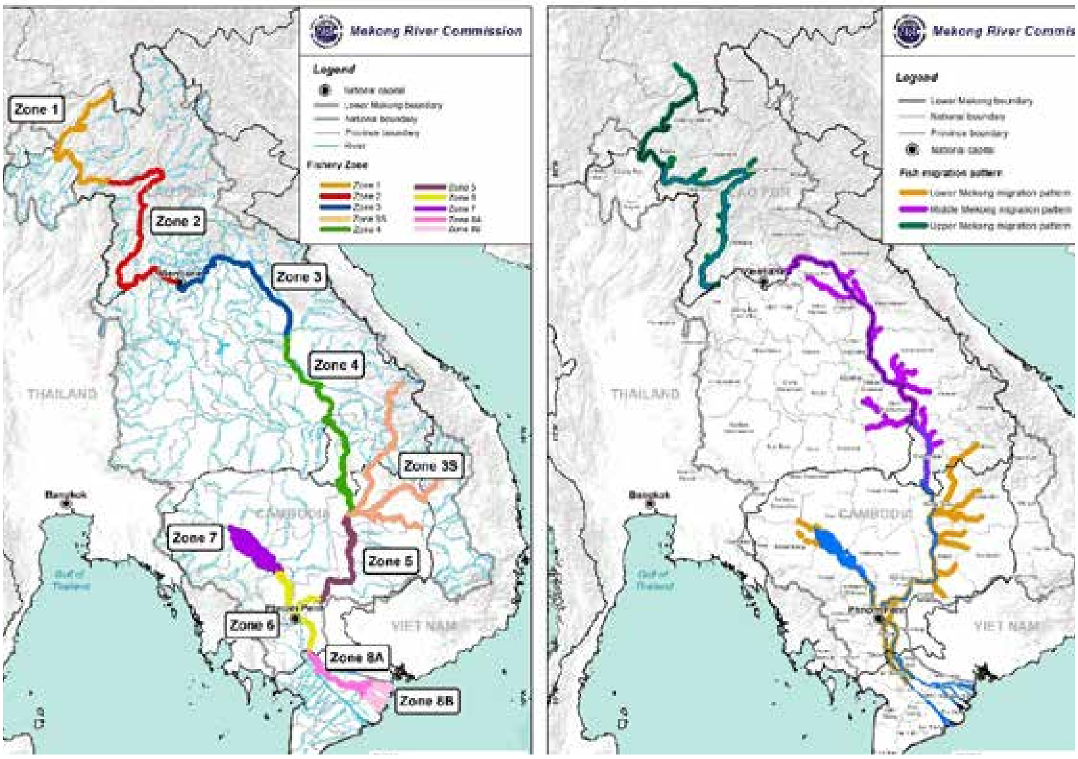


Figure 2.5. Maps of the Lower Mekong River Basin

Note: The maps shows the key ecological zones of the Mekong mainstream from the MRC Biological Resources Assessment, with Zone 3S added, encompassing the Sekong, Srepok and Sesan Rivers sub-basin (a) and the three general fish migration systems (b)

Source: MRC Information System

Fish populations of the Mekong River Basin are one of its most important environmental features, affecting the food security and livelihoods of millions of people, and the Tonle Sap is widely recognized as one of the most productive inland fisheries in the world. Mekong fish communities are characterized by high diversity of species with many exhibiting complex life cycles that involve migration between different areas of the river, particularly upstream migration to spawning areas. Instream barriers to fish movement from water resources development in the Mekong mainstream and tributaries are therefore a significant threat to fish populations. The general understanding of migration patterns in the Mekong is that there are three main groupings (Figure 2.5b):

- **The upper system,** which stretches upstream from the Loei River. Here, the fish migrate upstream to spawning habitats during the wet season to return later to their dry season habitats, which are also located along the main river (van Zalinge et al., 2004).
- **The middle system,** which runs from above Khone Falls to the Loei River. In this system, fish generally move upstream during the wet season on the rising waters and enter the tributaries and their associated flooded areas for feeding. During drawdown they leave the tributaries and return to dry season refuges downstream in the lower system.
- **The lower system,** which extends downstream from the Khone Falls and includes the Tonle Sap River and lake system in Cambodia and the Mekong Delta in Viet Nam. In this system, fish migrations are basically movements out of the floodplains and tributaries, including the Tonle Sap, to and up the Mekong River at drawdown period. A number of species spawn around their dry season refuges usually at the onset of the monsoon and the beginning of water-level rise.

Within the river, deep pools and rapids and seasonally flooded forests provide diverse habitats and food for fish and other aquatic animals (OAAs). As reflected in the Council Study (MRC, 2017a) and previous SOBRs (e.g. MRC, 2019), exposed sandy habitat is critical for vegetation, amphibians, reptiles and birds in the dry season. The availability of exposed sandy habitats depends on the creation and maintenance of sandbars, banks and islands through alluvial deposition, and the exposure of the deposits due to changes in water levels. Inundated sandy habitat is also important for insects that require a sandy substrate for life-cycle processes. Rapids or rocky habitats are important for the nesting of certain species and for macroinvertebrates and vegetation communities that depend on inundation for life-cycle processes.

Deep pools in the Mekong River Basin are recognized as important geomorphic features, providing refuge and spawning habitat for a variety of fish species (Halls et al., 2013). Given the dependency of these features on the balance between the timing and magnitude of flow and sediment delivery in the LMB, deep pools can also be considered good geomorphic indicators of channel functioning.

Important wetland areas of the Mekong River Basin (Figure 2.6a) include flooded forests, seasonally inundated grasslands, permanent rivers, streams and lakes, marshes, swamps and mangrove forests. Flooded forests in particular afford a highly significant, if not the primary, source of biomass in Mekong floodplains and therefore play a critical role in the productivity of basin ecosystems (MRC, 2017a). The seasonal inundation of forested areas is essential to the carbon and nutrient cycles of the Basin, providing food and habitat for fish and OAAs. The floodplains around the Tonle Sap

Great Lake are a key feature in this cycle as the flood pulse first fills the lake and then recedes, providing cues for fish migration and carrying nutrient rich water from the Tonle Sap Lake to the delta.

Recognising the importance of the environmental assets and related ecosystem services of the Mekong River basin, the regional Strategy for Basin-wide Environmental Management (SBEM) 2021–2025 (MRC, 2021d) focuses on the environmental management of an initial list of 12 priority environmental assets of regional importance. The 12 initial assets (Figure 2.6b) were prioritized by Member Countries of the MRC from a list of more than 120 based on their ecological and hydrological importance, their rareness or uniqueness, the importance of the ecosystem services they provide, and their global, regional or transboundary importance. 'Environmental asset' adopted in the SBEM is defined as: naturally occurring areas that provide environmental 'functions' and services' for sustainable generations (current and future) of the Lower Mekong Basin.

The environmental assets selected include areas that are designated as Ramsar Wetlands of International Importance, Biosphere Reserves, United Nations Education Scientific and Cultural Organization (UNESCO) World Heritage Sites, National Protected Areas (including terrestrial, aquatic and marine protected areas), national parks, wildlife sanctuaries, waterbird areas, Greater Mekong Subregion (GMS) biodiversity conservation corridors, protected landscapes and National Heritage Parks.

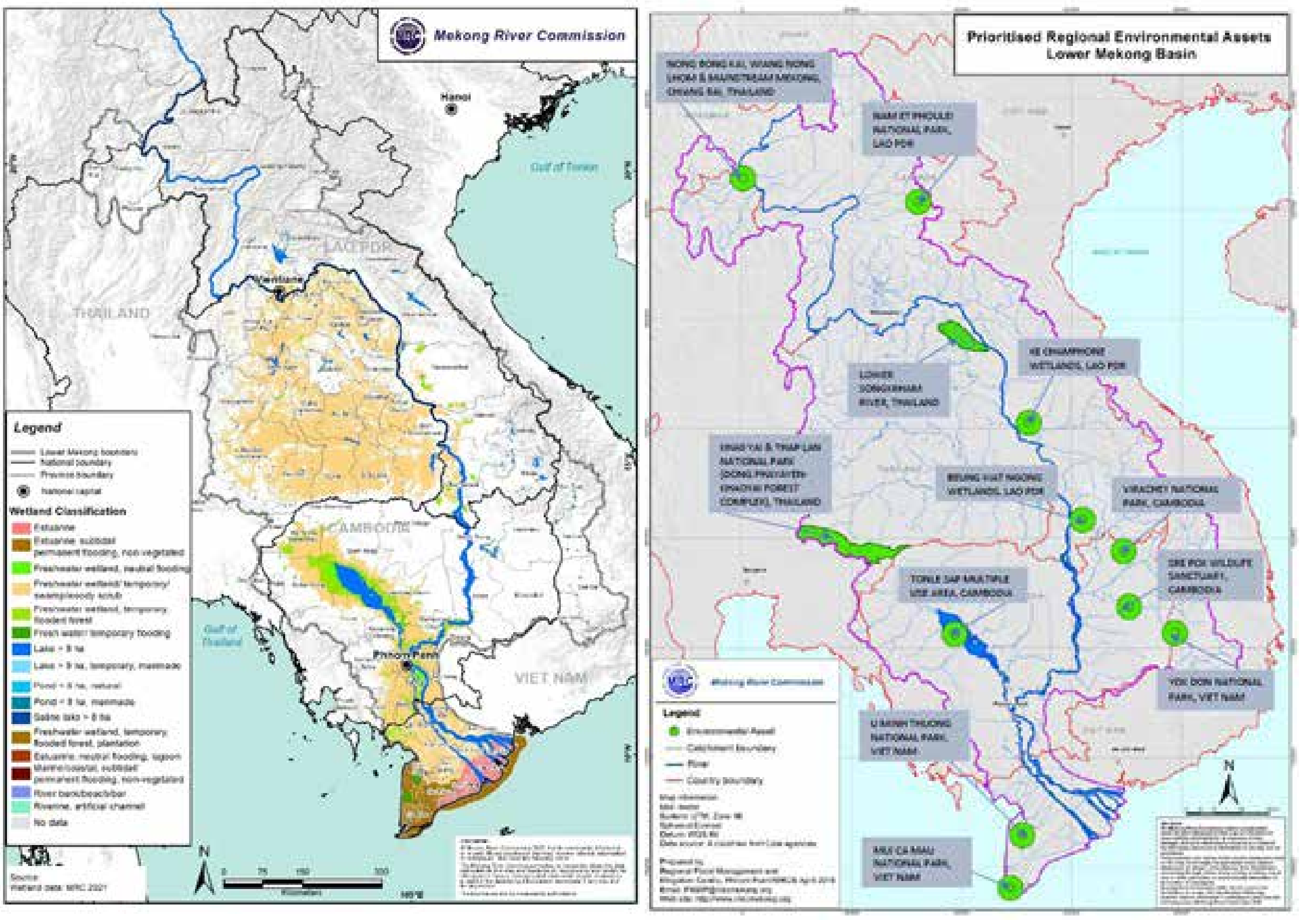


Figure 2.6. Maps of the Lower Mekong River Basin illustrating wetland areas (a); and the initial 12 priority environmental assets of regional importance selected in the Lower Mekong River Basin (b)

Source: MRC Information System

The initial 12 priority environmental assets include areas located in the upper parts of basin catchments (four assets) as well as those in lower catchment areas, mostly rivers, streams and wetlands (eight assets), some of which, due to their location are more susceptible to transboundary threats than others. In total, the 12 assets cover almost 6% (47,202 km²) of the total area of the Mekong River Basin (810,000 km²) and more than 7.5% of the LMB (624,814 km²).

2.3. Social and economic context, and the dimensions of vulnerability

2.3.1. Demographics

There are around 69 million people estimated to be living in the Mekong River Basin (Table 2.3), of whom 7 million are in the UMB and 62 million in the LMB. Thailand and Viet Nam together account for around 60% of the total basin population, while Cambodia consists of around 20%, and China, Lao PDR and Myanmar, each less than 10%.

Over the last 20 years, the population of the LMB has grown by just under half a million per year (13% since 2000), at a remarkably consistent rate, except in Thailand, where the population within the Basin started to decline from 2018 (Figure 2.7). Based on population estimates between the 2018 SOBR and the current SOBR, the population of the UMB is fairly stable, that is, declining slightly from 7.1 million to 7 million.

Table 2.3. Estimated population of the Mekong River Basin, 2020

Country	Total population (million)	Population density (no./km²)	Male (million)	Female (million)
Cambodia	13.6	87	5.9	7.8
China	6.4	39	3.3	3.1
Lao PDR	6.8	33	3.4	3.4
Myanmar	0.6	25	0.3	0.3
Thailand	23.8	117	11.8	12.0
Viet Nam	18.1	271	9.0	9.1
Total	**69.3**	**85**	**33.7**	**35.7**

Data source: National statistics provided by basin countries adjusted for proportion of province estimated within the Basin (see Annex A). Note that these estimates applied basin-wide may differ from other official sources that use different methods within countries.

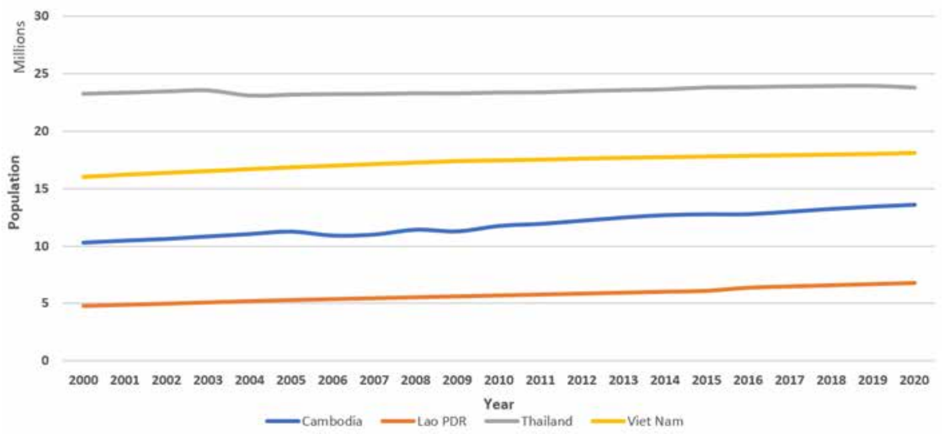


Figure 2.7. Estimated population in the Lower Mekong River Basin by basin country, 2000–2020

Data source: National Statistics provided by basin countries adjusted for proportion of province estimated within the Basin

Across the Mekong River Basin, the ratio of males to females is 94 to 100. The sex ratio is lowest in Cambodia at 75 to 100, and highest in China, at 108 to 100. Overall, there are more males than females in the UMB, and more females than males in the LMB. Both Cambodia and Lao PDR have shown a marked decline in the sex ratio over recent years, the causes of which are unclear.

The proportion of the national population living in the Mekong River Basin is highest in Cambodia and Lao PDR, at over 90%, and lowest in China, at about 0.4%. The average population density across the Basin is 85 persons per km^2, although there is significant variation both between and within countries, with the relatively fertile plains, and riverine and deltaic areas having higher population densities and hosting major population centres, including Phnom Penh, Vientiane, Udon Thani, Ubon Ratchathani and Can Tho (Figure 2.8). Population density is highest in Viet Nam, at 271 persons per km^2, and lowest in Myanmar, at 25 persons per km^2. Since 2015, the population density of the Mekong River Basin as reported in the 2018 SOBR has not changed significantly (MRC, 2019).

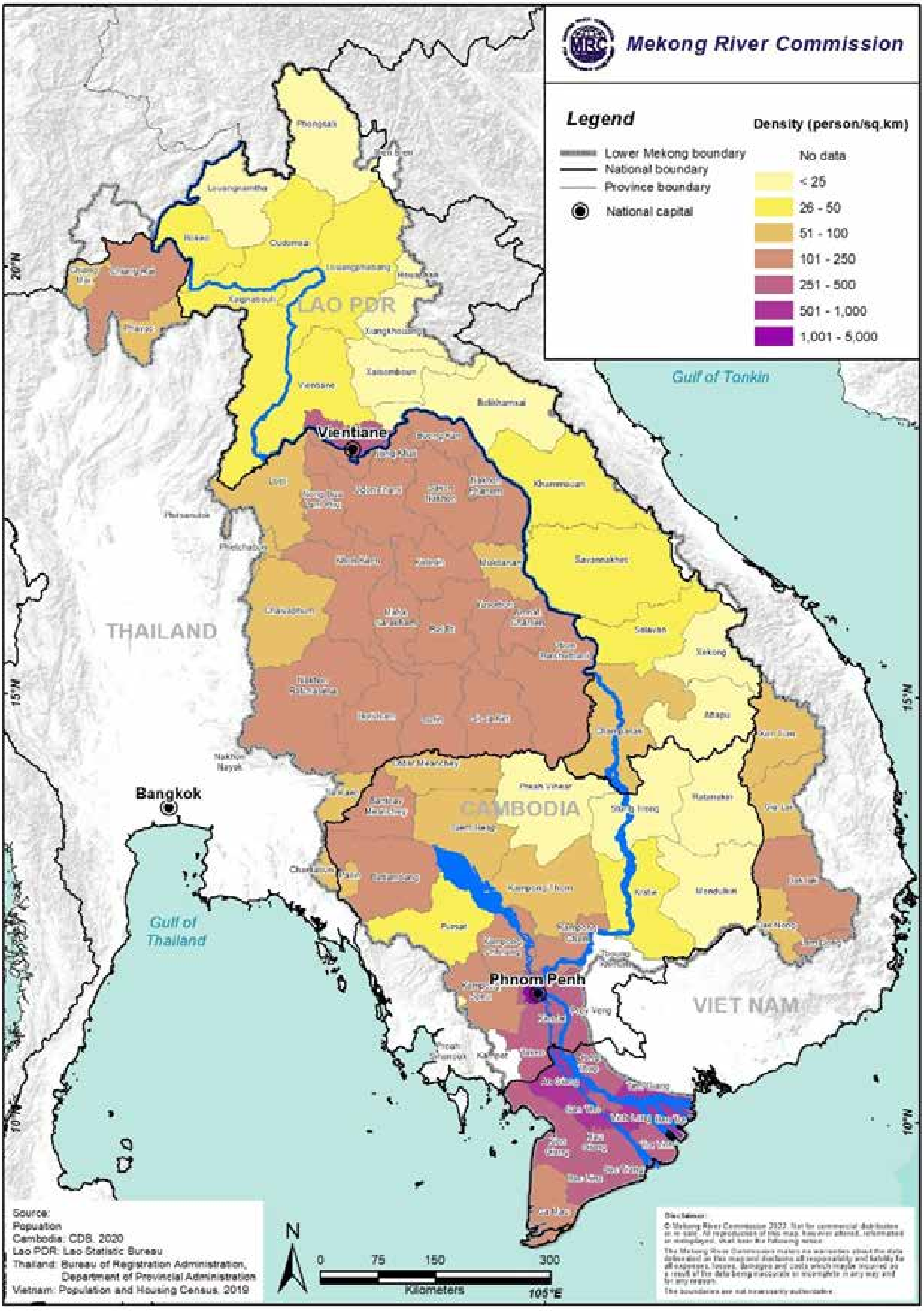


Figure 2.8. Population density in the Lower Mekong River Basin, by province

Data source: National statistics for basin provinces

The population of the Basin is increasingly urban as the proportion of the population living in rural areas has been declining (Table 2.4) following a consistent trend associated with economic growth and structural change seen throughout the world. From 2000 to 2020, in Cambodia, the rural population in basin provinces decreased only slightly, from 84% to 82%, but in Viet Nam, it decreased from 81% to 74%. Provincial-scale data were not available for other basin countries, but at a national level the trends are similar. The rural population in Lao PDR and Thailand decreased by 18% and 29%, respectively, between 2000 and 2020, and in China and Myanmar, by 39% and 4%, respectively. These changes correspond to declining rural population growth rates at the national level across all basin countries (Figure 2.9). Indeed, China, Thailand and Viet Nam all have rural populations that are in decline, and the remaining three basin countries are likely to soon join them. An increase in manufacturing and service sectors of the economy in each country is no doubt a factor contributing to these trends.

Table 2.4. Rural population as a percentage of total population in Mekong River Basin countries, 2000 and 2020

Country	2000	2020
Cambodia[2]	84	82
China[1]	64	39
Lao PDR[1]	78	64
Myanmar[1]	72	69
Thailand[1]	69	49
Viet Nam[2]	81	74
Average	75	63

Note: China, Lao PDR, Myanmar and Thailand are national figures; Cambodia and Viet Nam are basin figures.

Source: [1]World Development Indicators; [2]National Statistics for Basin provinces

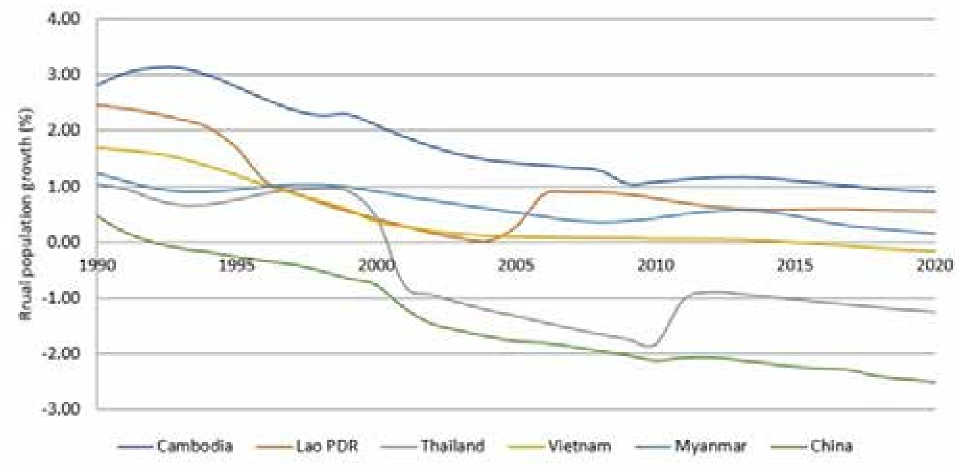


Figure 2.9. Rural population growth at the national level across basin countries, 1990–2020

Data source: World Development Indicators

There have been significant improvements in population life expectancy at birth across all basin countries over the past 20 years (Figure 2.10), with a current average life expectancy of 73 years of age (70 for males, 76 for females) (Table 2.5). The largest increase in life expectancy over the last two decades has been in Cambodia, where it increased by more than 10 years. In 2020, Thailand and China had the highest total life expectancy, at 79 and 78 years of age, respectively, followed by Viet Nam and Cambodia, at 74 and 70 years of age, respectively. Lao PDR and Myanmar had the lowest, at 68 and 67 years of age, respectively.

Average household sizes have been declining across the Mekong River Basin from an average across four countries of 5.1 persons per household in 2000 to 4.0 persons per household in 2020, while an average across six countries of 4.1 persons per household in 2020 (Table 2.6). This decline is consistent with reductions in fertility rates per person and are typical of countries around the world as economic growth and family planning lead to smaller families, lower household dependencies and ultimately lower population growth, subject to compensatory immigration levels.

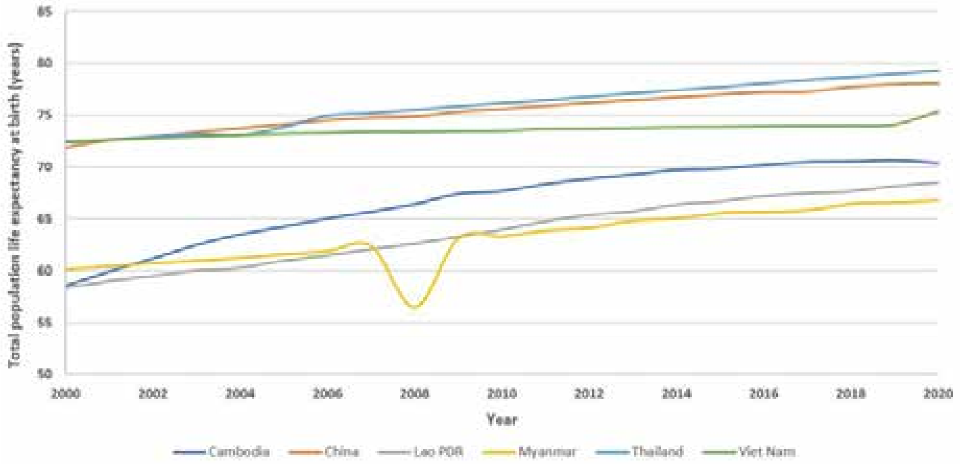


Figure 2.10. National population life expectancy by basin country, 2000–2020

Data source: World Development Indicators

Table 2.5. Population life expectancy in the Mekong River Basin countries, 2020

Country	Total population life expectancy (years)	Male life expectancy (years)	Female life expectancy (years)
Cambodia[2]	70	68	73
China[1]	78	75	81
Lao PDR[1]	68	67	71
Myanmar[1]	67	63	69
Thailand[1]	79	75	84
Viet Nam[2]	74	71	77
Average	**73**	**70**	**76**

Note: China, Myanmar and Thailand are national figures; Cambodia, Lao PDR and Viet Nam are basin figures.

Data source: [1] World Development Indicators; [2] National Statistics for basin provinces

Table 2.6. Estimated numbers of households and household size in Mekong River Basin, 2000 –2020

Country	2000		2020	
	No. of households	Av. household size (no. of persons)	No. of households	Av. household size (no. of persons)
Cambodia	313,473	5.0	3,726,834	4.4
China	-	-	1,675,125	3.8
Lao PDR[1]	913,763	6.0	1,322,989	5.1
Myanmar	-	-	124,925	4.8
Thailand	6,224,493	4.3	7,558,386	2.9
Viet Nam	3,591,731	4.9	6,303,870	3.7
Total	**-**	**5.1**	**20,665,745**	**4.1**

Note: Estimates of average household size for Myanmar and China are calculated based on population and number of households; trends are extrapolated to consistent 2020 end date for all countries.

Source: National Statistics for basin provinces. [1]The Lao PDR 2000 figure is from 2005.

2.3.2. Economic context

Mekong River Basin economies are growing rapidly; total gross domestic product (GDP) is estimated at around USD 187.4 billion (excluding Myanmar) for 2019/20, of which USD 133.7 billion (71%) from the LMB; around 30% of basin GDP from Thailand, 29% from China, and 22% from Viet Nam, with provincial values adjusted in proportion to the estimated population of each basin province (Table 2.7).

Average national growth in GDP within basin provinces across the LMB has been around 7.3 per cent per annum over the last decade, with the highest growth rate in Cambodia and the lowest in Thailand (Table 2.7). GDP growth per capita in China's Yunnan province tripled from 2007 to 2016. GDP per capita in the Mekong River Basin is estimated at USD 3,424 per person, and is highest in China and lowest in Cambodia. Across the LMB, annual GDP growth has generally moderated over the last decade (Figure 2.11), and for countries that provided data for 2020, the effects of the pandemic are evident, with average annual GDP growth in the Basin slumping to 1.7%.

Table 2.7. Estimated total GDP and GDP per capita, and average annual growth in GDP in the Mekong River Basin, from 2011 to the most recent year of data available

Country	GDP	Male life expectancy (years)	Female life expectancy (years)
Cambodia	18.1	1,321	8.8
China	53.7	8,528	-
Lao PDR	17.8	2,617	8.2
Myanmar	-	-	-
Thailand	56.5	2,373	5.3
Viet Nam	41.3	2,282	7.0
Total	**187.4**	**3,424**	**7.3**

Note: Most recent data available: Cambodia, 2019; Lao PDR, Thailand and Viet Nam, 2020; China's Yunnan province, 2021.

Source: National Statistics for basin provinces with GDP and GDP per capita adjusted based on the population of each province within the Basin

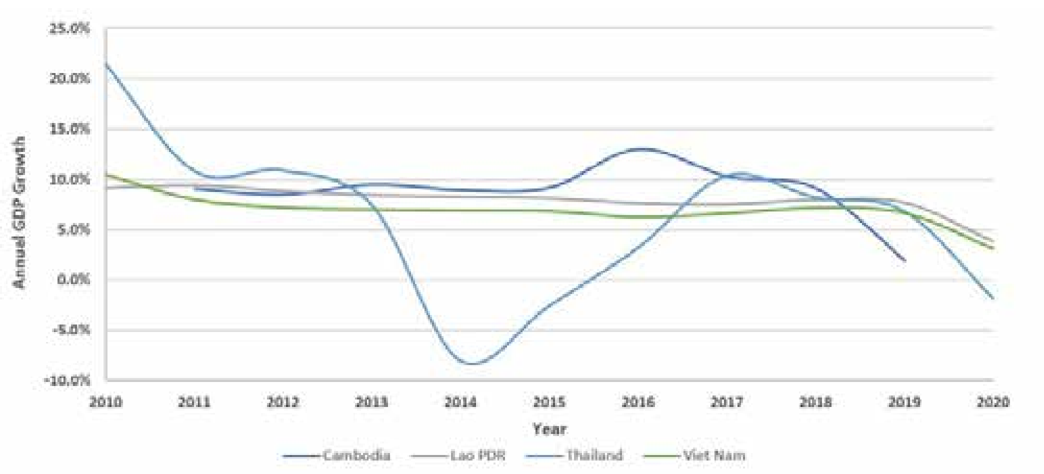


Figure 2.11. Lower Mekong River Basin annual GDP growth rates by basin country, 2010–2020

Source: National Statistics for basin provinces

Box 1: Economic shock of the COVID-19 pandemic on Mekong River Basin countries

The COVID-19 pandemic had a severe economic impact on countries around the world, including in the Mekong River Basin. Although the worst appears to be over and recovery is underway, the economic situation remains fragile (ADB, 2022). Lockdowns and border closures led to a contraction of economic growth in 2020 of -3.1% in Cambodia[1] and -6.1% in Thailand,[1] while growth in Lao PDR[1] was only 0.5%. China,[2] Myanmar[1] and Viet Nam1 continued to grow, although at roughly half the rate of 2019, and Myanmar subsequently suffered a 17% contraction in 2021.[1] Although growth rates have since rebounded, by 2022 they had surpassed 2019 rates only in Thailand and Viet Nam.[1]

The biggest economic impact in the region was on services and tourism (ibid.), as all basin countries experienced a dramatic decline in tourism receipts of more than 50%.[2] However, the value-added of agriculture, fisheries and forestry as a proportion of GDP was largely unaffected,[2] and ADB (2022) reported that job losses in tourism were at least partially to the benefit of agriculture as workers moved to the sector. Those among the population who were the most defenceless in facing the pandemic were the poor, who are mostly uninsured, work in the informal sector, and do not have savings to draw from during an emergency (ibid.).

Public sector finances were also heavily impacted by the pandemic and the public health response, with significantly worsened government budget balances in all countries except for China and Lao PDR. For instance, from 2019 to 2021, Cambodia recorded a budget surplus of +2.2% of GDP to a deficit of -7.3%;[1] Thailand's deficit increased from -1.8% to -9.1%;[3] and Myanmar's increased from 3.5% to -7.8%.[4]

The effects of the pandemic are lingering, including those related to problems with supply chains, contributing, among other factors, to very high rates of inflation in Cambodia, Lao PDR and Thailand, between 2.5 and 8.5 times higher than prior to the pandemic. The situation is somewhat better in China and Myanmar.

Sources: [1]Asian Development Bank; [2]World Bank World Development Indicators; [3]Thailand Ministry of Finance; [4]Myanmar Central Statistics Organisation.

As illustrated in previous SOBRs and the BDS 2021–2030, at the national level, water-related sectors such as agriculture are becoming a less significant part of the overall economy, with a declining share of total national GDP in all basin countries (Figure 2.12). Although the proportion of GDP from water-related sectors is substantially higher in the Basin than nationally, it is also in decline as a proportion of basin GDP. For example, in Cambodia and Viet Nam, the average share of basin GDP, which comprised water-related sectors such as hydropower, agriculture, fisheries, forestry and sand mining, declined from close to 50% in 2011 to around 40% by 2020 (Figure 2.13).

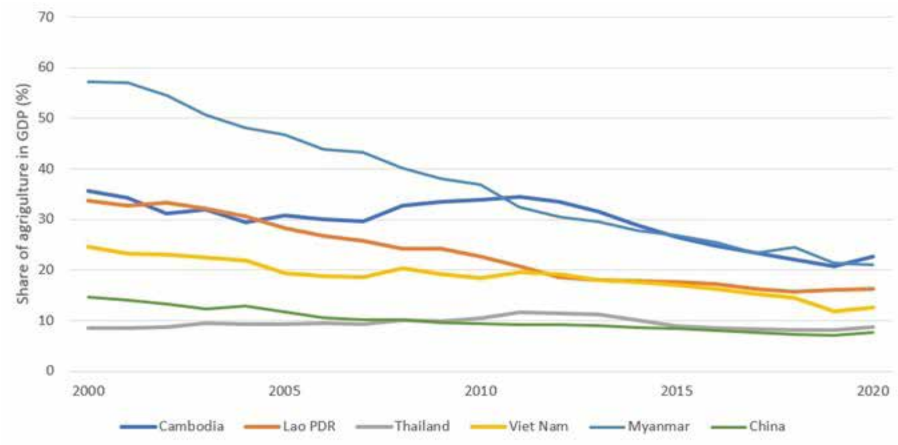


Figure 2.12. Agriculture's share of GDP at the national level in basin countries

Source: World Development Indicators

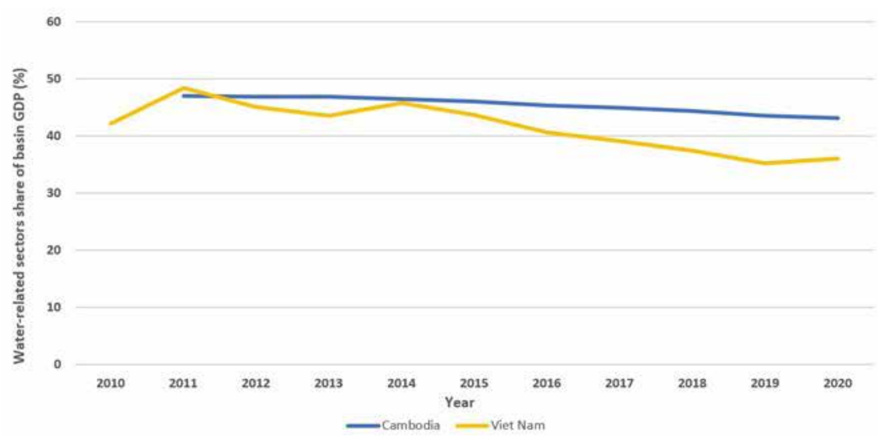


Figure 2.13. Water-related sectors' share of GDP at the basin level, Cambodia and Viet Nam

Source: National statistics for basin provinces

Although the share of GDP from agriculture and other water-related sectors is declining, these sectors remain vital across the Mekong River Basin for many reasons, such as for food security, and are a source of income, livelihoods and employment for basin communities.

2.3.3. Dimensions of water-related vulnerability

Vulnerability is broadly defined as 'exposure + sensitivity – resilience (or adaptive capacity)'. However, for vulnerability to be meaningful it must be defined in relation to specific drivers, impacts or events. Vulnerability as a concept related to water resources management and development was introduced to Mekong River Basin cooperation in 2005, and elaborated on and applied from 2010 onwards in SOBRs, scenario impact assessments, Basin Development Strategies (BDSs), Social Impact Monitoring and Vulnerability Assessments (SIMVAs), and in the various MRC programmes, activities and initiatives. The MRC's most recent SIMVA surveys (2011, 2014 and 2018) consider vulnerability with regard to food and livelihoods linked to changes in water resources (MRC, 2014, 2018, 2021e). The BDS 2021–2030 places particular emphasis on defining vulnerability in relation to floods and droughts, and on the collection and mapping of data disaggregated by gender and other dimensions of vulnerability affected by water resources management and development.

The major intersectional dimensions of vulnerability as they relate to water resources management and development (MRC, 2021f) are as follows:

- **Poverty.** People with less resources at their disposal are generally more exposed and sensitive to changes in livelihood conditions and water-related shocks, and have less adaptive capacity to respond. At the household level, poverty is often related to the source and nature of employment and other forms of income and livelihood, access to public services, the dependency ratio, and various legal, policy and cultural barriers to full economic participation. All other dimensions of vulnerability are acutely related to and contribute to poverty.
- **Gender.** Traditional gender roles are in force in many areas of the Mekong River Basin, and women and men do not have the same opportunities for employment and pay. They each contribute to water resources development, usually with different roles of equal importance; nevertheless, women's voices and participation are still underrepresented in water resources management and decision-making. A female-headed household is also more vulnerable – legally, socially, and economically, since it is typically also a single-parent household. Division of labour, wage gaps, access to and ownership of resources, and other means of economic advancement are all affected by gender. Women are also more vulnerable than men to floods and droughts due to their higher dependence on natural resources and the social barriers that can limit their adaptive capacity (MRC, 2017c).
- **Ethnicity.** In general, smaller ethnic groups, often living in remote areas, are more vulnerable to changes in access to natural resources on which their livelihoods depend. Access and ownership of resources, political influence, access to public services, and cultural barriers to meaningful economic participation all play a part in relative vulnerability for different ethnic groups.
- **Livelihood focus.** Due to more direct dependence on natural resources for food, income and other means of economic engagement, people are especially affected by changes in water flow and water quality conditions, whether through water resources development and utilization, other land use changes and development, or climate-induced impacts. People operating at the margins of profitability or sustenance, at a small scale, with less income and livelihood diversity and fewer assets to buffer against shocks are often more exposed and more sensitive to, damaging floods, droughts and other changes, as well as political and market risks, and have lower adaptive capacity to respond.

These major dimensions of vulnerability for water resources management and development are affected by many other risk factors more broadly across society, including those related to the economic situation, education, age, disability, language abilities, access to means of communication, and quality of governance, among others. They have a significant impact on the resilience of people living in the Mekong River Basin; hence, addressing them is critical to the sustainable development of the Basin.

The MRC's SIMVA study identifies several indicators related to food and livelihood vulnerability linked to changes in water resources: (i) fertility rate; (ii) household size; (iii) dependency ratio; (iv) child malnutrition; (v) infant mortality rate; (vi) poverty rate; (vii) employment in agriculture; and (viii) education. For the basin-wide assessment in this SOBR, consideration is given to the SIMVA vulnerability indicators that align with the MRB-IF and for which sufficient data are available. These include household size, food security as affected by household income, poverty levels, child malnutrition, and employment in water-related sectors.

In the MRB-IF, gender equality is considered primarily in relation to assessment indicator 19 in the Social Dimension, namely 'Gender equality in employment and economic engagement', which includes the monitoring parameter 'ratio of female-to-male employment levels in water-related sectors', and in relation to the monitoring parameter 'education and land ownership. However, the DAGAP also requires the collection of gender-disaggregated data from all other relevant indicators in the Social Dimension, and to the extent that they are available, this SOBR also provides commentary on gender equality issues related to food, water, energy and health security. However, except for basic demographic data, basin-level data (i.e. at an appropriate subnational scale) disaggregated by gender were only available from national statistics for the following five monitoring parameters:

- Number of boys and girls attending primary education (three countries)
- Number of boys and girls attending secondary education (three countries)
- Number of reported cases of malaria and dengue (one country)
- Number of people primarily employed in water-related sectors (two countries)
- Migration rate (one country).

Where relevant, data from international databases at the national level (e.g. the World Bank's World Development Indicators) have been used to fill some of the gaps and complement the basin-level data, noting that, except for Cambodia and Lao PDR, these national-level data may not well reflect the conditions in the Basin.

Due to relative paucity of gender-disaggregated data across the Mekong River Basin in the Social Dimension of the MRB-IF (MRC, 2021f), as with previous SOBRs, an evaluation of gender equality and vulnerability in this report is necessarily limited. The BDS 2021–2030 seeks to correct these gaps over time, encouraging a gender and vulnerability approach among basin stakeholders to account for intersectional inequity, the need to internalize the costs of externalities, and the different dimensions of vulnerability in planning and decision-making. The BDS 2021–2030 approach focuses initially on spatially and gender-disaggregated data collection to identify and map poor water-related resource users and to determine how they are impacted, where vulnerabilities lie, and what the opportunities are to improve resilience.

CHAPTER 3

ENVIRONMENTAL CONDITIONS AND TRENDS

CHAPTER 3: ENVIRONMENTAL CONDITIONS AND TRENDS

3.1. Introduction

The Environment Dimension of the MRB-IF reflects the commitments made by the parties to the 1995 Mekong Agreement to:

- protect the environment, natural resources, aquatic life and conditions, and the ecological balance of the Mekong River Basin from pollution or other harmful effects resulting from any development plans and uses of water and related resources in the Basin (Article 3); and
- make every effort to avoid, minimize and mitigate harmful effects that might occur to the environment, especially the water quantity and quality, the aquatic (eco-system) conditions, and the ecological balance of the river system from the development and use of Mekong River Basin water resources, or discharges of wastes and return flows (Article 7).

To this end, the Member Countries of the MRC agreed to maintain mainstream flow and water quality conditions within certain limits, as expressed in the PMFM and the PWQ and their accompanying technical guidelines. Compliance with the MRC Procedures, and the monitoring of environmental conditions related to water resources more broadly, is evaluated through a comprehensive routine river monitoring programme, which the MRC implements through its Member Countries. Since its inception, the MRC has also undertaken a wide range of regional studies and data collection programmes to promote better understanding of the environment and resources of the Mekong River Basin and the implications of water resource management and development on the reasonable and equitable enjoyment of these resources by all basin countries.

To assess the status of conditions and trends in the environment of the Mekong River Basin, the MRB-IF encompasses four strategic indicators and 11 assessment indicators, as reflected below (Table 3.1). This chapter provides an assessment of the status of conditions and trends in each of these strategic and assessment indicators.

Table 3.1. Strategic and assessment indicators in the Environment Dimension of the MRB-IF

Strategic indicators	Assessment indicators
Water flow conditions	Compliance of dry season flows with the Procedures for Monitoring Flows on the Mainstream (PMFM)
	Compliance of flood season flows with the PMFM
	Compliance of Tonle Sap reverse flows with the PMFM
	Change in the timing of the onset of flood season flows
Water quality and sediment conditions	Ecological health and compliance of water quality with the Procedures for Water Quality (PWQ)
	Changes in sediment transport
	Salinity intrusion in the Delta
Status of environmental assets	Extent of wetland area
	Condition of riverine, estuarine and coastal habitats
	Condition and status of fisheries and other aquatic resources
	Condition and status of ecologically significant areas
Overall environmental conditions	-

The assessment of conditions and trends is undertaken taking into consideration the BDS 2021–2030 Strategic Priority for the Environment Dimension:

Maintain the ecological function of the Mekong River Basin

The BDS Strategic Priority responds to growing concerns that the Mekong River Basin's environment is being heavily modified, placing the ongoing viability of some important ecosystems and dependent biota at risk, such as fish. These ecosystems include river and wetland habitats and forested watersheds, all of which provide valuable provisioning, regulating, supporting and cultural services to the countries and people of the Basin, contributing to sustainable economic development and social wellbeing. The BDS 2021–2030 identifies the most critical issues to be addressed by 2030 as changes in water flow conditions, reduced sediment transport due to dams and sediment extraction, the loss of remaining wetlands and unsustainable management of watersheds.

3.2. Water flow conditions

3.2.4. Assessment methodology

There are two major processes that define the natural hydrological regime of the Mekong. The Southwest Monsoon between June and October is the main driver of the annual flood pulse of the Mekong River, causing distinct wet and dry seasons of approximately equal length.[1] In addition, individual storm events caused by tropical depressions often form in the sea off the coast of Viet Nam. These events lead to intense rainfall over the Basin and often generate distinct individual flow peaks.

In recent decades, these hydrological dynamics have been significantly impacted by anthropogenic water management and water use in association with prevailing climatic conditions. Among other changes, the construction of dams in the mainstream and tributaries, as well as abstraction of water resources for various purposes have affected both annual river discharge and the seasonality of the flow regime. The magnitude of these impacts varies along the river.

Under the PMFM, the Member Countries of the MRC agreed to “cooperate in the maintenance of the flows on the mainstream from diversions, storage releases, or other actions of a permanent nature, except in the cases of historically severe droughts and/or floods”. More specifically, the Member Countries agreed to: (i) maintain monthly flows in the dry season that do not fall below the acceptable minimum monthly natural flow; (ii) enable the acceptable natural reverse flow of the Tonle Sap River to take place during the wet season; and (iii) prevent average daily peak flows greater than would normally occur during the flood season.

The following sections evaluate the status and trends regarding water flow conditions with respect to the reference conditions that were agreed under the PMFM for four assessment indicators of the MRB-IF:

- Compliance of dry season flows with the PMFM (Article 6A)
- Compliance of flood season flows with the PMFM (Article 6C)
- Compliance of Tonle Sap reverse flows with the PMFM (Article 6B)
- Change in the timing of onset of flood season flows.

1 Although it is recognized in the 1995 Mekong Agreement that the dates of the start and end of the wet and dry seasons vary throughout the Basin, the Member Countries of the MRC have agreed on a working definition of the dry season and the flood season in the PMFM Technical Guidelines, i.e. from 1 December to 31 May, and from 1 July to 31 October annually, respectively.

Daily flow data of the Lower Mekong River were obtained from the MRC Hydrological Database based on MRC monitoring at mainstream stations (Figure 3.1) and subject to additional quality control before being used to evaluate the assessment indicators listed above. Since discharge data from the river sections in China and Myanmar are limited in the MRC databases and no PMFM thresholds have been set for stations in this part of the Basin, water flow conditions for the Upper Mekong are mostly presented in a descriptive manner based on review of secondary sources. An exception is the dataset of flow for Jinghong in China, for which year-round water levels and discharge have been shared with the MRCS since June 2020. For earlier years, daily flows at Jinghong are only available for the flood season.

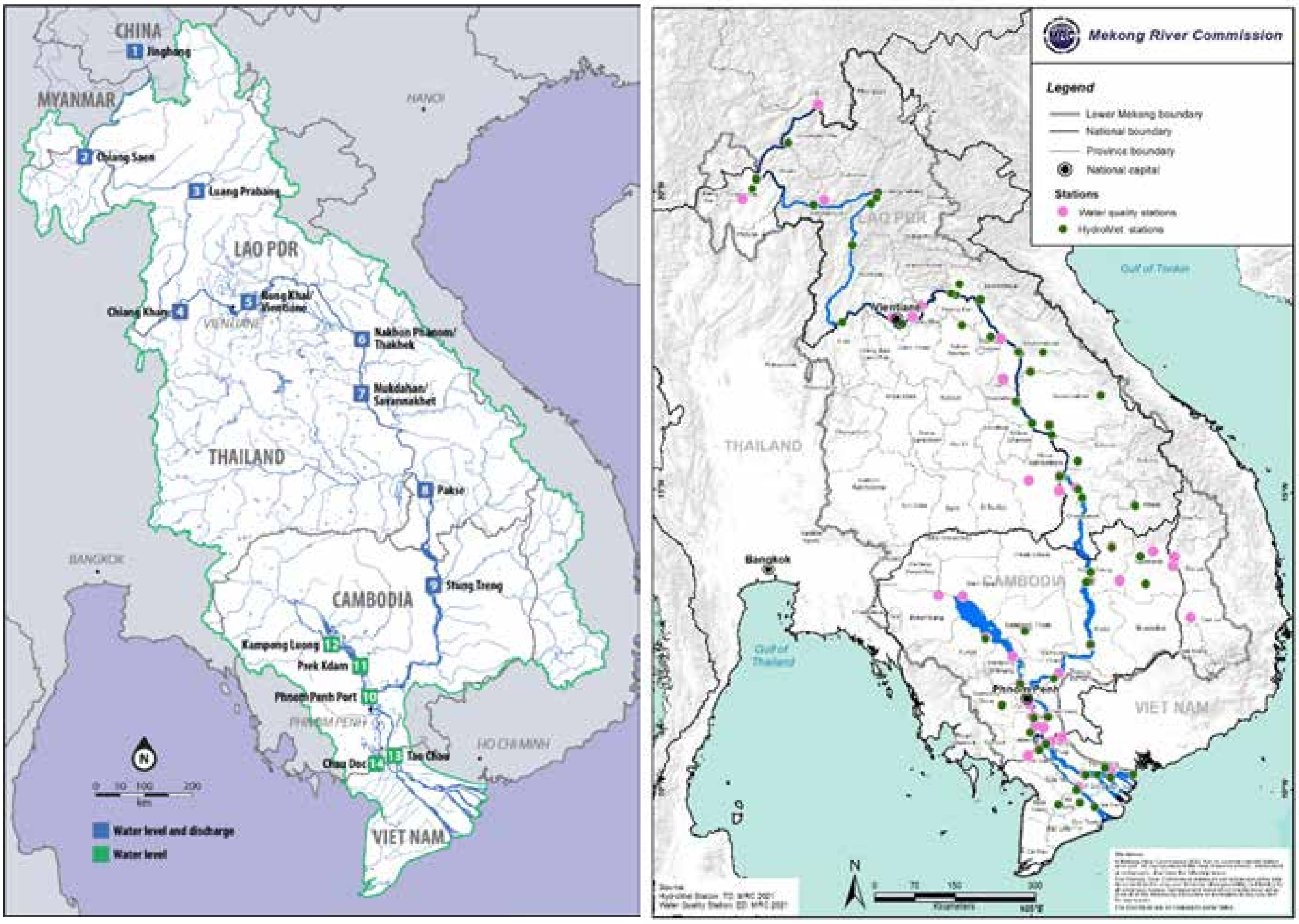


Figure 3.1. Key mainstream hydrological stations (a) and MRC flow and water quality monitoring networks (b)

Source: MRC Information System

To properly interpret the assessment of compliance with the PMFM in each season, it is important to consider the overall flow regime throughout the year and how it has changed over the past decade. Shifts in seasonality are clearly visible when comparing the 2011–2022 period with 1981–2010 period (Figure 3.2). Dry season flows over the last decade were substantially higher than they were during the previous 30 years, at 10 out of 11 evaluated discharge stations (except for Kampong Cham). At Chiang

Saen, average monthly dry season flows were almost 60% higher in the 2011–2022 period than in the 1981–2010 period.

A statistical analysis on the full 1981–2022 period yields a significant increasing trend in average daily dry season flows for these same 10 stations. In general, the relative impact is greatest in the upper parts of the LMB, although it varies considerably between stations. The highest relative increase in daily dry season flows is observed at Luang Prabang, but this is at least partly due to the backwater effect of Xayaburi Dam in recent years. A relatively high dry season flow increase at Stung Treng may be due to its location directly downstream of the 3S confluence, where the impacts of reservoirs including the Lower Sesan 2 Dam (commissioned in 2018) likely affect flow distribution. The absolute volumetric change in dry season flow is generally greater downstream, likely reflecting the cumulative impact of upstream development and climatic changes throughout the Basin, especially lower annual precipitation over the last decade, as described in the MRC-MLC Water Joint Study (MRC-LMCWRCC, 2023) and illustrated in Section 6.3.4.

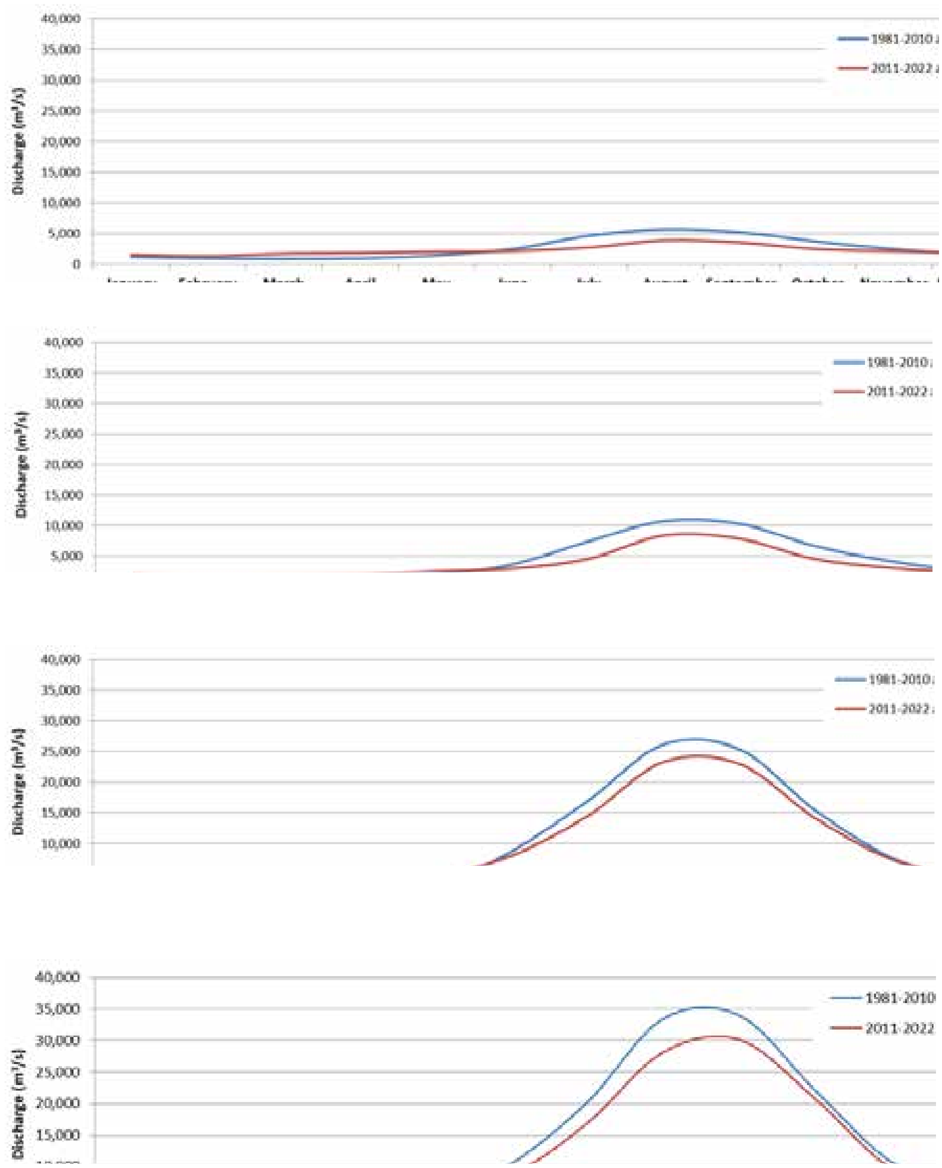


Figure 3.2. Average monthly discharge for the 1981–2010 and 2011–2022 periods at: Chiang Saen (a); Vientiane (b); Pakse (c); and Kratie (d)

Data source: MRC Hydromet monitoring

Flood season flows were lower over the past ten years than they were during the previous 30 years (1981–2010) at all mainstream monitoring stations. Similar to the change in dry season flows, the proportional impact is generally greater at upstream stations. These changes are broadly consistent with the Joint Study (MRC-LMCWRCC, 2023), demonstrating a shift in the proportion of the annual flow occurring in the dry season compared to the flood season, for example, in the 2000–2009 period, from around 20% in the dry season and 80% in the flood season at Chiang Saen, to around 40% in the dry season and 60% in the flood season (Figure 3.3), and further downstream; at Stung Treng, from 14% in the dry season and 86% in the flood season, to 18% in the dry season and 82% in the flood season. The average change across nine mainstream stations is a shift between the two periods from 18% to 28% of annual flows now occurring in the dry season.

(billion m³)	Dry season		Wet season		Annual
Station	Volume	Ratio	Volume	Ratio	volume
(1) Jinghong (0 km)					
2000–2009	12	23%	41	77%	53
2010–2020	21	48%	23	52%	44
Deviation	+9	-	-18	-	-9
% change	+76%	+25%	-45%	-25%	-17%
(2) Chiang Saen (+343 km)					
2000–2009	19	21%	69	79%	88
2010–2020	27	37%	46	63%	73
Deviation	+8	-	-23	-	-15
% change	+44%	+16%	-33%	-16%	-17%
(3) Luang Prabang (+697 km)					
2000–2009	23	19%	99	81%	122
2010–2020	40	33%	80	67%	120
Deviation	+17	-	-19	-	-2
% change	+72%	+14%	-19%	-14%	-2%
(4) Chiang Khan (+992 km)					
2000–2009	28	20%	116	80%	144
2010–2020	39	29%	98	71%	137
Deviation	+11	-	-18	-	-7
% change	+39%	+9%	-16%	-9%	-5%
(5) Nong Khai/Vientiane (+1,158 km)					
2000–2009	28	19%	116	81%	144
2010–2020	33	26%	94	74%	127
Deviation	+5	-	-22	-	-17
% change	+20%	+7%	-19%	-7%	-12%
(6) Nakhon Phanom/Thakhek (+1,486 km)					
2000–2009	46	16%	242	84%	287
2010–2020	49	21%	187	79%	236
Deviation	+4	-	-55	-	-52
% change	+8%	+5%	-23%	-5%	-18%
(7) Mukdahan/Savannakhet (+1,579 km)					
2000–2009	44	16%	237	84%	281
2010–2020	56	22%	202	78%	258
Deviation	+13	-	-35	-	-22
% change	+29%	+6%	-15%	-6%	-8%
(8) Pakse (+1,841 km)					
2000–2009	46	14%	291	86%	337
2010–2020	59	19%	244	81%	303
Deviation	+12	-	-47	-	-34
% change	+27%	+6%	-16%	-6%	-10%
(9) Stung Treng (+2,024 km)					
2000–2009	61	14%	383	86%	444
2010–2020	66	18%	299	82%	366
Deviation	+5	-	-84	-	-78
% change	+9%	+4%	-22%	-4%	-18%

Note: It is important to note that the values don't add to their sums or 100% because of rounding.
The dry season covers December to May from while the wet season is from June to November.

Figure 3.3. Seasonal volume distribution at mainstream monitoring stations, 2000–2009 and 2010–2020

Source: MRC-MLC Water Joint Study, 2023

Since the dam is located furthest downstream on the Upper Mekong (Lancang) River in China, conditions at Jinghong reflect the integrated impact of operations of the reservoir cascade upstream. Minimum flow requirements during the dry season are in place for large dams such as Gongguoqiao (168 m3/s), Xiaowan (269 m3/s) and Jinghong Dams, for environmental as well as navigation purposes (Yu et al., 2018). During the flood season, peak flows are reduced due to the storage of water in the reservoir cascade. As a result, in the past decade, the intra-annual dynamics of the Upper Mekong flow contribution have been strongly governed by reservoir operations (Keovilignavong et al., 2021).

Average annual flow volume measured at Jinghong decreased from around 53 km^3 in the 2000–2009 period to 44.0 km^3 in the 2010–2020 period (MRC-LMCWRCC, 2023); i.e. a 17% reduction in annual flows and a reduction in annual flows at Chiang Saen (Figure 3.3). This reduction of annual flow may be a consequence of multiple factors, including climate change and reservoir construction (Han et al., 2019a), noting that there has been a reduction in annual rainfall over the last decade (MRC-LMCWRCC, 2023).

The available station data for Jinghong show an even stronger shift in seasonal flows than is observed at stations further downstream. Over the 2000–2009 period, around 77% of the flow occurred in the wet season and 23% in the dry season (Figure 3.3), compared to 52% in the wet season and 48% in the dry season in the 2010–2020 period. The average dry season flow volume at Jinghong Dam during the 2010–2020 period was 21 km^3, a marked increase of 76% with respect to the 2000–2009 average of 12 km^3 (ibid.).

No data were available to evaluate the water flow conditions for the Mekong stretch in Myanmar. The Basin in Myanmar is still relatively undeveloped. However, with a planned total reservoir capacity of 1,557 million cubic metres installed by 2025 (12% of its annual discharge), planned hydropower development is expected to affect the hydrograph of the Nam Lwe River, likely leading to a more even distribution of intra-annual streamflow into the Mekong River.

3.2.5. Compliance of dry season flows with the PMFM (Article 6A)

Very Good	Good	Of Concern	**Requires Action**	Requires Urgent Action

River flow in the dry season is essential for the supply of water to people, agriculture, fisheries, aquaculture and ecosystems. The dry season is defined in the PMFM as occurring from December to May (six months). Article 6A of the PMFM prescribes flow categories based on ranges derived from various station-specific statistical analysis with monitoring results published by the MRC.[2]

As expected from the increase in average dry season flows described in the previous section, the compliance of dry season flows with PMFM 6A has improved at some stations. However, while the number of days with normal conditions is higher in recent years at stations such as Chiang Saen and Pakse, this is not the case at Vientiane and Kratie (Figure 3.4). At Kratie, daily dry season flows were more unstable in the past decade than in earlier years. Since average dry season flows have, in fact, increased over the same period, it is clear that, especially in dry years (e.g. 2016 and 2020), the number of days with unstable and even severe flow conditions can still be high, despite the higher degree of water resources development and associated flow regulation. The situation is especially severe further downstream, for instance, in relation to water levels at Tan Chau where the number of days of normal conditions has declined and the number of days of severe conditions has increased considerably since 2014 (Figure 3.4(e)).

2 https://pmfm.mrcmekong.org/monitoring/6a

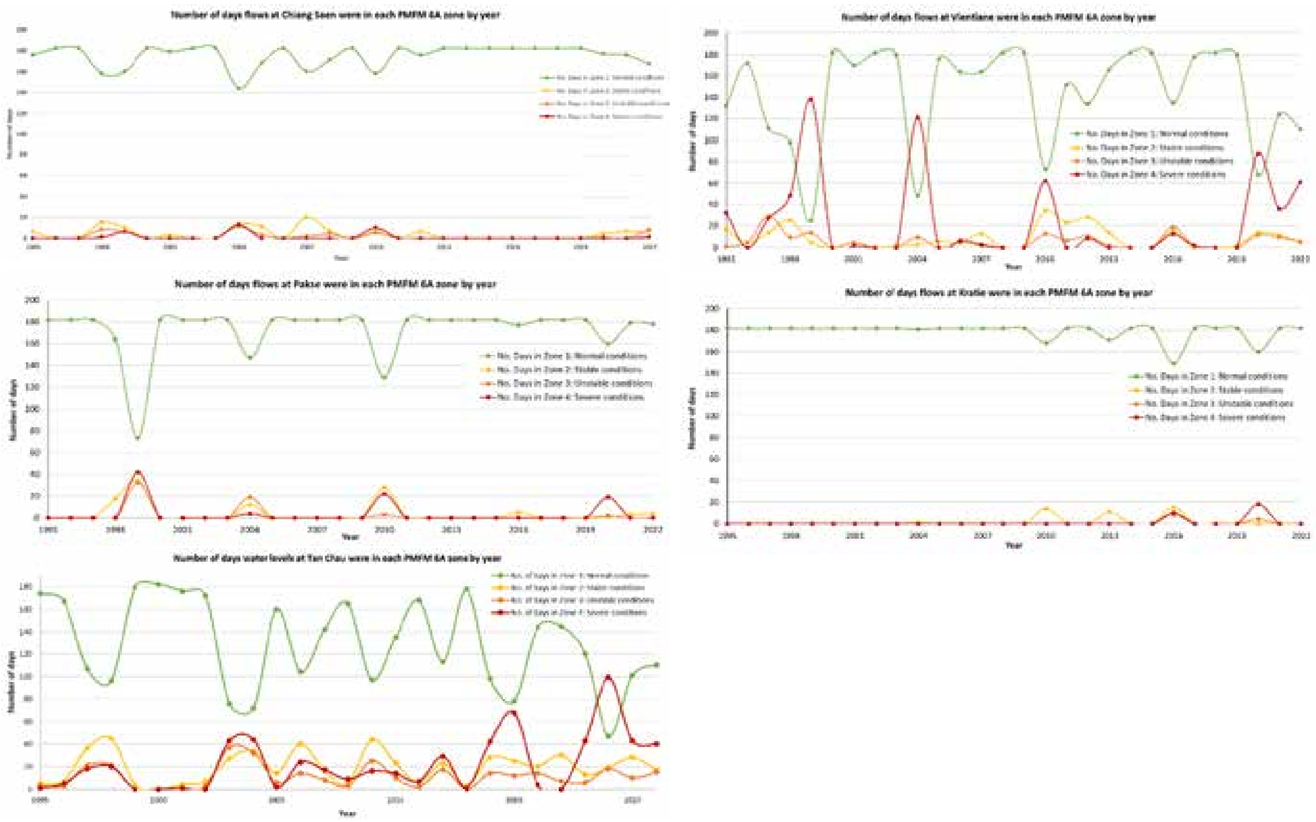


Figure 3.4. Number of days per dry season with flows in each PMFM 6A zone for the stations (a) Chiang Saen, (b) Vientiane, (c) Pakse,(d) Kratie, and (e) for water levels at Tan Chau, 1995–2022

Source: MRC Hydromet monitoring

Days with unstable and severe flow conditions generally occur early in the dry season. This can be due to, for example, a flood season with relatively little precipitation or a relatively early end, or to reservoir operations as flood season water is stored to generate power through more constant release over the dry season. This situation was illustrated at Vientiane between 2018 and 2022. In very dry years, unstable conditions can extend into March as they did at Vientiane in 2020 (Figure 3.5).

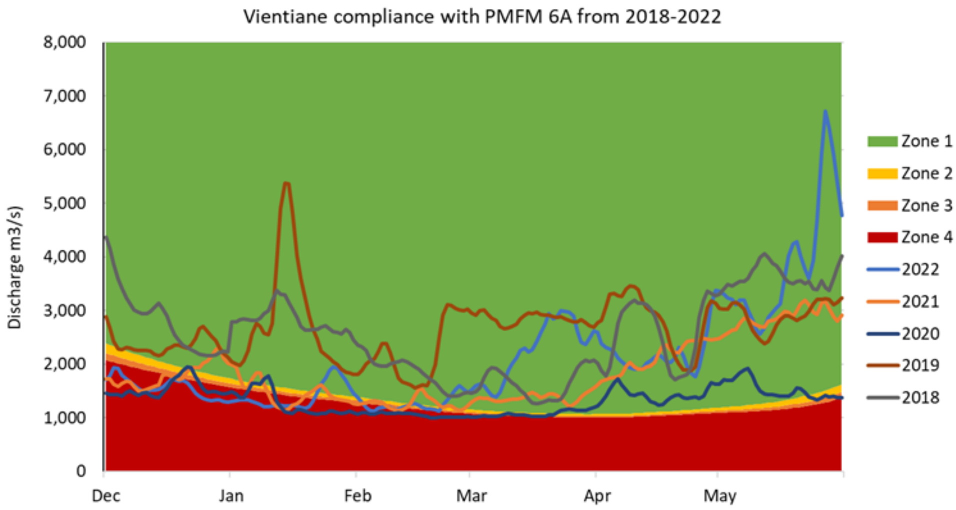


Figure 3.5. PMFM 6A flow categories for Vientiane with daily dry season flows at the station, 2018–2022

Data source: MRC Hydromet monitoring

Over recent years, dry season flows have been more stable at some stations (e.g. Chiang Saen). However, flows were considered unstable for 23% of the time at Vientiane, Lao PDR, and water levels were considered unstable for 29% of the time at Chau Doc and severe for 32% of the time at Tan Chau, Viet Nam. Overall, dry season flows are therefore assessed as 'Requires Action' according to the PMFM Article 6A. This is due to the continued occurrence of unstable conditions at several mainstream stations, the relatively long period of time where unstable conditions extend into the dry season when they do occur, and the dramatic increase in severe water level conditions in the Mekong Delta over the past eight years.

3.2.6. Compliance of flood season flows with the PMFM (Article 6C)

Very Good	Good	Of Concern	Requires Action	Requires Urgent Action

Yearly floods of the Mekong River are vital to natural ecosystems, fisheries and biodiversity, and for sustaining livelihoods across the Basin. However, peak flows need to be maintained below certain thresholds to limit the occurrence of flood events that have harmful consequences to agriculture, rural infrastructure, residential areas and essential services, and/or that cause loss of life. This assessment indicator considers only compliance with Article 6C of the PMFM and not an assessment of flood conditions more broadly. The monitoring thresholds for annual daily peak discharge set in Article 6C of the PMFM are used for evaluating daily flow conditions during the flood season at selected stations, having particular regard to flood hazard. [3] Article 6C monitors compliance with the prevention of average daily peak flows greater than what naturally occurs on the average during the flood season. It therefore considers only the avoidance of flood hazard rather than the minimum flood requirements needed for healthy environmental, social and economic conditions.

Compliance of flood season flows with PMFM Article 6C at seven mainstream stations over the 1995–2022 period has generally been within normal or stable conditions. Flow conditions corresponding with unstable or severe conditions have hardly occurred in the past decade (Figure 3.6), which is consistent with the overall finding that average discharge of the Mekong River in the flood season has decreased (see above). The observation of overall compliance with the PMFM Article 6C is valid for stations along the length of the Lower Mekong, from Chiang Saen to Tan Chau in the delta. Where unstable or severe conditions do occur, this is often the result of storm events, including from typhoons. However, as noted in Chapter Six, intense rainfall events, as well as the frequency of typhoons crossing into the Basin are declining, and there is some evidence that total annual rainfall across the Basin is also declining (see also MRC-LMCWRCC, 2023).

Compliance with PMFM 6C signifies that mainstream flood hazard has been low. Based on this analysis, illustrating very few instances of what are considered ‘unstable conditions’ over recent years, the compliance of flood season flows with PMFM Article 6C is assessed as ‘Very Good’. However, it should be noted that compliance with the PMFM does not consider negative impacts from reduced flood season flows. These include the effects on reduced Tonle Sap reverse flows (see Section 3.2.4) and the negative impacts on wetland areas, fish populations (see Section 3.4.4) and other biodiversity, recession agriculture, and water quality in the Mekong Delta. The considerable reduction in flood season water levels at Tan Chau (Figure 3.6) is therefore a worrying sign when considered from a perspective other than flood safety; hence, this assessment indicator should be interpreted in a broader context. When considering flood conditions more broadly, Article 6B of the PMFM is also considered, and as indicated below, is assessed as ‘Requires Action’.

3 https://pmfm.mrcmekong.org/monitoring/6c

Figure 3.6. Number of days per flood season with annual daily peak flows in each PMFM 6C zone for the stations (a) Chiang Saen, (b) Vientiane, (c) Pakse, (d) Stung Treng, and (e) Kratie, and for water levels at (f) Tan Chau and (g) Chau Doc, 1995–2022

Data source: MRC Hydromet monitoring

3.2.7. Compliance of Tonle Sap reverse flows with the PMFM (Article 6B)

Very Good	Good	Of Concern	Requires Action	Requires Urgent Action

The Mekong River Basin has a unique hydrologic feature that occurs roughly from June to October, when massive floodwater from the

Mekong River flows upstream along the Tonle Sap River reverses its flow and raises water levels in the Tonle Sap Lake. Once the water level of the Mekong River recedes in the dry season, outflow occurs again from the lake to the river and downstream to the delta.

Following Article 6B of the PMFM, accumulated reverse flow volumes at Prek Kdam (regarded as an outlet point of the lake) are determined by combining the available water level data at Kampong Luong and Phnom Penh Port stations. The 1995–2005 period is the reference period, which defines the range of reverse flows within which the annual accumulated flows should fall. Monitoring results are published by the MRC.[4]

Accumulated reverse flow into Tonle Sap has been strikingly low in recent years, with flows in 2020, 2021 and 2022 all below the minimum required over almost the entire duration of the flood season (Figure 3.7). The reduction in reverse flow volumes contributes to substantial reductions in Tonle Sap outflows to the Mekong Delta during the early dry season (MRC-LMCWRCC, 2023). The onset of reverse flows in the last few years has also generally occurred later than during the reference period.

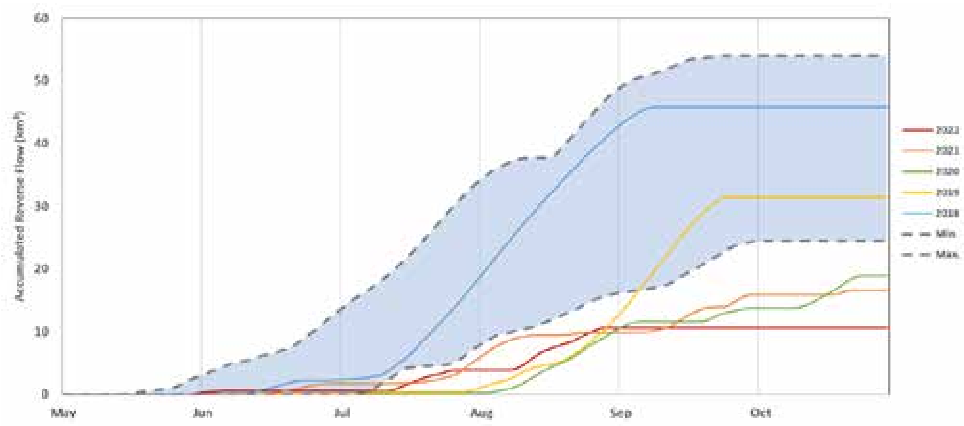


Figure 3.7. Accumulated reverse flows to Tonle Sap in the 2018–2022 period, plotted against the range (min. – max.) of flows occurring in the 1995–2005 reference period for PMFM Article 6B

Data source: MRC Hydromet monitoring

Results from the Joint Study (MRC-LMCWRCC, 2023) also illustrate the reduction in reverse flow to Tonle Sap Lake over the 2010–2020 decade compared to the preceding decade (2000–2009), and the increased gap between the minimum and maximum reverse flows, especially from August to October (Figure 3.8).

4 https://pmfm.mrcmekong.org/monitoring/6b

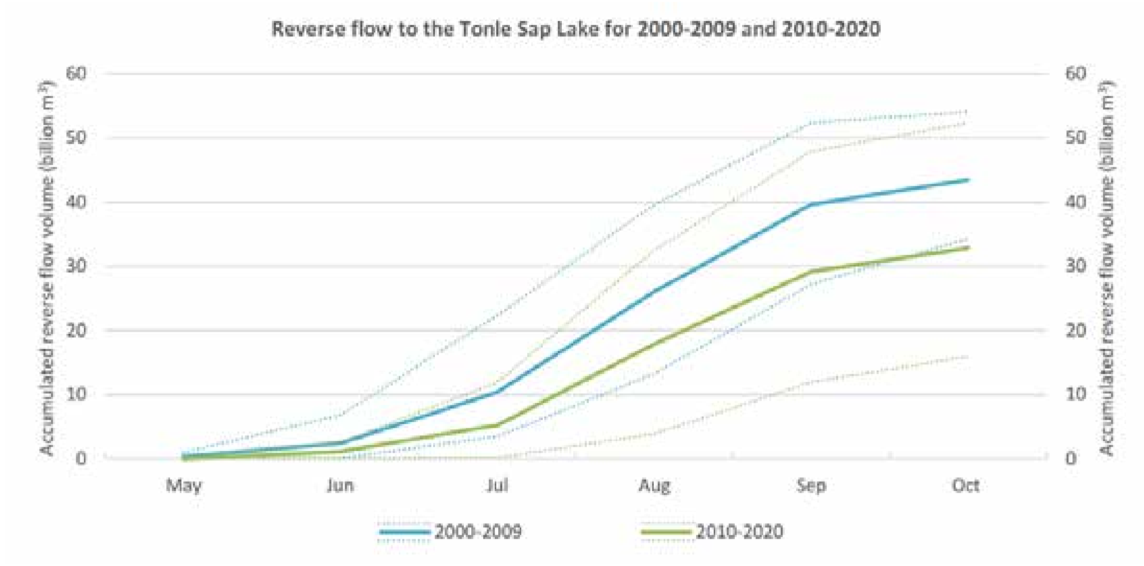


Figure 3.8. Observed minimum, maximum and average reverse flows to the Tonle Sap Lake for the 2000–2009 period (blue) and the 2010–2020 period (green)

Source: MRC Hydromet monitoring, from MRC-LMCWRCC (2023)

The decline in reverse flow volumes can also be expressed by the number of days that PMFM Article 6B has been breached annually since 2006, the end of the reference period (Figure 3.9). The yearly number of breaches has increased significantly ($p < 0.05$) over the 2006–2022 period, to an average of over 100 days per year over the last four years. In all cases, the breach has been of the minimum PMFM threshold, reflecting the lower flood season flows discussed above. Although a higher number of breaches often coincide with El Niño events and severe drought years (MRC-LMCWRCC, 2023), for example, in 2010, 2015–2016 and 2019–2020, the trend towards more breaches over time remains, encompassing years when El Niño events do not occur.

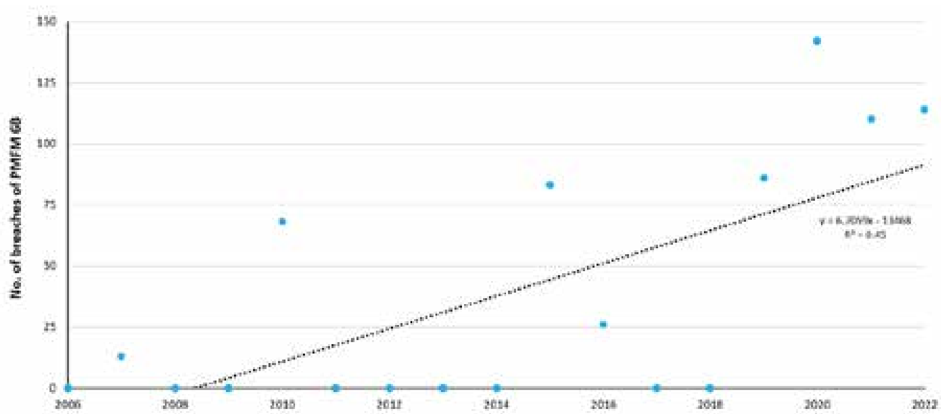


Figure 3.9. Number of days that the PMFM Article 6B was breached per year, 2006–2022

Data source: MRC Hydromet monitoring

The changes in Tonle Sap reverse flows including breaches of PMFM Article 6B are considered of significant concern given the high importance of this hydrological mechanism to ecosystems, fisheries, agriculture and livelihoods in a substantial part of the Basin, not only around Tonle Sap, but throughout the Mekong Delta and with potential implications for food security more broadly. This change is associated with both reduced flood season rainfall, which reduces the flows in the river, and increased storage and water withdrawals throughout the Basin, which are contributing both to reduced accumulated reverse flow volumes and a delayed start to the commencement of reverse flows. Due to the substantial reduction of accumulated reverse flows in recent years, this indicator is assessed as 'Requires Action'. Further investigation of the factors influencing the flow of the Tonle Sap Lake will be undertaken in a subsequent phase of the MRC-MLC Water Joint Study.

3.2.8. Change in the timing of onset of flood season flows

Very Good	Good	Of Concern	Requires Action	Requires Urgent Action

The flood season in the Mekong River Basin is defined as beginning when the flow of the river first exceeds the long-term mean annual discharge. It is one of the four bio-hydrological seasons of the Mekong, preceded and succeeded by transition seasons that connect the dry and flood seasons. The timing of the onset of flood season flows is a key assessment indicator for identifying changes or trends in the hydrological regime with potential for impacts on biodiversity that react to hydrological cues.

For individual years, this assessment indicator is most meaningful at hydrological stations located downstream, such as Pakse and Kratie, where the exceedance of the long-term annual average is clearly associated with seasonality. In the upper parts of the LMB (e.g. at Chiang Saen and Vientiane) the hydrograph is more erratic, and the threshold is increasingly exceeded even in the dry season, likely at least in part due to upstream reservoir management. The analysis in this section therefore focuses on changes in the longer-term average timing of the flood season.

Figures 3.10 and 3.11 present the average daily flows at Vientiane and Kratie, respectively, for two periods, 1981–2010 and 2011–2022. Dashed lines mark critical moments in the annual hydrological cycle, notably: the start of the transition season, a); the onset of flood season flows, b); and the end of the flood season, c). When comparing the two periods, it is clear for both stations that the start of the flood season has occurred later over the last decade than during the 1981–2010 period. The start of the first transition period and the end of the flood season, in contrast, occurred earlier over the last decade than during the 30 years prior. These differences are more pronounced at Vientiane than at Kratie. On average, the length of the flood season decreased by 22 days (16%) at Vientiane, and 11 days (8%) at Kratie; the shifts in flow dynamics visible at Vientiane and Kratie can be considered representative of conditions along most of the Lower Mekong mainstream. Table 3.1 presents the changes in the timing of flood season flows at the mainstream stations, comparing the 2011–2022 period with the 1981–2010 period. With the exception of Chiang Saen, records for all stations paint a similar picture: a somewhat later onset of flood season flows and a slightly earlier end to the flood season, resulting in an overall shorter duration of the flood season. The change in flood season duration at Chiang Saen is not included in the table because the procedure for computing the bio-hydrological seasons does not produce sensible results due to the relatively small difference between wet and dry season flows in the 2011–2022 period.

Figure 3.10. Average daily flows at Vientiane, 1981–2010 and 2011–2022

Note: This figure illustrates: the start of the first transition period, defined as the first day that daily flow exceeds twice the minimum daily flow in the dry season, a) the start of the flood season, defined as the first day that daily flow exceeds the annual average daily flow, b); and the end of the flood season, defined as the last day that daily flow exceeds the annual average daily flow, c).

Data source: MRC Hydromet monitoring

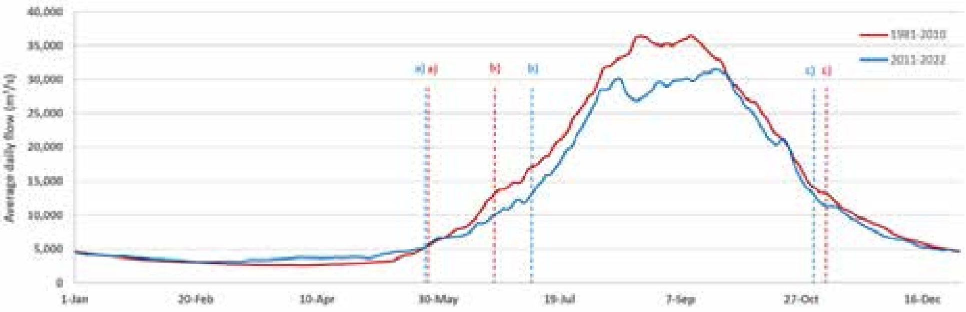


Figure 3.11. Average daily flows at Kratie, 1981–2010 and 2011–2022

Note: The figure illustrates: (a) the start of the first transition period, defined as the first day that daily flow exceeds twice the minimum daily flow in the dry season; (b) the start of the flood season, defined as the first day that daily flow exceeds the annual average daily flow; and (c) the end of the flood season, defined as the last day that daily flow exceeds the annual average daily flow.

Data source: MRC Hydromet monitoring

The shifts in flow dynamics that are visible at Vientiane and Kratie can be considered representative of conditions along most of the Lower Mekong mainstream. Table 3.2 presents the changes in the timing of flood season flows at the mainstream stations, comparing the 2011–2022 period with the 1981–2010 period. With the exception of Chiang Saen, records for all stations paint a similar picture: a somewhat later onset of flood season flows and a slightly earlier end to the flood season, resulting in an overall shorter duration of the flood season. The change in flood season duration at Chiang Saen is not included in the table because the procedure for computing the bio-hydrological seasons does not produce sensible results due to the relatively small difference between wet and dry season flows in the 2011–2022 period.

Table 3.2. Changes in the timing of flood season flows at ten mainstream stations

Station	Start of the flood season (DoY)			End of the flood season (DoY)			Flood season duration (d)		
	1981-2010	*2011-2022*	*Difference*	*1981-2010*	*2011-2022*	*Difference*	*1981-2010*	*2011-2022*	*Reduction*
Chiang Saen*	173	160	-13	314	311	-3	141	151	N/A*
Luang Prabang	178	195	17	315	317	2	137	122	15
Vientiane / Nong Khai	179	194	15	316	309	-7	137	115	22
Nakhon Phanom	169	171	2	302	296	-6	133	125	8
Mukdahan	169	171	2	302	297	-5	133	126	7
Pakse	170	174	4	307	307	0	137	133	4
Stung Treng	172	176	4	313	308	-5	141	132	9
Kratie	173	182	9	312	310	-2	139	128	11
Kampong Cham	176	177	1	313	309	-4	137	132	5
Tan Chau**	199	202	3	352	347	-5	153	145	8

Note: Flood season length is calculated as the difference between the start and end of the flood season.

* For Chiang Saen, the validity of this indicator is questionable, as flows during the wet and dry seasons are relatively similar, for example. the threshold for the start of the transition season according to the standard MRC protocol is currently higher than the flood season onset threshold.

** As discharge records are unavailable for Tan Chau, the start and end of the flood season were based on water level measurements.

Based on the analyses presented above, this indicator is assessed as 'Of Concern'. There has been a clear delay in the timing of the onset of the flood season over recent years, more so at Vientiane than Kratie, and an earlier transition from the flood season to the subsequent dry season. The overall effect of these changes is a shorter flood season, ranging from an average reduction of 4 days at Pakse to a reduction of 22 days at Vientiane. This change in hydrological dynamics has potential implications for riverine and wetland habitats, and dependent biodiversity across the Basin. Further investigation of the causes of these changes and the impacts on ecological conditions and biodiversity may be warranted.

3.3. Water quality and sediment conditions

3.3.1. Assessment methodology

Sufficient water quality and adequate sediment transport dynamics are essential to the health the environment and the human population of the Basin. The water resources of the Mekong River and its tributaries are an important source of drinking water and are essential for agricultural use to produce food grain, fruits and vegetable crops, and for aquaculture and animal husbandry. The transport of sediment and associated nutrients helps maintain fish populations, as well as the fertility of floodplain soils. The annual flood pulse drives the delivery of nutrient-rich sediments to the floodplains, which support agricultural production and human livelihoods.

The strategic indicator 'water quality and sediment conditions' is defined as the extent to which water quality and sediment conditions "have departed from agreed reference points considered necessary for a sustainable environment". The following sections evaluate the status and trends regarding water quality and sediment conditions for the three assessment indicators of the MRB-IF:

- Water quality and ecological health
- Changes in sediment transport
- Extent of salinity intrusion in the delta.

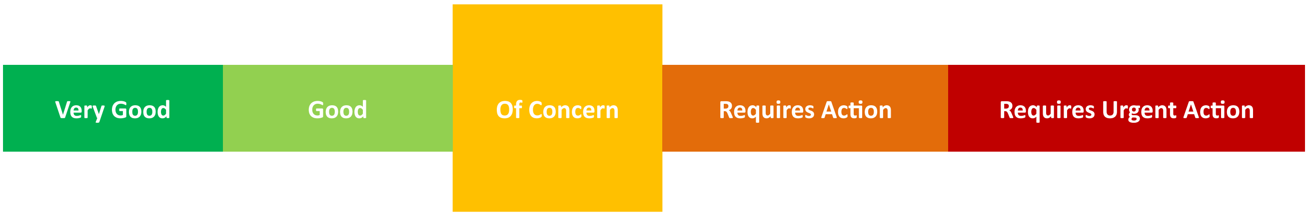
With regard to water quality, the agreed reference points and threshold levels are captured in the PWQ, with the objective to maintain good or acceptable water quality and to promote the sustainable development of the Mekong River Basin (MRC, 2011b). The PWQ include technical guidelines and threshold levels for different purposes of water use, including for the protection of human health, and of aquatic life, and for agricultural use.

An important source of data for examining water quality, ecological health and sediment transport is the MRC's routine water quality, ecological health, and discharge and sediment monitoring activities. With regard to the extent of salinity intrusion in the Mekong Delta, the extent of the river affected by salinity concentrations above 1 g/l and 4 g/l are reported in the MRC's Annual Flood and Drought Reports.

Although not defined as a separate assessment indicator in the MRB-IF, plastic waste pollution is considered an important aspect of overall water quality conditions in the Basin, including due to the contribution of the Mekong to plastic waste in the ocean. Plastic waste pollution is discussed in the next section based on the regional report on the status and trends of plastic waste pollution in the Mekong River (MRC, 2022a).

For the Upper Mekong in China and Myanmar, in the absence of time-series data on water quality, the water quality and sediment conditions were informed by a review of the relevant literature, such as technical reports, policy reports and scientific literature.

3.3.2. Ecological health and water quality compliance with the Procedures for Water Quality



Water quality

Water quality along the Mekong mainstream is evaluated according to the Indices for the Protection of Aquatic Life, Human Health, and Agricultural Use. Based on the data collected at MRC monitoring stations, water quality overall according to these indices is considered satisfactory with most stations rated as either ‘Good’ or ‘Excellent’ (Figures 3.12, 3.13 and 3.14). There has also been an increase over time in the number of stations rating ‘Excellent’ on the index for the Protection of Aquatic Life.

In 2021, 15 out of 22 mainstream Mekong and Bassac River stations were rated as ‘Excellent’ for the protection of aquatic life and 13 stations as ‘Excellent’ for the protection of human health. Only two stations, My Tho and Can Tho in Viet Nam, were rated lower than ‘Good’ in 2021, both with ‘Moderate’ water quality for the Protection of Aquatic Life, and My Tho also with ‘Moderate’ water quality for the protection of human health. My Tho in Viet Nam was also the only station that in some years failed to be rated as ‘Good’ against the Index for Agricultural Use, mostly as a result of salinity intrusion. All other stations are routinely rated as having good water quality for agricultural use, which signifies no negative consequence for general irrigation or paddy rice in relation to electrical conductivity.

Protection of Aquatic Life

No.	Station Names	Rivers	Countries	Class											
				2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
1	Houa Khong	Mekong	Laos	A	A	B	B	B	B	B	B	B	A	A	A
2	Chiang Saen	Mekong	Thailand	B	A	B	B	A	B	B	B	B	A	B	B
3	Luang Prabang	Mekong	Laos	B	A	A	B	B	B	A	B	A	A	A	A
4	Vientiane	Mekong	Laos	A	A	A	B	B	A	A	A	A	A	A	A
5	Nakhon Phanom	Mekong	Thailand	B	A	B	B	A	A	B	B	B	A	A	A
6	Savannakhet	Mekong	Laos	A	A	A	B	B	B	A	A	B	A	A	A
7	Khong Chiam	Mekong	Thailand	A	A	A	B	A	A	A	B	A	A	A	A
8	Pakse	Mekong	Laos	A	A	A	B	B	B	A	A	B	A	A	A
9	Stung Treng	Mekong	Cambodia	B	B	B	B	B	B	B	A	A	A	A	A
10	Kratie	Mekong	Cambodia	B	B	B	B	B	B	A	B	B	B	A	A
11	Kampong Cham	Mekong	Cambodia	B	B	B	B	A	B	A	A	B	B	A	A
12	Chrouy Changvar	Mekong	Cambodia	B	B	B	B	B	B	A	A	B	B	A	A
13	Neak Loung	Mekong	Cambodia	B	B	B	B	B	B	A	A	B	A	A	A
14	Krom Samnor	Mekong	Cambodia	B	B	B	B	B	B	A	A	B	A	A	A
15	Tan Chau	Mekong	Viet Nam	B	B	B	B	B	B	B	A	B	B	B	B
16	My Thuan	Mekong	Viet Nam	B	B	B	B	B	B	B	B	B	B	B	B
17	My Tho	Mekong	Viet Nam	C	C	B	C	C	C	D	C	B	C	C	C
18	Takhmao	Bassac	Cambodia	B	B	B	B	B	B	B	B	B	B	B	B
19	Koh Khel	Bassac	Cambodia	B	B	B	B	B	B	B	B	B	B	B	A
20	Koh Thom	Bassac	Cambodia	B	B	B	B	A	B	B	B	B	A	B	A
21	Chau Doc	Bassac	Viet Nam	B	B	B	B	B	B	B	B	C	C	C	B
22	Can Tho	Bassac	Viet Nam	C	C	C	C	B	B	B	B	B	C	C	C

A	Excellent
B	Good
C	Moderate
D	Poor
E	Very Poor

Figure 3.12. Classes of water quality conditions (Protection of Aquatic Life) for MRC monitoring stations, 2010–2021

Protection of Human Health

No.	Station Names	Rivers	Countries	Class											
				2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
1	Houa Khong	Mekong	Lao PDR	B	A	B	B	C	A	A	B	B	A	A	A
2	Chiang Saen	Mekong	Thailand	B	A	B	B	B	B	B	B	B	A	A	B
3	Luang Prabang	Mekong	Lao PDR	B	A	B	A	B	B	B	A	B	A	A	A
4	Vientiane	Mekong	Lao PDR	B	A	B	B	B	B	B	A	B	A	B	A
5	Nakhon Phanom	Mekong	Thailand	B	B	B	B	B	B	B	B	B	B	A	B
6	Savannakhet	Mekong	Lao PDR	A	A	B	B	C	B	B	A	A	A	A	A
7	Khong Chiam	Mekong	Thailand	B	A	B	B	B	B	B	B	B	A	B	B
8	Pakse	Mekong	Lao PDR	A	A	A	B	A	B	B	A	A	A	B	A
9	Stung Treng	Mekong	Cambodia	A	A	A	A	A	A	A	A	A	A	B	A
10	Kratie	Mekong	Cambodia	A	A	A	A	A	A	A	A	A	A	A	A
11	Kampong Cham	Mekong	Cambodia	A	A	A	A	A	B	A	A	A	A	A	A
12	Chrouy Changvar	Mekong	Cambodia	A	A	A	A	A	A	A	A	A	A	A	A
13	Neak Loung	Mekong	Cambodia	A	A	A	A	A	B	A	A	A	A	A	A
14	Krom Samnor	Mekong	Cambodia	A	A	B	A	A	B	A	A	A	A	A	A
15	Tan Chau	Mekong	Viet Nam	B	B	A	A	A	A	A	A	B	B	A	B
16	My Thuan	Mekong	Viet Nam	C	A	A	B	A	A	A	B	B	A	B	B
17	My Tho	Mekong	Viet Nam	C	B	B	B	B	A	B	B	B	B	C	C
18	Takhmao	Bassac	Cambodia	A	A	A	B	C	A	B	A	B	B	B	B
19	Koh Khel	Bassac	Cambodia	B	A	B	B	A	B	A	A	A	A	A	A
20	Koh Thom	Bassac	Cambodia	A	A	B	B	A	A	A	A	A	A	A	A
21	Chau Doc	Bassac	Viet Nam	C	B	B	A	A	A	A	B	B	B	A	B
22	Can Tho	Bassac	Viet Nam	C	B	A	A	A	A	A	A	B	A	A	B

A	Excellent
B	Good
C	Moderate
D	Poor
E	Very Poor

Figure 3.13. Classes of water quality conditions (Protection of Human Health) for MRC monitoring stations, 2010–2021

Agricultural Use

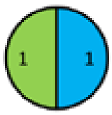
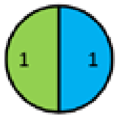
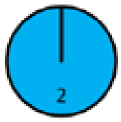
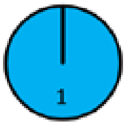
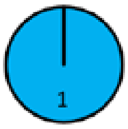
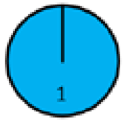
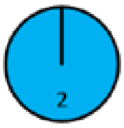
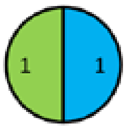
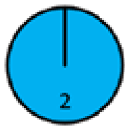
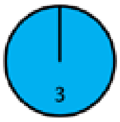
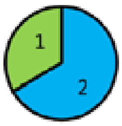
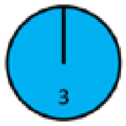
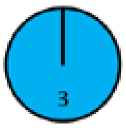
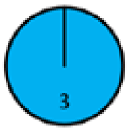
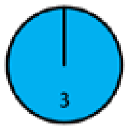
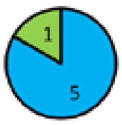
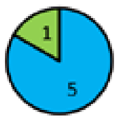
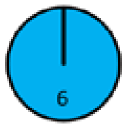
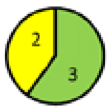
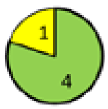
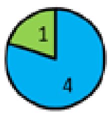
No.	Station Name	Rivers	Countries	Class											
				2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
1	Houa Khong	Mekong	Lao PDR	A	A	A	A	A	A	A	A	A	A	A	A
2	Chiang Saen	Mekong	Thailand	A	A	A	A	A	A	A	A	A	A	A	A
3	Luang Prabang	Mekong	Lao PDR	A	A	A	A	A	A	A	A	A	A	A	A
4	Vientiane	Mekong	Lao PDR	A	A	A	A	A	A	A	A	A	A	A	A
5	Nakhon Phanom	Mekong	Thailand	A	A	A	A	A	A	A	A	A	A	A	A
6	Savannakhet	Mekong	Lao PDR	A	A	A	A	A	A	A	A	A	A	A	A
7	Khong Chiam	Mekong	Thailand	A	A	A	A	A	A	A	A	A	A	A	A
8	Pakse	Mekong	Lao PDR	A	A	A	A	A	A	A	A	A	A	A	A
9	Stung Treng	Mekong	Cambodia	A	A	A	A	A	A	A	A	A	A	A	A
10	Kratie	Mekong	Cambodia	A	A	A	A	A	A	A	A	A	A	A	A
11	Kampong Cham	Mekong	Cambodia	A	A	A	A	A	A	A	A	A	A	A	A
12	Chrouy Changvar	Mekong	Cambodia	A	A	A	A	A	A	A	A	A	A	A	A
13	Neak Loung	Mekong	Cambodia	A	A	A	A	A	A	A	A	A	A	A	A
14	Kaorm Samnor	Mekong	Cambodia	A	A	A	A	A	A	A	A	A	A	A	A
15	Tan Chau	Mekong	Viet Nam	A	A	A	A	A	A	A	A	A	A	A	A
16	My Thuan	Mekong	Viet Nam	A	A	A	A	A	A	A	A	A	A	A	A
17	My Tho	Mekong	Viet Nam	A	A	A	A	A	A	B	A	A	A	C	B
18	Takhmao	Bassac	Cambodia	A	A	A	A	A	A	A	A	A	A	A	A
19	Khos Khel	Bassac	Cambodia	A	A	A	A	A	A	A	A	A	A	A	A
20	Khos Thom	Bassac	Cambodia	A	A	A	A	A	A	A	A	A	A	A	A
21	Chau Doc	Bassac	Viet Nam	A	A	A	A	A	A	A	A	A	A	A	A
22	Can Tho	Bassac	Viet Nam	A	A	A	A	A	A	A	A	A	A	A	A

A	Good
B	Fair
C	Poor

Figure 3.14. Classes of water quality conditions (Agricultural Use) for MRC monitoring stations, 2010–2021

Considering water quality by BioRA zone for the most recent year of data available, 2021, there is a generally lower water quality in Zone 8 than in other BioRA zones (Table 3.3). Zone 8 encompasses the Mekong Delta in Viet Nam (Figure 2.5) and likely reflects the cumulative impacts from upstream catchments as well as sources of poor water quality in the immediate vicinity.

Table 3.3. Classification of water quality in 2021 according to the Procedures for Water Quality, per BioRA zone

BioRA Zone	Protection of Aquatic Life	Protection of Human Health	Agricultural Use
1			
2			
3			
4			
5			
6			
8			

Notes: Zone 1: Houa Khong, Chiang Saen; Zone 2: Luang Prabang; Zone 3: Vientiane, Nakhon Phanom; Zone 4: Savannakhet, Khong Chiam, Pakse; Zone 5: Stung Treng, Kratie, Kampong Cham; Zone 6: Chrouy Changvar, Neak Loung, Kaorm Samnor, Takhmao, Khos Khel, Khos Thom; Zone 8: Tan Chau, My Thuan, My Tho, Chau Doc, Can Tho.

Numbers correspond to the numbers of stations per zone with water quality values in each of the five classes (as indicated in Figures 3.12, 3.13 and 3.14).

The overall classification of water quality conditions is based on the reference values for each water quality parameter defined in the PWQ. Over the 2010–2021 period, reference levels for five key water quality parameters were only rarely exceeded (Figure 3.15). For instance, the dissolved oxygen (DO) reference value of >5 mg/L for aquatic life was only rarely exceeded; i.e. DO levels were generally higher than the reference level, indicating better water quality. Only two stations, Houay Mak Hiao in Lao PDR and Thong Binh in Viet Nam, had a median DO concentration below the reference value over the 2010–2021 period. The reference value of ≥ 6 mg/L for human health was exceeded more frequently, with ten stations out of 48 having a median value below this level between 2010 and 2021, i.e. Houay Mak Hiao in Lao PDR, and Can Tho, Chau Doc, My Tho, My Thuan, Pleiku, Tan Chau, Thong Binh, Tinh Bien and Tu Thuong in Viet Nam.

Nitrate-nitrite (NO3-2) concentrations were consistently well below the reference values for human health and aquatic life (5 mg/L) in all years, with only rare exceedances in 2014 and 2017, at Houay Mak Hiao in Lao PDR. Average median values across all stations were between 0.17 mg/L and 0.25 mg/L during the 2010–2021 period.

Ammonium (NH4N) concentrations were close to, but mostly below, the reference values for the protection of human health (0.05 mg/L), with average median values ranging between 0.04 mg/L and 0.06 mg/L across all stations between 2010 and 2021; however, 15 stations had median concentrations above the reference levels during the same period. Median values were particularly high at Takhmao in Cambodia (0.18 mg/L) and Thong Binh in Viet Nam (0.24 mg/L), although Luang Prabang and Houay Mak Hiao in Lao PDR, and My Tho in Viet Nam also occasionally recorded very high readings of greater than 2.5 mg/L.

The chemical oxygen demand (COD) reference value of 5 mg/L for the protection of human health was only rarely exceeded; stations with a median value above this level from 2010 to 2021 were Houay Mak Hiao in Lao PDR and Chiang Rai and Ubon in Thailand, although several other stations occasionally recorded very high readings – Phnom Krom in Cambodia (up to 15 mg/L), and Vientiane (up to 27 mg/L), Se Bang Fai and Bang Kengdone (up to 22 mg/L) and Houay Mak Hiao (up to 41 mg/L) in Lao PDR.

Since 2010, at mainstream stations, there have been statistically significant trends ($p < 0.05$) over time in the annual median values for water temperature (increasing trend), total suspended solids (decreasing trend) and total phosphorous (decreasing trend). Since 2010, across all 48 LMB water quality stations, there are statistically significant trends in the average median water quality parameters for pH (increasing tend), electrical conductivity (increasing trend), NO3-2 (increasing trend) and total nitrogen (increasing trend) (Figure 3.16).

Average mainstream water temperature increased at an alarming rate, i.e. 1.8 °C between 2010 and 2021 (or 0.16°C per year). Over the same period, mainstream total suspended solids decreased by around 40%, and total phosphorus concentrations by around one-third. The combination of increasing water temperatures, low flow conditions and increasing nutrient concentrations, such as total nitrogen, has the potential to stimulate algae growth, leading to water eutrophication and algal blooms.[5]

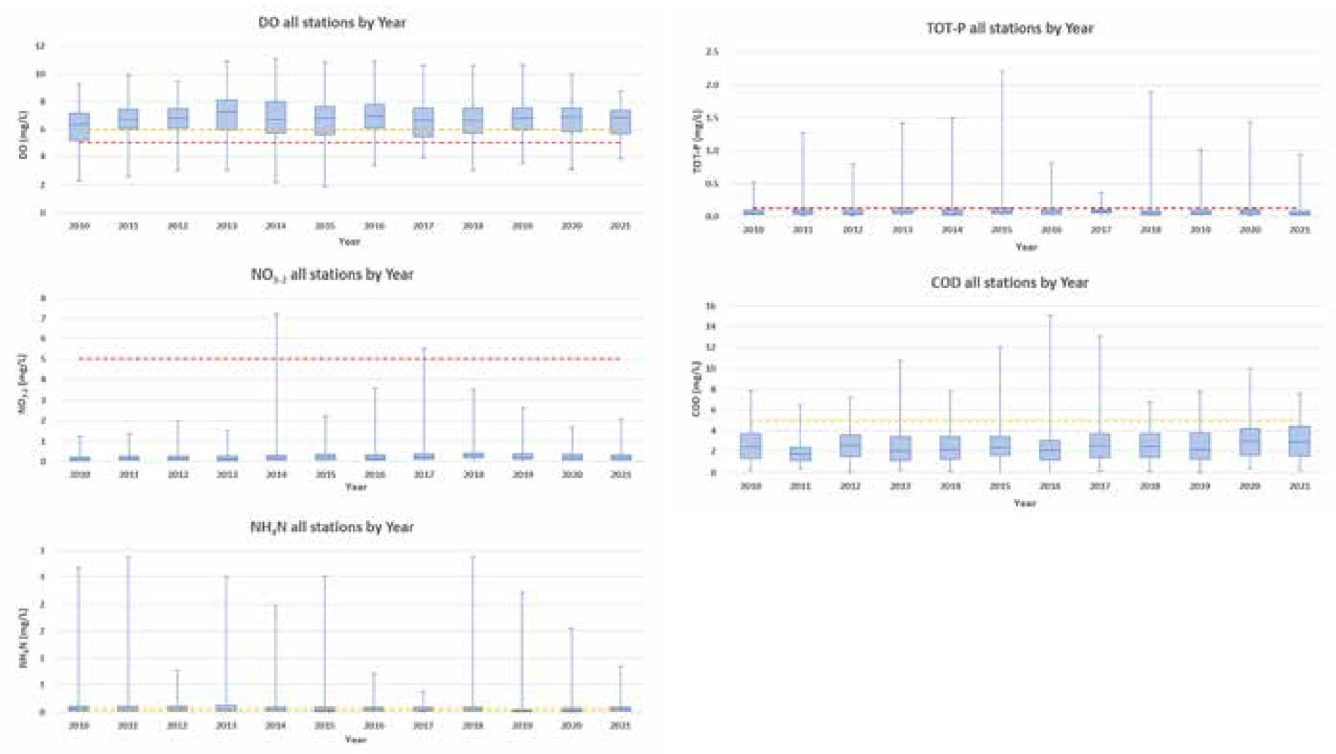


Figure 3.15. Average levels of various water quality monitoring parameters during the dry season

Note: The yellow-dotted line indicates threshold levels for the protection of human health and the red-dotted lines, thresholds for the protection of aquatic life.

Data source: MRC Water Quality Monitoring

5 www.mrcmekong.org/news-and-events/news/mekong-rivers-aquamarine-hue-likely-to-occur-elsewhere-due-to-low-flows-bringing-possible-risks

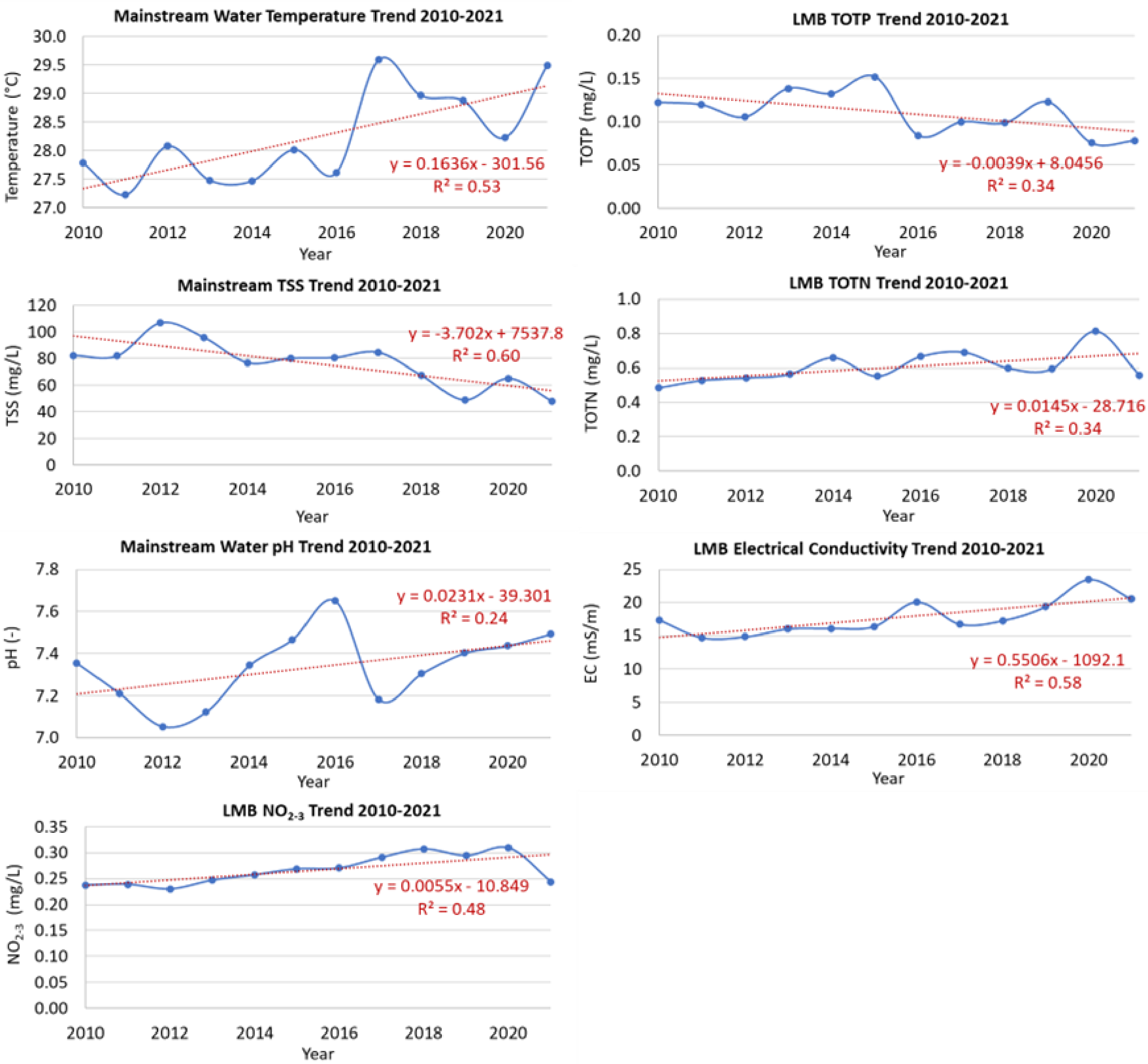


Figure 3.16. Water quality parameters for which a statistically significant trend ($p < 0.05$) was observed between 2010 and 2021 either at mainstream stations (a), or for the entire Lower Mekong River Basin (b)

Data source: MRC Water Quality Monitoring

Although no primary water quality data were available for the UMB in China, water quality is monitored at 38 gauging stations along the stretch of the mainstream in Yunnan Province. According to an environmental quality communique of Yunnan Province in 2014 (cited in Yu et al., 2018), 31 mainstream stations met at least the minimum requirement for drinking and direct human contact. Although local water quality issues are known to occur, these results suggest that water quality on the Mekong mainstream in the UMB was generally acceptable in 2014. A more recent study focused on three stations located in Xishuangbanna Prefecture, and yielded similar results of satisfactory water quality conditions when looking at various parameters including total nitrogen and phosphorus (Wen et al., 2020). However, COD trends point at increasing organic pollution in the Jinghong - Guanlei reach (Tang et al., 2018).

Locally, water quality issues do occur in the Mekong River in both Myanmar and China. Wastewater from mining is increasingly impacting water quality in the UMB. Hotspots of heavy metal pollution include the stretch of the Bi River tributary downstream from Jinding lead-zinc mine (Huang et al., 2016; Yi et al., 2012) and the Loi Kham hills in Myanmar, where extensive unregulated gold mining has led to drinking water pollution and a range of other environmental impacts.[6] Other sources of pollution are wastewater from paper plants, sugar plants, domestic wastewater from Dali City and Jinghong City, as well as fertilizers and chemicals from agricultural fields (Tang et al., 2018). Impacts of the Chinese mainstream reservoirs on water quality are complex, and a clear positive or negative trend cannot be easily identified (Yu et al., 2018).

Ecological health

Four groups of organisms are considered effective indicators of the health of the aquatic environment in the Mekong River Basin: benthic diatoms, zooplankton, littoral macroinvertebrates and benthic macroinvertebrates. Ecological health is evaluated based on the calculation of three metrics for each of these groups of organisms: average abundance, average richness and Average Tolerance Score Per Taxon (ATSPT). A healthy ecosystem is characterized by high average abundance, high average richness, and low ATSPT. Each metric was calculated for individual samples of each group of organisms.

Based on this approach, the ecological health of the river has been relatively good in recent years (Figure 3.17). In 2021, 39 of 41 stations were rated as either ‘Excellent’ or ‘Good’ based on the ecological health classification for the LMB. The number of stations rated as ‘Poor’ declined from seven in 2013 to one in 2019 and then to zero in 2021, and only two stations were rated as ‘Moderate’ in 2021, i.e. Se Bang Fai in Lao PDR, and Nakhon Phanom City in Thailand. Nevertheless, signs of ecological stress are evident in the values for ATSPT across all biological groups.

Trends in species abundance and richness are markedly different for different taxa and stations in each country. For benthic diatoms, the average abundance decreased over time in all countries except for Viet Nam, which saw substantial improvements, although this was mainly due to statistically significant increases at one station, Da Phuoc on the Bassac River. Average

6 https://www.mekongeye.com/2023/01/30/gold-loses-its-shine-myanmar

richness of diatoms improved most notably in Lao PDR at three stations and at one station in Viet Nam, while Cambodia saw declines, with a statistically significant ($p < 0.05$) decreasing trend at six stations.

For benthic macroinvertebrates, there were large declines in both average abundance and richness in Thailand, but Lao PDR generally saw improvements in both abundance and richness, with three stations showing statistically significant improvements in abundance and five stations showing statistically significant improvements in richness over the 2011–2021 period. One station in Cambodia also showed a statistically significant increasing trend in species richness, at Preh Kanlong, Kratie.

For littoral macroinvertebrates, Cambodia saw substantial improvements in average abundance and richness over the 2011–2021 period, although a statistically significant increasing trend ($p < 0.05$) was observed only at only one station, Kampi Pool, Kratie. A statistically significant declining trend in both abundance and richness was evident at one station, Nakorn Phanom City in Thailand.

Average abundance and richness of zooplankton generally improved across all four countries over the 2011–2021 period, with the most substantial increases in Cambodia. Statistically significant increases ($p < 0.05$) in abundance were evident at two stations in Cambodia, and increases in zooplankton richness at six stations in Cambodia.

The threshold values for the ATSPT were exceeded in 2021 for littoral macroinvertebrates at all stations, for benthic macroinvertebrates at 28 stations, for diatoms at 29 stations, and for zooplankton at 15 stations. In 2021 the ATSPT was exceeded at all stations in Viet Nam for all taxa, indicating sites that are under stress and more favourable to taxa that dominate in disturbed environments.

Over the 2011–2021 period, there was a statistically significant deterioration in ATSPT for diatoms at 10 stations, for benthic macroinvertebrates at five stations, and for littoral macroinvertebrates at 18 stations. ATSPT for zooplankton improved at two stations, both in Cambodia.

Location	Waterbody	Site	2011	2013	2015	2017	2019	2021
Se Bang Fai, Khammouan	Se Bang Fai River	LBF	C	D	C	B	C	C
Songkhone, Savannakhet	Se Bang Hieng River	LBH	B	D	C	B	C	B
Done Ngiew, Pathumphone	Mekong River	LDN	A	D	B	B	B	B
Ban Hae, Pakse	Se Done River	LSD	B	D	B	B	B	B
Ban Somsanouk, Attapeu	Sekong River	LKL	C	D	B	C	C	B
Done Chor, Luang Prabang	Mekong River	LPB	A	C	B	B	B	B
Ban Xiengkok, Luangnamtha	Mekong River	LMX	D	C	C	B	C	B
Ban Huayhome, Vientiane	Mekong River	LVT	C	D	B	B	B	B
Nakorn Phanom City	Mekong River	TNP	B	A	B	C	B	C
Songkhram River Junction, Nakorn Phanom	Mekong River	TSM	C	B	A	C	B	B
Na Kae, Mukdahan	Nam Kham River	TNK	B	A	B	B	B	B
Kong Chiam, Ubon Rachathani	Mun River	TMU	C	A	A	B	B	B
Mun River Junction, Ubon Rachathani	Mekong River	TKC	C	B	A	C	C	B
Ubon Rachathani City	Mun River	TUN	A	A	A	A	B	B
Chiang San, Chiang Rai	Mekong River	TCS	B	B	B	D	D	B
Chiang Rai City	Kok River	TKO	B	B	B	C	C	B
Phnom Penh Port	Tonle Sap River	CPP	B	C	C	B	B	B
Kampong Thom	Stung Sen River	CSN	B	C	C	B	B	B
Battambang	Stoeng Sangke River	CSK	C	B	B	B	B	B
Chong Khnease, Siem Reap	Tonle Sap Lake	CCK	B	B	B	B	B	B
Damnak Ampil, Pursat	Pursat River	CPS	B	B	B	B	B	B
Khos Khel, Kandal	Bassac River	CKK	B	B	B	B	C	B
Kampi Pool, Kratie	Mekong River	CKT	A	B	B	A	B	A
Preh Kanlong, Kratie	Prek Te River	CPT	C	D	B	B	B	B
Dey It, Ratanakiri	Sesan River	CUS	C	B	B	A	B	B
Veunsai, Ratanakiri	Sesan River	CSS	B	C	B	B	A	B
Phik, Rattanakiri	Srepok River	CSP	A	B	A	B	A	B
Ramsar Site, Stung Treng	Mekong River	CMR	A	B	B	B	B	A
Kbal Koh, Stung Treng	Sekong River	CKM	B	C	B	A	B	B
D/S Junction with Srepok	Sesan River	CSJ	A	C	C	A	A	A
Neak Loeung, Prey Veng	Mekong River	CNL	B	C	B	B	B	B
Kampong Luong	Tonle Sap Lake	CKL	B	B	B	A	A	B
Prek Kdam Ferry, Kandal	Tonle Sap River	CTU	B	B	C	A	B	B
Phu An, Can Tho	Bassac River	VCT	B	C	B	B	B	B
Long Xuyen, An Giang	Bassac River	VLX	C	C	B	B	C	B
Da Phuoc	Bassac River	VDP	B	C	B	B	C	B
Khanh Binh, An Giang	Bassac River	VKB	B	B	B	B	B	B
Thuong Phuoc, Dong Thap	Mekong River	VTP	B	C	C	C	B	B
Thuong Thoi, Dong Thap	Mekong River	VTT	B	C	B	B	B	B
Cao Lanh, Dong Thap	Mekong River	VCL	B	B	B	B	C	B
My Thuan, Vinh Long	Mekong River	VVL	C	C	B	B	B	B

A	Excellent
B	Good
C	Moderate
D	Poor

Figure 3.17. Overall rating of ecological health for sites across the Lower Mekong Basin, 2011–2021

Data source: MRC Ecological Health Monitoring

Plastic pollution

Pollution of the Mekong River from plastic waste is considered of increasing concern due to the manifold negative impacts on the ecosystem in and around the river and as a contribution to plastic waste in the ocean. Both macroplastics (objects larger than 5 mm) and microplastics (under 5 mm) have harmful impacts on aquatic life through various mechanisms including entanglement and ingestion (often involving bioaccumulation of toxic substances).

In 2021, monitoring of riverine plastic debris pollution in the LMB was carried out by the UN Environment Programme (UNEP) under its Promotion of action against marine plastic litter in Asia and the Pacific (CounterMEASURE II) project. Surveys were conducted to investigate riverine macroplastics, riverine microplastics, plastic leakage hotspots and plastic accumulation hotspots across the Basin. Surveys were conducted by national line agencies, and survey methods varied widely, prohibiting a detailed comparison. Still, a preliminary diagnosis of plastic pollution across the LMB is provided by these monitoring efforts.

Based on this UNEP project, it is estimated that the Mekong River contributes between 17.4 tonnes/day and 101 tonnes/day of plastic debris to the world's oceans (Figure 3.18), which is the 10th largest amount from rivers globally. On average, at an annual scale, the Mekong supplies about 2–3% of the global total for each plastics category to the marine environment. Within the Mekong there is an accumulation of plastic waste downstream, particularly of microplastics. The volume of microplastics at delta sampling locations is roughly 5 to 10 times higher than in locations upstream (Figure 3.18). The volume of macroplastics is more variable, with large volumes collected in both upstream and downstream locations (Figure 3.19). Sources of the plastic waste vary (Figure 3.19): the highest portion of macroplastics come from food wrappers, and the presence of plastic foam is also significant in the Mekong Delta. In artificial barriers, plastic bags and bottles make up more than 50% of the plastic waste in upstream sampling locations.

The MRC is currently in the process of standardizing plastic monitoring procedures in a regional protocol for the long-term and cost-effective monitoring of riverine plastic debris pollution in the LMB (MRC Riverine Plastic Monitoring Methodology). Initial pilot studies have been conducted both in the dry and wet seasons, addressing techniques for monitoring floating microplastics, riverine microplastics, as well as floating and accumulated macroplastics. There are no trend data available yet on riverine plastic pollution in the Mekong Basin. However, in general, there is a strong correlation between plastic waste pollution and population growth and economic development, which are both ongoing processes in the Basin.

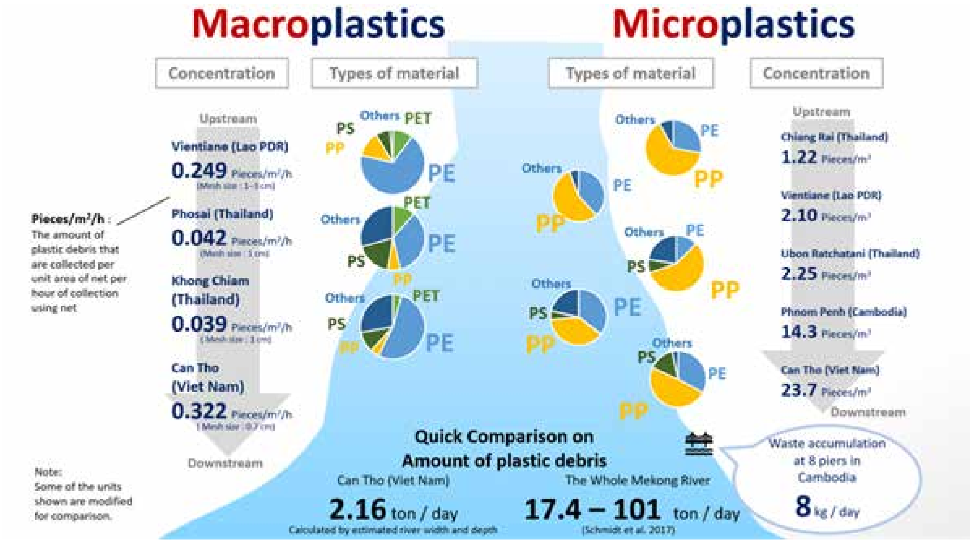


Figure 3.18. A summary of macro- and microplastic types and compositions surveyed by the CounterMEASURE II Project in the Lower Mekong Basin

Note: PP = Polyproylene; PE = Polyethylene; PET = Polyethylene terephthalate; PS = Polystyrene.

Source: UNEP (2020)

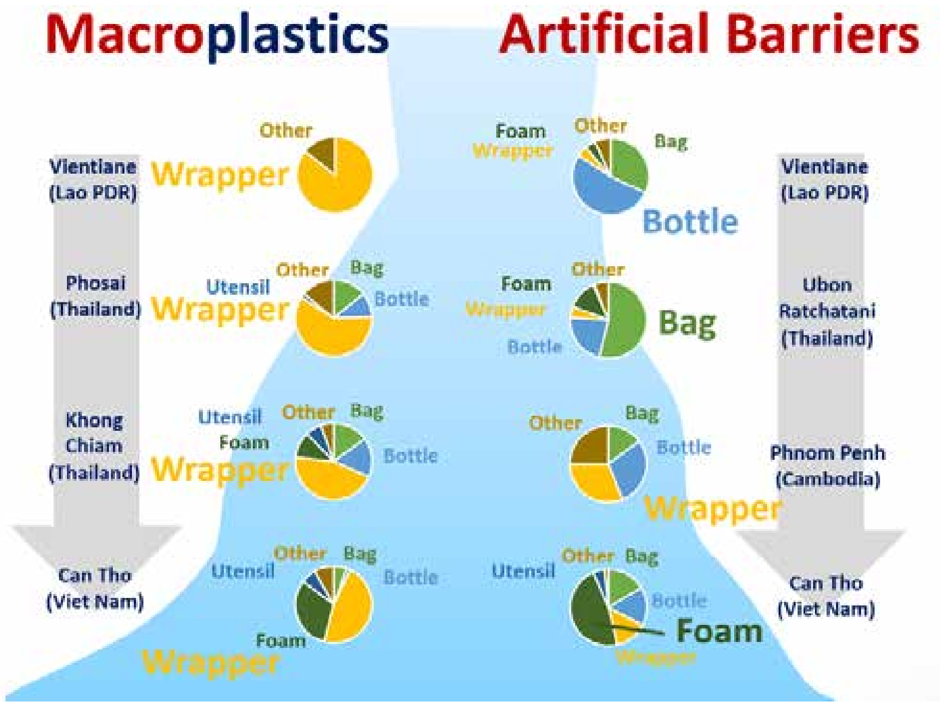


Figure 3.19. A summary of the types of macroplastics collected at artificial barriers in the LMB by the CounterMEASURE II Project

Source: UNEP (2020)

The assessment indicator on water quality and ecological health indicates that, although the concentration of many water quality parameters is considered acceptable in accordance with PWQ Indices for Human Health, Aquatic Life and Agricultural Use, there are several emerging issues that cause this indicator to be considered "Of Concern", particularly: (i) the rapid increase in water temperature over recent years as well as significant temporal trends in some other parameters either in the mainstream or at stations across the LMB; (ii) the ecological stress evidenced by high ATSPT values and increasing trends for many sites across the LMB; and (iii) the high degree of plastic waste pollution in the riverine system. The thresholds for the PWQ may need to be reviewed by taking into consideration current international standards.

In the UMB, local water quality issues occur due to, *inter alia*, contamination with heavy metals (through mining wastewater), pesticides and fertilizers (agricultural wastewater). No updated information on heavy metal, pesticide and fertilizer pollution of the water column, sediments or biota was available for the LMB in this SOBR, representing a significant gap in understanding of whether conditions in relation to these contaminants are improving or deteriorating.

3.3.3. Changes in sediment transport

Historically, enormous amounts of sediment are transported by the Mekong River, from the UMB all the way to the delta. These sediments provide a number of crucial ecosystem services. They are critical for building and maintaining the Mekong Delta, which is increasingly relevant against the backdrop of sea level rise due to climate change. In addition, sediments and attached organic matter help maintain both aquatic and terrestrial ecosystems across the Basin by contributing to primary productivity and soil fertility. While the economies of the basin countries rely on sediment transport and deposition, for, among other reasons, their importance for agriculture and use in the construction industry, excessive amounts of sediment in the river have the potential to negatively impact navigation and other water uses.

Sediment transport by the river is highly variable in both space and time, and depends on, *inter alia*, the carrying capacity of the river and conditions in the upstream catchment related to land management, terrain and geology. Increasing development of the Basin, including land use changes and hydropower projects, is known to impact sediment transport dynamics. To monitor the spatial variability and temporal patterns of sediment concentrations, the MRC discharge and sediment monitoring activity measures suspended sediment concentrations at 15 sites along the Mekong mainstream, the delta, the Tonle Sap River and the Sekong River, and calculates the average annual daily and monthly concentrations (Table 3.4).[7]

Table 3.4. Average daily sediment concentrations (mg/L) by monitoring station by year, 2009–2022

Year	Chiang Saen	Luang Prabang	Chiang Khan	Nong Khai	Mukdahan	Kong Chiam	Stung Treng	Kratie	Chroy Chang Var	Koh Norea	Prek Kdam	MRC OSP	Sekong at Bridge	Tan Chau	Chau Doc	AVERAGE
2009	149		78.9	79.3	250.5	164.1								153.6	80.8	136.7
2010	111		71.2	64.5	237.6	349.5								56.3	41.2	133.0
2011	139	244.8	89.0	123.0	189.4	212.5	159.0	166.8	190.7	174.8	71.3	178.8		118.2	79.4	149.7
2012	216	117.0	90.4	92.9	165.5	125.0	68.4	115.6	109.9	136.1	72.0	146.8	74.1	73.8	46.8	110.0
2013	68	92.9	37.1	60.6	114.0	76.0	46.4	46.5	38.9	42.9	33.0	40.0	53.7	12.1	14.9	51.8
2014	63	94.1	60.5	94.2	142.4	104.6	93.6	105.5	98.4	110.8	60.5	109.1	77.2	82.5	50.4	89.8
2015	418	63.0	38.6	72.4	53.7	95.8	71.9	85.8	44.0	67.2	38.6	55.4	42.3	58.9	37.0	82.9
2018	171		167.3	140.4		108.6	158.7	140.5	106.2	98.0	61.4	146.9	91.4	84.4	60.3	118.1
2019	86	123.3	17.3	40.3	157.8	98.4	68.0	62.2	57.4	52.2	28.8	64.5	81.8	52.3	35.7	68.4
2020	19		55.9	86.6	90.6	234.9	63.5	77.7	55.9	56.7	50.6	57.0	115.4	47.5	42.5	75.3
2021		52.5	61.9	40.3	92.0	180.5	65.0	73.6	57.4	50.6	41.5	58.0	74.6	41.2	33.5	64.5
2022	124	80.1	38.0	51.8	154.5	132.8	55.4	65.3	56.9	55.2	38.9	64.1	51.5	40.4	36.7	69.8

Note: The colour gradient indicating highest to lowest values by year at each station.

Data source: MRC discharge and sediment monitoring

Daily sediment loads are calculated from sediment concentrations and discharge measured at the same locations and times. Based on the trend over the entire period of available data, the average annual daily load from the measured samples across all stations dropped by around half over the 2012 –2022 decade, from approximately 125,000 tonnes/day to around 60,000 tonnes/day (Table 3.5).7 This is generally consistent with the MRC (2019c) review of Discharge and Sediment Monitoring Project of the MRC (DSMP) data up to 2018, which indicated that the reduction in sediment transport previously documented by the DSMP relative to historic levels is continuing. The declining trend is significant ($p < 0.05$) at five of 13 stations examined. (Luang Prabang was excluded due to concerns about data processing.)

7 The record of measurements for sediment concentration and sediment loads is not complete for each month of every year, which may affect the average annual values calculated for some stations. Note, however, that declining trends in suspended sediment concentration are consistent with declining trends in total suspended solids for mainstream stations reported in Section 3.3.2.

Table 3.5. Average daily sediment loads (tonnes/day) by monitoring station, 2009–2022

Year	Chiang Saen	Luang Prabang	Chiang Khan	Nong Khai	Mukdahan	Kong Chiam	Stung Treng	Kratie	Chroy Chang Var	Koh Norea	Prek Kdam	MRC OSP	Sekong at Bridge	Tan Chau	Chau Doc	AVERAGE
2009	43,076		38,021	32,468	301,315	240,903								236,225		148,668
2010	29,743		32,509	26,806	270,876	546,480								72,049		163,077
2011	42,187	119,851	59,333	88,685	305,045	453,687	435,308	496,398	386,263	349,571	38,599	58,137				246,656
2012	61,361	63,808	46,876	39,986	205,449	153,853	130,526	233,854	243,932	241,601	31,472	34,668	36,024	160,834		124,649
2013	10,300	14,608	7,389	12,589	55,284	47,749	38,810	40,303	33,156	33,289	4,085	1,868	8,293	3,975		22,853
2014	15,337	40,601	18,813	55,640	151,757	144,448	201,634	215,031	216,679	184,115	18,813	29,580	36,819	1,790		99,266
2015	118,561	11,549	11,082	17,198	31,915	119,987	111,256	133,383	46,210	70,860	11,082	5,700	9,419	79		52,787
2018	59,738		114,608	107,374		200,516	500,031	363,754	273,292	202,165	30,370	53,214	74,215	149,666		176,912
2019	13,776	28,420	4,194	11,939	69,985	125,102	209,761	142,191	137,805	83,334	12,197	15,853	66,290	70,503		74,072
2020	2,512		18,876	34,647	69,659	274,062	104,007	117,932	86,633	74,474	8,456	7,133	72,150	61,349		71,684
2021		13,960	19,995	15,663	47,385	134,302	103,789	85,187	84,079	79,226	9,183	7,546	35,813	51,995		56,180
2022	33,908	33,624	19,691	28,434	129,149	165,905	109,883	123,407	111,813	92,451	8,510	12,115	26,099	47,163		69,887

Note: The colour gradient indicates highest (darkest) to lowest (lightest) values by year at each station.

Data source: MRC discharge and sediment monitoring

Across all MRC monitoring stations, measurements at only two sites (Chiang Saen and Sekong Bridge) do not show a declining trend in suspended sediment concentrations or loads since 2009. The declining trend in average daily sediment loads is statistically significant ($p < 0.05$) at Mukdahan, ChoyChangVar, Koh Norea, Prek Kdam and MRC OSP (Phnom Penh) (Figure 3.20).

Average daily sediment loads have decreased by more than 75% at Mukdahan over the period since 2009, and by around 70% at MRC OSP (Phnom Penh) since 2011. Suspended sediment concentrations at Tan Chau have approximately halved since 2009 (Figure 3.20). In the absence of sediment rating curves for interpolating between measurements, the annual and monthly data were calculated based on the average of measurements in each month (sometimes with only one measurement in a month). This simplified approach may lead to an insufficient representation of the dynamics of flow conditions, and potentially a bias due to the time of sampling. Nevertheless, as noted above, these trends are broadly consistent with previous results (MRC, 2019).

Chiang Saen is one of the two stations where no decreasing trend is visible in the most recent measurement records, from 2009 to 2022 (Figure 3.21). Measured sediment concentrations at Chiang Saen had already declined substantially prior to 2009 (Figure 3.22), suggesting that suspended sediment transport from the upper to the UMB to the LMB may have now stabilized, albeit at a much lower level.

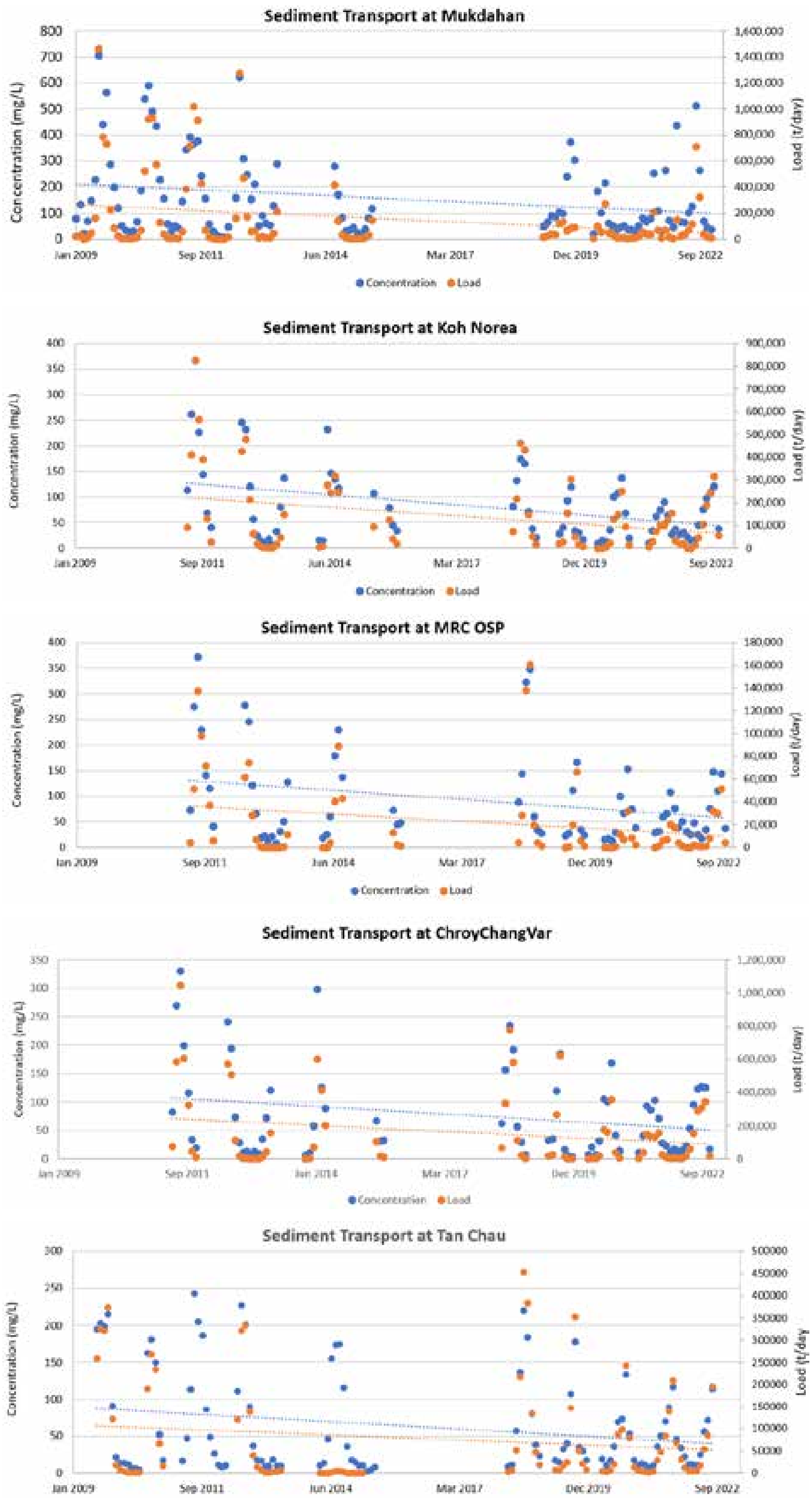


Figure 3.20. Suspended sediment concentrations and loads, 2009–2022, at the DSMP stations for which a statistically significant trend in daily sediment loads was observed

Data source: MRC Sediment and Discharge Monitoring

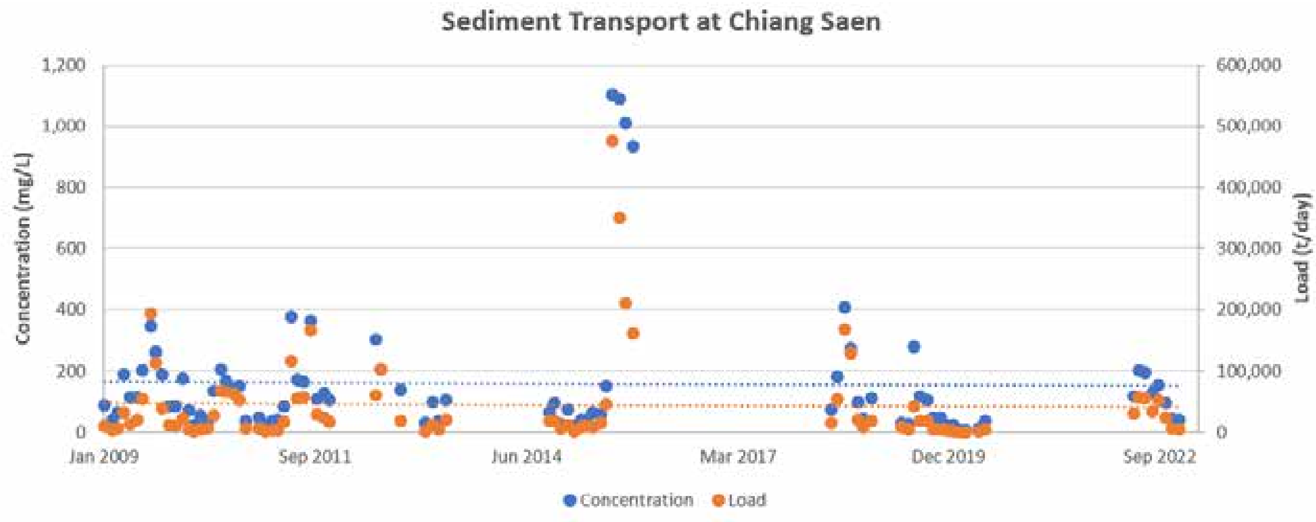


Figure 3.21. Suspended sediment concentrations and loads 2009 and 2022 at Chiang Saen illustrating no trend in either concentration or load

Data source: MRC Sediment and Discharge Monitoring

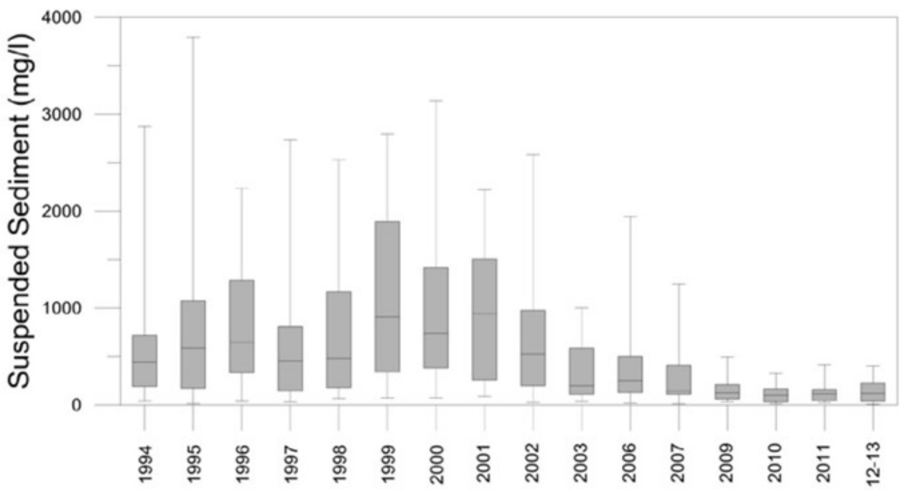


Figure 3.22. Suspended sediment concentrations at Chiang Saen, 1994–2013, illustrating much lower suspended sediment concentrations since around 2003 compared to 1994–2002

Source: MRC (2014) with data from the MRC DSMP and Walling (2005)

Although Luang Prabang was excluded from the analysis mentioned above, in addition to MRC monitoring, the developer of the Xayaburi Hydropower Project, Xayaburi Power shared the initial sediment transport monitoring findings since the project's start. These findings suggest that sediment loads between January 2022 and March 2023 showed no significant change between the impoundment just upstream of Xayaburi and immediately downstream of the project. A more extended data collection period is necessary to comprehensively assess the impact of water infrastructure on sediment transport. The MRC encourages the continued sharing of information and reporting results from developers in line with its guidelines on Joint Environmental Monitoring (JEM) of Mainstream Hydropower.

Grainsize data of bedload samples at Chiang Saen, Nong Khai and Kratie were analysed for recent years, consistent with the methodology in the previous two MRC DSMP reports (2009–2013 and 2014–2018). What stands out at Chiang Saen (Figure 3.23) is the larger proportion of the coarsest class of grain size (> 4.75 or gravel pebbles) from June 2020 onwards. No clear trends are observed for Nong Khai (Figure 3.24). For Kratie, there are clear shifts in grain size distributions towards coarser grain sizes over time (Figure 3.25).

There are no straightforward explanations for the shifts in grain size at Chiang Saen and Kratie in the months and years observed, although as noted in the 2019 DSMP report (MRC, 2019), the coarsening of the bedload is consistent with the generally expected response to upstream dam placement due to trapping of bedload material in the dam and bed materials becoming coarser as finer sediment is winnowed away and not replaced. The 2019 DSMP report, however, also identified a loss of pebbles at upstream stations in 2018 relative to 2011, which is not shown here. Further monitoring and follow-up investigation could help to explain this variability and the drivers of the apparent changes.

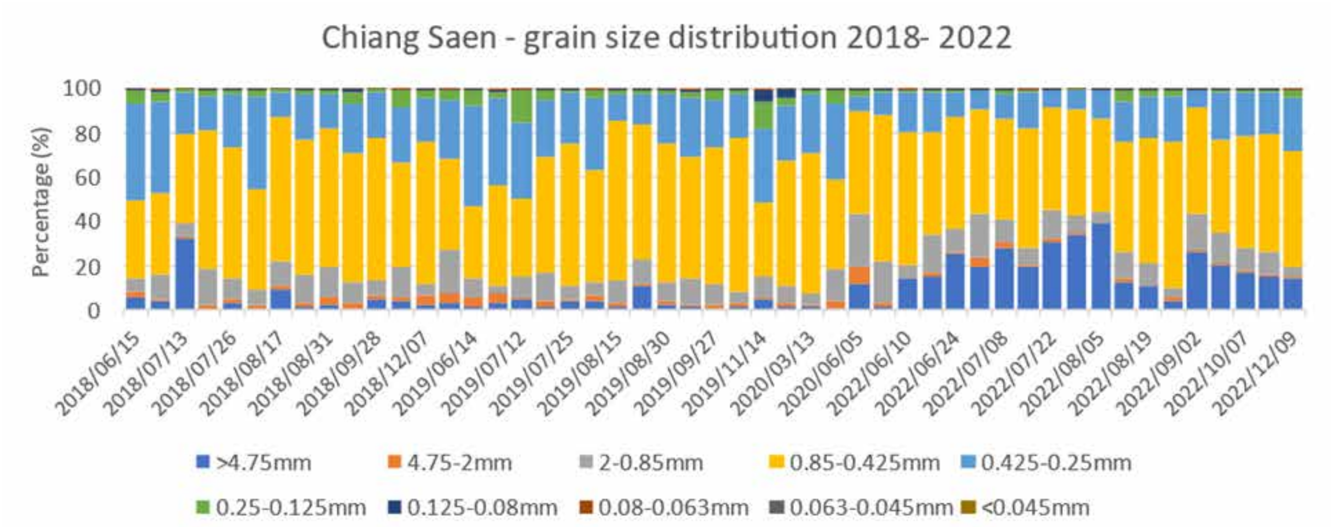


Figure 3.23. Grain size of bedload samples taken at Chiang Saen, 2018–2022

Data source: MRC Sediment and Discharge Monitoring

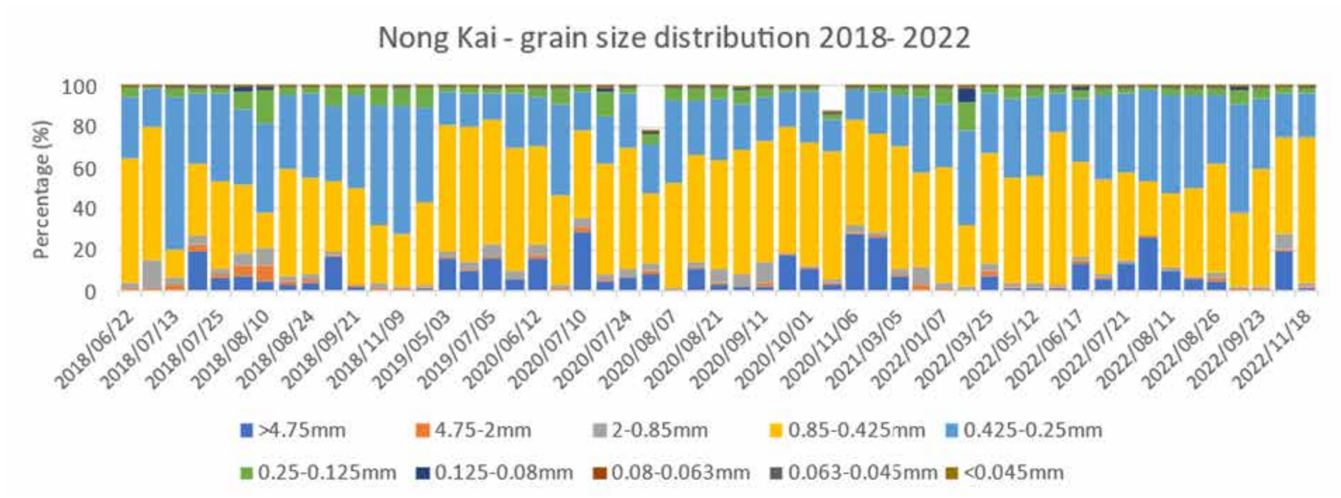


Figure 3.24. Grain size of bedload samples taken at Nong Khai, 2018–2022

Data source: MRC Sediment and Discharge Monitoring

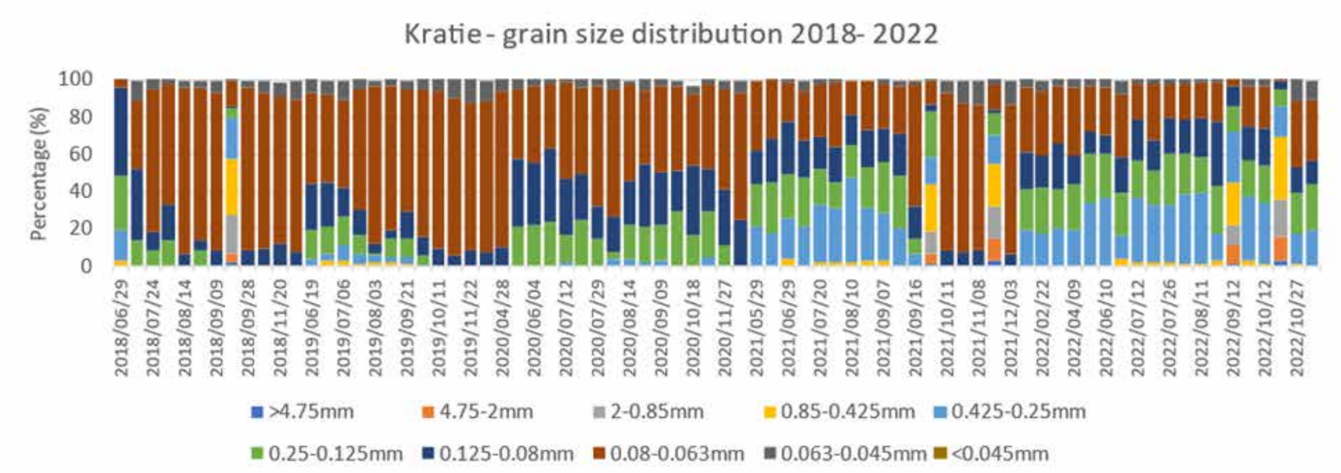


Figure 3.25. Grain size of bedload samples taken at Kratie, 2018–2022

Data source: MRC Sediment and Discharge Monitoring

Historical time series of measured sediment concentration in the UMB in China are available from several studies and reviewed by Yu et al., (2018). Data compiled from 13 stations in the Yunnan section of the Basin show the average sediment concentration in different tributaries ranges between around 0.1 kg/m3 and 1.45 kg/m3. However, sediment loads of the Mekong River are strongly correlated with streamflow dynamics (He et al., 2018), and almost all sediment transport takes place during the monsoon, which is a known phenomenon across the Basin (Henck et al., 2010).

Since hydropower dams are known to affect the intra-annual hydrological dynamics, various studies have looked into the impact of recently constructed reservoirs on sediment concentrations. Focusing on the river stretch immediately downstream of Jinghong, Wang et al., (2020) performed a study based on satellite imagery to explore how the erosion-sedimentation balance has been affected due to upstream reservoir construction, various channel regulation projects and sand mining. They observed a clear reduction of sediment loads and accretion due to reservoir construction while channel regulation and riverbed mining severely affected river morphology and associated erosion-sedimentation processes. Sand mining likely affects the riverbed sediment balance also in other stretches of the Mekong River, but quantitative data on its volumes and impacts are unavailable.

Using different statistical time series analysis techniques, Sun et al. (2022) concluded from long-term sediment measurements that suspended sediment loads have been altered dramatically due to reservoir operations. For the stations of Gajiu (located directly downstream of Manwan Reservoir) and Yunjinghong (located directly downstream of Jinhong Reservoir), reductions of 95% and 99% were observed compared with the period before reservoir construction, respectively. The full-time series of data on suspended sediment load are presented in Figure 3.26 with normalized values (i.e. annual averages were divided by the multi-annual average for each station).

The increasing trend from the 1960s until the early 1990s can be ascribed to changes in land use as a consequence of increased economic development, such as the replacement of natural forest by plantations (Liu et al., 2013). The impact of reservoir construction is clearly reflected in sediment discharges post-1993, the year of the impoundment of Manwan Reservoir. Remarkable declines of 64% and 75% since 1993 were observed at Gajiu and Yunjinghong (data from Lu et al., 2006, cited by Yu et al., 2018). These can be attributed to the trapping of sediment by the reservoir: 54% of Manwan Reservoir had already filled with sediment during the 1992–2005 period (Mei et al., 2006, cited by Yu et al., 2018). Consistent with the results for Chiang Saen mentioned above, there has been very little further change in sediment loads at these two sites since around 2009.

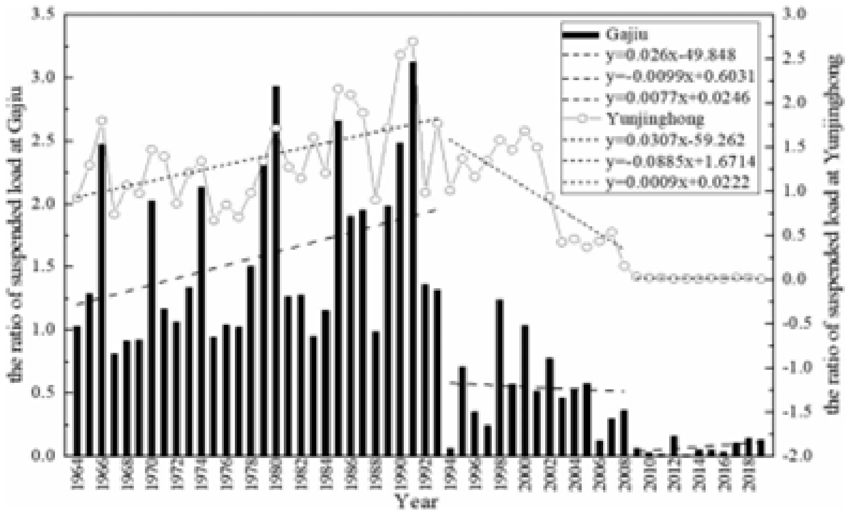


Figure 3.26. Normalized annual suspended load at Gaiju and Yunjinghong, 1964–2019

Source: Sun et al. (2022)

Due to its steeply sloped terrain and hard rock, the basin in Myanmar has significant potential capacity for generating coarse sediments such as sands and gravel. However, no quantitative data of suspended sediments or bed load were available for analysis. Changes in sediment concentration in this part of the Basin can be expected due to land-use changes (particularly, deforestation, increased mining operations, expansion of agriculture and plantations) and increasing climatic extremes. Several dam projects are planned on tributaries in Myanmar, including one already operational.

From the analysis presented above (and consistent with water quality monitoring results reported in Section 3.3.2), it is clear that sediment transport has decreased significantly over the past 10 to 20 years due to water resources development throughout the Basin. Although the reduction in sediment load that has been evident at Chiang Saen since around 2009 stabilized at a much lower level, the decrease is not limited to a particular stretch of the river, as it has been observed at sites along the Chinese section of the river all the way to Tan Chau, where the sediment is of potential significance to building and maintaining the Mekong Delta. The potential impacts of a loss of sediment include increased riverbank, bed and coastal erosion, reduced nutrient deposition on the floodplain, and exacerbation of land subsidence issues in the delta, especially in combination with sand mining. Urgent action is required to address the issue of reduced sediment loads in the river and their delivery to lower floodplains and the delta. As a result, this indicator is assessed as 'Requires Urgent Action'.

3.3.4. Extent of salinity intrusion in the Mekong Delta

Very Good | Good | Of Concern | Requires Action | Requires Urgent Action

Data availability on salinity intrusion in the delta is relatively limited to only a few years in the MRC's annual Mekong flood and drought reports. This indicator focuses on the area of the delta affected by salinity intrusion at concentrations of 1 g/l and 4 g/l; the data only consider the maximum distance inland of these salinity concentrations each dry season (e.g. MRC, 2023a).

In the Mekong and Bassac Rivers, data for each of three years, 2016, 2020 and 2021, show salinity concentrations of greater than 4 g/l extending much further inland than the long-term average and the average of the last decade (Table 3.6). For example, on the Bassac River in 2016, salinity concentrations of 4 g/l extended an additional 23 km inland, and in 2020, an additional 28 km inland. Only a few individual years of data were available, and 2020 showed the greatest salinity intrusion at a concentration of 4 g/l, with an additional 22 km inland on the Mekong River and an additional 28 km on the Bassac River compared to the long-term average. For salinity concentrations of 1 g/l, the increased salinity intrusion was 29 km on the Bassac River and 35 km on the Mekong River in both 2016 and 2020 (MRC, 2023a). As presented in Section 6.3.6, 2020 followed a year with large areas of severe and extreme meteorological and hydrological drought throughout the LMB.

Table 3.6. Distance inland where salinity concentrations exceeded 4 g/l and 1 g/l in April 2016, 2020 and 2021, compared to the 2012–2020 average and the long-term average

	Mekong (km)		Bassac (km)	
	4 g/l	1 g/l	4 g/l	1 g/l
April 2016	52	80	70	82
April 2020	62	80	75	82
April 2021	46	53	56	65
2012–2020 average	36	58	33	58
Long-term average	**40**	**45**	**47**	**53**

Data source: MRC annual flood and drought reports from reporting by Member Countries

Due to the use of water control infrastructure in the delta, extensive riverine salinity intrusion does not necessarily translate into significant areas of agricultural land being affected. However, when gates and sluices are closed to protect farmland from saline water, this also limits the capacity to use freshwater for irrigating crops, which is a negative consequence of high riverine salinity intrusion.

To better understand the area of land affected by salinity, the MRC has been working to develop and implement a methodology using satellite-derived data of salinity concentrations across the transboundary Mekong Delta (Simons, 2022c). This approach has the advantage of allowing extensive time series and spatial data to be generated and is especially useful for evaluating relative changes and trends over time; however, due to a lack of ground-truthing, it was not ready for inclusion in this SOBR. It is anticipated that further development of the approach in conjunction with ground-truthing will enable its use in future to support a more comprehensive periodic assessment of the conditions and trends in salinity intrusion in the Mekong Delta.

The MRC's Water Quality Monitoring Network (WQMN) also monitors electrical conductivity at stations throughout the Basin. Only at My Tho station were the MRB-IF thresholds of 1 g/L (EC = 150 mS/m) and 4 g/L (EC = 620 mS/m) exceeded, in total on six occasions and one occasion, respectively, during the 2011–2020 period (Figure 3.27). However, despite most stations not recording values above the threshold levels, significant increasing trends are observed in all but two WQMN stations in the delta (Section 3.3.2). These trends are also observed at sites located inland, not typically prone to salinity intrusion.

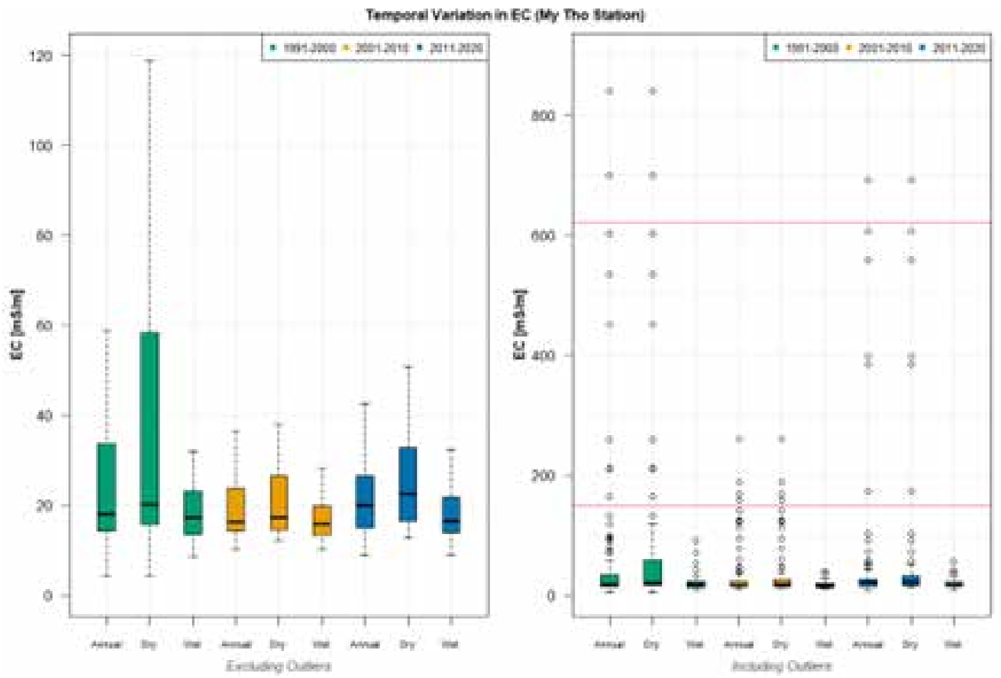


Figure 3.27. Electrical conductivity levels at My Tho Station, 1991–2000, 2001–2010 and 2010–2020, at annual and seasonal scales

Data source: MRC Water Quality monitoring

Salinity intrusion in the Mekong Delta is assessed as 'Of Concern.' The significant depth inland of salinity intrusion in recent years for which data are available, well beyond long-term average distances for both 4 g/l and 1g/l concentrations, and the trends toward higher electrical conductivity at water quality monitoring stations (Section 3.3.2) have the potential for negative impacts on agriculture, human health and ecosystems. Elevated salinity levels may be related to the changes in flow conditions upstream due to multiple causes, which are resulting in reduced Tonle Sap outflows early in the dry season, as well as sea-level rise (Section 6.3.2) and other local factors. Further investigation of this issue is warranted to identify the long-term trends in salinity intrusion, potential causes of any changes and the areas affected, and whether further options are needed to mitigate the impacts.

3.4. Status of environmental assets

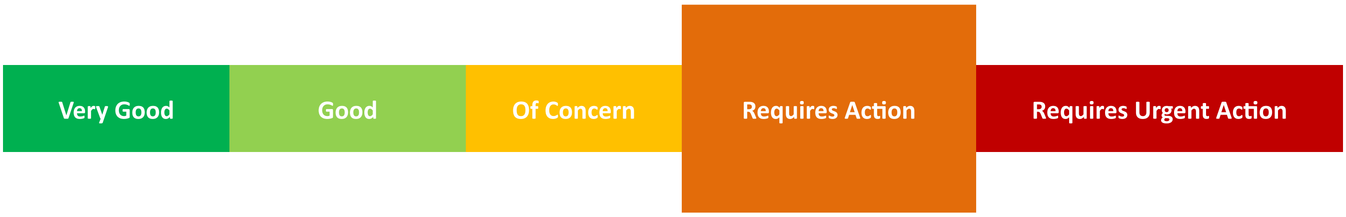
3.4.1. Assessment methodology

The environmental assets of the Mekong River Basin are diverse, as are the methods and data required for this comprehensive set of four assessment indicators. Spatial data both from MRC initiatives and third parties have been analysed to describe the status of the Basin's environmental assets. Data sources include the MRC Wetland and Land Use/Land Cover Datasets, and the MRC Wetland Mapping Project, as well as data from the Fish Abundance and Diversity Monitoring (FADM) activity. For the UMB, due to more limited data availability, secondary data were obtained from literature review, where available.

The following sections evaluate the status and trends of environmental assets for the four assessment indicators of the MRB-IF:

- Extent of wetland area
- Condition of riverine, estuarine and coastal habitats
- Condition and status of fisheries and other aquatic resources
- Condition and status of ecologically significant assets.

3.4.2. Extent of wetland area



The MRC's Water Quality Monitoring Network (WQMN) also monitors electrical conductivity at stations throughout the Basin. Only at My Tho station were the MRB-IF thresholds of 1 g/L (EC = 150 mS/m) and 4 g/L (EC = 620 mS/m) exceeded, in total on six occasions and one occasion, respectively, during the 2011–2020 period (Figure 3.27). However, despite most stations not recording values above the threshold levels, significant increasing trends are observed in all but two WQMN stations in the delta (Section 3.3.2). These trends are also observed at sites located inland, not typically prone to salinity intrusion.

MRC land use/land cover products include various classes of wetland types. The spatial extent of different wetland types across the LMB in 2020 is illustrated in Figure 3.28. The total area of wetlands in the LMB is around 180,000 km², of which around 30,000 km², or 17%, are considered 'natural wetlands,' and the rest mostly either paddy rice fields or aquaculture ponds. Although the water bodies class in MRC land use/land cover mapping includes some artificial wetlands, such as reservoirs and other impoundments on rivers and streams throughout the Basin, in Table 3.7, the areas are adjusted to only include 'natural' water bodies.

Due to the different methodologies applied over time between different land use/landcover maps, it is not possible to identify changes over time in wetland areas from these products alone. In addition, no consideration has been given to inundation dynamics (e.g. inundated grassland vs. dryland grassland) or changes in frequency, depth or duration of flooding that have the potential to affect the ecological character of wetlands throughout the Basin and therefore the quality and quantity of ecosystem services they provide. Nevertheless, the loss of wetlands and their conversion to rice fields and other cropping areas has been well-established, as previously reported in the SOBR (MRC, 2019b) and other technical assessments by the MRC (e.g. MRC, 2017a). Ongoing reductions in the area of mangrove forests in the delta are reported in Section 3.4.3. Mangroves play an important role in buffering coastal areas affected by sea-level rise (Section 6.3.2) and typhoon-induced storm surge. Reductions in flood extents and flood season water levels are also likely to significantly impact wetland areas, and therefore this indicator is assessed as 'Requires Action'.

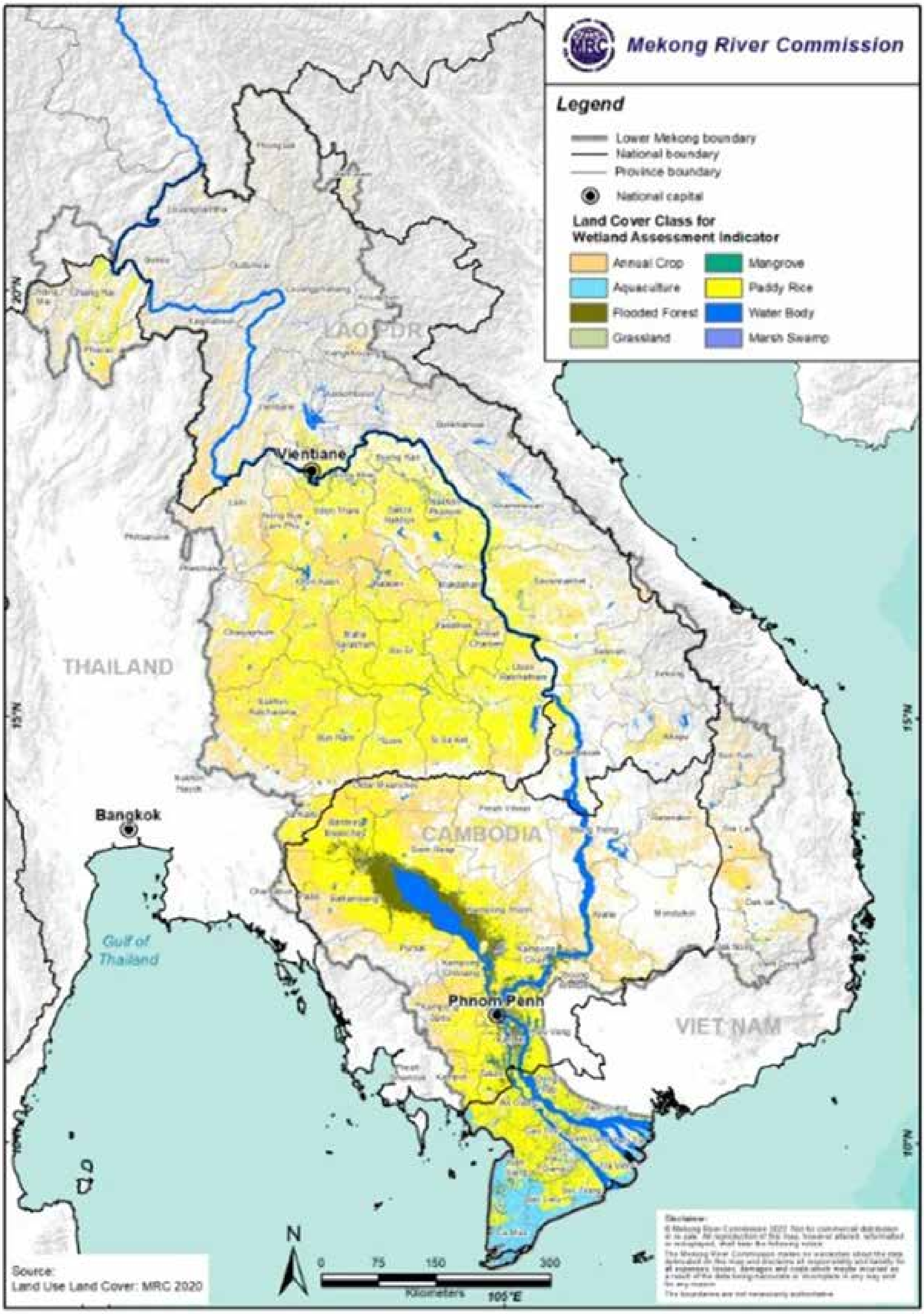


Figure 3.28. Wetland classes (and annual crops) in the Lower Mekong Basin

Data source: MRC Land Use/Land Cover (2021)

Table 3.7. Extent of wetlands by class in the Lower Mekong River Basin, 2020

Wetland type	Extent of wetland area (km²)					
	Cambodia	Lao PDR	Thailand	Viet Nam	Lower Mekong River Basin	
Flooded forests	9,075	12	2	1,105	10,194	5.7%
Inundated grasslands	5	27	11	11	54	0.0%
Marshes and swamps	2,626	2,843	1,778	1,814	9,061	5.1%
Mangroves	0	0	0	914	914	0.5%
Water bodies (natural)	4,352	1,758	2,325	1,225	9,660	5.4%
Total natural wetlands	**16,059**	**4,640**	**4,116**	**5,069**	**29,883**	**16.8%**
Aquaculture	229	215	1,069	8,396	9,910	5.4%
Inundated rice fields	38,706	10,844	73,800	15,116	138,467	77.7%
Total	**54,994**	**15,699**	**78,985**	**28,581**	**178,260**	

Data source: MRC Information System

3.4.3. Condition of riverine, estuarine and coastal habitats

Insufficient data or information to draw a conclusion

There are seven monitoring parameters in the MRB-IF for evaluating the condition of riverine, estuarine and coastal habitats: (i) area of vegetated riparian habitat; (ii) area of riverbank erosion; (iii) area of coastal erosion; (iv) area of rocky habitats; (v) depth of deep pools; (vi) area of sandy habitat; and (vii) area of mangrove forest. To better understand the condition of these habitats, the MRC has been working to develop and implement a systematic methodology using satellite-derived data to track changes in the areas of riparian vegetation, sandy habitat, riverbank and coastal erosion and mangrove forest (Simons, 2022a).

This approach has the advantage of allowing extensive time series and spatial data to be generated and is especially useful for evaluating relative changes and trends over time; however, due to a lack of ground-truthing, it was not ready for inclusion in this SOBR. It is anticipated that further development of the approach in conjunction with ground-truthing will enable its use in the future to support a more comprehensive periodic assessment of the conditions and trends of riverine, estuarine and coastal habitats. Only the area of mangrove forest is included because this is based on existing MRC land use and land cover (LU/LC) mapping.

Area of mangrove forest

The MRC LU/LC products show a steady decline of the area of mangrove forest in the Mekong Delta, which is consistent with other analysis, for example, from the Mekong SERVIR Regional Land Cover Monitoring System data. Based on the MRC 2020 LU/LC product, the extent of mangroves in 2020 was 915 **km²**. This is approximately half of the 1,839 **km²** of mangrove forest in the MRC's 2003 land cover map of the LMB (Figure 3.29).

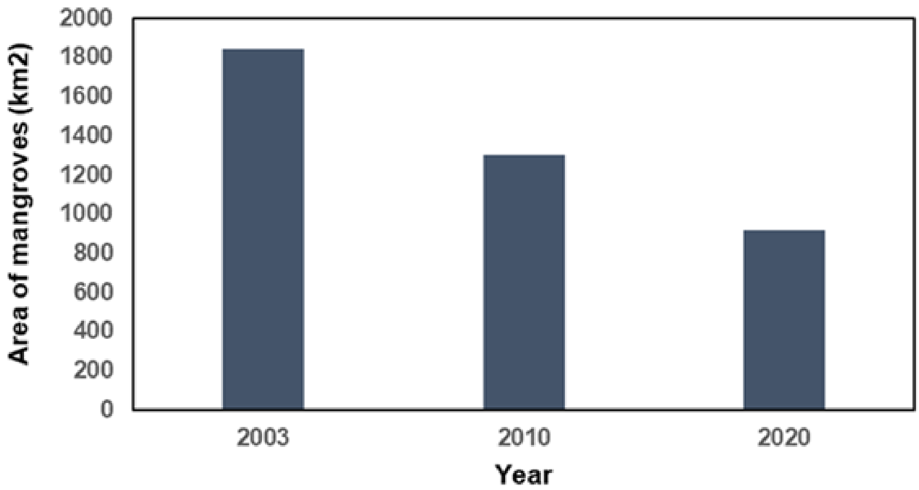


Figure 3.29. Area of mangroves assessed in the MRC's land use/land cover maps, 2003–2020

Data source: MRC Land Use/Land Cover (2021)

The riverine, estuarine and coastal habitats of the Mekong River Basin are highly variable both spatially and temporally because they encompass both terrestrial and aquatic environments, and different degrees and types of vegetation cover that are influenced by hydrological conditions. Most of the habitats highlighted in this section have undergone considerable changes over many decades, as found in the MRC Council Study (MRC, 2017a), which was based on expert judgment and reported in the 2018 SOBR (MRC, 2019b). However, except for the area of mangrove forests, there are insufficient data or information from sources or methodologies approved by MRC Member Countries to report the updated status of conditions and trends in these habitats for this SOBR.

3.4.4. Condition and status of fisheries and other aquatic resources

Very Good	Good	**Of Concern**	Requires Action	Requires Urgent Action

The condition and status of fisheries and other aquatic resources is assessed in relation to monitoring parameters for: (i) fish abundance; (ii) fishing effort; (iii) fish size; (iv) fish diversity; (v) other aquatic animals/ plants (OAAs/Ps) abundance; (vi) OAA/P harvest effort; (vii) OAA/P diversity; (viii) diversity and abundance of non-native species; and (ix) abundance of other wetland-dependent biodiversity. Data are sourced from the updated MRC fisheries habitat yield assessment (MRC, 2023b), the MRC's FADM and the International Union for Conservation of Nature (IUCN) Red List of Threatened Species.

Fish abundance

The total fish yield from the LMB is estimated periodically based on the area of major fish habitat types and on household and fisher surveys on amounts of their catch in different habitats (Figure 3.30) (MRC, 2023b). Available data suggest that annual finfish yield from the LMB ranges from 1.5 million tonnes to – 1.7 million tonnes, and an annual OAA yield of around 443,000 tonnes (Table 3.8; MRC, 2023b). The estimate is within the range, but at the lower end, of the estimate provided in the SOBR 2018 (1.3 million – 2.7 million tonnes). These data represent a considerable reduction, of around 25–30%, in the estimate of fish catch since the 2000 and 2010 surveys due in part to changes in the assessment methodology, which now takes better account of actual flood conditions in the flood zone during the period of assessment.

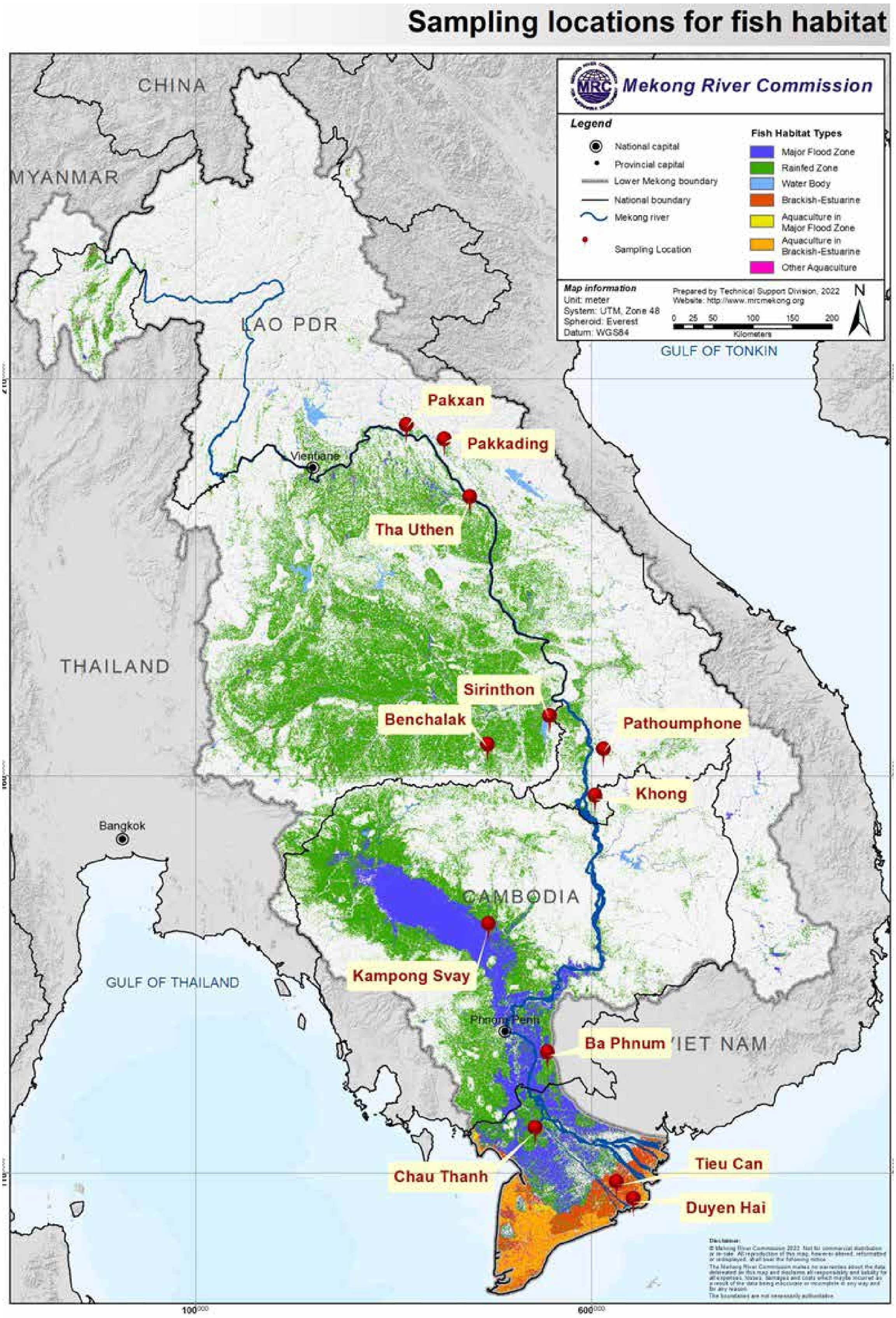


Figure 3.30. Spatial distribution of fish habitat types and locations of survey villages

Source: MRC (2023b)

Table 3.8. Estimated total inland capture fishery yields (tonnes) in each Lower Mekong River Basin country based on SIMVA and household surveys, and area of habitat

Habitat zone	Cambodia	Lao PDR	Thailand	Viet Nam Delta	Viet Nam Highlands	LMB
Major flood zone	245,466	24,156	18,930	94,398	4,092	294,549
Rainfed	238,235	59,394	450,447	49,178	4,896	747,550
Water bodies	2,836	22,448	20,297	23	4,076	48,868
Brackish-estuarine	379			271,091		271,469
Total yields for area of each habitat type in each province	**486,963**	**105,998**	**489,674**	**414,689**	**13,064**	**1,510,388**
Total based on mean yield per area of each aquatic habitat type in each country	**643,384**	**148,680**	**602,633**	**301,090**	**16,533**	**1,712,320**

Data source: MRC (2023b)

Most of the fisheries yield in the Basin is harvested from rainfed and flooded habitat, contributing 53% and 25% of the catch, respectively. The brackish water zone, especially in Viet Nam, contributes around 18%, while water bodies, mostly artificial reservoirs and storages, are the least productive fish habitats. This distribution of catch highlights the importance of protecting and preserving these key habitats to sustain fish stocks.

For the LMB, fish abundance was also evaluated from 2007 to 2022 from FADM fish catch data for each Biological Resources Assessment (BioRA) zone along the mainstream, with an additional Zone 3S encompassing the 3S rivers (Sesan, Srepok and Sekong) and Zone 8 in the Viet Nam part of the Mekong Delta divided into freshwater (8a) and estuarine (8b) areas (Figure 2.5). Fish abundance over the period, as reflected in fish catch biomass, is highest in Zone 7, followed by Zones 6 and 8, which together encompass the Tonle Sap Lake and River, and the Mekong Delta.

Over the 2007–2018 period, average fish abundance from catch data either increased or was stable at three out of six BioRA zones evaluated (Figure 3.31). In two zones, Zones 4 and 8, there was a substantial decline in fish abundance. These two zones encompass the area around Khone Falls in the border region between Lao PDR and Cambodia and the Viet Nam Mekong Delta. More recently, from 2018 to 2022, there was a general decline in total catch monitored across all zones except in Zones 1, 2 and 8, where the catch either remained stable or increased. In zones where catch declined, the decline was greatest in Zones 3S, 6 and 7 (Figure 3.32).

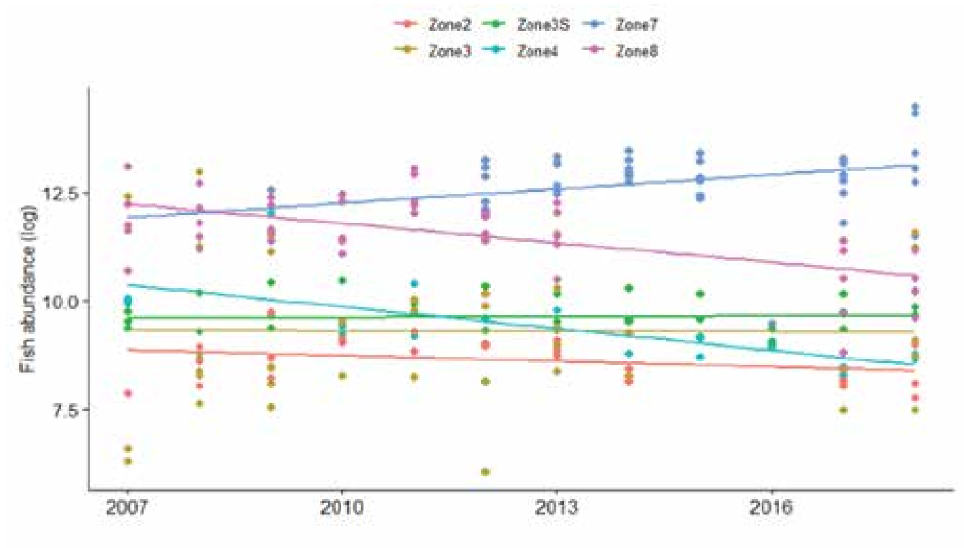


Figure 3.31. Scatterplot of monthly fish abundance by year in the MRC BioRA zones and Zone 3S, 2007–2018

Note: This figure shows the relative changes over time with a linear fitted model rather than actual amounts caught.

Source: MRC (2021g)

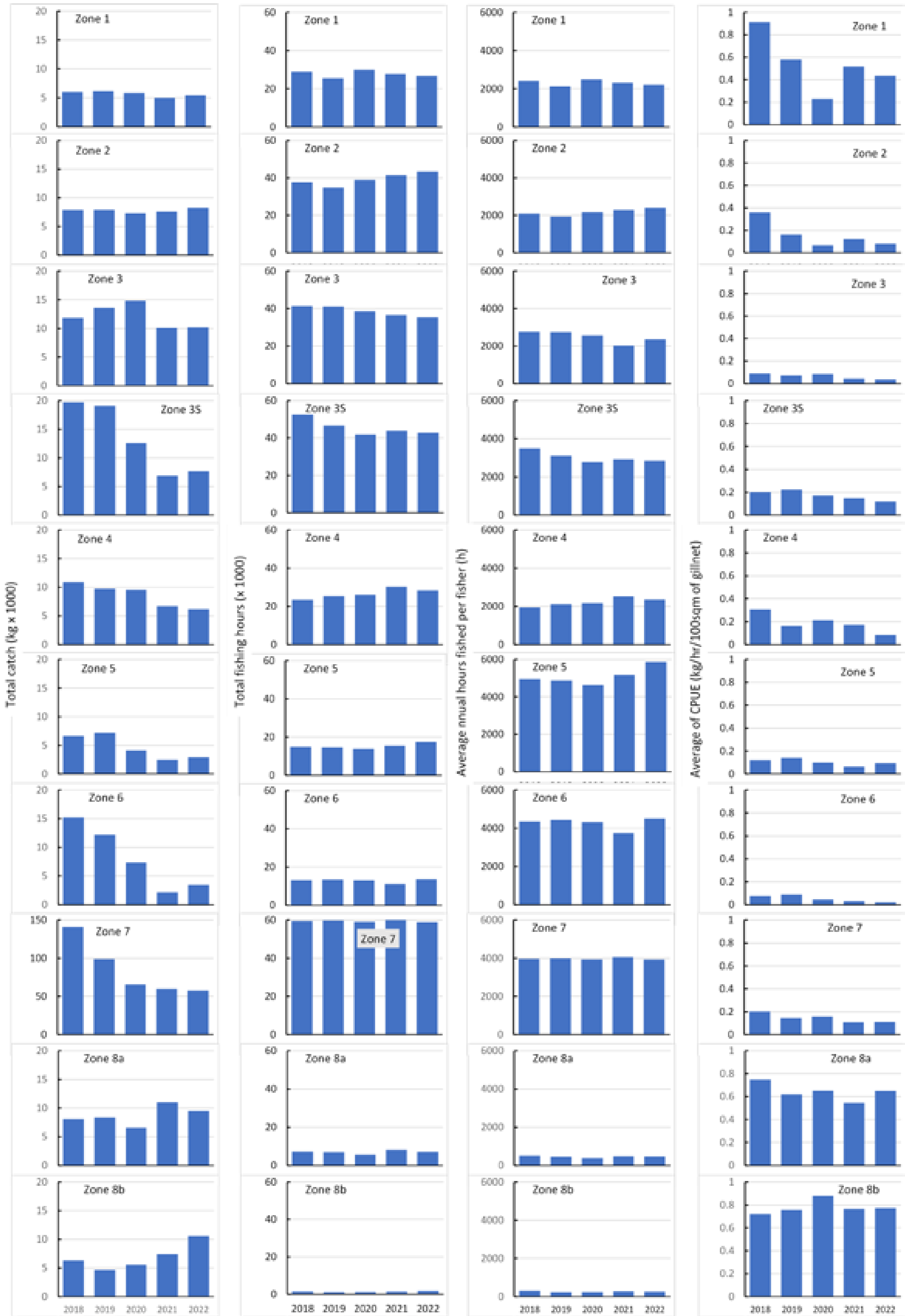


Figure 3.32. Total catch (a); total hours fished (b); average hours fished per fisher (c); and CPUE recorded in FADM logbooks for each ecological zone (d)

Data source: MRC Fish Abundance and Diversity Monitoring

The significant decline in fish catch in Zones 6 and 7 over the last five years aligns with a reduction in the annual flood pulse that is described in Sections 3.2.3 and 3.2.4. The productivity of the Tonle Sap Lake and Tonle Sap River is highly dependent on the magnitude of the annual flood, with a positive correlation between the volume of accumulated annual reverse flow and total catch in these zones (Figure 3.33). The stepwise regression model illustrated below explains around 70–80% of the variation in total catch, with lower reverse flow volumes coinciding with lower total fish catch. If reverse flow volumes continue to decline, this reduction in fish catch from Tonle Sap can be expected to continue.

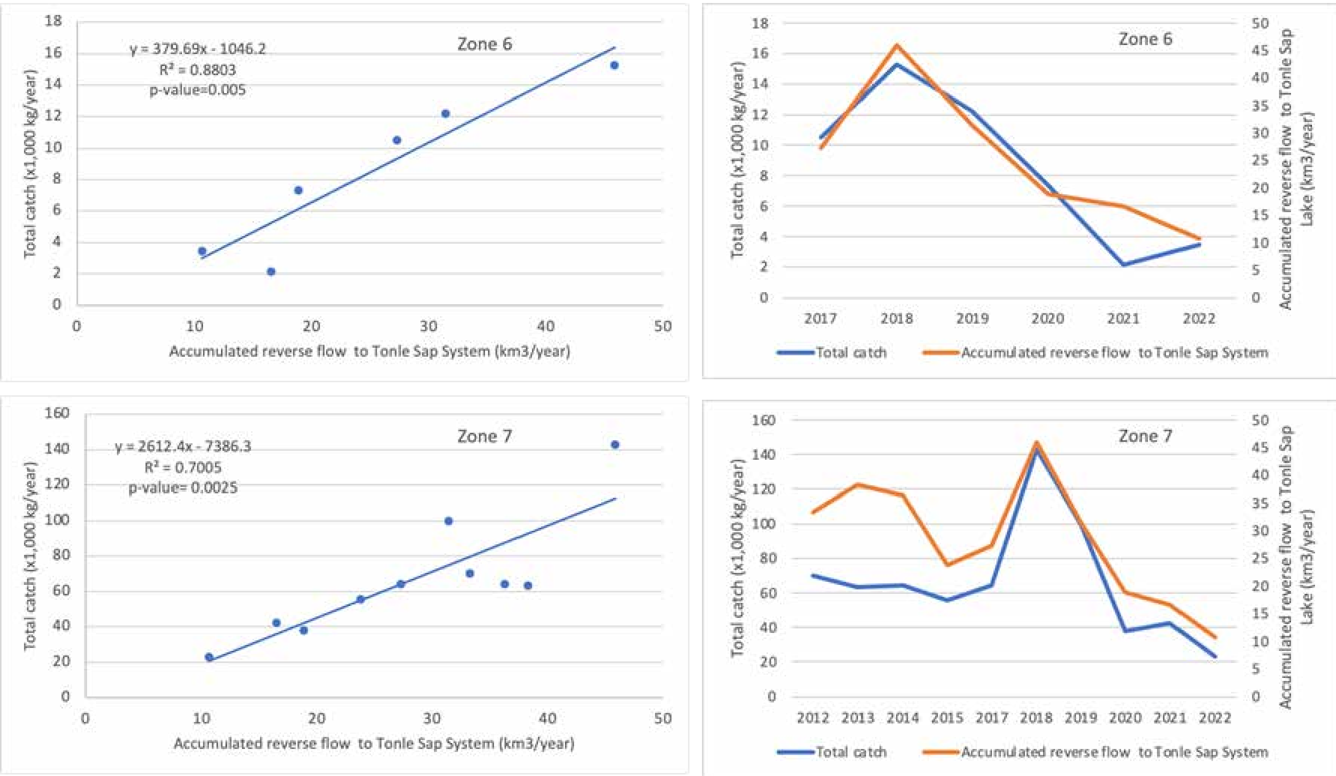


Figure 3.33. Relationship between fish catch and accumulated reverse flow into Tonle Sap

Data source: MRC Fish Abundance and Diversity Monitoring and MRC Hydromet monitoring

Unlike Zones 6 and 7, an increasing trend in fish catch was observed in both the freshwater (8a) and estuarine (8b) zones in the Mekong Delta. This trend was due to an increasing contribution of generalist species in the freshwater part and estuarine and marine-related species in the estuarine part of Zone 8. The growing amount of estuarine and marine-related species in the total LMB catch, from 75% in 2018 to 91% in 2022, may partly be due to increasing salinity levels in the extreme dry years between 2019 and 2021, which increased the areas of the river favouring these species, although changes in gear used may also be a factor.

Fishing effort

Many different types of fishing gear are employed in the LMB, which can be grouped into 11 main types based on their operation. Overall catch from all gear types combined in the FADM 2018–2022 logbooks declined mainly due to a reduction in the contribution from stationary and drifting gillnets, and to a lesser extent, seine nets and traps (Figure 3.34). The type of gear used varies by zone, but the stationary gillnet is by far the most important in terms of the overall contribution to the catch.

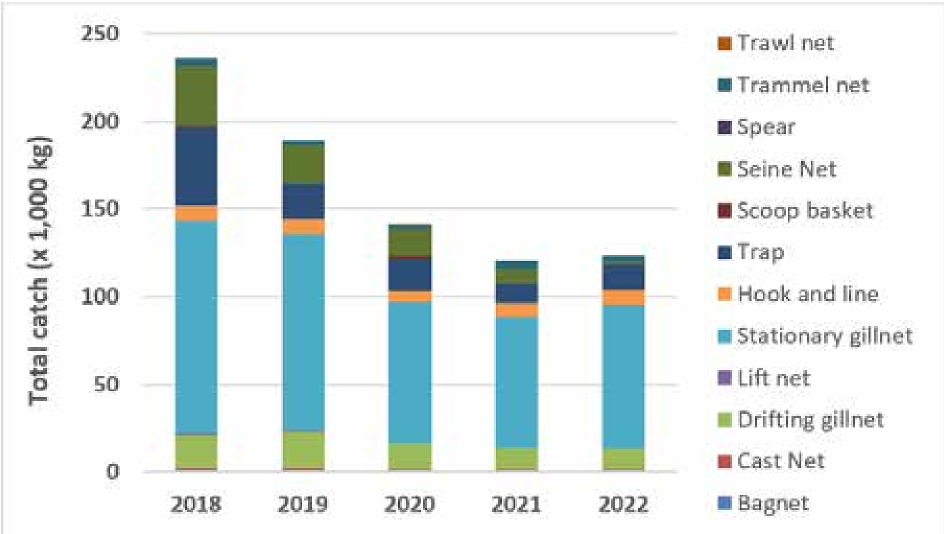


Figure 3.34. Total catch from different gear types by year, 2018–2022

Data source: MRC Fish Abundance and Diversity Monitoring

CPUE by stationary gillnet mesh size enables a standardized comparison of catch between zones and years, and shows the differences between zones (Figure 3.35). CPUE of stationary gillnets in Zones 1 and 2 follow the same trends as the total catch over the 2018–2022 period. The average CPUE in these zones is 0.3 and 0.17 kg/hr/100 m2, respectively. The CPUE of stationary gillnets in Zones 3, 4, 5 and 6 declined over the period, again similar to the trends seen in total catch. However, the CPUE in Zones 3S and 7 did not decline and was relatively stable over the period (Figure 3.35). Zones 8a and 8b have the highest CPUE in the LMB, at around 0.7 kg/hr/100 m2, which is 2 to 5 times higher than other zones. The CPUE in these zones of the Mekong Delta was stable over the last five years. The disagreement between trends in total catch and CPUE in Zones 3S, 7 and 8 is due to the contribution from different kinds of fishing gear rather than effort associated with stationary gillnets alone. The least effective fishing was in Zone 6 with a CPUE of around 0.03 kg/hr/100 m2 (Figure 3.35).

Prior to 2018, significant declines in CPUE were evident at site TCK in Thailand Zone 2, at LVP in Zone 3, at CSP on the Sre Pok River in Zone 3S, at CKC on the Tonle Sap Lake in Zone 7, and at VAP in An Giang Province in Zone 8 (Mekong Delta). Notably, even within the same zone, the trend in CPUE over a given time period can be quite different, with some sites increasing and others decreasing (Figure 3.36). This may be due to local site-specific factors or changes in the use of gear types in different areas over time.

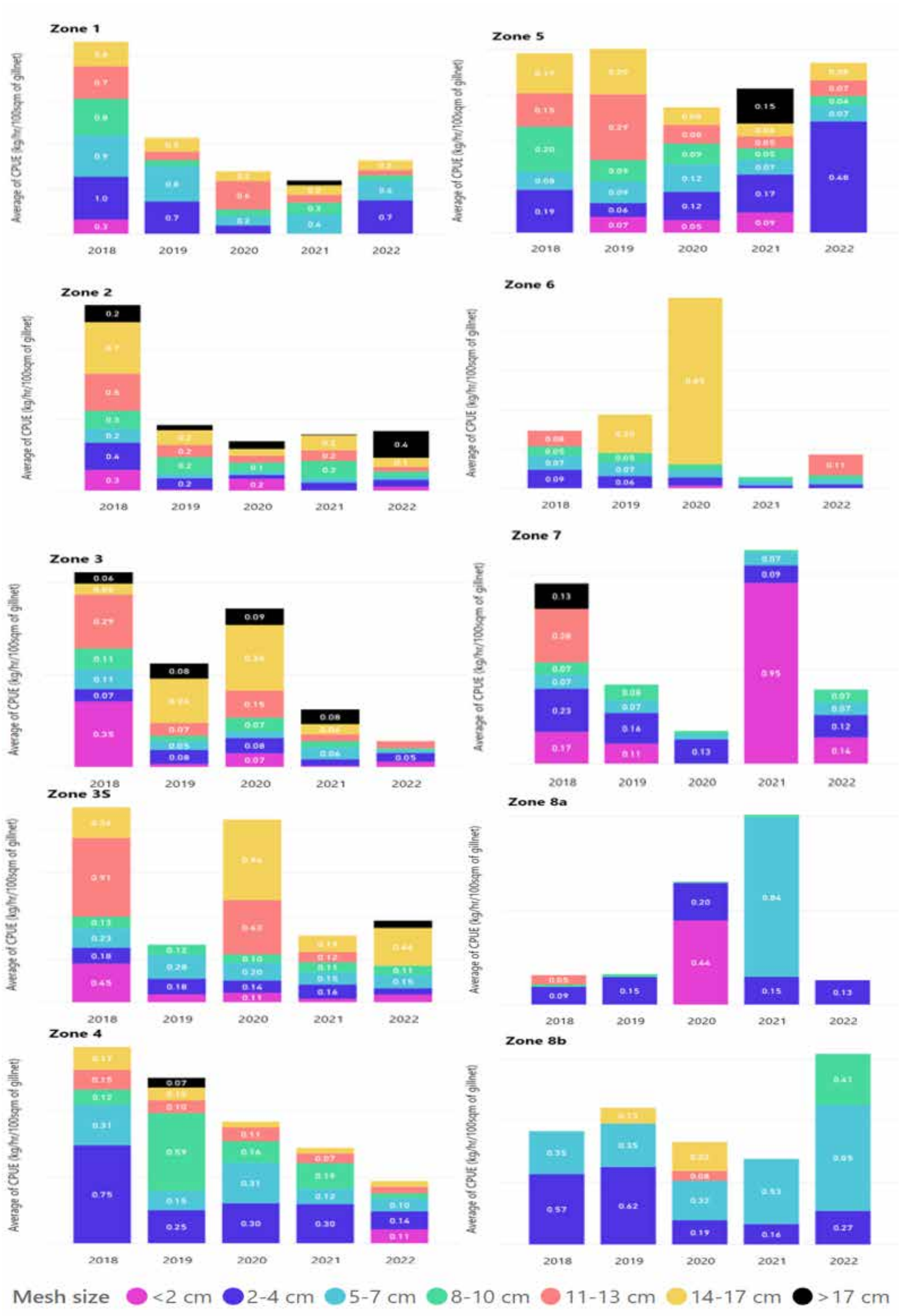


Figure 3.35. Total catch per unit effort (CPUE) from stationary gillnets by mesh size recorded in FADM logbooks for each ecological zone

Note: CPUE > 1 kg/hr/100m2 has been excluded.

Data source: MRC Fish Abundance and Diversity Monitoring

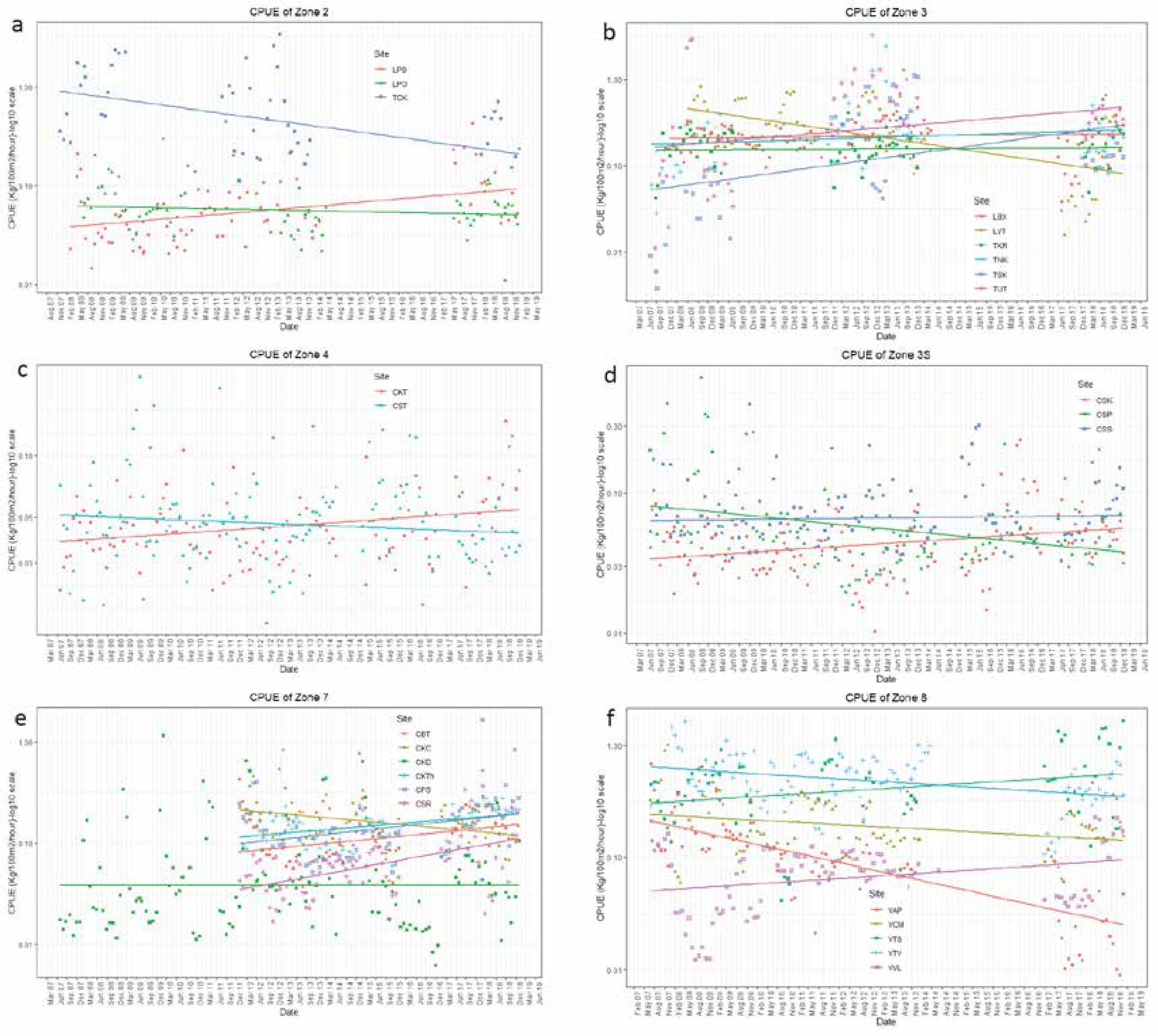


Figure 3.36. CPUE effort over time in six BioRA zones, 2007–2018

Source: MRC (2021g)

Fish size

The relative abundance-biomass curve is an indicator of fish community disturbance based on biomass caught relative to what would be expected according to fish abundance in terms of the number of individuals caught. Figure 3.37 illustrates that fish caught in the LMB over the 2007–2018 period were smaller and shorter-lived than might be expected. According to this curve, the fish community for the LMB as a whole could be considered moderately disturbed and under stress. Data for the individual zones were all in agreement with this conclusion, except for the 3S zone and part of the catch in the Viet Nam Mekong Delta zone, where fish size and age are somewhat above expectations based on abundance (MRC, 2021g).

However, more recent data from 2018 to 2022 with more frequent monitoring suggest that, generally, the average size of the fish caught across the Basin is stable or increasing rather than decreasing (Figure 3.38). These potentially conflicting results require further monitoring and analysis over a longer time period to understand the actual trends, if any, and the likely causes of change. It is also important to consider any changes in the average fish size in conjunction with changes in total catch. For instance, increasing fish size with stable abundance such as in Zones 1, 2 and 3 may be a sign of a healthy population, whereas increasing fish size with declining abundance such as in Zones 3S, 4, 5, 6 and 7 could be an indication of problems associated with fish breeding and recruitment, leading to a shrinking population.

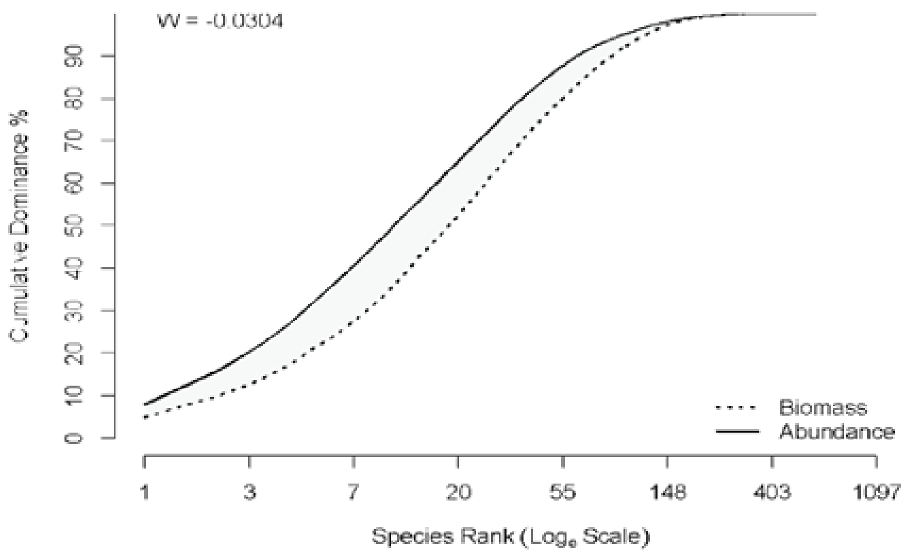


Figure 3.37. Relative Abundance-Biomass Curve for fish catch in the Lower Mekong Basin, 2007–2018

Source: MRC (2021g)

Figure 3.38. Average size of fish (kg/fish) per year in each BioRA zone, by fish guild, 2018–2022

Legend: G1 = Rhithron resident; G2 = Migratory main channel resident; G3 = Migratory main channel spawner; G4 = Migratory Main Channel refuge seeker; G5 = Generalist; G6 = Floodplain resident; G7 = Estuarine resident; G8 = Anadromous; G9 = Catadromous; G10 = Marine visitor; G11 = Non-native.

Data source: MRC Fisheries Abundance and Diversity Monitoring

Fish diversity

The Mekong River Basin hosts one of the most diverse and prolific freshwater capture fisheries in the world. Recent estimates of the biota of the greater Mekong region include up to 1,148 species of fish, as well as 20,000 plant species, 430 mammals, 1,200 birds, and 800 reptiles and amphibians (MRC, 2019b). However, accelerating economic development, population growth and increased consumption patterns are placing pressure on fish habitats and ecology.

It is important to note that counts of species based on catch data from fishers such as obtained through the FADM activity can be problematic due to difficulties with accurate identification and reporting. Caution should therefore be applied when considering absolute numbers of species, with a focus on relative differences and broader trends, which are more appropriate in this context. From 2007 to 2018, fish species richness was highest in Zones 3S, 4 and 7, which include the 3S sub-basin, the border region around Khone Falls between Lao PDR and Cambodia, and the Tonle Sap Lake. Fish species richness was increasing or stable in four of six zones during this period and declining substantially in two zones, Zones 4 and 8. Over time, across all zones fish diversity as reflected in fish catch across the LMB are increasing (Figure 3.39).

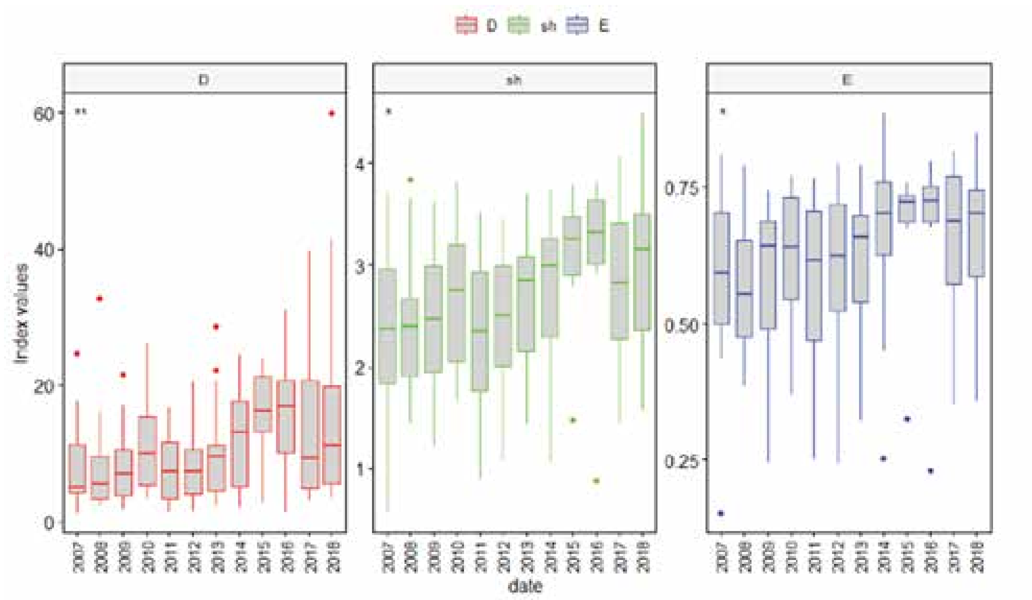


Figure 3.39. Annual fish diversity over time according to: (i) the inverse Simpson Index (D); (ii) the Shannon-Winer Index (sh); and (iii) the Evenness Index (E)

Source: MRC (2021g)

Over five years, from 2018 to 2022, species richness was relatively stable in Zones 3, 4, 5, 6 and 8a, and increased in Zone 8b, but declined significantly in Zones 1, 2, 3S and 7 (Figure 3.40). Despite shifts in species richness, the

Shannon-Wiener Species Diversity index (H') was relatively stable in all zones, expect Zone 8b where it increased marginally, and Zones 1, 5 and 7 where it declined. These changes likely reflect shifts in the contribution of different species to the catch rather the decline in species richness, in particular, a reduction in contribution of migratory species to the catch. From 2018 to 2022, FADM data show the highest number of species in the catch from Zone 8 (Mekong Delta), followed by Zones 2, 3 and 4 (Figure 3.41a).

Fish diversity from IUCN records of threatened species is particularly high in Zone 3 along stretches of the Mekong mainstream at the border between Thailand and Lao PDR, most notably downstream of Vientiane and upstream of Pakse (Figure 3.41b). This is largely consistent with relatively high diversity in the mid-stream sections of the Mekong as evident in FADM data but appears to significantly under-represent the number of species present in the Mekong Delta and around Tonle Sap Lake.

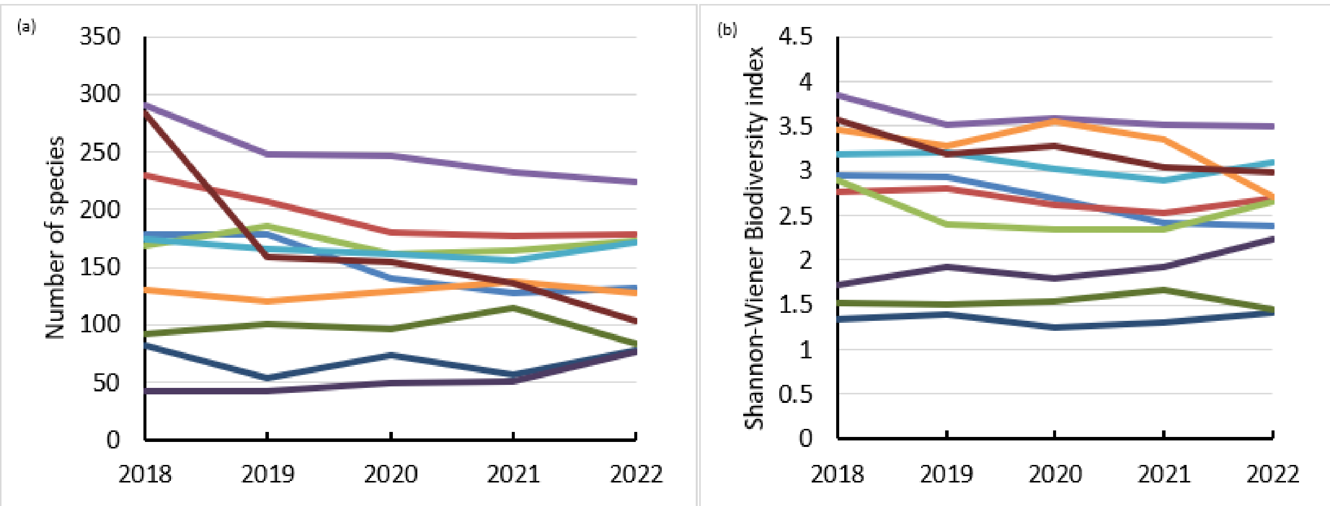


Figure 3.40. Number of species (a); and Shannon-Wiener Biodiversity Index (H')(b) in each zone, 2018–2022

Note: Caution should be applied in considering specific numbers of species as accurate recording of the catch by fishers can be problematic.

Data source: MRC Fisheries Abundance and Diversity Monitoring

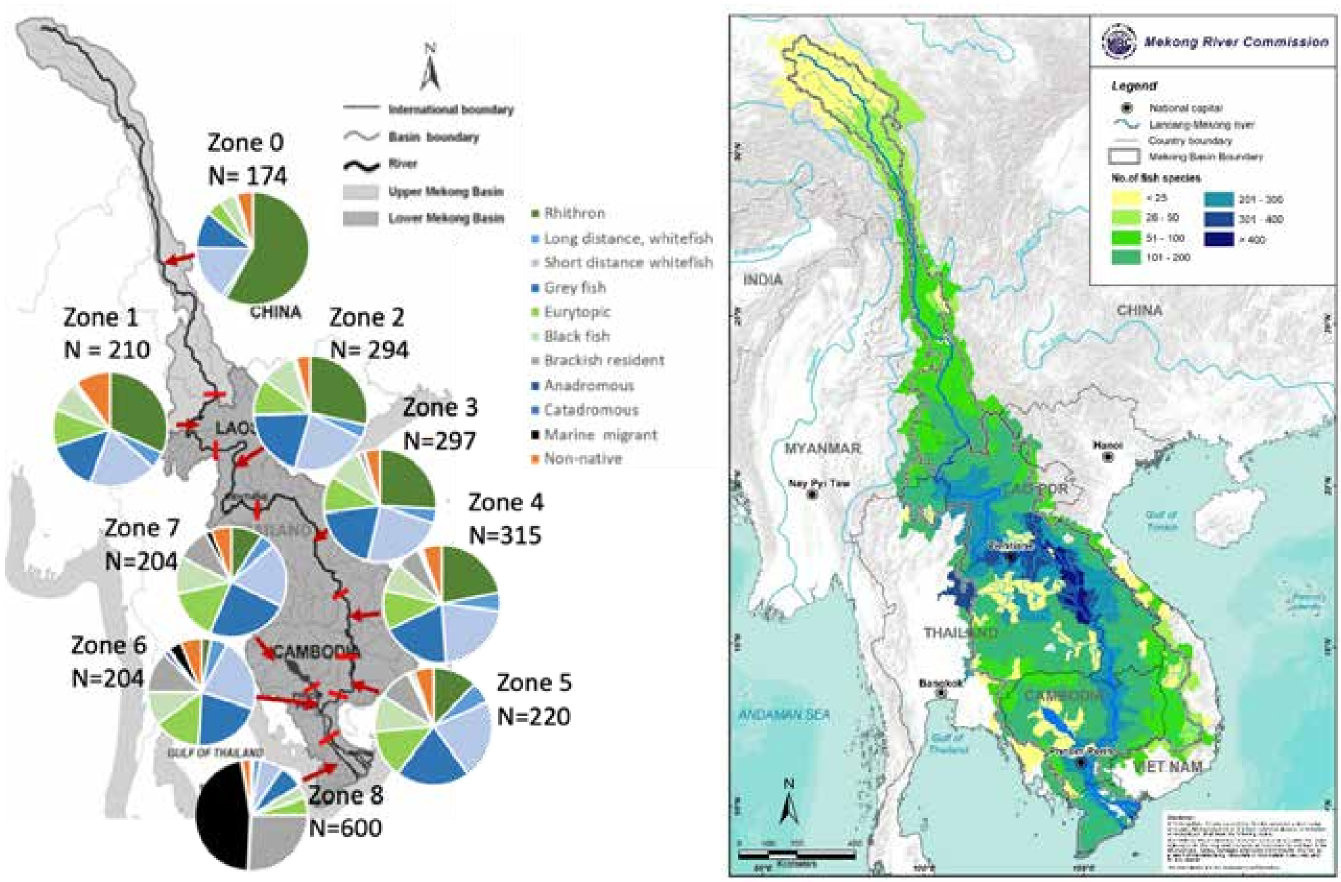


Figure 3.41. Number of fish species by guild and zone throughout the Lower Mekong River Basin from MRC FADM data (a); and number of fish species observed in each subbasin of the Mekong River Basin from IUCN Red List data (b)

Note: Although Zone 8 has the largest number of species, almost half of them are marine migrants rather than freshwater species. Caution should be applied in considering specific numbers of species as accurate recording of the catch by fishers can be problematic. The IUCN Red List does not fully reflect fish diversity in the Mekong Delta and around Tonle Sap, or in the tributary headwaters across the Basin.

Data source: (a) MRC Fish Abundance and Diversity Monitoring; and (b) IUCN Red List.

A large number of native Mekong fish species (113; 15% of fish evaluated) are threatened according to the IUCN Red List (IUCN, 2022). This includes 23 species that are Critically Endangered or Endangered, and 32 that are Vulnerable ; and many are iconic species, such as the Mekong giant catfish (*Pangasianodon gigas*) and giant barb (*Catlacarpio siamensis*). Most species inhabit the middle and lower reaches of the Lower Mekong River Basin (Zones 3 –7), while those found in Zone 8 are mostly of marine origin. Thirty species (2%) were Near Threatened and 609 (49%) were of Least Concern; the remainder were either Data Deficient (228 species, 18%) or Not Evaluated (262 species, 21%).

Of particular concern are the large proportions of migratory species that are threatened (Figure 3.42): i.e. 35% of threatened Red List species, compared with 23% of diadromous and potamodromous migratory species (i.e. not including marine migrants and amphidromous estuarine species as migrants) in the Mekong fish assemblage. These species need free movement in both an upstream and downstream direction to complete their life cycles. Many of these species inhabit multiple ecological zones in the Mekong, which suggests that they may migrate between zones, highlighting the importance of maintaining longitudinal connectivity. Many of the Least Concern and Data Deficient species are typically small endemic species found in upland areas and small streams, and are mostly only accounted for in species inventories during taxonomic field surveys (e.g. Kottelat, 2001, 2015; Roberts and Warren, 1994). Listed species also include iconic species such as the Irrawaddy dolphin and Mekong giant catfish.

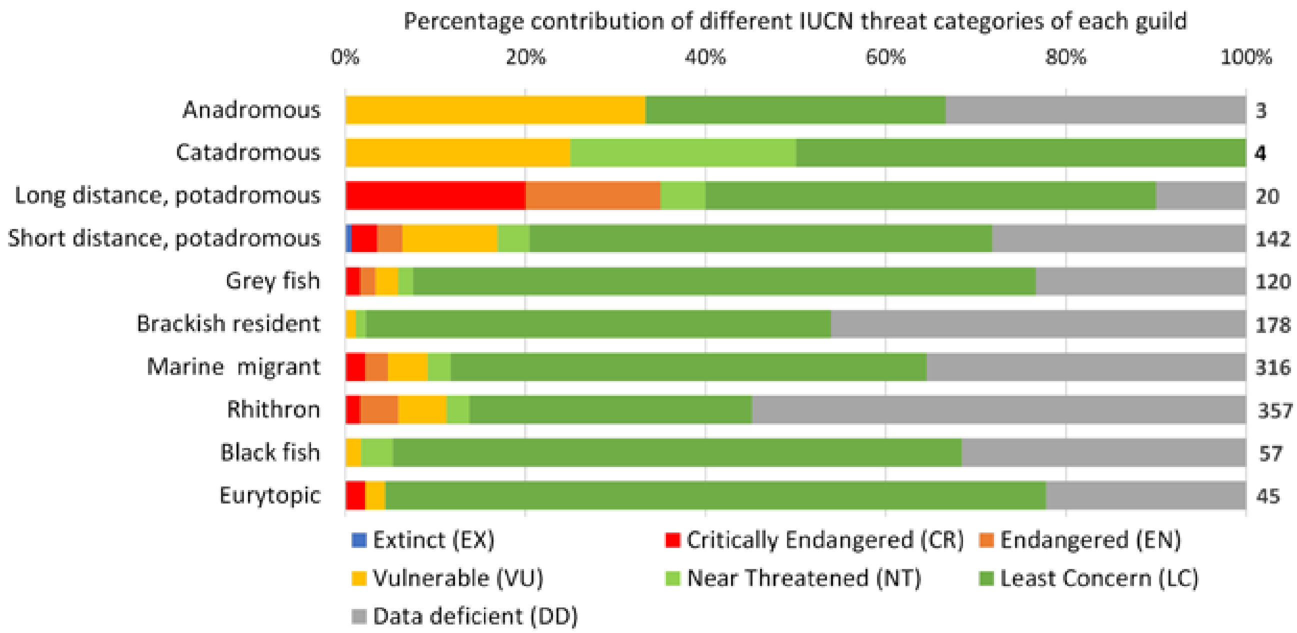


Figure 3.42. Breakdown of IUCN Red List status by fish guild with the total number of fishes in each guild on the right vertical axis

Data source: MRC Fisheries Abundance and Diversity Monitoring

The number of fish species present in the UMB in China has decreased dramatically in recent years (Yu et al., 2018). Zhang et al., (2019a) found a decline in the lower half of the UMB-C from 162 species prior to the 1990s, to 135 species in the 2006–2015 period. In upstream undammed regions, an average of 23.8% of the historical native species disappeared per region, while in the downstream region, an average of 47.2% of the historical native species disappeared per region. The declining fish diversity is attributed to habitat fragmentation and the disturbance of migration patterns, as a consequence of reservoir development (Zhang et al., 2019a).

The implementation of fish tagging technology developed and trialled under the MRC's Joint Environmental Monitoring Programme as part of the MRC's Core River Monitoring Network and data sharing with project operators will be important to evaluate the effects of mainstream hydropower on fish populations and movements, especially given the high number of migratory species that are listed as threatened. The results of the JEM trials at Xayabury and Don Sahong dams indicate that the technologies are effective in detecting tagged fish. While the number of fish species being detected is broadly consistent over time from some preliminary results, data are insufficient at this stage to assess the impact of these developments on fish populations or the effectiveness of the mitigation measures that have been put in place. At Don Sahong, early results suggest that most fish migrating up to the dam turned around and headed back to Cambodia rather than moving through the modified fish passage, probably due to their inability to find the entrance. Monitoring fish passage effectiveness can provide early insights into dam impacts on migration, allowing for timely adjustment to dam and passage operations.

Other aquatic animal abundance

The total yield of OAAs throughout the LMB is estimated based on the updated MRC Fish Habitat Yield Assessment report. Unlike for fish catch, the yield per unit area was not updated in the 2020 surveys, hence the yield per unit of habitat type was based on the previous 2015 estimate (Hortle and Bamrungrach, 2015) and the updated SIMVA surveys of fish and OAA consumption (MRC, 2021e).

More than half of the harvest of OAAs occurs in the rainfed habitat zone, of which around 75% in Thailand and Viet Nam (Table 3.9). The total estimated harvest is 442,810 tonnes across the four LMB countries and the four fish habitat zones. This estimate is higher than the 2010 estimate from Hortle (2017) of 412,553 tonnes but lower than the 2000 estimate from Hortle (2017) of 506,877 tonnes (MRC, 2023b). From 2010 to 2020, across the four LMB countries, declines in OAA consumption of between 15% and 30% were evident in Cambodia, Lao PDR and Thailand, while Viet Nam saw an increase in consumption of over 100% (ibid.).

Table 3.9. Estimated total inland yield of OAAs (tonnes) in each LMB country based on the literature review

Annual OAAs yield	Cambodia	Lao PDR	Thailand	Viet Nam	LMB
Major flood zone	2,712	4,020	934	85,173	92,839
Rainfed	77,403	23,028	142,421	53,508	296,360
Water bodies	0	0	0	0	0
Brackish-estuarine	0	0	0	53,611	53,611
Total	**80,116**	**27,048**	**143,355**	**192,292**	**442,810**

Data source: Hortle and Bamrungrach (2015) published in MRC (2023b)

Diversity and abundance of non-native fish species

Non-native or introduced species are considered a relatively recent threat to the biodiversity of the aquatic environment in the Mekong River Basin, especially in the Mekong Delta and in areas of northern Lao PDR and Thailand (MRC, 2017a). Most non-native species in the Basin are generalist species with the capacity to exploit a range of habitats, especially where native fish populations are under pressure due to changes in suitable environmental conditions. From the FADM, the proportion of the catch made up of non-native species from across the LMB monitoring sites was a consistent 2% from 2018 to 2022. This is a slight reduction from the 3% reported in the 2018 SOBR (MRC, 2019b) and an encouraging sign. The proportion of the total number of non-native fish caught ranged between 0% and 1% of the total number of individuals caught over the last five years. However, the average proportion of non-native species caught across all zones was around 5.6%, with a low of 1.9% in Zone 6 in 2019, and a high of 8.2% in Zone 8a in 2020 (MRC, 2023b). The largest quantity of exotic biomass caught in the FADM monitoring activity is of the species *Cyprinus carpio* (common carp), *Oreochromis niloticus* (Nile tilapia) and *Leptobarbus hoevenii* (Hoven's carp).

The highest proportion of non-native species in the total catch biomass is generally caught in BioRA zones 1, 2, and 8a, with 13%, 5% and 5%, respectively (Figure 3.43). These zones coincide with area of intensive aquaculture production, especially caged culture along the riverbanks. Cage culture production systems are highly vulnerable to escape, often because of poor construction and damage during high flows. Other pathways to the introduction of non-native species include intensive stocking of non-natives in reservoirs and piggy-backing with other species. The number caught in each zone is relatively stable from year to year, suggesting a stable, self-sustaining breeding population in the wild, rather than an episodic escape from fish farms.

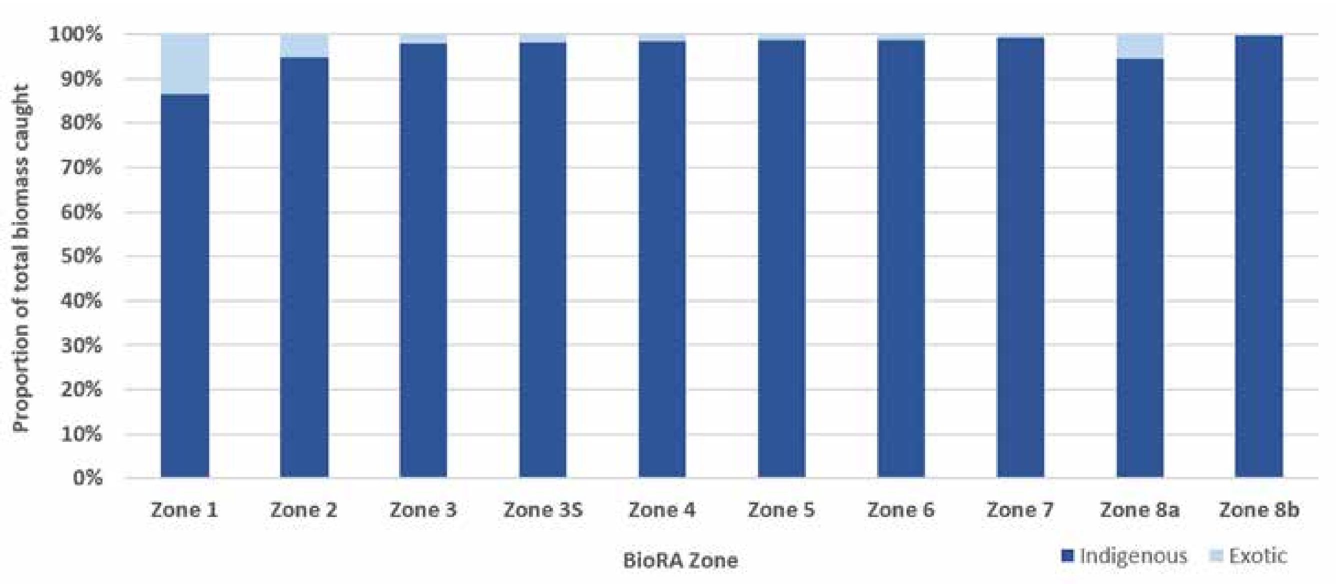


Figure 3.43. Proportion of indigenous and mom-native biomass caught from the total FADM fish catch monitoring by BioRA zone, 2018–2022

Data source: MRC Fisheries Abundance and Diversity Monitoring

In summary, the total fish catch in the Lower Mekong Basin has declined over recent years, mostly driven by declines in the catch from Tonle Sap Lake and the 3S sub-basin, while some other ecological zones show either stable or increasing catch. This reduction in catch is likely at least in part due to hydrological changes observed over the last decade, especially lower flood season flows and reduced Tonle Sap reverse flows. These hydrological changes are significantly reducing the amount of flood zone habitat for fish, and as illustrated above, there is a direct correlation between lower accumulated reverse flows to Tonle Sap and reduced fish catch.

There is evidence, albeit inconclusive, that fish caught are of a greater diversity and smaller size than in the past, hence warranting further monitoring and analysis. The greatest reduction in fish catch over the last five years appears to be in the Tonle Sap Lake and River and the 3S sub-basin, although CPUE is also declining in Zones 3, 4 and 5, in addition to Zone 6 – the areas encompassing the Mekong mainstream from around Vientiane down to the border between Cambodia and Viet Nam and including the Tonle Sap River. This further evidence of fish populations under stress means that the condition and status of fisheries and other aquatic resources is assessed as 'Of Concern', and that investment will be required to ensure that basin fisheries are resilient to current and future threats.

3.4.5. Condition and status of ecologically significant areas

Insufficient data or information to draw a conclusion

Relatively undisturbed forests and other important habitats in the Mekong River Basin are ecologically significant because of their often exceptional biodiversity and presence of rare and threatened plant and animal species. Large areas of these forests and other important ecosystems such as wetlands are therefore under some form of protection, encompassing around 164,000 km^2 of ecologically important areas across 228 sites in the six Mekong River Basin countries (Table 3.10). This amounts to more than 20% of the total basin area, which is higher than the global level of 17% of the earth's terrestrial area protected, but less than the 30% goal that countries have committed to achieve by 2030 under the Kunming-Montreal Global Biodiversity Framework (GBF).

Figure 3.44 provides an overview of the spatial distribution of protected areas in the Mekong River Basin. It is based on the latest data available from the World Database of Protected Areas (WDPA), which in turn draws from official resources available for each country; however, due to differences in the classification of areas, it does not exactly correspond to the data in Table 3.10.

The GBF seeks to ensure not only that important areas have protection status, but also that there are effective conservation and management within these areas, with particular importance placed on biodiversity and ecosystem functioning and services. The Framework encourages the prioritization of ecologically representative, well-connected and equitably governed systems of protected areas and other effective area-based conservation. Information on effective conservation and management within protected areas was not available for this SOBR.

Table 3.10. Overview of protected or ecologically significant areas in the Mekong River Basin, by type and country

Annual OAAs yield	Cambodia		Lao PDR		Thailand		Viet Nam		China		Myanmar	
	No.	Area (km²)	No.	Area (km²)	No.	Area (km²)	No.	Area (km²)	No.	Area (km²)	No.	Area (km²)
Ramsar Wetlands	4	569	2	148	4	162	4	620				
UNESCO or National Biosphere Reserve	1	14,833	1	885	1	328	4	24,020	1	3,778		
Nationally Important Wetland			26	12,511	5	19	18	827				
National Protected Area/National Park	7	11,279	24	37,681	26	116	10	13,397			1	77
Wildlife Sanctuary	16	6,659			10	6,675						
Other (e.g. Nature Reserve, Protected Landscape)	34	43,514			2	334	3	1,058	23	6,778	1	41
Total	**62**	**55,362**	**53**	**51,225**	**48**	**7,634**	**39**	**39,922**	**24**	**10,557**	**2**	**118**

Note: Since some designations overlap, the total is not necessarily the sum of individual categories, and some areas are partly within and partly outside the Mekong River Basin.

Data source: MRC Member Countries; Protected Planet for UMB countries.

This assessment indicator includes a monitoring parameter on the extent of natural land cover within ecologically significant areas of the Basin as an indicator of their condition. However, there is no approved data source or methodology available to undertake such an assessment, hence no rating has been provided for this assessment indicator. This is a gap that should be addressed for future SOBRs to help inform improved management and conservation of regionally important assets.

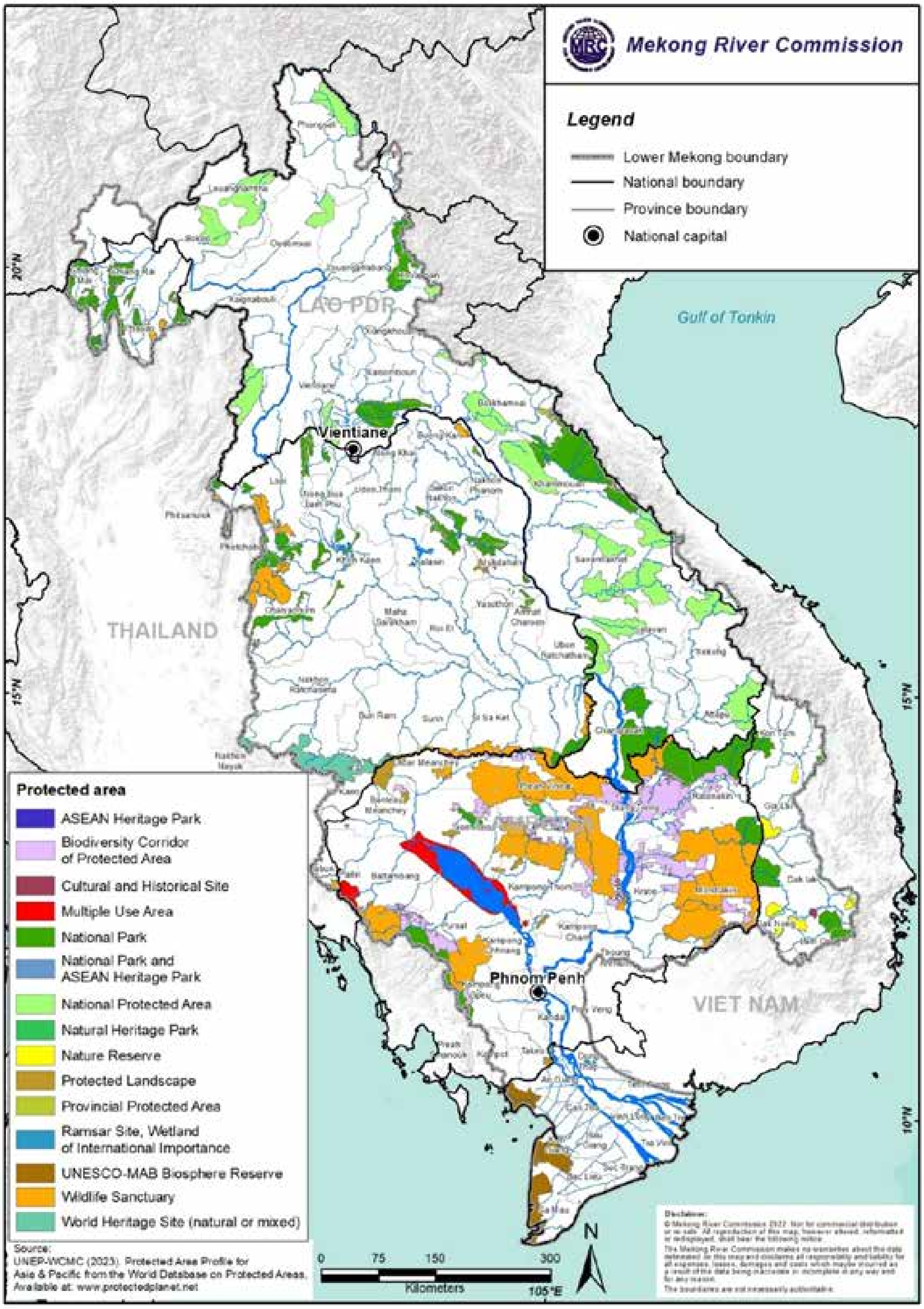


Figure 3.44. Map of protected areas in the Lower Mekong River Basin

Data source: World Database of Protected Areas, based on the Department of eospatial Information Services (DGIS), Ministry of Environment (MOE), Cambodia (2023); Ministry of Agriculture and Forestry (MAF), Lao PDR (2020); Department of National Park, Wildlife and Plant Conservation and Department of Marine and Coastal Resources, Thailand (2023); and Department of Nature Conservation, Viet Nam Administration of Forestry, Viet Nam (2015)

3.5. Overall environmental conditions

The overall environmental conditions of the Mekong River Basin are in a concerning state, and trends in conditions across several indicators are not encouraging. Water flow conditions have changed significantly since the 1995 Mekong Agreement was signed. Regulation of the flow through water resource development has increased dry season flows and decreased flood season flows as expected, largely in compliance with the PMFM. However, flow monitoring indicates that, especially in dry years, this regulation may not be sufficient to prevent 'unstable' and even 'severe' conditions in dry season water levels.

In addition, due to the reduction in flood season flows, the reverse flow volume to Tonle Sap is dramatically reduced, which has implications for the viability of wetlands, especially flooded forests, around Tonle Sap Lake and throughout the delta. Less flow into the lake also means reduced flows out of the lake in the early dry season, a likely contributing factor to extensive salinity intrusion evident in the delta in conjunction with rising sea levels and other local factors. Less wetland area flooded in turn means less carbon and nutrient inputs to the aquatic environment, placing additional pressure on fish populations that appear to be under stress, as evidenced by a declining total catch, especially from the Tonle Sap Lake and a reduction in CPUE at several other locations.

Sediment transport continues to decline at stations throughout the Basin, and although water quality overall is generally compliant with the PWQ, the trends evident in several individual water quality parameters are alarming. This is particularly the case with regard to water temperatures (possibly related to climate change or low flows at certain times of year), total suspended solids (related to sediment transport), electrical conductivity (related to salinity intrusion) and total nitrogen levels (related to use of fertilizers in agriculture and possibly urban and industrial development).

It has not been possible with available data to assess further trends in wetland areas, except for mangroves, where both MRC and Mekong SERVIR data point to a continuing decline. This is an indicator of concern within the context of sea-level rise at the delta and the vulnerability of coastal communities to storm surge occurring on higher seas due to climate change.

3.6. Progress towards BDS outcomes

The BDS 2021–2030 outlines three outcomes under the Environment Dimension Strategic Priority for achievement by 2030:

1.1 Adequate water flow and quality for a healthy environment and productive communities

1.2 Sediment transport managed to mitigate bank erosion and maintain wetland and floodplain productivity

1.3 Ecosystem services from wetlands and watersheds ensured.

These Outcomes seek to ensure that by 2030, the environment continues to provide important ecosystem services, supporting food security and livelihoods, especially for people in vulnerable situations. The assessment of progress towards BDS 2021–2030 Outcomes in the Environment Dimension is summarized in Table 3.11, taking into consideration the alignment of strategic indicators with each BDS Outcome in Table 1.3.

The assessment of environmental conditions and trends indicates that there are *some issues to address* with water flow conditions and *some significant issues to address* in relation to water quality, sediments and the status of environmental assets, consistent with the findings of the 2018 SOBR (MRC, 2019b). The changed flow regime described in this chapter indicates that, at some locations, there is likely adequate water flow in the dry season for productive communities as flows are higher than in the past, and as reflected in the previous SOBR (MRC, 2019b), also indicates potentially more opportunity for their use for consumptive purposes. However, further consideration will need to be given by basin countries as to how much additional dry season flow is too much, given the potential negative impacts on the environment including on riparian wetlands, and in-stream rocky and sandy habitats that may no longer be exposed for part of the year as frequently as in the past. In addition, due to the ongoing unstable and even severe conditions in the early dry season during very dry years at some stations, coordinated operation of basin storages should be promoted to ensure adequate dry season flows to support water security of all basin countries and to help basin communities cope with drought.

Table 3.11. Summary of progress towards BDS 2021–2030 Outcomes based on conditions and trends for aligned strategic indicators in the Environment Dimension

BDS Outcomes	Strategic indicators	Condition	Trend	Key Issues	BDS Progress
1.1 Adequate water flow and quality for a healthy environment and productive communities	Water flow conditions	●	↘	Dry season flows unstable or severe in some areas for extended periods in the early dry season Reduced Tonle Sap reverse flows	↓
1.2 Sediment transport managed to mitigate bank erosion and maintain wetland and floodplain productivity	Water quality and sediment conditions	●	↘	Declining water quality of unknown cause for several parameters Continued reduction in sediment transport at multiple stations along the river	→
1.3 Ecosystem services from wetlands and watersheds ensured	Status of environmental assets	●	↘	Significant loss of natural wetlands Risks to wild fish populations with declining total catch in recent years	→

With regard to Outcome 1.1, the reduction in flood season flows is likely having a negative impact on the environment. Lower flood season flows mean reduced wetland areas around the Tonle Sap Lake and in the delta floodplains, with potential adverse impacts on fish, OAAs and recession rice agriculture, and irrigated agriculture in the delta being potentially exposed to high riverine salinity intrusion. The need for additional flow thresholds agreed between the countries that reflect this new hydrological reality but that can protect what remains of the Basin's environmental assets is as important now as ever. Implementation of the PMFM and countries' cooperation in response to breaches need to balance the inherent, implicit trade-offs between articles 6B and 6c: i.e. article 6B emphasizes flood season flows necessary to meet the historical eco-hydrological conditions of Tonle Sap, and article 6C emphasizes the importance of not exceeding maximum flood season flows to avoid flood hazards rather than imposing the necessary minimum flood flow requirements to enable the benefits of flooding.

The trends in several water quality parameters suggest that ensuring adequate water flow and quality is only becoming more challenging, not less. Further emphasis needs to be put on investigating the water quality situation further, including the nature of the water quality problems, likely causes and what efforts can be made to address them, either through transboundary cooperation or national action, as appropriate. Updated information on heavy metals, pesticides, fertilizers and other toxic pollutants in the water column, sediments and biota would also be beneficial, given the length of time since the MRC's previous regional assessment, the reported issues at some places in the UMB, and the extensive urban, industrial and mining development that has occurred throughout the Basin over the last decade.

Managing sediment transport (Outcome 1.2) is also becoming more challenging as the volumes of sediment flowing down the river continues to decline at multiple stations. While the initial sediment loss was most clearly associated with the construction of the upstream hydropower cascade in China (and sediment loads at Chiang Saen appear now to have stabilized at a much lower level), an ongoing decline is evident at several monitoring stations along the river and is likely evidence of the cumulative impacts of water resource development throughout the Basin. There was insufficient information available for this SOBR on the extent of riverbank erosion.

There is insufficient evidence to date on the extent to which ensuring ecosystem services from wetlands and watersheds is becoming more or less challenging to meet (Outcome 1.3). Due to the lack of consistent time-series data on wetland extent and any time-series data on the economic valuation of wetlands, short-term trends in these indicators over the last few years cannot be determined (see Section 5.3.6). Fisheries remain under pressure: indeed, a comprehensive assessment of data from the last decade reinforces earlier indications that fish populations are under stress because total fish catch has been lower over the last five years, CPUE has declined at a number of locations, and a large number of fish species are listed as threatened on the IUCN Red List. The further implementation of the BDS 2021–2030 over the remainder of the decade will need to try to address these shortcomings in information to support decision-making.

CHAPTER 4

SOCIAL CONDITIONS AND TRENDS

CHAPTER 4: SOCIAL CONDITIONS AND TRENDS

4.1. Introduction

The Social Dimension of the MRB-IF reflects the commitments made by the parties to the 1995 Mekong Agreement for the sustainable development of the Mekong River Basin and its Preamble which:

- recognizes that the Mekong River Basin and the related natural resources and environment are natural assets of immense value to all the riparian countries for the economic and social well-being and living standards of their peoples; and
- reaffirms the determination to continue to cooperate and promote in a constructive and mutually beneficial manner in the sustainable development, utilization, conservation and management of the Mekong River Basin water and related resources for … social and economic development and the wellbeing of all riparian States.

To this end, the Member Countries of the MRC agreed to promote, support, cooperate in and coordinate the development of the full potential of sustainable benefits to all riparian States. Progress is monitored through periodic assessments of current and future development scenarios that inform the basin-wide planning activities of the MRC, through periodic SIMVAs, and through the routine data collection of various social and economic statistics at the national level by Member Countries.[8] In addition, consistent with the MRB-IF and the DAGAP, largely national-level data were drawn from publicly available databases collected and maintained by international organizations such as the World Bank, ADB, Food and Agriculture Organization of the United Nations (FAO) and IEA, which contributes to an understanding of the socio-economic context of the Basin. Not all indicators can be assessed in full due to ongoing gaps in data availability and some inconsistency in datasets available from different basin countries.

To assess the status of social conditions and trends in the Mekong River Basin, the MRB-IF encompasses three strategic indicators and seven assessment indicators, as reflected below (Table 4.1). This chapter provides an assessment of the status of conditions and trends in each of these strategic and assessment indicators.

8 MRC initiatives to conduct socio-economic analysis include: the 2001 study, Local Knowledge in the Study of River Fish Biology: Experiences from the Mekong; the MRC's 2011 Initiative on Sustainable Hydropower; the Council Study 2017, which includes a socio-economic impact assessment and a macro-economic assessment; SIMVAs conducted in 2011, 2014 and 2018; and recently, the socio-economic data systematically collected and transmitted by the relevant line agencies o Member Countries, consistent with the DAGAP.

Table 4.1. Strategic and assessment indicators in the Social Dimension of the MRB-IF

Strategic Indicators	Assessment Indicators
Living conditions and wellbeing	Water security Food security Water-related health security Access to electricity
Livelihoods and employment in water-related sectors	Employment in water-related sectors Economic security Gender equality in employment and economic engagement
Overall social conditions	-

The assessment of conditions and trends is undertaken taking into consideration the BDS 2021–2030 Strategic Priority for the Social Dimension:

Enable inclusive access and utilization of the Basin's water and related resources

This BDS Strategic Priority recognizes that water resources development tends to exacerbate inequality. Poor, resource-dependent people in vulnerable situations bear the most risk due to a lack of alternative livelihoods and adaptive capacity. Gender differences in access to water and related resources, as well as opportunities from water resources development need to be better understood so that measures can be put in place to promote equity and achieve food, water and energy security for all, consistent with the SDGs and basin country commitments to fundamental human rights.

Improving understanding of these issues requires a concerted effort to enhance information and knowledge, supported by the collection, sharing and analysis of spatially distributed and gender-disaggregated data. As policymakers better understand the needs and opportunities of people in vulnerable situations who are impacted by water resource development, strategies for alternative livelihood and adaptive capacity development can be designed and implemented, including through joint investment projects and national projects of basin-wide significance.

4.2. Living conditions and well-being

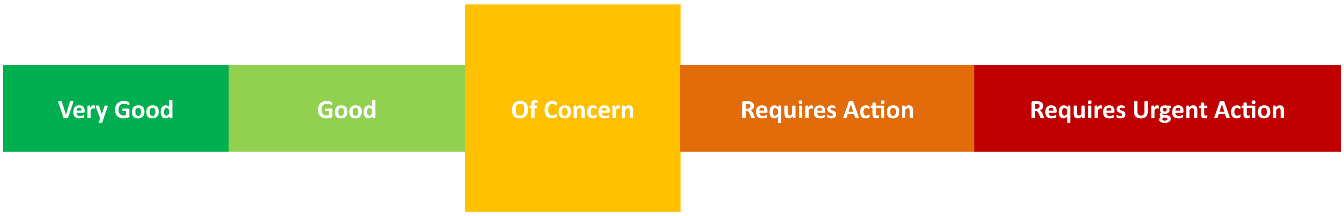
4.2.1. Assessment methodology

The strategic indicator 'Living conditions and wellbeing0 is defined as the level of community resilience as derived from the key components of societal wellbeing that help reduce vulnerability: water, food and health security, and access to electricity. The following sections evaluate the status and trends of living conditions and well-being for the four assessment indicators of the MRB-IF:

- Water security
- Food security
- Water-related health security
- Access to electricity.

Each assessment indicator is evaluated with respect to several monitoring parameters. Data and information for these assessment indicators are generally sourced from the national statistics of basin countries collected through the routine work of government agencies and supplemented where necessary with data from recognized international sources, as mentioned above.

4.2.2. Water security



There are many aspects to water security; ADB identifies five key dimensions: (i) household water security; (ii) economic water security; (iii) urban water security; (iv) environmental water security; and (iv) resilience to water-related disasters. Each of these dimensions is addressed in different ways throughout the MRB-IF, where the 'water security' assessment indicator in the Social Dimension focuses specifically on household water security, both with regard to safe drinking water and the adequacy of water for farming. In this respect, water security is defined as the ability of basin communities to meet their safe water demands for both domestic and agricultural uses. The two monitoring parameters under the water security indicator are: (i) adequacy of domestic water supply; and (ii) adequacy of water for farming.

Adequacy of domestic water supply, especially access to safe drinking water, is critical to well-being. Without safe drinking water, individuals can be prone to a range of diseases and illnesses related to contamination. Lack of adequate safe drinking water and associated enteric diseases are a key cause of protein malnutrition among infants. Access to safe water supplies is therefore used as an important indicator of well-being for populations in the Mekong River Basin. Safe or potable water sources include piped water on premises (i.e. piped household water connection located inside the user's dwelling, plot or yard), public taps or standpipes, tube wells or boreholes, protected dug wells, protected springs, and sometimes rainwater collection.

Subnational figures for household access to improved water sources are available at the provincial level for the LMB. In general, countries have improved access to potable water for households (Figure 4.1). Almost 100% of households have access to improved water sources in Thailand and Viet Nam. Cambodia has seen a steady improvement in access to improved water sources, i.e. just under 80% of households had access by 2020. Lao PDR has also seen improvements: the share of households with access to an improved water source increased from approximately 65% in 2015 to 70% by 2020. Despite the gains made, a significant share of the LMB population remains without access to improved water sources, which points to remaining issues to be addressed to improve water security for all basin communities. Caution should be applied in drawing comparisons between countries for this indicator because different countries may have used different definitions of an 'improved' water source.

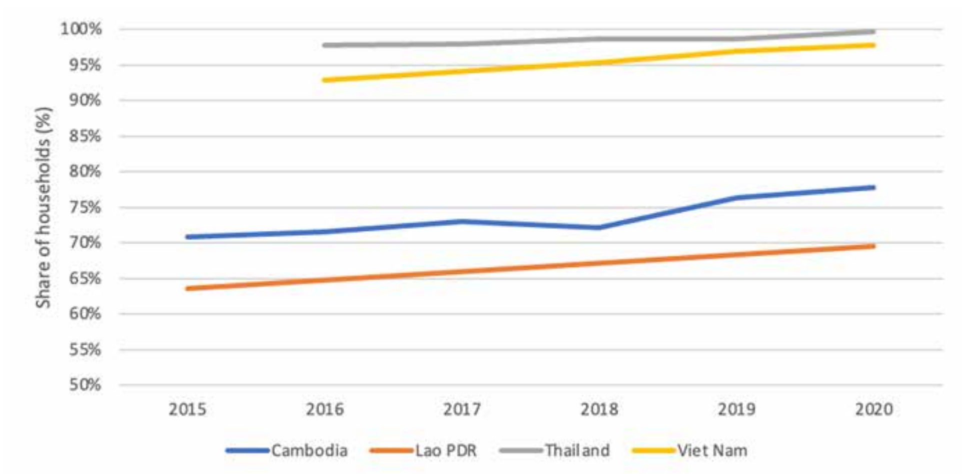


Figure 4.1. Average proportion of households with access to improved water supplies, in the Lower Mekong basin provinces, 2015–2020

Note: A full-time series was not available for each country. Where annual data were not available, trend lines between years were interpolated.

Data source: National statistics provided by basin countries adjusted for proportion of population estimated within the Basin.

Clearly, there are other aspects to the ability of basin communities to meet their safe water demands than is reflected in this single monitoring parameter. These aspects include the quantity and quality of the water supply on which the water source depends, the level of water treatment to ensure adequate safety of the source at all times, and the affordability of the supply for basic human needs. The adequacy of water for farming depends substantially on meteorological and hydrological conditions in different areas since they affect the water demands of different crops and the water quantity and quality available, as well as affordability and the availability of infrastructure to manage water when and where it is needed.

Sufficiency of water for farming. Due to the fluctuating rainfall patterns experienced throughout the year, many areas within the Mekong River Basin face the risk of severe drought (Section 6.3.6). The manifestations of drought are diverse, encompassing differences in: the timing, length and amount of wet season rainfall in various areas; the early start of the dry season; and intermittent rainless periods during the wet season. The prevalence of droughts is notably significant in the LMB, with all countries experiencing large average annual areas of meteorological, hydrological and agricultural drought over the past four decades. However, an effective measure to mitigate drought risk lies in the implementation of irrigation systems, which can provide essential water during critical periods of crop growth, when required.

The adequacy of water for farming is assessed in relation to the area of annual crops and paddy rice (from the 2020 MRC land use/land cover map [MRC, 2021c]) in meteorological drought-prone areas that are equipped with at least 25% irrigation by area based on FAO irrigation area data. The drought indicator used is the Standardized Precipitation Index (SPI) and the drought-prone areas by severity category are illustrated in Chapter Six (Figure 6.22).

The vast majority of basin area has been susceptible to drought to some degree over the past two decades. Of drought-prone cropped areas, Cambodia and Thailand have the largest areas affected, with almost 60,000 and 81,000 km^2, respectively, across all three categories of severity (Table 4.2). Of the drought-prone cropped areas, Cambodia has 3,146 km^2 (5.3%) equipped for irrigation, while Thailand has 7,647 km^2 (9.4%) equipped for irrigation. Viet Nam has the largest percentage of drought-prone cropped areas equipped for irrigation (39.4%), while Lao PDR has the smallest (0.7%).

Across the Basin as a whole, around 9% of drought-prone cropped areas are equipped for irrigation. Given the likely high economic costs of drought (Section 5.3.13) and the potential for droughts to become more extensive and severe due to climate change, this low proportion of equipped irrigation area is unlikely to be adequate to ensure water for farming during extreme dry periods. In addition to having sufficient irrigation infrastructure, there also needs to be sufficient flow in the river at the right times to supply water to irrigation areas. As identified in the MRC-MLC Water Joint Study (MRC-LMCWRCC, 2023), further consideration should be given to identifying and implementing drought mitigation measures, potentially including transboundary coordination of reservoir operations for water delivery.

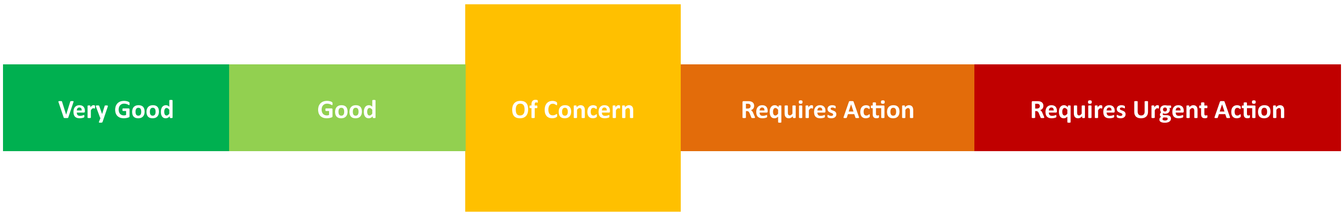
Table 4.2. Cropped areas equipped for irrigation in drought-prone areas, according to each severity category

	Assessment Indicators			Cropped areas equipped for irrigation (km²)		
	Moderate drought	Severe drought	Extreme drought	Moderate drought	Severe drought	Extreme drought
Cambodia	40,430	18,512	751	1,906	1,240	0
Lao PDR	15,469	2,190	2,164	131	2	0
Thailand	72,996	4,294	3,682	6,025	787	834
Viet Nam	8,148	1,939	234	3,946	115	0
Total	**137,043**	**26,935**	**6,832**	**12,009**	**2,144**	**834**

Data source: Area of cropping from MRC (2021c) Land Use/Land Cover map; drought-prone areas from the MRC Regional Flood and Drought Management Center analysis, as illustrated in Figure 6.22; areas equipped for irrigation from FAO irrigation area dataset

Overall, water security in the Mekong River Basin is assessed as 'Of Concern'. This is due to the relatively slow progress in increasing household access to improved water supplies and the large number of people, therefore, that remain without access in some countries. At the current rate of progress, the SDG regarding universal access to safe water supplies will not be met by 2030 in Cambodia or Lao PDR. The very low proportion of cropped area in drought-prone areas equipped for irrigation is also a concern.

4.2.3. Food security



Food security indicators in the Basin are the ability of basin communities and households to meet their food demands either through their own production of food grain and protein, sufficient income to purchase food and the lack of infant malnutrition. The following section looks at monitoring parameters for each of these indicators to derive an overall assessment of food security conditions in the LMB.

Ability to meet household food demand. In seeking to establish the extent to which households are able to meet food demand, two monitoring parameters were considered.[9] The first is ‘the adequacy of average daily energy supply’. This is an indicator of food availability and expresses the dietary energy supply as a percentage of the average dietary energy requirement. The country’s average supply of calories for food consumption (i.e. netting out any exported food and food production not used for human consumption) is normalized by the average dietary energy requirement estimated for the population. This provides an index of the adequacy of food supply in terms of dietary energy requirements (FAOSTAT, 2023).[10] The second monitoring parameter used is ‘prevalence of undernourishment’, which is the percentage of the population whose food intake falls below the minimum level of dietary energy requirements (UN, 2018). Considered together, energy supply adequacy and prevalence of undernourishment allow to evaluate whether undernourishment is a result of insufficient food supply or distributional considerations (FAOSTAT, 2023).

Between 2000 and 2020, adequacy of dietary energy supply improved considerably for all Mekong River Basin countries (Figure 4.2); indeed, all four of these countries saw rapid growth in the availability of food supply over the last 20 years. In 2000, food supply in Lao PDR and Myanmar was inadequate or marginal for meeting national dietary needs, but in 2020, it was adequate to meet these needs. In In 2000 in Cambodia and Viet Nam, food supply almost met national dietary needs, and by 2020, they recorded considerable surplus in meeting national dietary needs.

From 2000 to 2020, the prevalence of undernourishment declined in all Mekong Basin countries (Figure 4.3). By 2020, all four countries had dramatically reduced the levels of undernourishment since 2000: Cambodia, 6.3%, Lao PDR, 5.1%, Viet Nam, 5.7% and Myanmar, 2.6%. Although the rate of decline of undernourishment decreased in all countries since around 2014, Thailand recorded lower rates of decline, with around 9% of its population still considered undernourished in 2020. Nevertheless, all countries still have a significant share of their populations experiencing undernourishment. This mirrors the performance in the adequacy of dietary energy supply, and indicates that there is an issue with some groups facing chronic food insecurity.

9 While much more detailed evidence on food availability and consumption is available from the SIMVA social surveys conducted by the MRC and used in the recent Council Study, these focus on a 15-km corridor on either side of the Mekong mainstream. The rationale behind the choice of this corridor is that direct riverine influences tail off beyond 15 km; i.e. social and economic characteristics of populations in the corridor, due to their proximity to the mainstream, are likely to be substantially different to the rest of the population. For these reasons, national-level data have been preferred as the basis for estimates.

10 FAOSTAT database: www.fao.org/faostat/en/#home

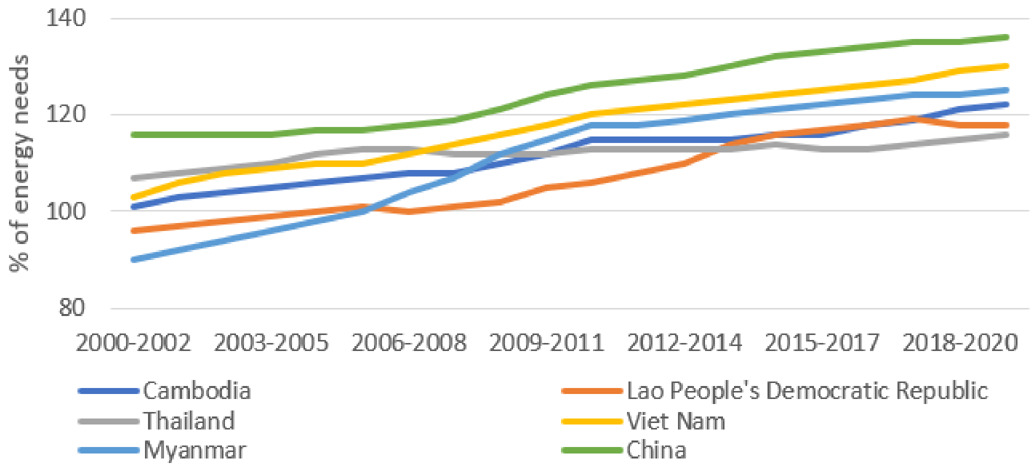


Figure 4.2. Adequacy of dietary energy supply (% of dietary energy needs met by national production) in Mekong River Basin countries, 2000–2020

Data source: FAOSTAT 2023

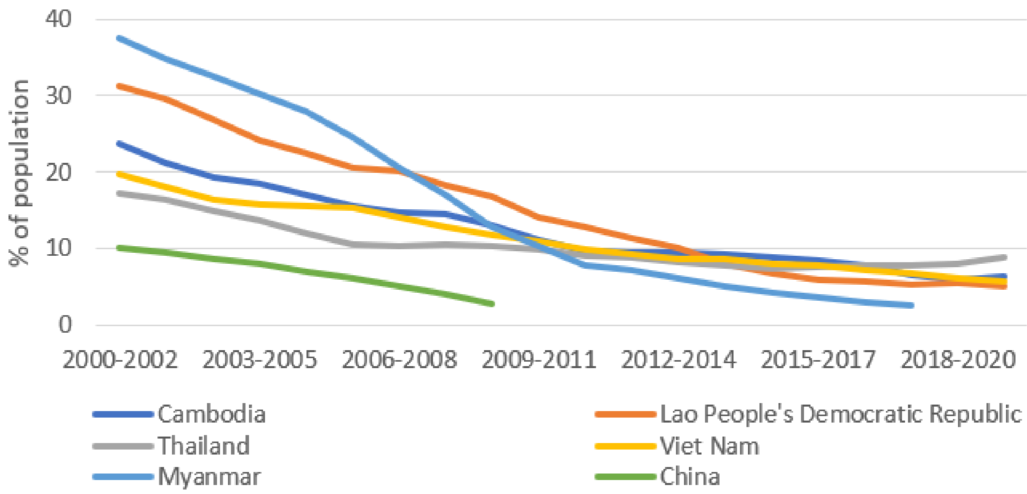


Figure 4.3. Prevalence of undernourishment in Mekong River Basin countries, 2000–2020 (% of the population)

Data source: FAOSTAT 2023

Limited data on the proportion of the population undernourished were available for basin provinces, with some data on Cambodia and Lao PDR available for the LMB between 2007 and 2019 (Figure 4.4). Care should be taken with comparing figures for the two countries since the large difference between levels of undernourishment reported likely reflects some differences in means of measurement. Nevertheless, basic trends in the indicator can be established, with a decline in the prevalence of undernourishment reported in Lao PDR from around 12% in 2013 to 10% in 2019. Cambodia, however, has seen a slight increase in undernourishment, from below 0.5% between 2007 and 2017, to 0.9% in 2019.

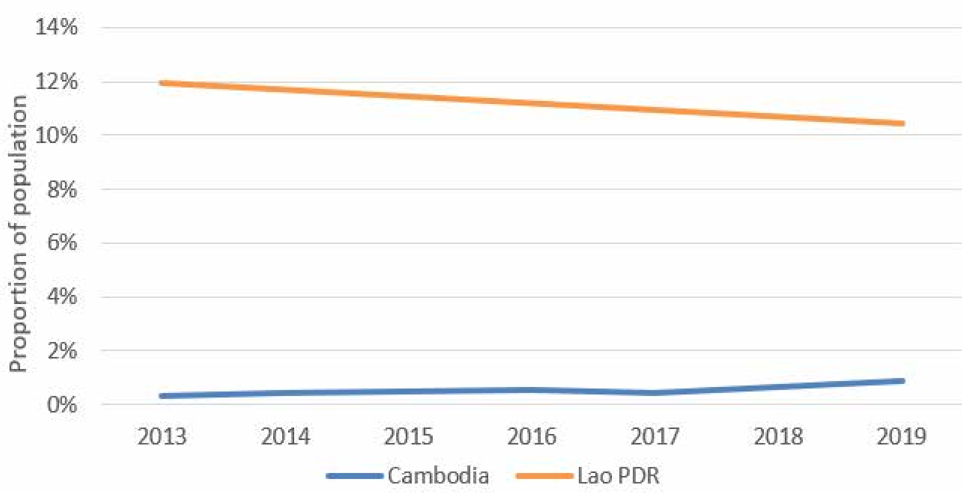


Figure 4.4. Prevalence of undernourishment as a proportion of the population in basin areas of Cambodia and Lao PDR, 2013–2019

Data source: National statistics provided by basin countries, adjusted for proportion of population estimated within the Basin

Data for Lao PDR highlight significant variation between provinces and between years (Figure 4.5). The data also suggest a higher level of undernourishment in 2019 in the basin population of Lao PDR, at 10%, than the FAO figures for the country as a whole, which gives a three-year average for 2019–2021 of approximately 5%. Also of note is the higher prevalence of undernourishment in provinces with large urban populations such as Vientiane Capital and Savannakhet (Figure 4.6), indicating that undernourishment may be becoming a more important issue in urban areas. This pattern is not repeated in Cambodia, where the highest prevalence of undernourishment is in the poorer provinces of Ratanakiri, Stung Treng and Prear Vihear, indicating different dynamics influencing undernourishment in the two countries.

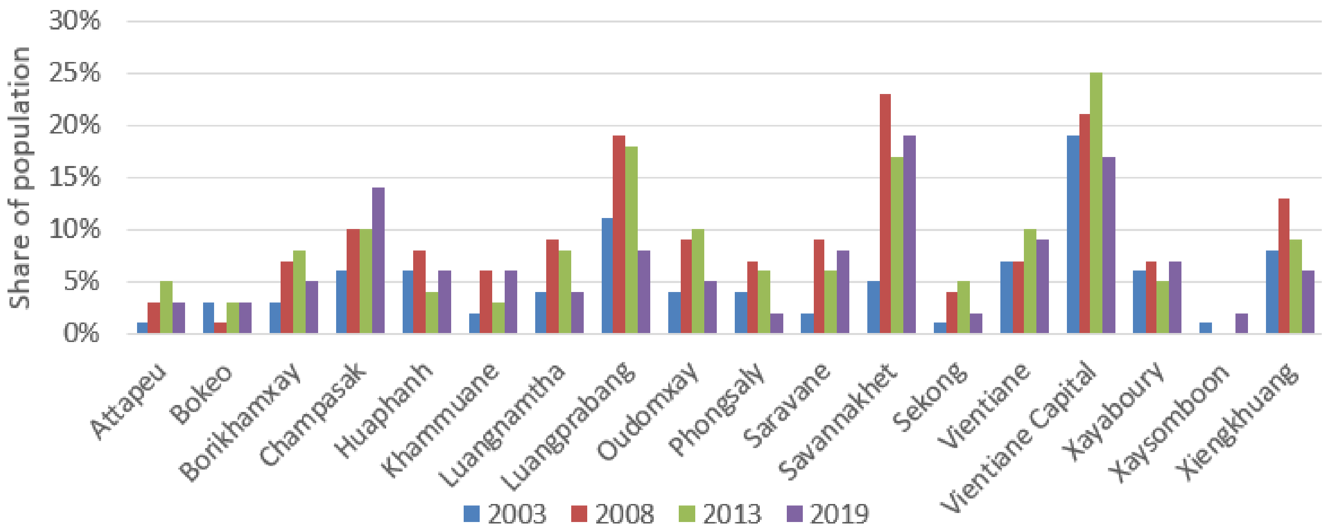


Figure 4.5. Prevalence of undernourishment as a proportion of the population, in Lao PDR basin provinces, 2003–2019

Data source: National statistics provided by Lao PDR, adjusted for proportion of population estimated within the Basin

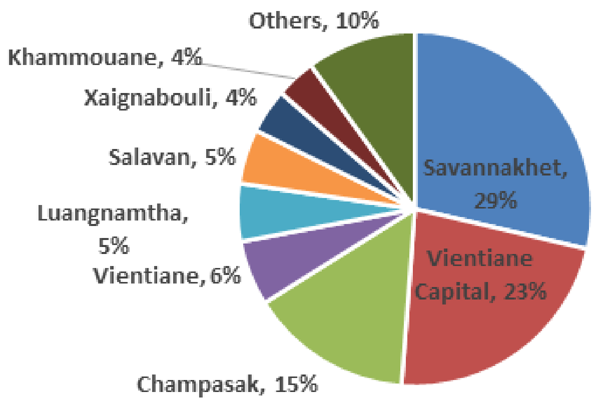


Figure 4.6. Undernourishment by province, by share of the total population of Lao PDR

Data source: National statistics provided by Lao PDR, adjusted for the proportion of population estimated within the Basin

Lack of infant malnutrition is frequently used as an indicator of food security. Undernourished children have lower resistance to infection and are more likely to die from common childhood ailments, including diarrheal diseases and respiratory infections. Frequent illness saps the nutritional status of those who survive, locking them into a vicious cycle of recurring sickness and faltering growth.

National data in basin countries on the prevalence of stunting[11] in children under five suggest that infant malnutrition remains a chronic problem in the Mekong River Basin, although it is at considerably lower levels in Thailand and China (Figure 4.7). Stunting has generally decreased over time; however, in 2020, it remains relatively high in Cambodia, Lao PDR, Myanmar and Viet Nam, at over 20%.

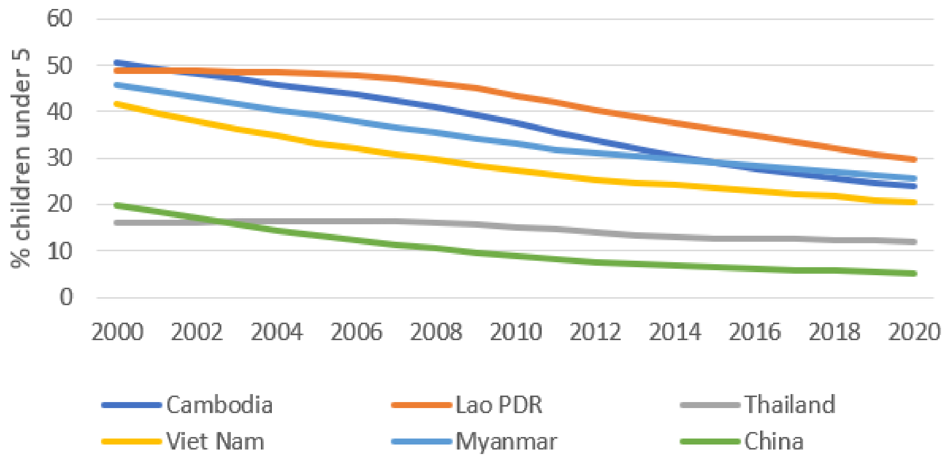


Figure 4.7. Prevalence of stunting, height for age (modelled estimate, % of children under five) in Mekong River Basin countries, 2000–2020

Data source: World Development Indicators

Within basin provinces, the latest available data suggest that the prevalence of stunting was around 32% in Cambodia in 2014, approximately 15% in Lao PDR in 2020, around 10% in Thailand in 2020, and around 22% in Viet Nam in 2020 (Figure 4.8). In the Basin, over the 2000–2020 period for which data are available, levels of stunting declined significantly in Cambodia and Viet Nam, and declined in the three years between 2018 and 2020 in Thailand, whereas the level of stunting grew substantially in Lao PDR between 2015 and 2020. Provincial-level data for Viet Nam from 2000 to 2020 show a higher level of stunting than at the national level but a similar decline in prevalence over time to national figures. Figures for Viet Nam also indicate rates of malnutrition much higher than the national average in the provinces of the central highlands (Kon Tum, Gia Lai and Dak Lak). Stunting decreased by approximately 40% in Viet Nam between 2000 and 2020, and by 15% in Lao PDR between 2010 and 2014, but remains relatively high. Basin provinces in Lao PDR and Thailand have relatively lower levels of stunting than in Cambodia and Viet Nam (Figure 4.9).

11 Prevalence of stunting (height for age <-2 standard deviation from the median of the WHO Child Growth Standards)

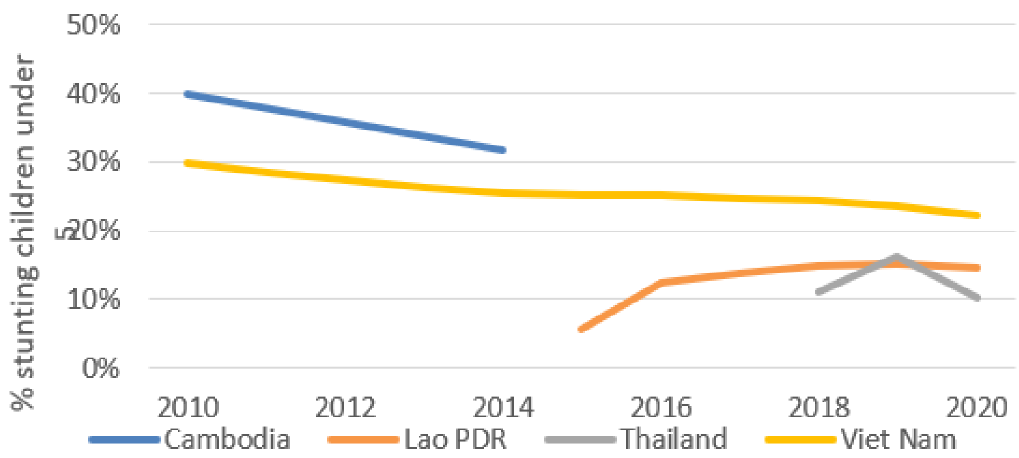


Figure 4.8. Prevalence of stunting in children under five, average of LMB provinces, 2010–2020

Note: National values reported for Lao PDR and basin provinces reported by other countries.

Data source: National statistics provided by basin countries, adjusted for proportion of population estimated within the Basin.

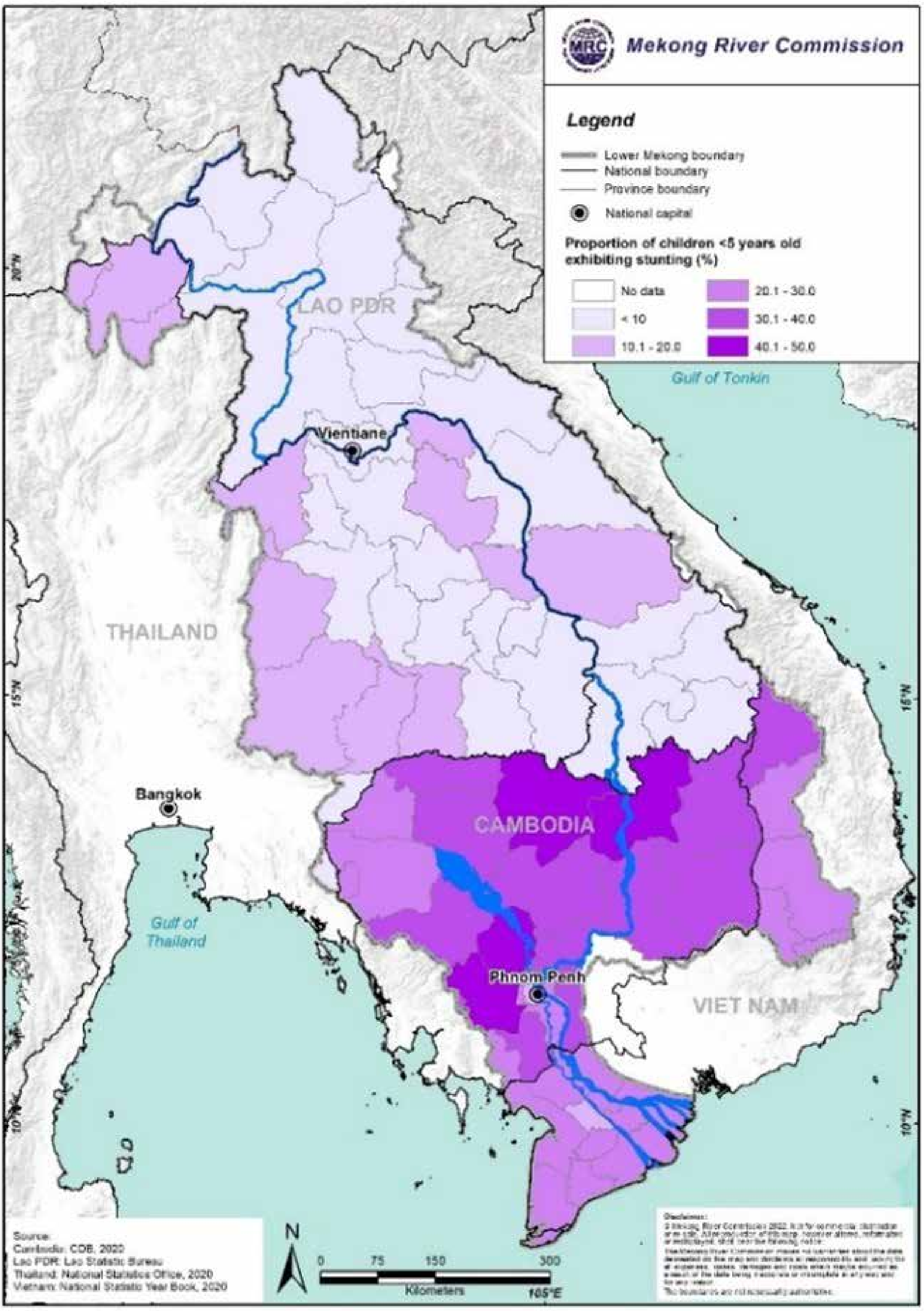


Figure 4.9. Proportion (%) of stunting in children under five across LMB provinces: Cambodia, 2014; Lao PDR, 2019; Thailand and Viet Nam, 2020

Data source: National statistics provided by basin countries

Based on national statistics from basin countries, prevalence of wasting[12] is also declining in the Basin, although progress is slow with high rates persisting in basin provinces in Cambodia (av. >10%) and Lao PDR (av. >11%) (Figure 4.10).

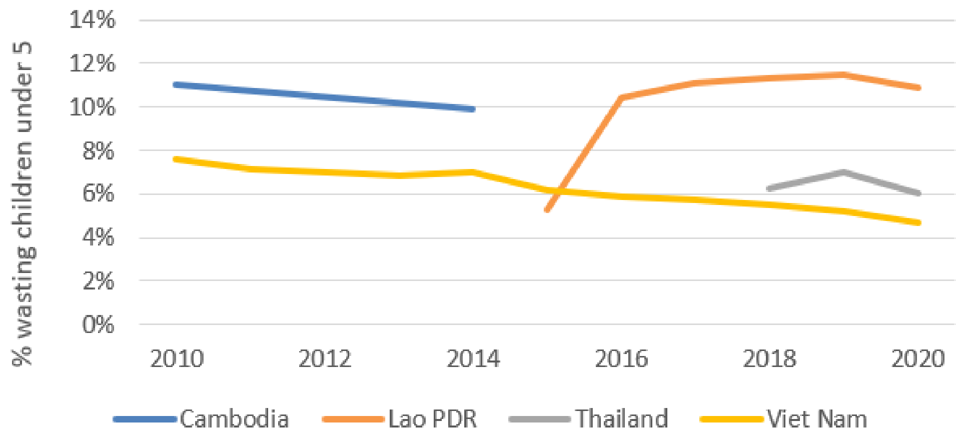


Figure 4.10. Prevalence of wasting (%) in children under five, average of LMB provinces, 2010–2020

Note: For Lao PDR National values are reported, whereas for the other countries, the values for basin provinces are reported.

Data source: National statistics provided by basin countries, adjusted according to the proportion of the population estimated within the Basin.

Food security in the Mekong River Basin is assessed as 'Of Concern'. Although adequacy of dietary energy supply is good at the macro level and more than sufficient to provide for the dietary needs of the population, there are relatively high levels of stunting and wasting of children in basin provinces, which suggests potential chronic problems of infant malnutrition. A slowing of progress to reduce undernourishment among the broader population (stabilizing at 5–10% of the population for all basin countries except Myanmar over the last five years) indicates that some vulnerable groups in society may be facing chronic food insecurity that is difficult to address. Further effort to identify these potentially vulnerable populations and the drivers of their food insecurity would be enhanced by the collection and analysis of relevant national and subnational data disaggregated by gender and other dimensions of vulnerability through basin countries' national surveys, data collection systems and processing mechanisms.

12 Prevalence of wasting (weight for height <-2 standard deviation from the median of the WHO Child Growth Standards) among children under five.

4.2.4. Water-related health security

Very Good	**Good**	Of Concern	Requires Action	Requires Urgent Action

Public health is a foundation for well-being and livelihoods. The water-related health security assessment indicator seeks to assess the extent to which basin communities are able to minimize the risk of disease and mortality related to waterborne pathogens. This in turn is indicated by access to safe water supplies, to sanitation, and to health facilities, as well as by the incidence of waterborne disease. Access to safe water supplies has already been discussed in Section 4.2.2 above.

Access to sanitation. Inadequate sanitation is an important cause of disease, and improvements to sanitation are known to have significant beneficial impacts for public health. In particular, basic sanitation reduces diarrheal disease and worm infections, which affect children disproportionately, weakening them and making them more susceptible to other malnutrition and to opportunistic infections like pneumonia. As such, access to sanitation is regarded as fundamental to human development.

All LMB countries have seen improvements in access to sanitation over the 2015–2020 period (Figure 4.11). This is clearest for Viet Nam and Cambodia, where the rate of increase is greater. The basin population of Cambodia has seen an increase in the proportion of households with access to sanitation from around 55% in 2015 to over 70% in 2020. Viet Nam has increased from just under 70% in 2016 to over 80% in 2020. Thailand had achieved near universal access to sanitation by 2016, which is maintained through to 2020.

Across the Basin, there are significant differences in the number of people with access to basic sanitation services by province (Figure 4.12). In provinces in Thailand and Viet Nam, in central areas of Lao PDR and around Tonle Sap, there are generally more people with access to sanitation facilities than in the northern and southern areas of Lao PDR and in areas of the 3S sub-basin in Cambodia. These differences reflect both the rate of access in different areas as well as the differences in the size of the population between provinces.

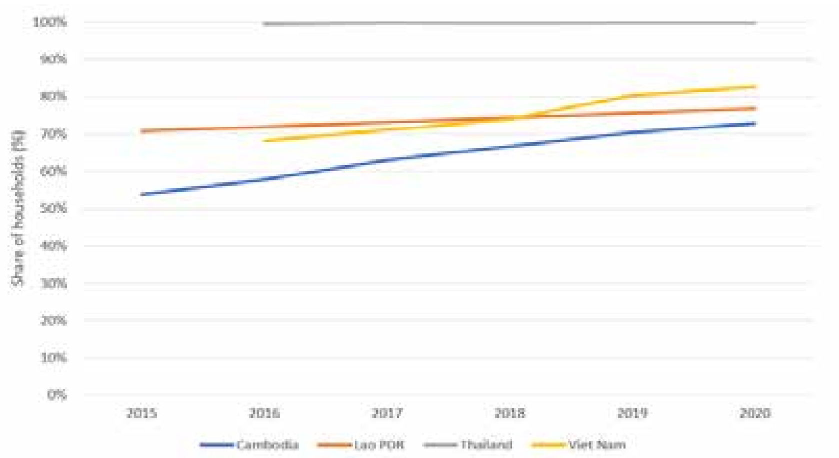


Figure 4.11. Proportion (%) of households in the Lower Mekong River Basin using at least basic sanitation services, 2005–2020

Data source: National statistics provided by basin countries, adjusted for proportion of population estimated within the Basin

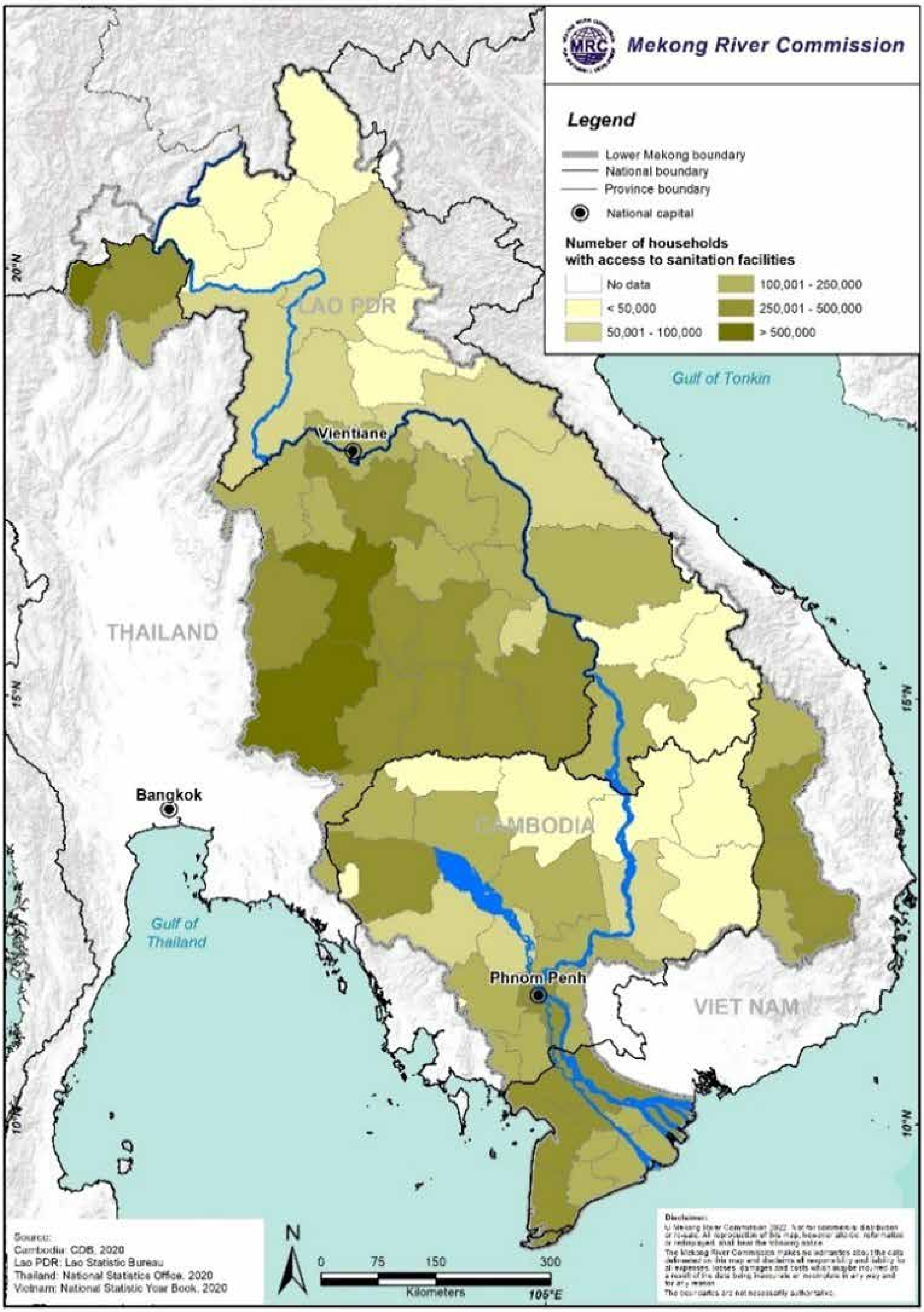


Figure 4.12. Number of households in the Lower Mekong River Basin using at least basic sanitation services, by basin province, 2020

Data source: National statistics provided by basin countries

Incidence of waterborne disease. In this report, consistent data on the incidence or prevalence of key waterborne diseases were only available in some countries for malaria and dengue fever. The data shows that the recorded incidence of these diseases was low or declining in most basin areas (Figures 4.13 and 4.14). Rates of malaria generally declined in all countries; only 2019 stood out in Lao PDR as a particularly high incidence year. Both malaria and dengue rates were much higher in Lao PDR than in other LMB countries.

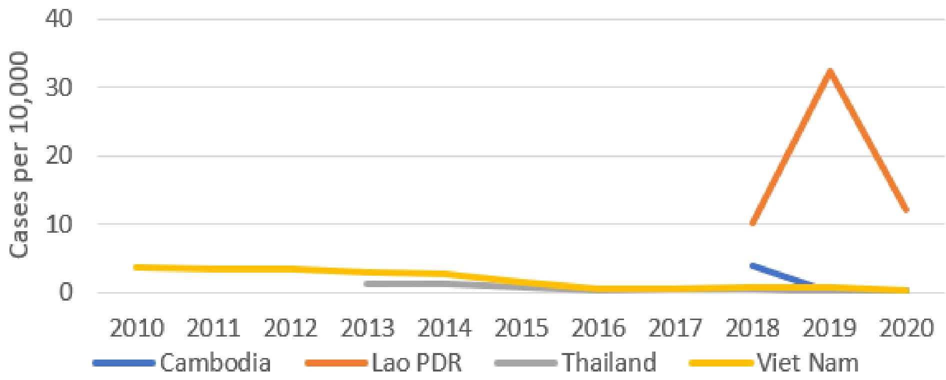


Figure 4.13. Incidence of malaria in Lower Mekong Basin populations in Cambodia and Viet Nam, 2000–2020 (cases per 10,000 population)

Data source: National statistics provided by basin countries, adjusted for proportion of population estimated within the Basin

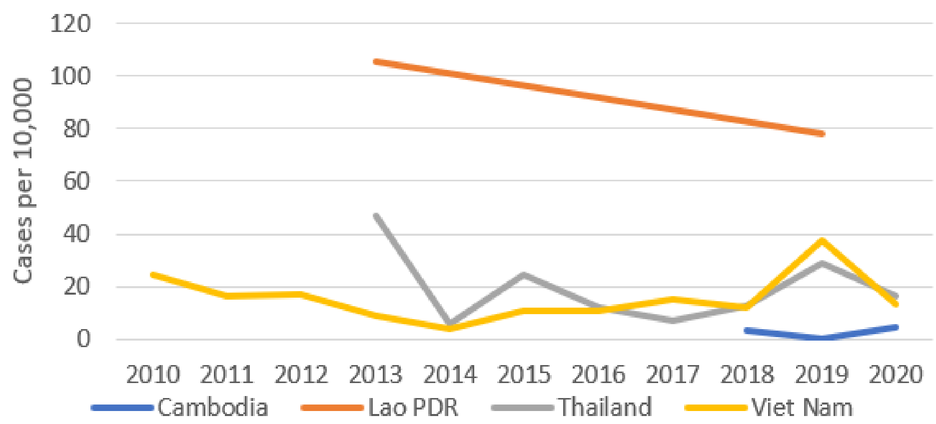


Figure 4.14. Incidence of dengue in Lower Mekong River Basin populations in Cambodia, Lao PDR and Viet Nam, 2003–2020 (cases per 10,000 population)

Data source: National statistics provided by basin countries, adjusted for proportion of population estimated within the Basin

Significant gender disparities are apparent in the data on the incidence of water-related disease in some countries. For instance, in 2020, around 75% of malaria cases in both Lao PDR and Thailand were among men, but approximately equal numbers of cases were among men and women in Cambodia. This may reflect differences in employment patterns and exposure to the disease. By contrast, in 2020, the proportion of men and women with dengue fever in Thailand was approximately equal, and only slightly higher for men than women in Cambodia (55% against 45%).

Water-related health security is assessed as 'Good' in the Mekong River Basin. Significant reductions in waterborne disease are evident in all countries, and increases in the proportion of households with access to at least basic sanitation have occurred in all four LMB countries.

4.2.5. Access to electricity

Access to modern energy services is an important element of well-being. Electricity offers many benefits to households such as cleaner and cheaper lighting, and cleaner cooking, and provides access to a range of household amenities otherwise not available, such as space cooling, food and medicines refrigeration, and access to modern communications such as television, phone charging and the internet. it can also supply a power source for household productive activities.

Approximately 100% of households in Thailand and Viet Nam's basin provinces had access to electricity by 2016 (Figure 4.15). Lao PDR also increased electrification rates, from approximately 75% of households in 2015 to around 90% of households in 2020. Cambodia experienced rapid growth in electrification from around 55% of households with access to electricity in 2015, to over 70% of households with access by 2020. Figures disaggregated by rural and urban access were available for Cambodia, which in 2020 had an urban electrification rate of approximately 83% and a rural rate of approximately 70%. However, these figures may overstate population access to electricity because they do not report the affordability of electricity or the quality of supply, which may be intermittent in many rural and remote areas, or the households that rely on off-grid electricity sources.

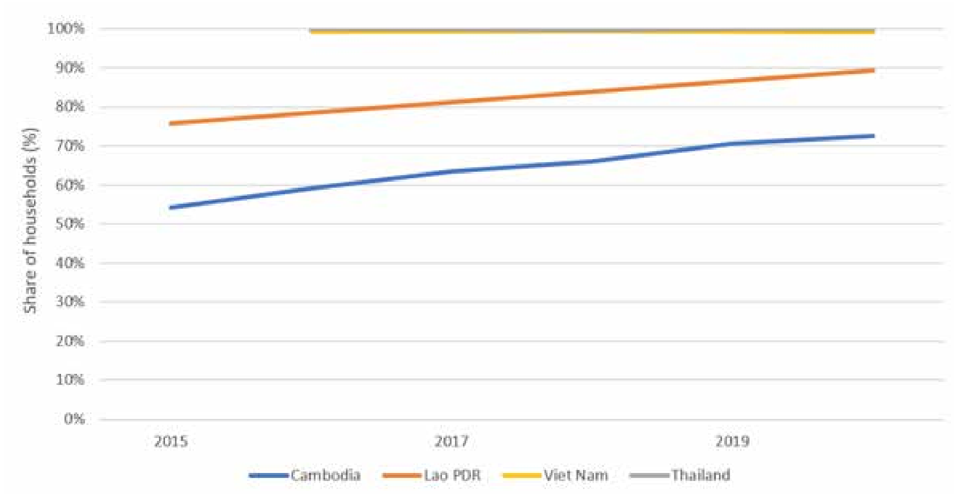
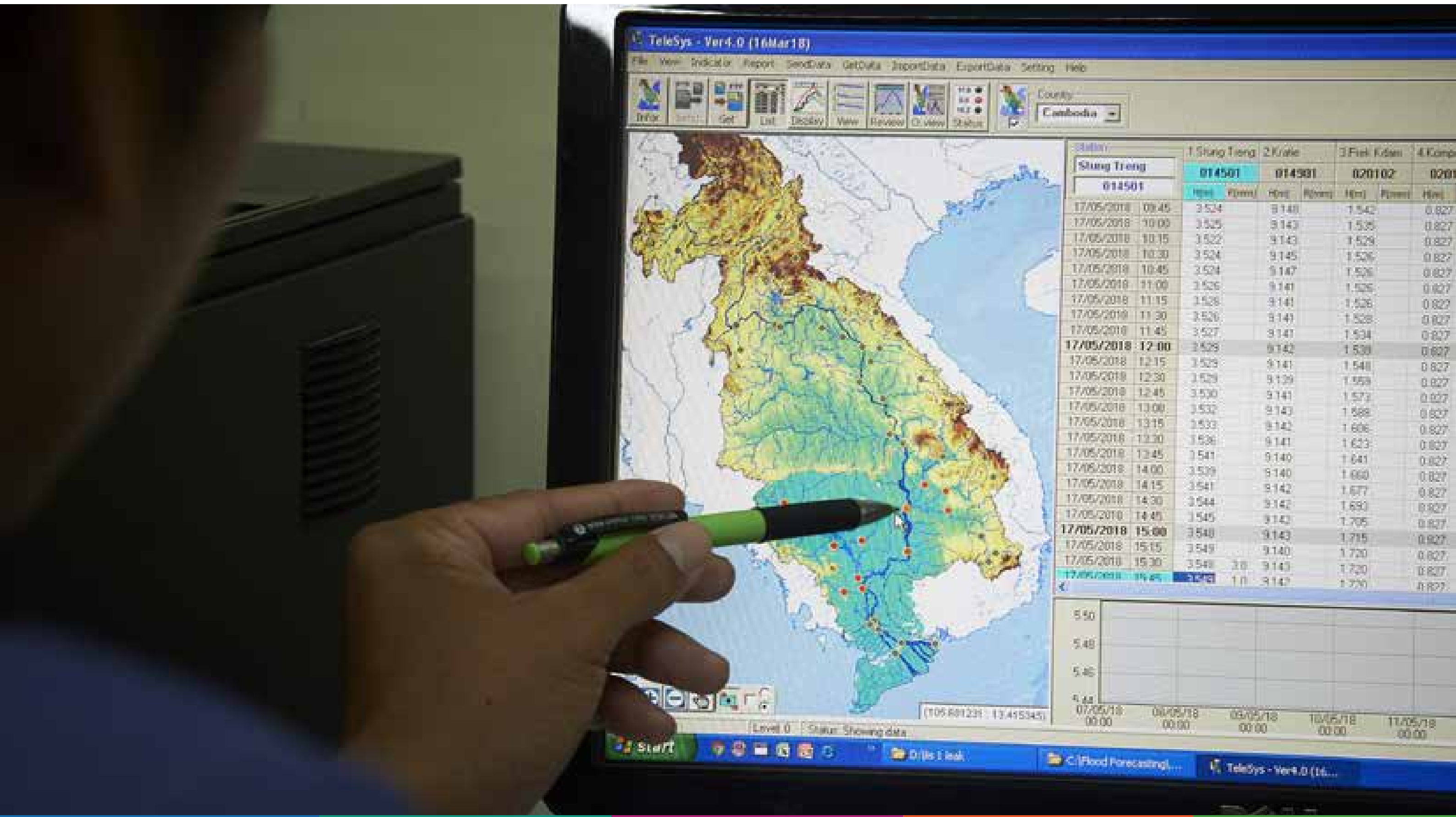


Figure 4.15. Proportion of households in the LMB with access to electricity, 2004–2020

Data source: National statistics provided by basin countries, adjusted for proportion of population estimated within the Basin

Across the Basin, there are significant differences in the number of people with access to electricity by province (Figure 4.16). Provinces in Thailand and Viet Nam, in central areas of Lao PDR and around Tonle Sap generally have more people with access to electricity, while in the northern and southern areas of Lao PDR, and in areas of the 3S sub-basin in Cambodia, there are far fewer people with access. These differences reflect both the rate of access in different areas and the differences in the size of the population between provinces.



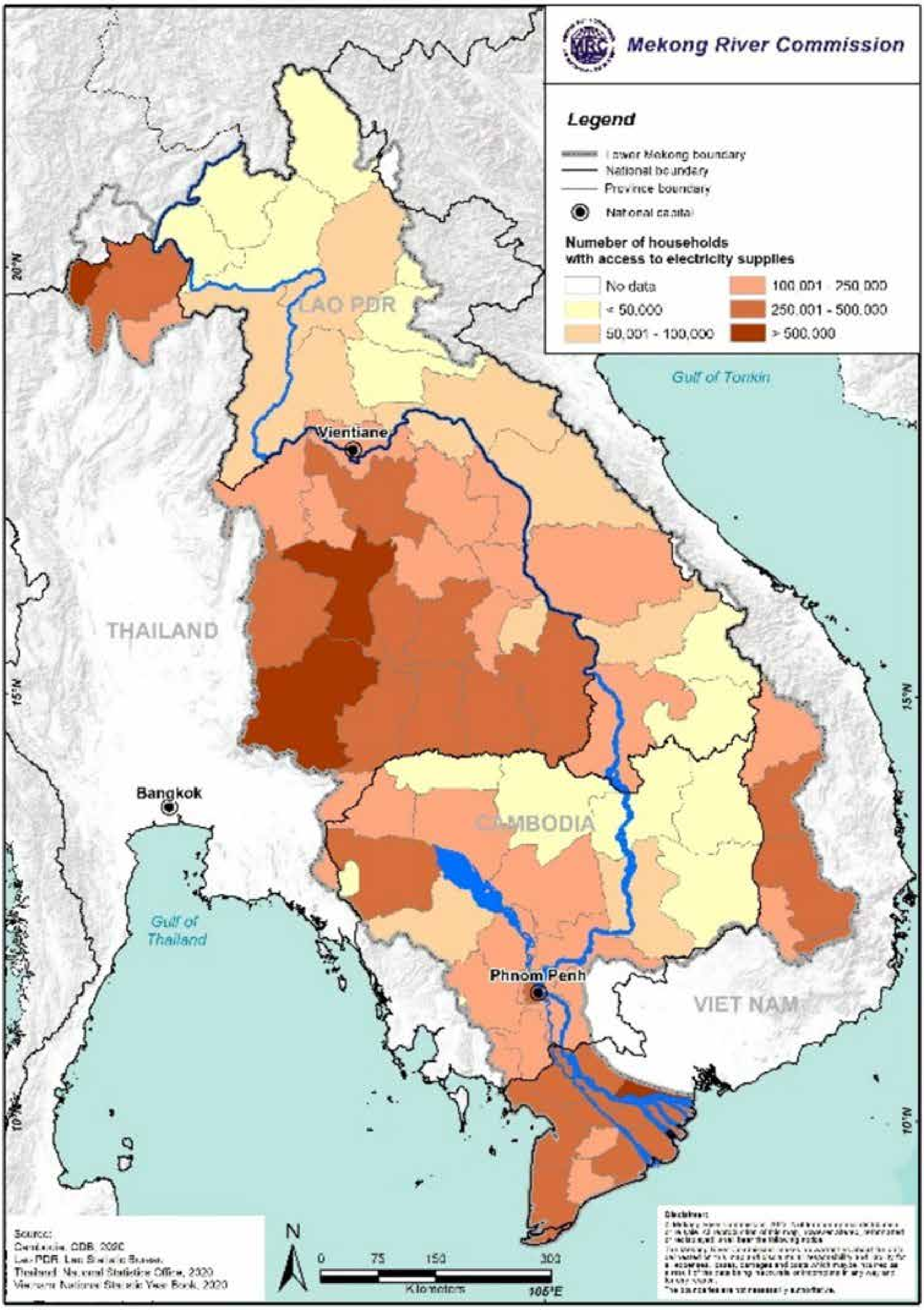


Figure 4.16. Number of households in the LMB with access to electricity, by basin province, 2020

Data source: National statistics provided by basin countries

Access to electricity is assessed as ‘Good’ in the Mekong River Basin. In Thailand and Viet Nam, there is essentially 100% access, and in Cambodia and Lao PDR, good progress is being made, which, at the current rate of improvement, would put the SDG for universal access to electricity within reach by 2030.

4.3. Livelihoods and employment in water-related sectors

4.3.7. Assessment methodology

The strategic indicator “Livelihoods and employment in water-related sectors” is defined as the level of community resilience as derived from the key components of sustainable livelihoods that help reduce vulnerability: employment, economic security and gender equality. The following sections evaluate the status and trends of livelihoods and employment in water-related sectors for the three assessment indicators of the MRB-IF:

- Employment rate in water-related sectors
- Economic security
- Gender equality in re-employment and economic engagement.

Each assessment indicator is evaluated with respect to several monitoring parameters. Data and information for these assessment indicators are generally sourced from the national statistics of basin countries as collected through the routine work of government agencies and supplemented where necessary with data from recognized international sources, as mentioned above.

4.3.8. Employment in water-related sectors

Very Good	**Good**	Of Concern	Requires Action	Requires Urgent Action

The main water-related sectors in the Basin are: (i) agriculture; (ii) fisheries (including aquaculture); (iii) forestry; (iv) navigation; (v) hydropower; (vi) sand mining; and (vii) tourism. This indicator aims to assess the importance of employment in these sectors for the population of the Basin. For this exercise, the focus has been on primary employment since data for other types of employment are limited.

The number of people primarily employed in agriculture, fisheries and forestry sectors has slightly declined over recent years. For example, from 2015/2016 to 2020, the share of the working-age population employed in agriculture decreased from 63% to 58% in Cambodia and from 39% to

34% in Viet Nam. Figures from Lao PDR and Thailand suggest an increase in agricultural employment in their basin provinces. The proportion of working-age people employed in fisheries and forestry remained relatively constant over the same period in both Cambodia and Viet Nam (Table 4.3).

This data provided for basin provinces are consistent with International Labour Organization (ILO) data on employment in Mekong River Basin countries for the share of employment in agricultural, fisheries and forestry sectors (Figure 4.17).[13] Based on these data, the agriculture, fisheries and forestry sectors have collectively seen their share of employment decline over the last two decades. From 2000 to 2020, employment in these sectors in Thailand had declined from 52% to around 34%, and in Viet Nam, from around 64% to 32%; China saw a similar decline, from 54% to 28%.

Table 4.3. Employment in water-related sectors as a share of total employment

	Cambodia		Lao PDR		Thailand		Viet Nam	
Sector	**2015(%)**	**2020(%)**	**2017(%)**	**2020(%)**	**2016(%)**	**2018(%)**	**2016(%)**	**2020(%)**
Hydropower	-	-	0.2	0.3	-	-	0.02	0.03
Agriculture	63.0	58.0	12.7	20.9	30.3	32.1	39.0	34.0
Fisheries	1.3	1.2	-	-	-	-	5.2	5.4
Forestry	0.1	0.1	-	-	-	-	0.1	0.1

Note: Countries use different criteria to define employment therefore a direct comparison between countries may be misleading. Lao employment refers to wage employment and excludes self-employment, which is likely to account for a large share of the agricultural workforce. This also explains the rapid growth of employment in the agricultural sector.

Data source: National statistics provided by basin countries

13 SIMVA data on employment in the mainstream corridor was not used because, as noted above, the socio-economic characteristics of the population in the mainstream corridor are unlikely to be representative of the LMB as a whole.

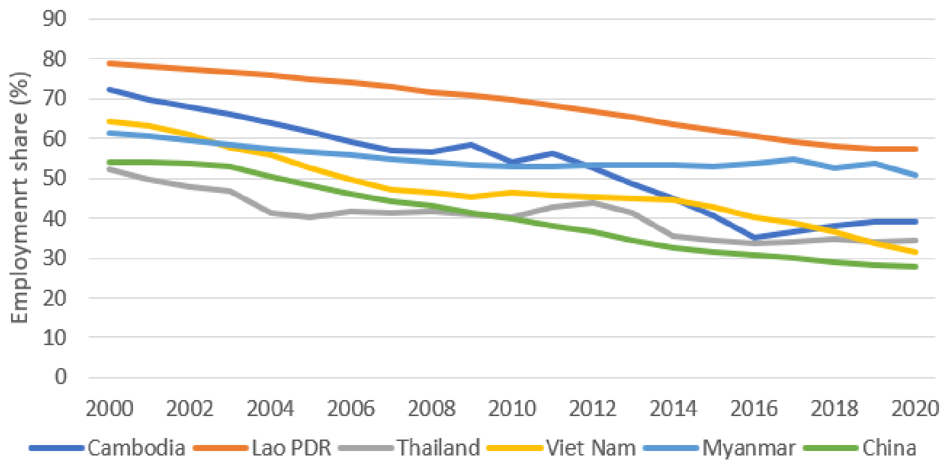


Figure 4.17. Employment in agriculture, forestry and fisheries in Mekong River Basin countries, 2000–2020

Data source: International Labour Organization

At the national level, Cambodia and Lao PDR have also seen significant declines in the share of employment in agriculture, forestry and fisheries. Both countries are on similar trajectories to Thailand, Viet Nam and China. From 2000 to 2020, the share of employment in agriculture and related sectors declined in Cambodia from 72% to an estimated 39%, and Lao PDR from 79% to 57%. In Myanmar, this share decline from 60% to 50% of employment in the sector, but at a slower rate than in the other basin countries.

In China, Myanmar, Thailand and Viet Nam, it is important to note that the national-level data are likely to be misleading as regards employment trends in the Mekong River Basin. The national decline in the employment share of agriculture, fisheries and forestry is likely to be a consequence of strong growth in employment in other sectors, especially the manufacturing and service sectors. This growth is likely to be concentrated in and around urban areas, and is closely associated with urbanization. Most of these large urban areas lie outside the Mekong River Basin (e.g. the Bangkok metropolitan area, Ho Chi Minh City and Hanoi).

More detailed subnational figures for the LMB show that the agriculture sector continues to be an important source of employment with high numbers of people employed in the sector. For example, in Cambodia in 2020 approximately 4.6 million people were primary employed in agriculture, compared with 6,129 people and 98,438 people employed in forestry and fisheries, respectively, in 2020. In Viet Nam in 2020, approximately 4.5 million people were primary employed in agriculture, compared with 3,530 people, 16,050 people and 729,488 people employed in hydropower, forestry and fisheries, respectively. These figures are consistent with the recent 2018 SIMVA study (MRC 2021e), which found that water resource-dependent occupations, such as the collection of OAAs/Ps, fish processing, aquaculture, navigation, and sand mining from the river, were the most or second most important activities for less than 1% of households, However, for some countries, the number engaged in fishing activities but not necessarily formerly employed in fishing is likely to be significantly higher based on past assessments. In the 2018 SOBR (MRC, 2019b) more than 1 million people were identified as engaged in basin fisheries in each country, either as fishers, fish farmers, processors or traders.

Although data on labour productivity per worker for the agricultural sector were only available from Cambodia and Viet Nam (Figure 4.18), after adjusting for changes in prices, this shows a gradual rise in value-added per agricultural worker from USD 870 per year in 2011 to USD 1,306 by 2019 in Cambodia. Viet Nam also saw a significant rise in labour productivity in the agricultural sector, from USD 2,428 per worker per year in 2016 to USD 3,091 by 2020.

It should be stressed that this probably underestimates the importance of secondary employment in other sectors such as fishing and forestry, although data on this were not available. For example, separate studies (MRC, 2021e; World Bank, 2012) suggest that the number of people either dependent on or otherwise engaged in fisheries including in a part-time or recreational capacity may involve as many as two-thirds of LMB households, or more than 40 million people.[14] A large proportion of the population is likely to continue to be dependent on agriculture and fisheries for the foreseeable future.

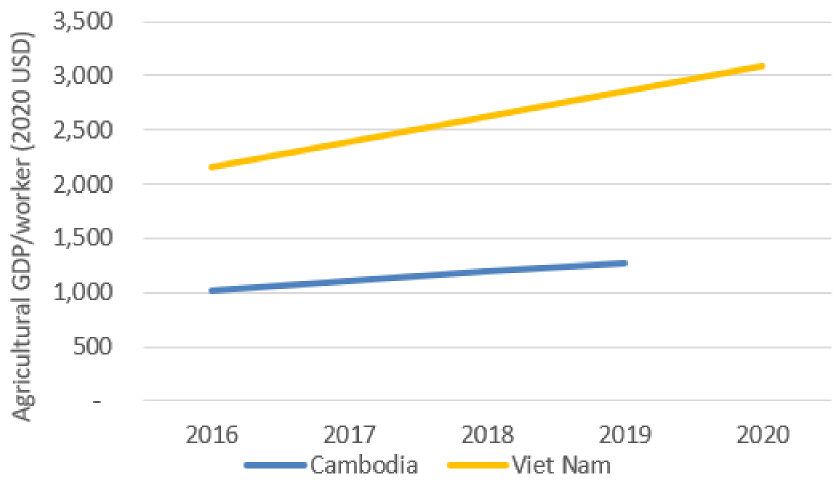


Figure 4.18. Labour productivity in the agricultural sectors of Cambodia and Viet Nam in the Lower Mekong River Basin, 2016–2020

Data source: National statistics provided by basin countries

14 Fishing is an integral part of the livelihoods, culture and food security coping strategies of upland peoples who are mostly indigenous or belong to ethnic minority groups that show the highest poverty incidences in the region (Xu and Daniel, 2011, cited in Nam et al., 2015)

Tourism is also likely to be a significant employer in areas of the LMB. The World Tavel and Tourism Council (WTTC) produces national estimates of employment in the sector. Therefore, to estimate figures for the LMB it was assumed that the share of tourism employment in the LMB was directly proportional to the share of the national population in the LMB. This may over-estimate the basin share of tourism employment in Thailand and Viet Nam, which both have a large number of tourist attractions outside the LMB. However, it is nevertheless clear that tourism is an important employer in the Basin (Table 4.4). Moreover, if indirect and induced tourism employment is taken into account the importance of tourism employment may increasingly rival other sectors such as fisheries.

Table 4.4. Employment in tourism, 2019–2021 (million people)

Country	2019	2020	2021
Cambodia	2.33	1.82	1.90
Lao PDR[1]	-	-	-
Thailand	3.15	2.56	2.63
Viet Nam	1.17	0.92	0.93

Note: [1]Data for Lao PDR are not available.

Data source: WTTC (2022a, 2022b, 2022c)

Employment in water-related sectors is assessed as 'Good' in the Mekong River Basin. The rate has declined in all countries, likely reflecting productivity improvements, particularly in agriculture, in Cambodia and Viet Nam. This has been accompanied by the movement often of younger people to urban areas for work in the expanding manufacturing and service sectors. In some cases, this seems to be leading to a rise in unemployment concentrated in urban areas, which was apparent even prior to the COVID-19 pandemic. However, care needs to be taken when interpreting these data because unemployment rates frequently do not capture issues of rural underemployment. For example, individuals may have work and often on their own landholding, but it only occupies a portion of the time that they could be economically active. Nevertheless, the overall employment rate across the countries remains relatively constant (Figure 4.19), indicating the likely effective allocation of labour to more productive sectors as economies transition to higher levels of manufacturing and services relative to primary industries.

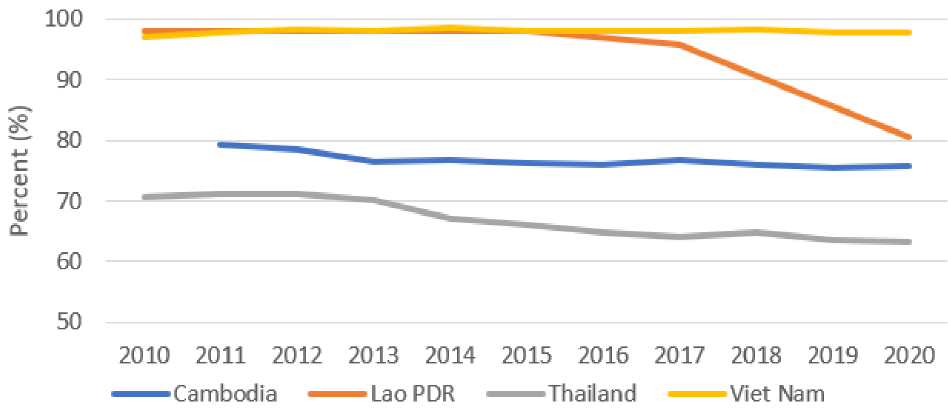
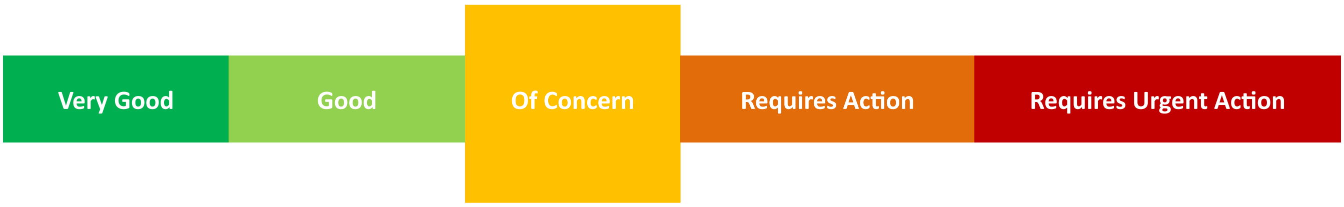


Figure 4.19. Average provincial employment rates for basin provinces in Lower Mekong Basin countries, 2010–2020

Note: The substantial reduction in Lao PDR in 2020 reflects a change in methodology.

Data source: National statistics provided by basin countries, adjusted for proportion of population estimated within the Basin

4.3.9. Economic security



The economic security assessment indicator as defined in the MRB-IF is composed of two monitoring parameters, sufficiency of household assets and household income. This section presents poverty rates for all Mekong River Basin countries and data for LMB countries on average household expenditure (commonly used as a proxy for income, although noting that expenditure may also be financed from debt) as well as data on ownership of land and other household assets for the countries where available. It should be taken into consideration, however, that comparisons between countries can be problematic due to different methodologies used for estimating these monitoring parameters.

Poverty rate is a commonly used metric, typically based on a poverty line that identifies a basic level of income (expenditure) below which income (expenditure) is deemed insufficient to meet basic needs and the household or individual is classified as poor. International expenditure-based poverty lines have been established for most countries, which correct for differences in purchasing power and allow comparisons of poverty rates between countries. Poverty rates based on an expenditure-based poverty line at purchasing power parity (PPP) show a clear downward trend across basin countries (Figure 4.20), with the obvious caveat that for Myanmar, China, Thailand and Viet Nam, national poverty rates may be misleading in terms of conditions in the Basin. National data for Cambodia was also not available although recent reports put poverty rates around 17.8% in 2019–2020 (World Bank, 2022a).

Poverty rates are also considered based on levels set by national governments using differing socio-economic criteria (Figure 4.21); for example, Viet Nam considers non-income factors such as access to services, which therefore does not allow a comparison between countries. Nevertheless, these rates provide a useful indication of the share of the population that the Government considers poor, and are a guide to socio-economic performance. Again, there is a downward trend in poverty rates across Mekong River Basin countries. The overall trends are borne out by recent reviews of poverty data for Viet Nam, Cambodia and Lao PDR conducted by the World Bank (World Bank, 2022b; 2022a; 2020).

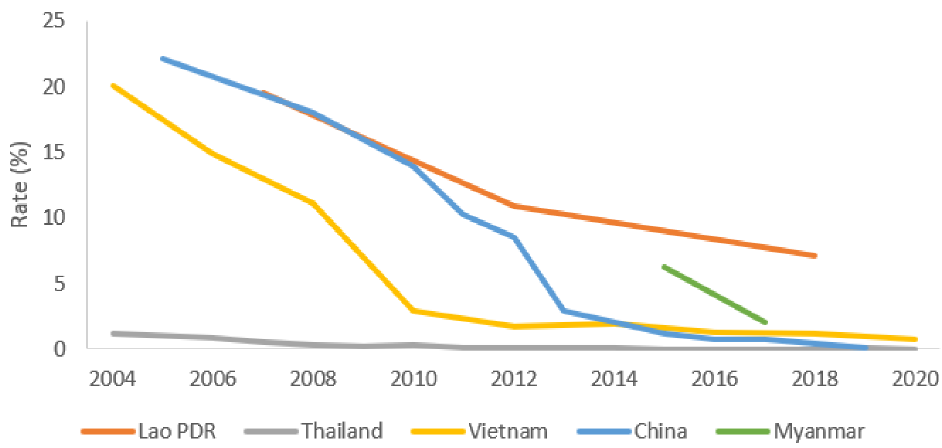


Figure 4.20. National poverty headcount ratio in Mekong River Basin countries based on the international poverty level set at USD 2.15 a day (2017 PPP) (% of population)

Note: Data for Cambodia are not available.

Data source: World Development Indicators

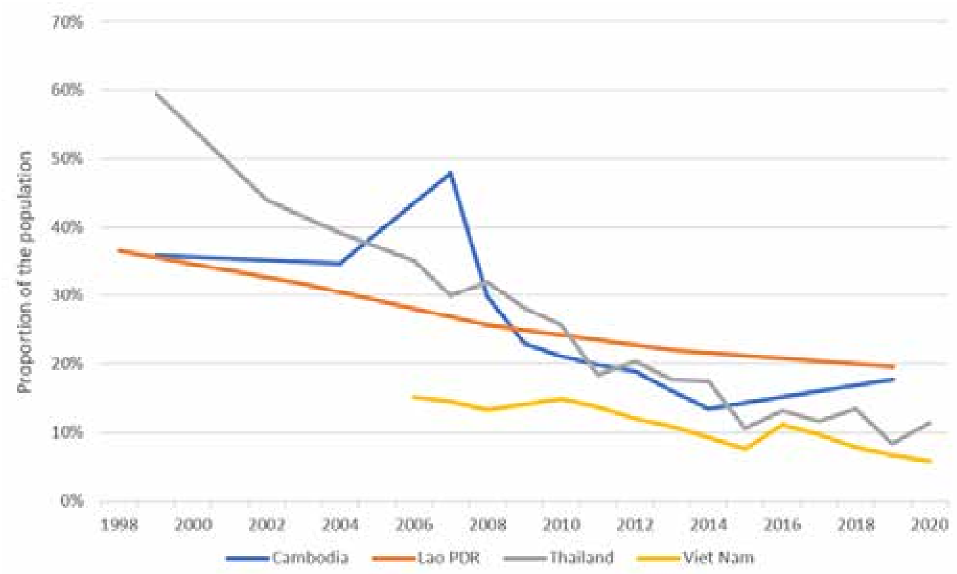


Figure 4.21. Poverty rate (% of population) at national poverty lines within basin provinces of LMB countries, 1999–2020

Data source: National statistics provided by basin countries, adjusted for proportion of population estimated within the Basin. For Cambodia, the values are national figures.

Evidence from recent socio-economic analysis in Cambodia (World Bank, 2022a) illustrates a variation in poverty dynamics across the country. The analysis found higher poverty rates in predominantly rural areas around Tonle Sap (23.8%) and in the plateau and mountainous regions (22.5%) in the northeast of the country. The poorest provinces were in the east of the country, with poverty affecting approximately a third of the population in Ratanakiri (29.6%), Mondulkiri (28.1%) and Stung Treng (27.3%). The study also found a large variation in poverty levels within provinces, with significant differences in poverty rates between districts and communes. The urban poverty rate was 9.6%, less than half the rural poverty rate of 22.8%, although given large differences in population density between rural and urban areas, the highest poverty densities are in Phnom Penh and surrounding areas.

The data for Lao PDR (World Bank, 2020) showed poverty rates of 18.6% nationally in 2019, down from 23.2% in 2013. Poverty rates were higher among agricultural households (25%) than for non-farm households (>10%). From these same data, most of Lao PDR's basin provinces showed substantial declines in poverty between 2013 and 2019, with the exceptions of Attepeu, Khammuane, Borikhamxay, Vientiane capital and Xayabury, which all see substantial increases in poverty rates. Based on the province data for Lao PDR in 2019, Sekong had the highest percentage of people below the national poverty level, at 30.6% while Vientiane Capital had the lowest, at 5%. In 2019, the provinces that had higher percentages than the average (between 19% and 31%) included Huanphanh, Xiengkhuang, Oudomxay, Luang Prabang, Xayabury, Bokeo, Borikhamxay, Khammuane, Savannakhet, Saravan, Sekong and Attapeu. These provinces could be considered vulnerable areas.

From the province data for Thailand in 2020, the average percentage of people below the national poverty level was 9.9%. Many LMB provinces had a higher percentage of people below the national poverty level than the average (between 12% and 24%) including Nakhon Ratchasima, Buri Ram, Surin, Si Sa Ket, Ubon Ratchathani, Amnat Charoen, Udon Thani, Kalasin, Nakhon Phanom and Phayao provinces. Kalasin province had the highest percentage of people below the national poverty level, at 23.8%, while Loei and Khon Kaen provinces had the lowest percentage, at 0.3% and 0.8%, respectively.

The data for Viet Nam (World Bank, 2022) also indicates similar patterns with large variations in poverty rates across geographic regions, and between different social and occupational groups. In particular, poverty rates remained high among farming households, at 21.3% in 2020, and in the Central Highlands (17.1%). Although poverty rates in the delta were low (3.7% in 2020), they increased from 2% in 2018 as a consequence of the pandemic. The World Bank's analysis points out that economic growth in Viet Nam has lifted many households out of poverty, but areas of chronic poverty persist, and a large share of the population remains economically vulnerable. Although the data on the broader Mekong River Basin are limited, it is likely that these general conclusions apply.

From the province data for Viet Nam in 2020, the average percentage of people below the national poverty level was 6.7%. Some basin provinces had a higher percentage of people below the national poverty level than the average (at rates of between 7% and 23%), including Kon Tum, Gia Lai, Dal Lak, Dak Nong, Tra Vinh and Bac Lieu provinces. Kon Tum province had the highest percentage of people below the national poverty level, at 22.0%, while Bac Lieu province had the lowest percentage, at 6.7%.

In addition to the proportion of people in basin provinces below the national poverty line, the estimated total number of people falling below the poverty line in each country shows similar declines (Figure 4.22). However, these figures also serve to illustrate the persistence of a large number of people still living in poverty within the Mekong River Basin of Cambodia, Thailand and Viet Nam. Lao PDR's much lower figure reflects its much lower population in the Basin. The figure also illustrates the decline in poverty reduction in recent years, likely because issues with chronic poverty are more difficult to address.

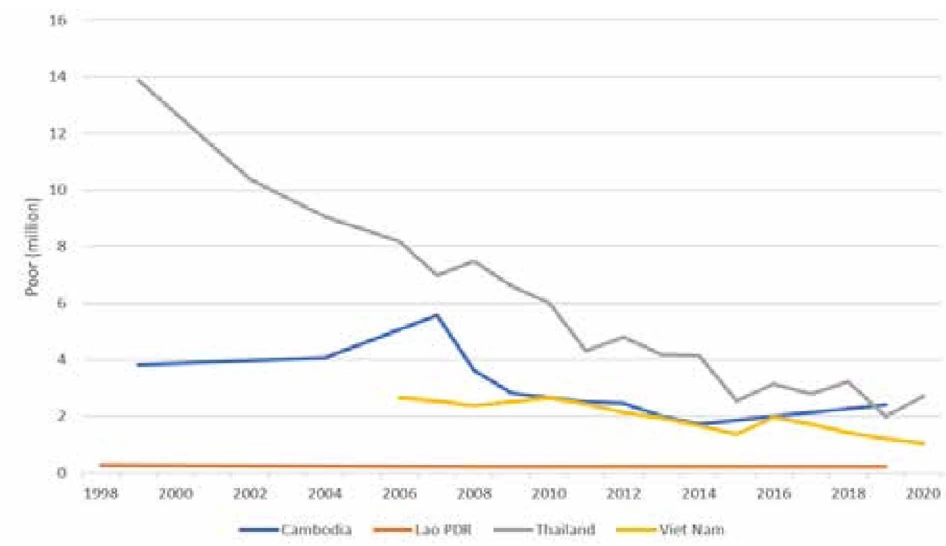


Figure 4.22. Number of people falling below the national poverty line in basin areas of Lower Mekong River Basin countries areas, 1999–2020

Data source: National statistics provided by basin countries, adjusted for proportion of population estimated within the Basin

There has been an upward trend in per capita expenditure[15] in the LMB (Figure 4.23), with significant gains in Thailand and Cambodia over recent years. However, average household expenditure is generally not an indication of the number of vulnerable households as uneven levels of household expenditure can act to skew the mean. For this reason, in many countries, the median is preferred as a summary measure of income and expenditure. Given the data on poverty presented above, Cambodia's high level of per capita expenditure/income relative to both Lao PDR and Viet Nam is surprising; this may reflect the impact of much higher income levels in Phnom Penh on the overall provincial average.

15 Expenditure measures are generally preferred to income-based measures because they tend to be easier to measure and are more accurate. Moreover, expenditure is regarded as a better indicator because it measures actual consumption more directly.

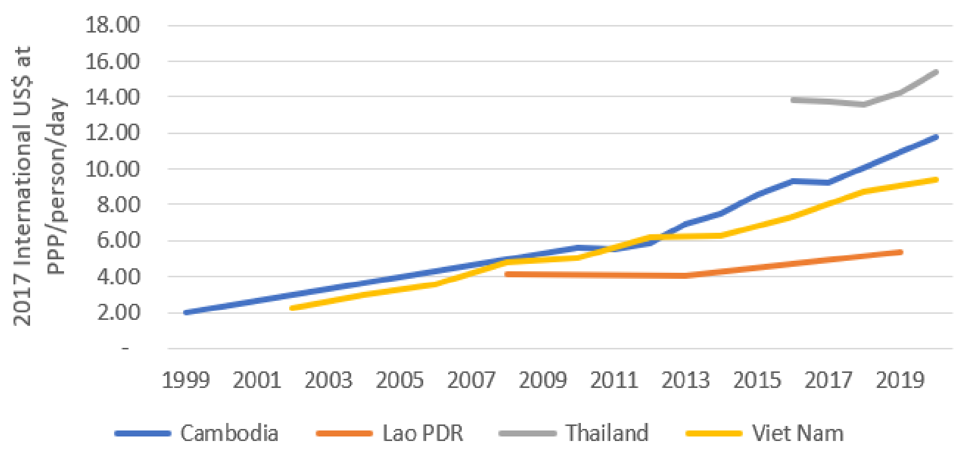


Figure 4.23. Average per capita expenditure per day (at PPP) for basin provinces in Lower Mekong River Basin countries, 1999–2020

Data source: National statistics provided by basin countries, adjusted for proportion of population estimated within the Basin

Gender-disaggregated figures for Cambodia indicate that, on average, expenditure by female-headed households was around 80% that by male-headed households in 2019, albeit an improvement from 2011, when female-headed households' expenditures were approximately 78% that of male-headed households. Female-headed households tend to be smaller, and if household size is taken into account, per capita expenditure in female-headed households in Cambodian basin provinces was approximately 96% that of male-headed households.

Other than poverty levels and household expenditure, another factor that can affect household economic security is land tenure. Within the LMB, considering the most recent year when data were available (Figure 4.24), Thailand (2020) and Lao PDR (2019) had the highest proportion of all households that own land within the Basin, at around 80% and 90%, respectively. In Viet Nam, around 63% of all households had access to household land (2020) and in Cambodia, 41% (2020). Although Cambodia has by far the lowest level of land ownership, rates increased more than 20% between 2011 and 2020 for all households, and by 5% over the same period for rural households. Caution should be applied in comparing rates of land ownership between countries due to different definitions applied in each country. Moreover, with the modernization and commercialization of agriculture in some areas of the region, land ownership is in decline as households rely more on wage labour for their livelihoods (rather than subsistence from their own land), such as in the Mekong Delta. This is not necessarily a cause for concern but is a result of structural change in the rural economy.

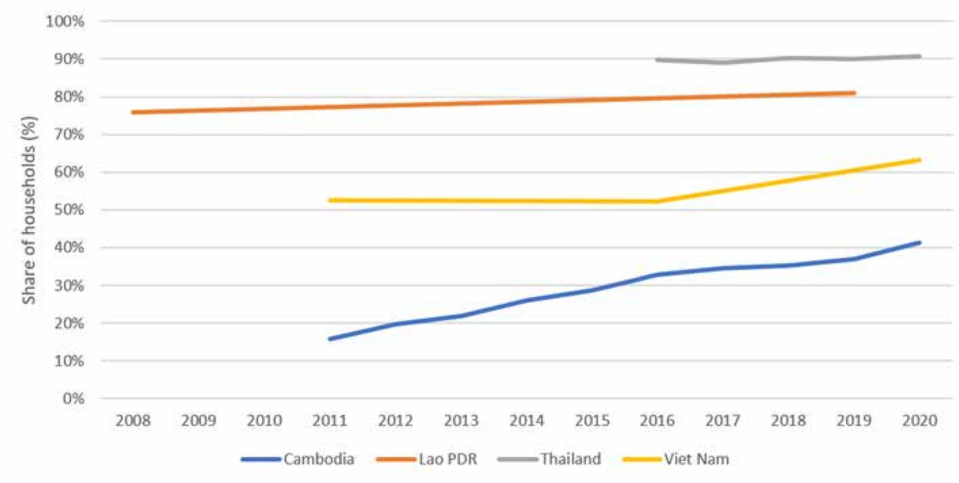


Figure 4.24. Share of households with access to land based on ownership in basin areas of Lower Mekong River Basin countries, 2008–2020

Data source: National statistics provided by basin countries, adjusted for proportion of population estimated within the Basin

Figure 4.25 gives the average value of household assets for basin provinces in Cambodia, Lao PDR, Thailand and Viet Nam. As with national poverty lines, the means of measuring assets and asset value differ between the countries, so they should not be compared directly. Cambodia and Thailand have seen significant increases in the value of household assets in real terms, whereas the value of household assets in Viet Nam has remained approximately the same over the last two decades, and those in Lao PDR have declined since around 2008. These changes are likely related to changes in land price, which typically constitutes a large share of household assets in the region.

Data disaggregated by female- and male-headed households were available for Cambodian basin provinces. On this basis, the value of household assets between the two groups has been broadly similar between 2011 and 2017, although with some fluctuation. For example, in 2011, the value of the average assets of female-headed households were 96% that of male-headed households, and in 2013, they increased to 103%. In the most recent available year, however, it was estimated that the value of the average assets of female-headed households had declined to 78% of that of male-headed households.

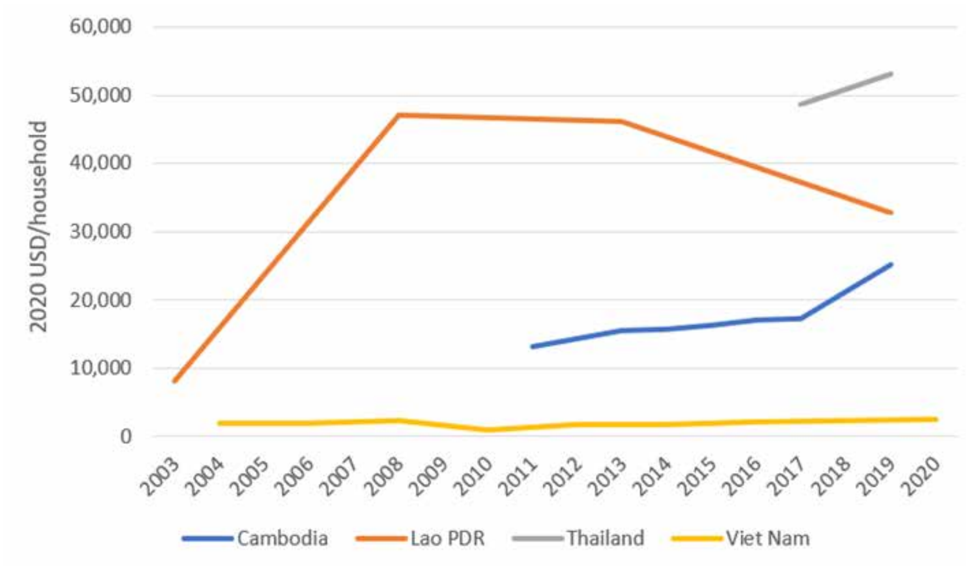


Figure 4.25. Average value of household assets in basin provinces of Lower Mekong River Basin countries, 2002–2020

Note: As with other socio-economic data, countries use differing bases for the estimation of the value of household assets; therefore, values should not be used for a cross-country comparison. All data were obtained from recent socio-economic surveys conducted in the four LMB countries, but the assets included in the estimates vary. Cambodia included all durable household assets, land, buildings and commercial property owned by households. Lao PDR included durable goods, land and buildings. Like Cambodia and Lao PDR, Thailand included durable household assets, land and buildings, but also explicitly included financial assets held by households. In contrast, Viet Nam's estimate covers only household durable goods, excluding other assets.

Data source: National statistics provided by basin countries, adjusted for proportion of population estimated within the Basin

Economic security is assessed as 'Of Concern' in the Mekong River Basin. Despite limitations in data availability, poverty rates have generally declined across basin countries, and household expenditure – and by implication income – have increased over recent years. However, poverty reduction has been patchy, with slowing gains and chronic levels of poverty persisting in certain geographic regions. For example, almost one-fifth of the population in Cambodia and Lao PDR remains below the national poverty line. An analysis of poverty data by the World Bank in Cambodia, Lao PDR and Viet Nam also suggests that a significant portion of the population remains economically vulnerable (World Bank, 2020, 2022a, 2022b). Rates of household access to land remain very low in some countries, especially Cambodia and Viet Nam.

4.3.10. Gender equality in employment and economic engagement

Very Good	Good	Of Concern	Requires Action	Requires Urgent Action

Gender equality in employment and economic engagement is considered in relation to the share of female-to-male employment in water-related sectors (agriculture, fisheries and forestry only) and the ratio of female to male enrolment in primary and secondary education (Gender Parity Index, or GPI). According to the MRB-IF, the proportion of female-headed rural households relative to male-headed households that own land or other significant economic assets should also be considered; however, there were insufficient data available to do so.

ILO-modelled data provide the share of female and male employment in agriculture, fisheries and forestry for Mekong River Basin countries (Figure 4.26). Where there is gender parity, the percentage is zero; negative numbers imply a higher female share than male; and positive numbers, a higher male share than female. In general, there is only a small difference between the share of female and male employment in agriculture, fisheries and forestry sectors. The biggest differences are in China, Myanmar and Thailand, where the sectors tend to be more male-dominated; this trend seems to be increasing in Myanmar and Thailand, but declining in China. Cambodia shows the least gender difference in employment in the sectors, with a slight majority of females employed. Viet Nam and Lao PDR see high proportions of female participation in these sectors, but the gap is reducing over time.

Provincial-level data from Thailand's basin regions suggest that the gap between female and male employment in agriculture is significantly larger than the national figures estimated by ILO. Provincial data show that the proportion of women employed in agriculture was between 75% and 76% of that of men between 2016 and 2018, respectively, suggesting a higher disparity in agricultural employment between genders in Thailand's basin regions than in the country as a whole. This varies considerably between provinces: in 2018, in Yasathon, gender parity was almost reached in agricultural employment, i.e. women's employment in the sector was 96% that of men's. In contrast, in 2018, Sa Kaeo (58%), Nong Bua Lam Phu (61%) and Nakhon Ratchasima (60%) had significantly lower rates of female than male employment in the sector. Generally, provinces with a higher rate of agricultural employment overall had higher levels of gender parity in agricultural employment. This may be as a result of greater opportunities for female employment in manufacturing and service sectors than for men.

Data available for agriculture, forestry and fisheries in basin provinces of Cambodia between 2011 and 2020 are given in Figure 4.27, which illustrate higher employment of men in all sectors, especially in forestry and fisheries. Over time, the employment of women relative to men in fisheries increased, but declined in agriculture and forestry.

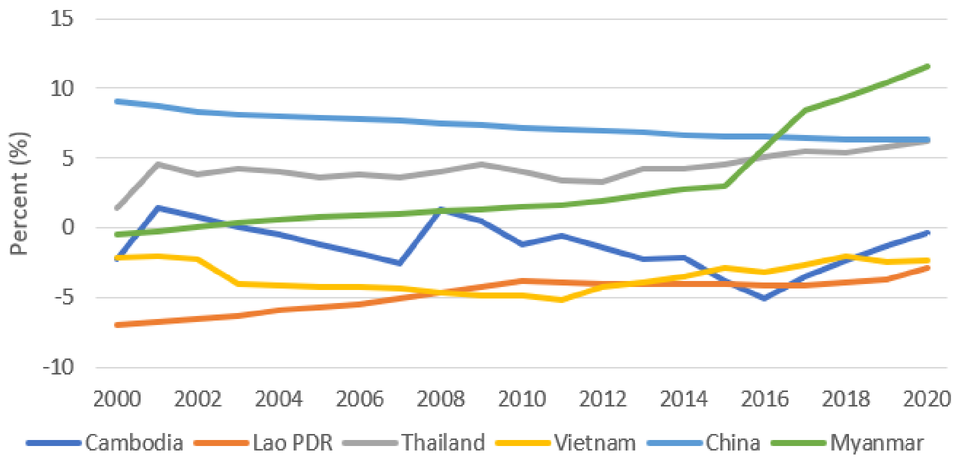


Figure 4.26. Difference in share of employment by gender in agricultural, fisheries and forestry sectors, 2000–2020

Note: Positive values indicate a higher proportion of males than females employed.

Data source: ILO modelled estimates from the World Development Indicators

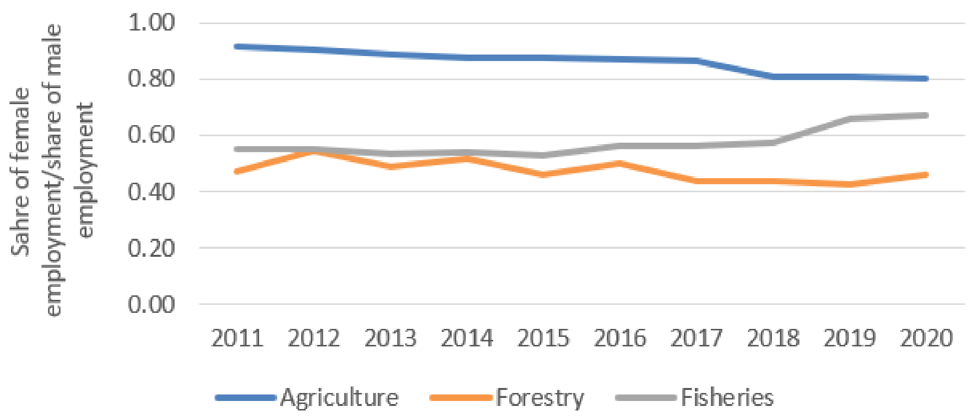


Figure 4.27. Share of female employment relative to male employment in agricultural, fisheries and forestry sectors in basin provinces of Cambodia, 2011–2020

Data source: National statistics from Cambodia, adjusted for proportion of population estimated within the Basin

In general, gender differentials in employment in these sectors seem relatively small. However, these figures do not capture differing gender roles within the sectors. They also do not capture differences in the extent of economic activity between men and women, which may be significant.

Moreover, there may be subnational variations in female participation in water-related sectors that are not evident in national and even provincial-level data.

With regard to gender differences in overall employment, in the 2001–2018 period, Cambodia had a higher overall employment rate among women (78%) than men (67%) in basin provinces, while in Thailand, between 72% and 80% of men, and between 55% and 61% of women were employed. Overall, female employment rates have consistently been around 75–76% of male employment rates, pointing to persistent disparities in employment opportunities (Figure 4.28).

Figure 4.28. Female and male employment rates and employment ratio in Thailand, 2001–2018

Data source: National statistics from Thailand, adjusted for proportion of population estimated within the Basin

The Gender Parity Index (GPI) for gross enrolment ratio in primary education is the ratio of girls to boys enrolled at primary level in public and private schools. Values of less than 1 indicate a higher proportion of boys enrolled in primary education than girls, and values greater than 1 indicate a higher proportion of girls enrolled than boys. Most Mekong River Basin countries have experienced significant and persistent historical gender differentials in primary school enrolment, with a greater level of male than female enrolment. However, all countries also improved significantly between 2000 and 2020 (Figure 4.29). Viet Nam and China had the best performance, with a gradual improvement in female enrolment and a GPI that has exceeded 1 since 2016. Thailand showed less improvement over the period, and in 2015, there was a relative decline in female enrolment after a GPI exceeding 1 in 2014. Cambodia and Lao PDR have also seen gradual improvement; however, GPIs in both countries indicate continuing gender differentials in primary enrolment rates. Myanmar has seen a marked decline in recent years, from a GPI close to 1 in the 2000s to below 0.95 in 2017.

At the secondary school level, GPI is also improving across LMB countries: Thailand had a higher rate of female-to-male enrolment, Cambodia reached parity with a GPI of 1 at around 2018, and Lao PDR increased to 0.96 in 2020 (Figure 4.30).

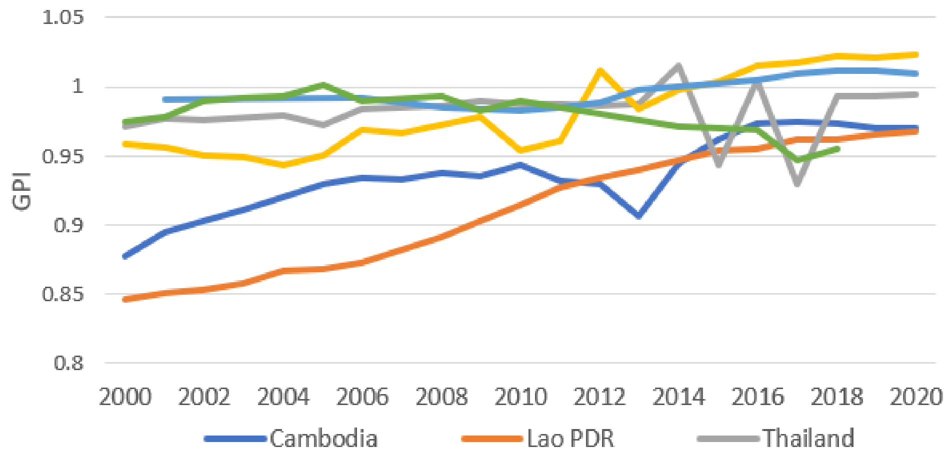


Figure 4.29. Gender Parity Index for primary school enrolment in the Mekong River Basin countries, 2000–2020

Data source: World Development Indicators

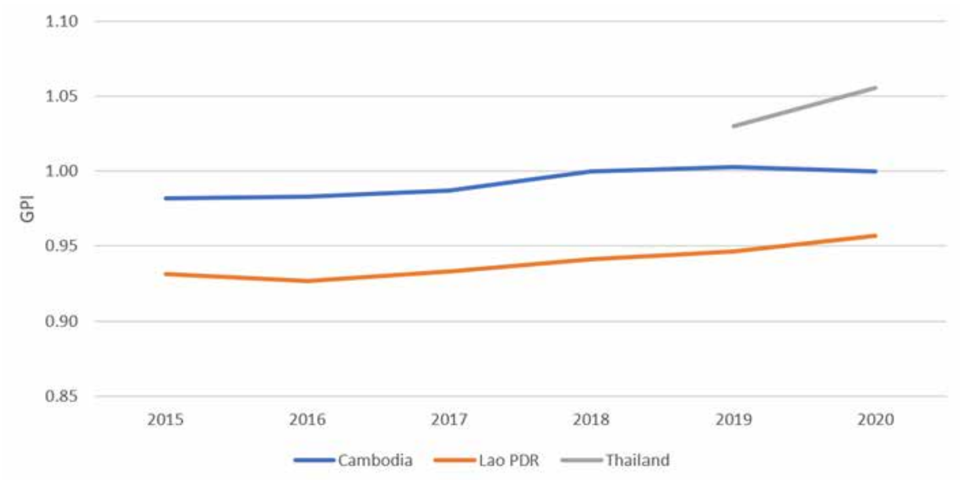


Figure 4.30. Gender Parity Index for secondary school enrolment for the basin areas of LMB countries, 2015–2020

Data source: National statistics provided by basin countries, adjusted for proportion of population estimated within the Basin

Gender equality in employment and economic engagement is assessed as 'Of Concern' due to the slowing of progress or decline in the indicators of gender equality related to employment and education in some countries, and the ongoing lack of gender-disaggregated data for a broader set of indicators to inform a more complete assessment. Although improvements in GPI in most countries at both primary and secondary levels are encouraging, it should be noted that there are multiple aspects to gender equality not captured in the data available for this SOBR based on equality of access to employment in water-related sectors and the GPI.

4.4. Overall social conditions

Overall living conditions and well-being in the Mekong River Basin have improved significantly over the last 20 years. All countries have experienced improvements in access to food and in nutritional outcomes (as indicated by falling malnutrition levels), more extensive access to improved water sources for drinking and agriculture, access to basic sanitation, lower rates of disease, and improved access to electricity. There remains significant variation in levels of access between countries, largely reflecting the different stages of development. There is also substantial subnational variation, which has been illustrated where data were available.

Employment in water-related sectors in the Basin remains high, although the importance of primary employment, particularly in agriculture, is declining as work opportunities in other non-water-related sectors (often services and manufacturing located outside the Basin) develop. Employment in fisheries also remains important for livelihoods, and tourism stands out as an increasingly important source of employment, which is likely to grow rapidly.

Although the broad picture of social development in the LMB shows that social conditions have improved substantially over the last two decades in all basin countries, efforts need to be made to achieve universal water, food and energy security. The slowing progress in improvements to the prevalence of undernourishment and in indicators of infant malnutrition suggest that there are vulnerable groups that may be difficult to reach with public services or less than fully engaged in economic opportunities. There is a risk of entrenching long-term poverty and inequality of access to food, water and energy security if these issues cannot be properly identified and addressed.

In terms of vulnerability as described in Chapter Two, the following major intersectional dimensions of vulnerability related to water resources management and development were addressed in relevant sections of this SOBR:

- **Poverty.** As reported in Section 4.3.3, poverty rates based on an expenditure-based poverty line at PPP as well as the national poverty line show a clear downward trend across all basin countries, although noting that for Myanmar, China, Thailand and Viet Nam, national poverty rates may be misleading in terms of conditions in the Basin. Despite this progress, poverty levels remain high in several countries, particularly in Cambodia, Lao PDR and Myanmar. Since poverty among agricultural households is generally higher than for non-farm households, it is possible that rates within the Basin are higher than national averages.
- **Gender.** As reported in Section 4.3.3, there have been improvements in gender equality across the Basin as reflected in the share of females to males employed in agriculture, fisheries and forestry sectors, and in the gender parity ratio for enrolment in primary and secondary school education. Nevertheless, gender differentials remain, and these indicators based on national data do not pick up subnational differences or additional drivers of inequality, such as differing roles and levels of pay, or other conditions of employment that occur within sectors.
- **Ethnicity.** No information or data on ethnicity and vulnerability were available for this SOBR.
- **Livelihood focus.** As reported in Section 4.3.2, the proportion of the working-age population employed in agriculture, forestry and fisheries in Mekong River Basin countries has declined over the past two decades. This may be a positive sign, providing that improvements in productivity can compensate for the reduced labour inputs, and that other work opportunities in higher value-added sectors are available for people to transition to, for example, manufacturing and service sector jobs. It is likely that these other sectors are less vulnerable to changes in river conditions. The relative stability of the overall employment rate in the Lower Mekong River Basin suggests that people are finding these other opportunities, although it is not possible to determine whether this applies to more vulnerable groups.

The SIMVA indicators related to food and livelihood vulnerability linked to changes in water resources are related to MRB-IF monitoring parameters, such as household size, food security as affected by household income, poverty levels, child malnutrition, and employment in water-related sectors.

As reported in Chapter Two, the average household size has declined across the Basin over the last two decades, from an average among four countries of 5.1 people per household, to an average among six countries of 4.1 people per household. Accompanied by an increase in household expenditure (income), this change is likely to have reduced household vulnerability to shocks, and all else being equal, helped to improve food security. Food security as reflected in the potential adequacy of dietary energy supply has likely strengthened, although this measure does not take into account affordability and nutritional quality, which are likely to be variable among different communities.

As mentioned, employment in water-related sectors and poverty levels have generally declined in basin countries, as has child malnutrition, as indicated by the prevalence of stunting and wasting in children under five (Section 4.2.3), which points to potential improvements in the level of vulnerability in the basin community. However, the prevalence of stunting at both the national and basin levels remains relatively high, especially in Cambodia, Lao PDR, Myanmar and Viet Nam, suggesting that infant malnutrition remains a chronic problem in the Mekong River Basin and that there are vulnerable groups in society experiencing food insecurity.

With regard to gender differences in levels of household expenditure and the value of household assets, for basin provinces, only Cambodia had data on household expenditure by sex of household head. On average across basin provinces in 2020, the average daily expenditure for male-headed households was around USD 19 per household per day, against around USD 14 for female-headed households. Similarly, the value of household assets in basin provinces of Cambodia was on average around 39% higher in male-headed households than in female-headed households. With greater access to economic resources and therefore capacity to respond to shocks, these figures suggest lower levels of vulnerability in male-headed households than in female-headed households in Cambodia.

The vulnerability of different communities to changes in the river environment is likely to be subject to considerable spatial differences. Communities close to the Mekong River in Lao PDR also generally have significantly lower rates of poverty than those further away (MRC, 2021j), especially in hilly and mountainous areas, and thus may have more capacity to cope with change than the population more broadly. Nevertheless, as illustrated in SIMVA studies, communities along the river still have important elements of their livelihoods that depend on aquatic resources, including fisheries and OAA, often as a secondary livelihood source (MRC, 2014; 2018). As the proportion of people employed in agriculture, fisheries and forestry declines over time (Section 4.3.2), vulnerability to changes in the river environment may also decline. However, both positive and negative impacts are likely to continue to be felt for some time to come, including for those engaged in growing sectors such as tourism and navigation.

4.5. Progress towards BDS Outcomes

The BDS outlines two outcomes under the Social Dimension Strategic Priority for achievement by 2030:

2.1 Strengthened water, food and energy security for basin community wellbeing

2.2 Increased employment and reduced poverty among vulnerable people dependent on river and wetland resources.

These outcomes seek to ensure that by 2030, the Basin's water and related resources continue to provide an important contribution to food, water and energy security for women and men while helping poor, resource-dependent communities achieve sustainable livelihoods with higher incomes. They seek to ensure that people, especially those in vulnerable situations, can meet their basic needs while sharing in the benefits of basin water resource development. Food security is addressed primarily by improving management of fisheries (including aquaculture) and addressing the risks to capture fisheries from a range of threats. The assessment of progress towards BDS 2021–2030 Outcomes in the Social Dimension is summarized in Table 4.5. Outcomes is not always a one-to-one relationship considering the alignment of strategic and assessment indicators with each BDS outcome. In many cases, the indicators provide relevant information to evaluate progress towards more than one BDS Outcome (Table 3.1). Where this is the case, commentary cross-referencing the results of evaluation against assessment indicators in other dimensions or for other strategic indicators is provided.

Table 4.5. Summary of progress towards BDS 2021–2030 Outcomes based on conditions and trends of aligned strategic indicators in the Social Dimension

BDS Outcomes	Strategic indicators	Condition	Trend	Key Issues	BDS Progress
2.1 Strengthened water, food and energy security for basin community wellbeing	Living conditions and wellbeing	●	↗	Inequality of access including potential chronic food insecurity in some vulnerable groups	→
2.2 Increased employment and reduced poverty among vulnerable people dependent on river and wetland resources	Livelihoods and employment in water-related sectors	●	↔	Slowing of gains in some countries over recent years	● ● ●

The strategic indicators in the Social Dimension both suggest that there are some issues to address. With regard to living conditions and wellbeing, the trends over the last two decades in water, food and energy security are generally positive. However, the slowing of progress in some countries in recent years, especially for food security, as indicated by the prevalence of undernourishment and infant malnutrition, suggests that the BDS Outcome will be increasingly challenging to meet by 2030. Targeted policy measures will need to be developed at the national level and implementation accelerated to extend services to the most hard-to-reach populations and to support vulnerable groups in society.

With regard to livelihoods and employment, there are also *some issues to address*. Although employment in agriculture is declining, other sectors including tourism are showing growth. However, the data are not sufficiently delineated to ascertain the extent to which vulnerable people dependent on river and wetland resources have access to these employment opportunities and can overcome entrenched disadvantage to improve their economic circumstances. Identifying these vulnerable people and supporting them in finding new sources of employment in growth sectors should be a focus of countries as they manage the transition to increased levels of manufacturing and services sectors. As people in rural areas move in search of these opportunities, it will be critical for government to further improve productivity in agriculture and other primary sectors in order to maintain output in the face of a smaller labour pool with potentially higher labour costs.

CHAPTER 5

ECONOMIC CONDITIONS AND TRENDS

CHAPTER 5: ECONOMIC CONDITIONS AND TRENDS

5.1. Introduction

The Economic Dimension of the MRB-IF reflects the commitments made by the parties to the 1995 Mekong Agreement to:

- cooperate in all fields of sustainable development, utilization, management and conservation of the water and related resources of the Mekong River Basin including, but not limited to irrigation, hydropower, navigation, flood control, fisheries, timber floating, recreation and tourism, in a manner to optimize the multiple-use and mutual benefits for all riparians and to minimize the harmful effect that might result from natural occurrences and man-made activities (Article 1); and
- utilize the waters of the Mekong River system in a reasonable and equitable manner in their respective territories (Article 5).

To this end, the Member Countries of the MRC agreed to promote and support, and cooperate and coordinate in, the development of the full potential of sustainable benefits to all riparian States and the prevention of wasteful use of Mekong River Basin waters, with an emphasis on and preference for joint and/or basin-wide development projects and basin programmes. Progress is monitored through periodic assessments of current and future development scenarios that inform the basin-wide planning activities of the MRC by maintaining regional databases on development activities in water-related sectors, and through the routine data collection of various economic statistics at the national level by basin countries. Supplementary datasets collected and maintained by various international organizations and that draw on national data provided by basin countries also contribute to our understanding of economic conditions in the Basin. Not all indicators can be assessed in full due to ongoing gaps in data availability and some inconsistency in datasets available from different basin countries.

To assess the status of conditions and trends in the economy of the Mekong River Basin, the MRB-IF encompasses two strategic indicators and 16 assessment indicators, as shown in Table 5.1. This chapter provides an assessment of the status of conditions and trends in each of these strategic and assessment indicators.

Table 5.1. Strategic and assessment indicators in the Economic Dimension of the MRB-IF

Strategic indicators	Assessment indicators
Contribution to the basin economy	Contribution of water-related sectors to basin, national and regional GDP
	Contribution to food grain supply
	Contribution to protein supply
	Contribution to power supply
Economic performance of water-related sectors	Economic value of agriculture
	Economic value of hydropower
	Economic value of navigation
	Economic value of sand mining
	Economic value of wetlands
	Economic value of capture fisheries
	Economic value of aquaculture
	Economic value of forestry
	Economic value of tourism and recreation
	Economic cost of riverbank and coastal erosion
	Economic cost of flood
	Economic cost of drought

The assessment of conditions and trends takes into consideration the BDS 2021–2030 Strategic Priority for the Economic Dimension:

Enhance optimal and sustainable development of water and related sectors

This BDS Strategic Priority recognizes that separate national development plans, designed and implemented in an uncoordinated way, are unlikely to optimize the benefits and minimize the costs for basin countries. Sustainable development and water security for all basin countries could be enhanced by identifying and implementing opportunities not yet considered in national plans, including significant joint investment projects and projects of basin-wide significance, with a view to achieving a better overall outcome across sectors and between communities, including protection against major floods and droughts. As the economy of the region is increasingly integrated, cooperation in water-related sector planning and management through the implementation of regional sector strategies can also help enhance the economic sustainability of individual sectors and build climate resilience and help manage flood and drought risks.

5.2. Contribution to the basin economy

5.2.1. Assessment methodology

The contribution to the basin economy is defined as the contribution of water-related economic sectors in the Mekong River Basin to overall economic, food and energy security within the Basin and beyond. The assessment indicators for this strategic indicator are:

- Contribution of water-related sectors to basin, national and regional GDP
- Contribution to food grain supply
- Contribution to protein supply
- Contribution to power supply.

Data and information for these assessment indicators are generally sourced from the national statistics of basin countries collected through the routine work of government agencies. The data are the same as those that inform the assessment indicators in Section 5.3, but for this strategic indicator, the focus is on the proportional contribution that these sectors make. The indicators help inform our understanding of the relative importance of basin water-related sectors to overall social and economic well-being with the basin, within countries and within the region.

5.2.2. Contribution of water-related sectors to basin, national and regional GDP

As presented in Chapter Two, total GDP in the Mekong River Basin was estimated at around USD 187.4 billion in 2019/20 (excluding Myanmar), of which USD 133.7 billion (71%) was from the LMB. Around 30% of basin GDP comes from Thailand, 29% from China, and 22% from Viet Nam.

Sufficient data were only available to allow an estimate of the share of national and LMB economic value attributable to production in the LMB in some key water-related sectors, namely from rice production, fisheries and hydropower. Rice production in the LMB makes a very significant contribution to national sector output, with over 85% of the total national economic value of rice production in Cambodia and Lao PDR, and around 50% in Thailand and Viet Nam coming from the basin (Table 5.2). The share of LMB economic value from rice production was highest in Viet Nam and Thailand, at almost 50% and 30%, respectively.

The contribution of the LMB to the economic value of national fisheries production is lower than for rice production, at around 43% in Cambodia, and 39% in Viet Nam, but close to 100% in Lao PDR and 86% in Thailand (Table 5.2). For hydropower, approximately 60% of the economic value of national production is from the Basin in Cambodia, approximately 18% from Viet Nam, and 88% from Lao PDR and 20% from Thailand. The figures allow for an approximate understanding of the relative economic contribution of key water-related sectors in the Mekong River Basin to national output in LMB countries and their high importance to the national economic value of each sector.

Table 5.2. Contribution of key Mekong water-related sectors to national economic output, 2020

	Cambodia	Lao PDR	Thailand	Viet Nam	Total
Rice production 2020 (gross value)					
National production (USD billion)	2.4	1.2	8.2	12.5	24.3
LMB production (USD billion)	2.1	1.2	3.8	6.2	13.2
LMB share of national production (%)	86%	96%	46%	50%	54%
Share of LMB (%)	16%	9%	29%	47%	100%
Total fisheries 2020 (gross value)					
National production (USD billion)	5.7	1.0	5.2	20.7	32.6
LMB aquaculture production (USD billion)	0.8	0.2	0.2	6.9	8.2
LMB capture fisheries production (USD billion)	1.6	0.8	4.3	1.1	7.8
LMB total fisheries production (USD billion)	2.4	1.0	4.5	8.1	16.0
LMB share of national production (%)	43%	100%	86%	39%	49%
Share of LMB (%)	15%	6%	28%	51%	100%
Hydropower 2020 (gross value)					
National production (USD billion)	0.5	2.3	0.5	6.0	9.3
LMB production (USD billion)	0.3	2.0	0.1	1.0	3.4
LMB share of national production (%)	60%	88%	20%	18%	37%
Share of LMB (%)	9%	59%	3%	29%	100%

Note: Data on gross national economic value of fisheries sectors in Lao PDR are missing, However, for Lao PDR, it is assumed that the economic value from the LMB is essentially around 100% of the national value.

Data source: National values for rice production are obtained from national statistics; gross national values of water-related sectors are derived from available figures for hydropower; and values of fisheries production are derived from estimates of total value derived in section 5.3.

The figures provided in Table 5.2 refer to gross annual economic values of some key water-related sectors only, because there were insufficient data available on the value of inputs for each sector from each country to calculate value-add. However, the estimated GDP (value-add) for water-related sectors was available from Cambodia (Figure 5.1) and Viet Nam (Figure 5.2). Real growth in GDP over the period was significant in both the agriculture and fisheries sectors, which provide by far the most added value in both countries part of the Basin. Forest and hydropower sectors were much smaller and saw lower levels of growth. In Cambodia, the growth in value-added production from sand mining grew significantly, particularly between 2017 and 2019.

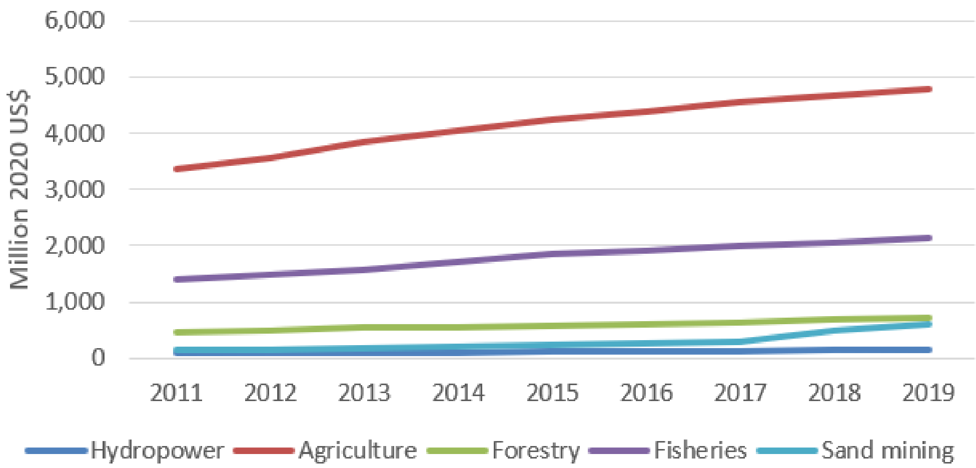


Figure 5.1. GDP from water-related sectors in Cambodia's part of the Basin, 2011–2019

Note: Figures exclude Palin and Phnom Penh for which data were not available, and are adjusted to reflect constant 2020 prices.

Data source: National statistics provided by Cambodia for basin provinces

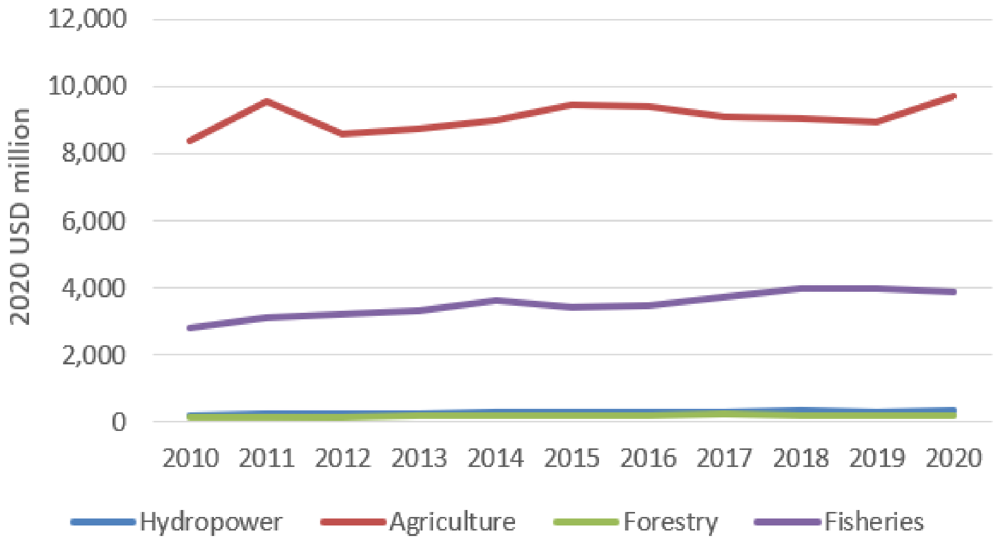


Figure 5.2. GDP from water related sectors in Viet Nam's part of the Basin, 2010–2020

Note: Figures are adjusted to reflect constant 2020 prices.

Data source: National statistics provided by Viet Nam for basin provinces

5.2.3. Contribution to food grain supply

The contribution of the LMB to national food grain supply is measured as the share of national annual food grain production produced in the LMB. Rice is the predominant food grain crop in the region and dominates food grain production, so the estimates are confined to the LMB contribution to the supply of rice (Table 5.3). Rice production is dominated by the two larger countries that have a much larger area of rice production in the Basin, where Viet Nam's delta area is particularly productive. However, in recent years, production in both Thailand and Viet Nam has declined to some extent, whereas production in Cambodia and Lao PDR continues to grow. The overall picture of generally growing rice production in the LMB is described further in Section 5.3.2.

The share of LMB rice production has remained stable in Lao PDR, has declined to some extent in Thailand and Viet Nam, and has grown in Cambodia (Table 5.3). All countries except for Thailand saw growth in rice production between 2010 and 2020. In Viet Nam and Lao PDR, growth in production was higher than that of rice production nationally, whereas in Cambodia figures suggest growth in rice production has been more rapid outside the LMB.

Table 5.3. National and LMB rice production in 2000, 2010 and 2020, and average annual growth rate, 2010–2020

	2000	2010	2020	Average annual growth rate 2010–2020
Cambodia				
National production (million t)	4.02	7.50	8.25	**0.96%**
LMB production (million t)	3.40	6.78	7.13	**0.51%**
LMB share of national (%)	84%	90%	90%	
Share of LMB (%)	11%	16%	16%	
Lao PDR				
National production (million t)	2.24	3.07	3.49	**1.27%**
LMB production (million t)	2.16	2.94	3.35	**1.32%**
LMB share of national (%)	96%	96%	96%	
Share of LMB (%)	7%	7%	7%	
Thailand				
National production (million t)	24.17	32.40	28.62	**-1.23%**
LMB production (million t)	9.62	13.17	13.14	**-0.42%**
LMB share of national (%)	40%	42%	46%	
Share of LMB (%)	32%	32%	29%	
LMB Total				
Regional production (million t)	62.96	82.97	83.11	**0.02%**
LMB production (million t)	30.05	42.61	44.84	**0.51%**
LMB share of regional (%)	48%	51%	54%	

Data source: National statistics provided by basin countries

5.2.4. Contribution to protein supply

The assessment indicator 'Contribution to national and regional protein demand' seeks to measure the degree to which protein demand in basin countries and the region can be met from basin resources. Given that the focus is on water-related sectors, this assessment considers the protein supply from rice and fisheries, as well as livestock, which in some cases are dependent on water-related sectors for inputs (e.g. cereal production for animal feed). National protein demand was calculated using FAO data on average daily protein consumption per capita in each of the LMB countries. This was scaled up for the whole population to arrive at an annual national protein demand. Available dietary protein levels of rice, fresh fish and livestock meat were taken from FAO Food Balance Sheet estimates for the region. These were 7 grams of protein per 100 grams for rice, 10.6 grams per 100 grams for fish, and 26 grams per 100 grams for meat. Using these figures and LMB production figures for rice, fish and meat, it was possible to arrive at an estimate for total protein supply derived from these LMB resources, and from this an equivalent share of national protein demand (Table 5.4).

Table 5.4. Protein supply from rice, fisheries and livestock sectors as share of national protein demand, LMB demand and regional demand, 2020

	Cambodia	Lao PDR	Thailand	Viet Nam	Total
Protein consumption (g/person/day)	65.7	68.9	60.9	81.7	-
National protein demand (1,000 t)	395.2	181.9	1,471	2,910	4,958
LMB protein demand (1,000t)	330	169	491	544	1,533
Rice protein					
LMB rice production (1,000 t)	7,128	3,351	13,136	21,229	44,844
LMB rice protein production (1,000 t)	499	235	920	1,486	3,139
Share of national protein demand (%)	126%	129%	63%	51%	63%
Share of LMB protein demand (%)	33%	15%	60%	97%	205%
Fish protein					
LMB fish production (1,000 t)	790	253	733	3,815	5,591
LMB fish protein production (1,000 t)	84	27	78	404	592
Share of national protein demand (%)	21%	15%	5%	14%	12%
Share of LMB protein demand (%)	6%	2%	5%	26%	39%
Animal protein					
LMB meat production (1,000 t)	342	486	1,030	1,030	2,888
LMB meat protein production (1,000 t)	89	126	268	268	751
Share of national protein demand (%)	22%	69%	18%	9%	15%
Share of LMB protein demand (%)	2%	8%	17%	17%	49%

LMB total					
LMB total protein production (1,000 t)	661	388	1,276	2,161	4,486
Share of national protein demand (%)	167%	214%	87%	74%	90%
Share of LMB protein demand (%)	201%	230%	260%	397%	293%

Data source: FAO Food Balance Sheets 2018; National and provincial-level statistics provided by basin countries

It should be noted that the figures in Table 5.4 are very general estimates. The estimates do not take into account other uses of fish, rice and meat production except for food, nor exports; rather, they represent the potential contribution to national protein supply. Nevertheless, it is clear that LMB resources can potentially supply a high proportion of national protein demand in all four countries, for instance, greater than 100% in Cambodia and Lao PDR. In Thailand, up to 87% and in Viet Nam up to 74% of protein demand can potentially be supplied from rice, fish and meat production combined from their part of the Basin. Overall, the LMB provides adequate protein to supply 88% of the total estimated protein requirements of the populations in the four LMB countries, and 284% of the total protein requirements of the population within the Basin.

5.2.5. Contribution to national power supply

The 'Contribution to national power supply' indicator seeks to measure the importance of hydropower generation in the LMB for power supply in each of the LMB countries and for the LMB region more generally. The metric used to assess this is the proportion of national power demand (consumption) met from LMB hydropower generation.

LMB hydropower sources are clearly important for all LMB countries (Table 5.5), accounting for around 12% of total electricity demand, with around 53 TWh of electricity produced from LMB hydropower in 2020. It should be noted that the figures do not account for where the electricity is consumed while recognizing noting the importance of the cross-border trade in power that occurs within the Basin.

Table 5.5. Annual electricity demand (consumption) and share supplied by LMB hydropower, 2020

Country	Total annual electricity national consumption (TWh)	Total national hydropower production (TWh)	Total LMB hydropower production (TWh)	LMB hydropower production, share of national HP (%)	LMB hydropower production, share of national consumption (%)
Cambodia	11.5	-	2.0	-	17
Lao PDR	7.0	42.1	37.4	88	535
Thailand	193.4	4.5	0.7	16	0.4
Viet Nam	226.0	73.4	12.8	18	5.7
Total	**437.8**	**-**	**52.9**	**-**	**12.1%**

Data source: National and provincial data on hydropower production, national power consumption data from the International Energy Agency (2023)

5.3. Economic performance of water-related sectors

5.3.1. Assessment methodology

The strategic indicator 'economic performance of water-related sectors' is defined as the net economic output of water-related sectors. For this report, and due to data limitations, this has been modified to the gross economic output of water-related sectors. The assessment indicators for this strategic indicator are:

- Economic value of agriculture
- Economic value of hydropower
- Economic value of navigation
- Economic value of sand mining
- Economic value of wetlands
- Economic value of capture fisheries
- Economic value of aquaculture
- Economic value of forestry
- Economic value of tourism and recreation
- Economic cost of riverbank and coastal erosion
- Economic cost of flood
- Economic cost of drought.

Data and information for these assessment indicators are generally sourced from the national statistics of basin countries collected through the routine work of government agencies. The indicators help inform our understanding of the contribution of basin water-related sectors to overall social and economic wellbeing with the Basin, and the extent to which basin countries are developing and utilizing the water and related resources of the Mekong River Basin. According to the 1995 Mekong Agreement, these sectors should include, but are not limited to irrigation, hydropower, navigation, flood control, fisheries, timber floating, recreation and tourism. Whether or not this development and utilization of water and related resources are sustainable can only be evaluated by considering the economic value generated in conjunction with the assessment of the state of conditions and trends in the Social and Environmental Dimensions.

5.3.2. Economic value of agriculture

The relative share of economic production attributable to agriculture in the Mekong River Basin countries has declined (see Chapter Two). However, the sector remains of critical importance for food security, employment generation and poverty reduction (see Chapter Four). Agriculture has become increasingly diversified across the Basin in recent years. Rice production continues to dominate lowland and deltaic areas, while upland areas have seen a growth in the cultivation of maize, cassava, cashews, rubber, coffee and other plantation and field crops (Cramb, 2019). In the UMB in Yunnan, there has been rapid growth in the output of fruit, vegetables and tea in recent years, with little change in rice output (NBS, 2021). In Myanmar, available data suggest that rice production has declined in favour of commercially grown crops such as maize and sugar cane (Fang and Belton, 2020; CSO, 2017; 2020).

Although agricultural production is more diversified, particularly as other upland crops have replaced swidden cultivation of rainfed upland rice, rice remains by far the dominant agricultural activity (Cramb, 2019). Within the LMB, rice production utilizes over 10 million hectares of agricultural land, and accounts for over 80% of the region's agricultural output.[16] Irrigation also plays a significant role, accounting for more than 70% of current water usage, mostly for rice production. As the dominant crop in the Basin, rice production is used as a proxy for the overall performance of the agricultural sector.

Northeast Thailand accounts for slightly over 50% of the agricultural area in the Basin, as well as a little under 50% of paddy land. However, Viet Nam holds the largest share of agricultural land dedicated to paddy production, at around 57%, and the highest proportion of irrigated paddy land, at 74%. Additionally, Viet Nam achieves an average yield of 6 tonnes/ha, contributing to almost half of the total output from paddy production in the Basin (ibid.).

16 MRC: Agriculture and Irrigation website: www.mrcmekong.org/our-work/topics/agriculture-and-irrigation/#:~:text=More%20than%2010%20million%20hectares,for%20agriculture%20in%20the%20basin

Based on national statistics in basin provinces, between 2000 and 2010, rice production in the LMB grew annually relatively rapidly, i.e. rapid annual growth in Cambodia (7.2%), and with more moderate growth in Lao PDR (3.1%), Thailand (3.6%) and Viet Nam (2.6%). From 2010 to 2020, production growth slowed in Lao PDR (1.3%), Viet Nam (1.0%) and Cambodia (0.5%), and fluctuated at around approximately the same level in Thailand (-0.4%) (Figure 5.3).

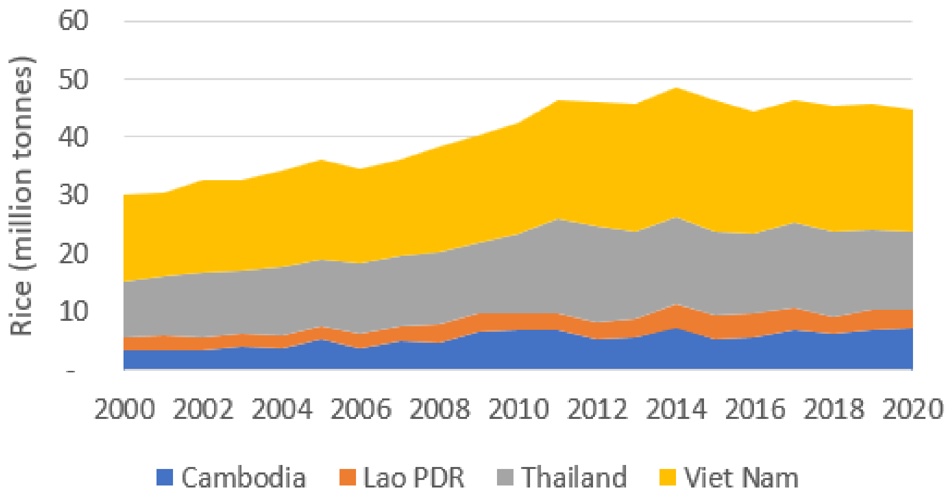


Figure 5.3. Rice production in the Lower Mekong River Basin by country, 2000–2020

Data source: National statistics provided by basin countries

The gross value of output from rice production across the LMB in 2020 was estimated at approximately USD 13.2 billion, from 44.8 million tonnes of rice produced (Table 5.6), of which Lao PDR accounted for 9% of the gross economic value, Cambodia, 16%, Thailand, 29% and Viet Nam, 47%. The total value is almost double the estimated economic value from irrigated rice production reported in the 2018 SOBR (MRC, 2019b), although the previous figure only included irrigated rice cultivation and not rainfed production.

The MRB-IF identifies recession rice production, riverbank gardens and rainfed cultivation as further components of the sector contributing to the overall economic value of agriculture. Other agricultural production is likely to be important with growth in industrial and cash crops such as rubber, pepper cassava and coffee. However, insufficient data are available to assess the value of these sub-sectors.

Table 5.6. Gross value of output from rice production in the Lower Mekong River Basin, by country, 2020

Country	Rice production (million tonnes)	Farm gate price (USD/tonne)	Economic value (USD billion)	Share of LMB production (%)	Share of LMB value (%)
Cambodia	7.1	287.8[1]	2.1	16	16
Lao PDR	3.4	347.6[1]	1.2	8	9
Thailand	13.1	287.2	3.8	29	29
Viet Nam	21.2	292.2[1]	6.2	47	47
Total	**44.8**	**-**	**13.2**	**100**	**100**

Data source: National statistics on production provided by basin countries; [1]price data from FAOSTAT

5.3.3. Economic value of hydropower

The estimated total hydropower potential of the Mekong River Basin is approximately 58,930 MW, of which approximately 30,000 MW is in the LMB and 28,930 MW is in the UMB. Development of hydropower has accelerated in recent years. In the UMB, China has constructed 13 hydropower dams with a total hydropower potential of 21,615 MW (only hydropower plants above 10 MW in capacity were included), with another 11 plants each of greater than 100 MW capacity either being constructed or planned. Myanmar has only one 66 MW hydropower plant in operation in the Basin (at Mongwa). Nam Lin is also listed with a planned commissioning date of 2021. However, no updated information was available on the current status of the project. The total installed hydropower capacity on the UMB is currently 21,681 MW (MRC Hydropower Database, 2023).

In the LMB, development has also been rapid. In 2001, there were approximately 17 hydropower projects in operation with a capacity of less than 1,400 MW. Between 2002 and 2015, another 40 hydropower projects with a combined capacity of 6,442 MW were commissioned. As of 2020, there were 88 hydropower projects in operation in the LMB with around 11,397 MW total installed capacity (MRC Hydropower Database, 2023). Around 15 dams with a total capacity of 1,600 MW are under construction. By 2040, it is estimated that hydropower in the LMB will generate over 30,000 MW (MRC Hydropower Database, 2023).

Table 5.7 gives estimated capacity, power production and economic values (in terms of gross revenues) for 2020. China accounts for over 60% of installed capacity in the Basin, followed by Lao PDR (23%) and Viet Nam (8%). China also dominates hydroelectricity production (63%), followed by Lao PDR (26%), and Viet Nam (9%). Hydropower electricity production in Thailand has been stable in recent years.

Caution should be exercised in making direct comparisons with previous estimates because they are estimated using different datasets and price data; nevertheless, the economic value of LMB power production (based upon gross revenue) has increased rapidly, estimated at USD 547 million in 2005 and USD 2.0 billion in 2015 (MRC, 2018), to almost USD 3.4 billion in 2020, or around 31% of the total economic value generated from hydropower across the Mekong River Basin.

Table 5.7. Installed capacity, annual production and economic value of Mekong River Basin hydropower, 2020

Country	Installed capacity (MW) (% of total) [1]	Farm gate price (USD/tonne)[2]	Economic value (USD billion)[3]
Cambodia	401 (1.2%)	1,957 (1.4%)	289.6
China	21,615 (65.3%)	90,502 (63.0%)	7,240.2
Lao PDR	7,644 (23.1%)	37,424 (26.0%)	2,009.4
Myanmar	66 (0.2%)	331 (0.2%)	25.8
Thailand	745 (2.3%)	666 (0.5%)	70.6
Viet Nam	2,607 (7.9%)	12,838 (8.9%)	1,045.0
Total	**33,078**	**143,718**	**10,681**

Data sources: [1] Installed capacity figures from MRC hydropower database inclusive of all listed plants above 10 MW; [2]Annual energy generation in 2020 derived from national statistics (figures for Cambodia estimated based on average national hydropower load factor and capacity); [3] Value of power based upon on gross revenue estimates, using power prices from national data, and for China, Myanmar and Cambodia using electricity price data from www.globalpetrolprices.com

5.3.4. The economic value of navigation

The Mekong River has long been an important inland waterway for traditional cargo and passenger transport between the numerous settlements along the river. The river has also emerged as an increasingly important international trade route connecting the six Mekong Basin countries, especially from the lower reaches of the Basin to the sea and wider international markets.

Currently, the average unit costs of Inland Waterway Transport (IWT) surpass those of road transport. Nevertheless, for transporting larger cargo volumes over considerable distances, IWT can offer a cost advantage. The development of IWT in the upper reaches of the Mekong River (above the Khone Falls) faces limitations due to narrow and turbulent river sections, as well as significant seasonal fluctuations in water levels. Despite these constraints, the Mekong River plays a crucial role in connecting Kunming and Bangkok as a transit route. Although current estimates are not available, the most recent study of IWT in the LMB, conducted for the Council Study in 2017, estimated that in total, approximately 800,000 tonnes of IWT cargo are shipped annually between China, Thailand, Myanmar and Lao PDR (MRC, 2017d).

In recent years, IWT in the Lower Mekong River has experienced notable growth, as evidenced by the steady increase in container traffic at Phnom Penh port, and general cargo through Can Tho port. The development of IWT received a significant boost with the establishment of a new deep-water port at Cai Mep in Viet Nam, which can accommodate some of the largest container ships globally. This advancement allows cargo to be transported internationally to and from Phnom Penh with just a single trans-shipment at Cai Mep. In addition, the Royal Government of Cambodia approved a project, the Funan Techo Canal, to link the Mekong-Bassac Rivers via Kandal, Takeo and Kampot provinces to the sea in Kep province. The project is expected to reduce travel times and transportation costs.[17]

This assessment indicator 'economic value of navigation' refers to the gross annual economic performance of navigation in the LMB. The monitoring parameters to assess this indicator include: (i) volume of cargo transport; (ii) passenger transport numbers; and (iii) navigation prices. Based on the socio-economic data transmitted by LMB countries, there are some data gaps, especially with regard to navigation price, which is not available to calculate and assess the gross economic value and the change over time for both cargo and passenger transport for the Basin and for each member country.

When looking at provincial-level data in 2020, the cargo transport volume rose from 66 million tonnes in 2015 to 85 million tonnes; most of this increase was attributed to Viet Nam, with IWT transport on the delta accounting for 84.6 million tonnes (Figure 5.4). Viet Nam accounted for 99% of cargo moved by IWT in the LMB.

Figure 5.4 also illustrates a significant increase in the quantity of IWT cargo transport in Lao PDR and Viet Nam over time, while figures for Cambodia and Thailand show no discernible trend. The volume of cargo transported by IWT significantly decreased in Cambodia, Lao PDR and Thailand in 2020, particularly in Lao PDR and Thailand, from 285,200 tonnes and 739,971 tonnes in 2019, to 100,000 tonnes and 362,661 tonnes in 2020, respectively. This is likely to reflect the impact of the COVID-19 pandemic. If indicators from Lao PDR are any guide, volumes can be expected to rebound quickly, with volumes of cargo transportation in Lao PDR increasing to 236,300 tonnes in 2021.

17 www.information.gov.kh/articles/105327

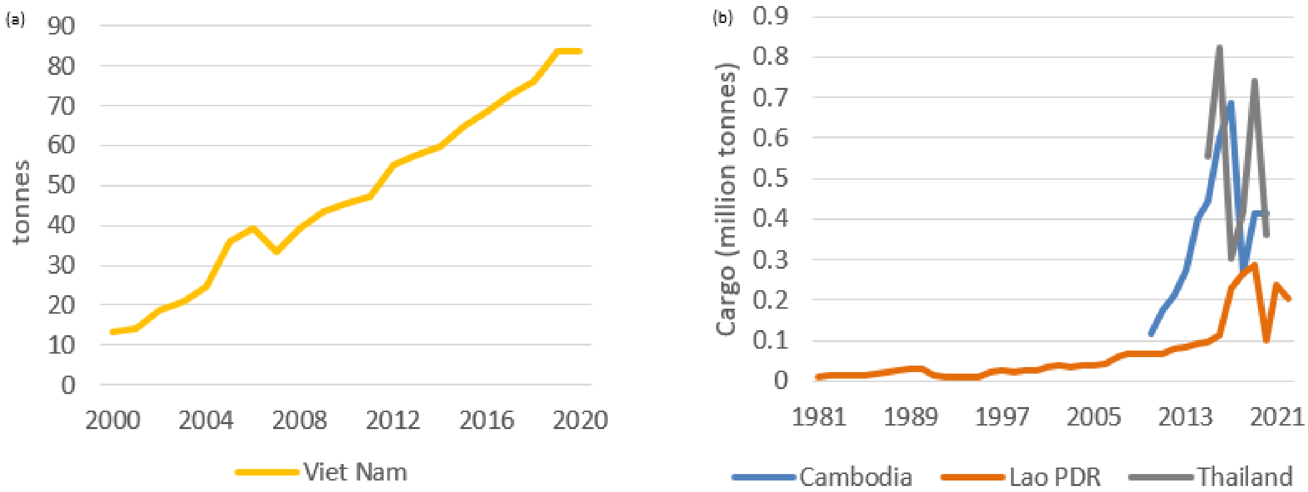


Figure 5.4. IWT cargo volumes within basin provinces for Viet Nam, 2000–2020 (a) and Cambodia, 2010–2020, Lao PDR, 1981–2021 and Thailand, 2015–2020 (b)

Data source: National statistics provided by basin countries

In addition to cargo transportation, IWT plays a vital role in providing passenger services in the upper reaches of the Mekong. In 2017, it was estimated that approximately 50,000 passengers, including tourists, were transported between China, Thailand, Myanmar and Lao PDR using IWT. In the Lower Mekong River, the number of passengers utilizing IWT (speed boats and cruise vessels) is also substantial.

Consolidated national data from basin provinces on IWT of passengers show a similar picture to that of cargo with passenger transport in Viet Nam, but much larger than that in Cambodia and Thailand (Figure 5.5). This reflects the importance of IWT in the delta as well as high population density and transportation demand in the delta area. Between 2010 and 2019, Cambodia saw passenger numbers increase slightly, from approximately 50,000 to 60,000, although there has been significant variability over the past decade, for example, with numbers only reaching 14,000 in 2016. Data for Thailand were only available from 2015 to 2020, in which passenger numbers show a great deal of variability with no discernible trend; in 2019, approximately 500,000 passengers used IWT.

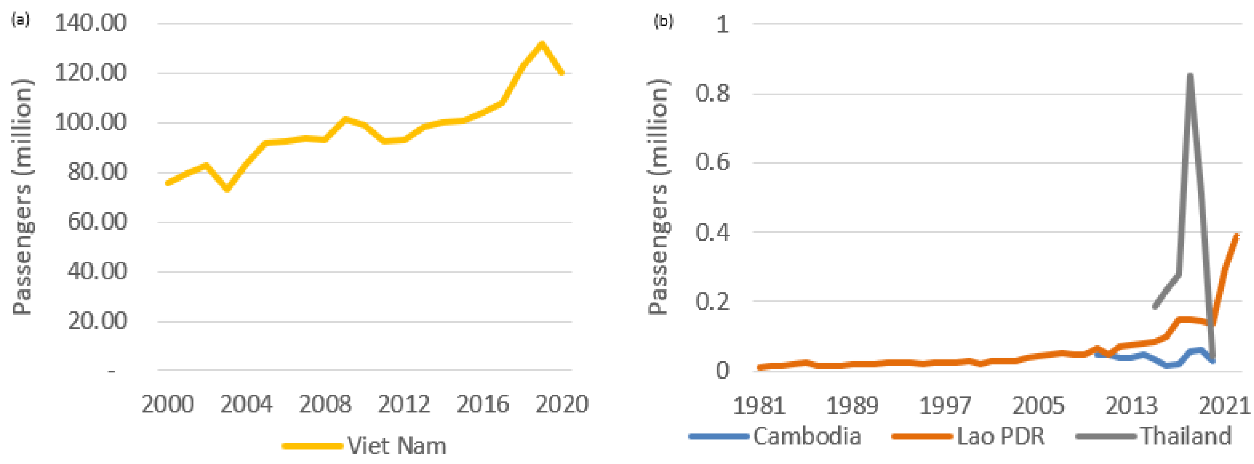


Figure 5.5. IWT passenger numbers within basin provinces for Viet Nam, 2000–2020 (a); and Cambodia, 2010–2020, Lao PDR, 1981–2021 and Thailand, 2015–2020 (b)

Data source: National statistics provided by basin countries

In Lao PDR, growth in passenger transport was slow between 1981 and 2013, but was more rapid between 2013 and 2020. And although there was a downturn in passenger numbers in 2021, probably attributable to the pandemic, there has been a dramatic uptick in 2022. The reasons for this large jump in 2022 are not yet clear. In Viet Nam, passenger numbers increased steadily from 75.5 million in 2000 to 131.8 million in 2019. All countries experienced a decline in passenger numbers in 2020 probably due to the impacts of the COVID-19 pandemic.

5.3.5. Economic value of sand mining

Sand mining in the Mekong River Basin is extensive and serves as a critical support for the construction and industrial sectors. Moreover, extracting significant quantities of sediments from the river changes the river's geomorphology. This in turn can lead to a range of implications, including the degradation of natural habitats and an escalation in erosion and channel incision. The extraction of sand, gravel and aggregates in this area has experienced a rapid surge in response to the growing demands of developing riparian economies. The need for infrastructure development in the delta and the demand from export markets in Malaysia and Singapore have been major contributing factors to this increased demand (Piman and Shrestha, 2017).

National data from basin provinces in Viet Nam (data for Cambodia, Lao PDR and Thailand were not available) show a distinct decline in sand mining within the Basin, from approximately 30 million tonnes in 2010 to

19.3 million tonnes in 2020 (Figure 5.6).[18] As with the LMB, limited data are available on sand mining in the UMB, although due to the difficulty of the terrain, the morphology of the river in the upper reaches and the logistics of brining aggregates to market, it is likely to be only a small fraction of that extracted from the LMB.

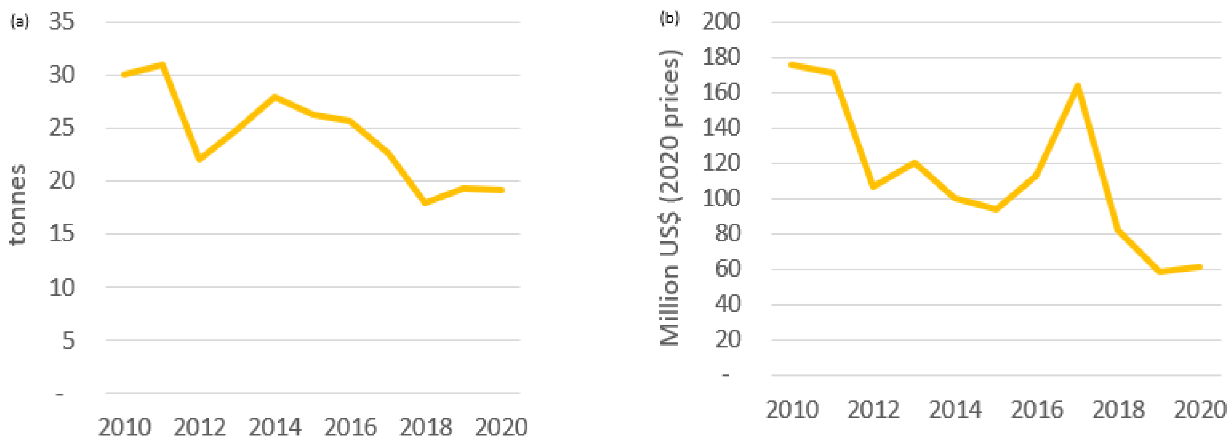


Figure 5.6. Quantity of aggregates, sand and gravel extracted for commercial purposes in Viet Nam by weight (a) and by gross value (2020 prices) (b)

Data source: National statistics provided by Viet Nam. Data not available for Cambodia, Lao PDR and Thailand

The value of mined sand essentially consists of the price of extraction and transport, and therefore varies significantly over time. In Viet Nam, aggregate prices were reported to have declined from 6 USD/tonne in 2010 to 3 USD/tonne in 2020.[19] The total reported value of aggregate extraction in Viet Nam was estimated at USD 61.3 million in 2020.

5.3.6. Economic value of wetlands

There were approximately 178,260 km² of wetlands in the LMB in 2020, of which 29,883 **km²** (17%) were considered 'natural wetlands' (Section 3.4.2). Natural wetlands provide a range of ecosystem goods and services, and represent a critical contribution to livelihoods and the economy of the Basin. Wetland goods and services are defined in terms of the direct and indirect benefits people obtain from these ecosystems. Services are commonly grouped into provisioning, regulating and maintenance, and cultural services (Potschin and Haines-Young, 2016).

18 Care should be taken with these estimates because there is a strong incentive to under-report extraction to avoid royalties and taxes, and government monitoring of these activities in the region is weak.

19 All figures are in real 2020 prices.

Ecosystem values for wetland areas in the LMB were estimated using the Ecosystem Value Estimator (ESV). The ESV was developed in partnership with the United States Agency for International Development (USAID) as an easy-to-use tool to produce rapid and accessible estimates of monetized ecosystem service values. The value ranges are based on economic valuation results available across the Greater Mekong Sub-region. A total of 191 wetland and mangrove valuations published since 2000 were considered in developing the tool, with the most recent results from 2013 (MRC, 2022d).

Overall, the services derived from wetlands in the LMB have an estimated mean total economic value (TEV)[20] of approximately USD 43 billion per year and a total net present value (NPV)[21] of USD 834 billion (Table 5.8). Of the total value, flooded forest, inundated grassland and natural water bodies contribute a little under a third each, with the remainder contributed by marshes/swamps and mangroves. Approximately 74% of services from LMB wetlands are classified as regulating services, 20% as provisioning services, and 6% as cultural services (Figure 5.7).

Table 5.8. Economic value of wetlands by class, 2021

Wetland class		TEV (USD million/year)			NPV (USD million)		
	Area (ha)	Min	Mean	Max	Min	Mean	Max
Flooded forests	1,019,552	10,882	14,297	17,711	210,738	276,868	342,995
Marshes/swamps	5,316	58	76	94	1,122	1,474	1,826
Inundated grasslands	906,083	9,815	12,896	15,975	190,084	249,731	309,377
Mangroves	91,437	1,046	2,193	3,340	20,251	42,466	64,681
Natural water bodies	965,912	10,337	13,581	16,824	200,184	263,000	325,816
Total	**2,988,300**	**32,137**	**43,043**	**53,944**	**622,379**	**833,539**	**1,044,695**

Data source: MRC (2022d)

20 TEV is one of the most widely used and commonly accepted conceptual frameworks for classifying wetland economic benefits. It takes into account subsistence and non-market values, ecological services and non-use benefits. The TEV framework is used to overcome the problems associated with the under-valuation of wetland benefits and costs that have typified conventional economic analysis and decision-making. However, it is also widely understood that many non-use values may be challenging and resource-intensive to obtain, and potentially overly subjective (MRC 2022d).

21 The NPV is calculated over 25 years, and translates future economic benefits and costs into today's values. It is applied when wetland values are needed for comparative purposes over a number of years, and the benefits and costs accrue at different intervals over the evaluation period of several years. Typically, NPV is used to evaluate the relative benefits and costs of different investments or developments compared to wetland conservation. For the calculation of NPV in this case, an approach approximating hyperbolic discounting was adopted, with the application of a discount rate of 4% for the first five years, and an annual drop of the discount rate of 0.4% for the next 10 years after which no further discounting is applied (MRC 2022d).

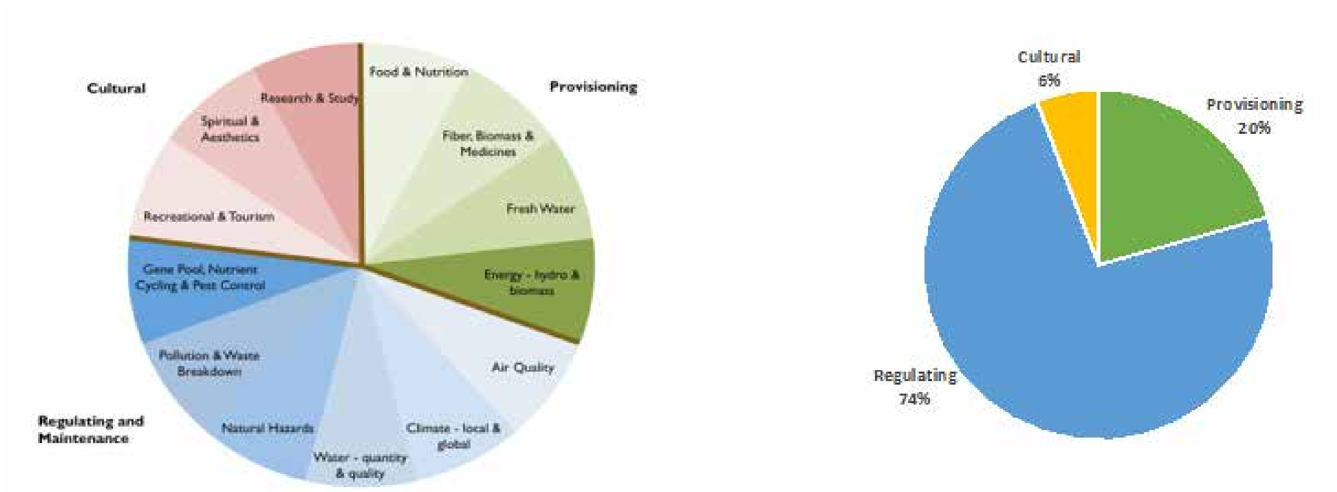


Figure 5.7. Types of ecosystem services and share of their economic value in the Lower Mekong River Basin

Data source: MRC (2022d)

Wetlands are concentrated in the lower regions of the Basin in the large flood plain, deltaic areas and in the Tonle Sap system. As such, not including water bodies, Cambodia accounts for approximately 39% of the economic value from wetlands, Viet Nam approximately 15%, Lao PDR 10%, and Thailand 5%, with the remainder attributable to water bodies (Table 5.9).

Table 5.9. Economic value of wetlands in the Lower Mekong River Basin, by country, 2021

Wetland class	TEV (USD million/year)			NPV (USD million)		
	Min	Mean	Max	Min	Mean	Max
Cambodia	12,605	16,561	20,516	244,117	320,719	397,321
Lao PDR	3,213	4,222	5,230	62,232	81,760	101,288
Thailand	1,773	2,329	2,886	34,335	45,110	55,884
Viet Nam	4,209	6,349	8,488	81,512	122,950	164,388
LMB	**21,800**	**29,461**	**37,120**	**422,195**	**570,539**	**718,880**
LMB (+ water bodies)	**32,137**	**43,042**	**53,944**	**622,379**	**833,539**	**1,044,696**

Data source: MRC (2022d)

5.3.7. Economic value of capture fisheries

As described in Section 3.4.4, the available data from the MRC's updated Fisheries Habitat Yield Assessment suggests that annual finfish yield from the LMB falls within a range of 1.5–1.7 million tonnes and the yield of OAAs is around 443,000 tonnes (MRC, 2023b). Most of this yield is harvested from rainfed and flooded habitats, contributing 53% and 25% of the catch, respectively. The brackish water zone, especially in Viet Nam, contributes around 18%, while water bodies, mostly artificial reservoirs and storages, are the least productive fish habitats.

The estimated value of the finfish catch ranged between USD 7.1 billion and USD 8.4 billion annually based on the different methods of estimation (MRC, 2023b), with the average value (i.e. the average yield from household and consumption surveys multiplied by price) estimated at 7.8 billion annually (Table 5.10). In addition, the harvest of OAAs is estimated at around USD 1.13 billion, which is approximately 17% lower than the estimate in SOBR 2018. While these catches represent a significant contribution to GDP and food security in countries of the LMB, this valuation is a lower estimate than the value reported in the 2015 Fisheries Habitat Yield Assessment. A number of factors may contribute to this revised estimate, such as alteration of flooding patterns caused by dam development, prolonged dry conditions in the Mekong River Basin over recent years, and the application of enhanced estimation methods, including a more conservative GIS assessment of the flooded zone as noted above.

Table 5.10. Comparison of total catch in the Lower Mekong River Basin using several different assessment approaches, by country, 2019–2020

Wetland class	Inland fish yield - household surveys (tonnes)	Inland fish yield - consumption surveys (tonnes)	Estimated average value based on final retail price
Cambodia	486,916	292,614	1.6
Lao PDR	105,998	141,007	0.8
Thailand	489,674	732,802	4.3
Viet Nam	427,751	485,436	1.1
Total LMB	**1,510,340**	**1,651,858**	**7.8**

Note: Fish yield from consumption surveys is often higher than from household surveys since much fish consumed is purchased from local markets and some originate from elsewhere.

Data source: MRC (2023b)

5.3.8. Economic value of aquaculture

Aquaculture production has grown rapidly in the Mekong River Basin. In 2010, total aquaculture production was estimated at approximately 2.3 million tonnes. By 2015, production was 2.9 million tonnes, and by 2020, 4.0 million tonnes. Production is dominated by fish, accounting for 75% of aquaculture output in 2020, followed by shrimp, at 20% and OAAs, at 5%. Viet Nam dominates the sector, producing approximately 3.4 million tonnes of fish, shrimp and OAAs in 2020, or 84% of total LMB production, reflecting the importance of the sector in the delta region (Table 5.11).

Table 5.11. Aquaculture production including fish, shrimp and OAAs ('000 tonnes) in the Lower Mekong River Basin, by country, 2010, 2015 and 2020

	2010			2015			2020		
	Fish	Shrimp	OAA	Fish	Shrimp	OAA	Fish	Shrimp	OAA
Cambodia	60.0	-	-	142.7	-	-	400.4	-	-
Lao PDR	102.4	-	-	107.6	-	-	130.0	-	-
Thailand	132.2	-	0.2	119.9	-	0.6	121.8	-	0.3
Viet Nam	1,577.9	347.2	82.8	1,837.7	511.0	156.1	2,355.9	789.7	213.2
Total	**1,873**	**347**	**83**	**2,208**	**511**	**157**	**3,008**	**790**	**213**

Data source: National statistics from basin countries

The sector's value was estimated at around USD 8.2 billion in 2020, up from USD 4.3 billion in 2010 and USD 5.6 billion in 2015 (Figure 5.8). Viet Nam again dominates, accounting for 85% of the gross value of output, followed by Cambodia (12%), Lao PDR (3%) and Thailand (3%) (Table 5.12). Data were not available on aquaculture in the UMB, although the sector is reportedly relatively undeveloped in both the Myanmar and Chinese sections of the river.

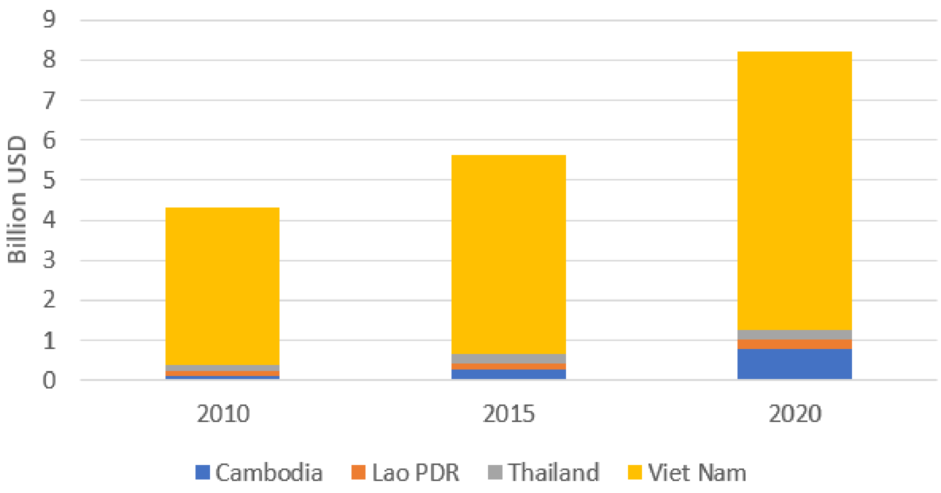


Figure 5.8. Economic value of aquaculture in the Lower Mekong River Basin, by country, 2010–2020

Data source: National statistics from basin countries

Table 5.12. The economic value of aquaculture production in the Lower Mekong River Basin, 2020

	Gross economic value of aquaculture (USD million)	Share of aquaculture production (%)
Cambodia	800.8	10
Lao PDR	227.5	3
Thailand	227.2	3
Viet Nam	6,944.8	85
Total	**8,200**	**100**

Data source: National statistics from basin countries

5.3.9. The economic value of forestry

Forests play an important role in the Mekong River Basin. Forestry and timber extraction is an important economic sector, and fuelwood and charcoal continue to meet a significant portion of household energy requirements. Forests also provide a range of economically valuable ecosystem services including various non-timber forest products (NTFPs) such as fruit, nuts, resins, honey, medicinal plants and ratan, among others. Regulating and maintenance services, including nutrient retention, erosion control and sediment reduction, ground water recharge, flow regulation and flood risk reduction, air purification, and carbon storage and sequestration, as well as biodiversity and cultural benefits, are also significant.

In the Chinese-administered UMB, data from Yunnan province shows the steady increase in gross output of the forestry sector between 2007 and 2021. Gross output roughly doubled between 2011 and 2021, reaching USD 7.7 billion, although some of this value is accounted for by rubber production. The production of timber declined between 2012 and 2016, when significant volumes of timber were imported from neighbouring Myanmar. However, timber production in China has rebounded since then, and was estimated at approximately 8.4 million m3 in 2021 for the whole Yunnan province. Other forestry outputs produced in Yunnan include pine resin, bamboo, tea-oil seeds and lacquer (NBS, 2021).

In the Myanmar part of the Basin, timber and charcoal trade are important economic sectors. Wood is harvested from natural forests and forests are being converted to wood and pulp plantations (IFC, 2017c; Woods, 2013). Increased activity in this sector has followed the growing demand for wood within Myanmar as well as on the export market (UNODC, 2015). Illegal logging is widespread, particularly in response to market demand in China and India. In the wake of the 2021 political events, illicit cross-border timber trade with Yunnan Province has reportedly increased (Mahadevan, 2021).

In 2021, Lao PDR as a whole had approximately 2.7 million ha of natural forest and forest plantations available for sustainable forest management, and forest area in concessions dedicated to other land uses was around 90,000 ha (GIZ, 2021). According to figures from a recent study, the annual supply of timber is estimated at approximately 1.1 million – 1.7 million m3 (GIZ, 2021). Assuming timber production is uniform across the country, this would be equivalent to 1.0–1.5 million m3 from the Basin. Using 2020 prices reported from Viet Nam as a benchmark, this suggests a potential value of around USD 155 million to USD 239 million.

Cambodia as a whole is estimated to have produced 0.8 million m3 of timber in 2020. Timber production has declined since the implementation of a ban on logging in natural forests in 2002, and suspension of timber exports in 2006. At present, most timber is sourced form land clearance from economic concessions (Timber Trade Portal, 2023).[22] Assuming timber production is uniform across the country, this would be equivalent to approximately 0.7 million m3 from the Basin. Using price levels for Viet Nam, this trade would have been worth approximately USD 107 million in 2020. Estimating Thailand's basin forestry output from national-level data is challenging because the Mekong Basin within Thailand only accounts for around 36% of the national land area, and most of Thailand's large, forested areas are in the west and north of the country, outside the Basin.

Based on provincial data from Viet Nam, the total forest area in LMB

22 Timber Trade Portal, 2023. www.timbertradeportal.com/en/cambodia/159/timber-sector

provinces decreased significantly between 2000 and 2020, from a peak in 2001 of 19,155 km² to 16,305 km² in 2020. Most of the forested area is in Viet Nam's central highlands provinces. It is notable that there was a marked decline in forested area between 2013 and 2014, which may have been due to a reclassification of forested areas (Figure 5.9a).

Data on LMB forestry production and prices in Viet Nam shows that forestry production has approximately doubled between 2010 and 2020 (Figure 5.9b). However, the average price of wood extracted from the Basin over the same period has declined, this resulted in the gross value of production remained approximately the same at USD 150 million (Figure 5.9b) .

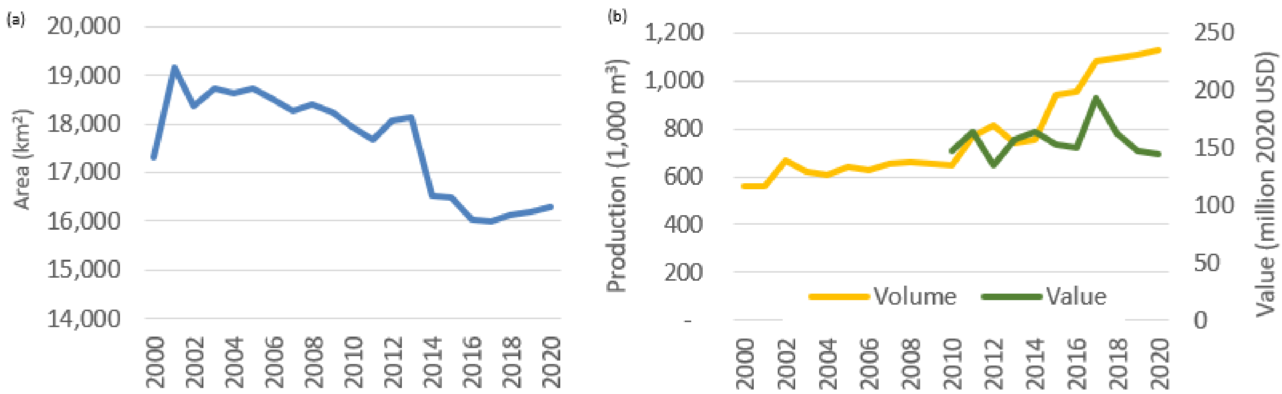


Figure 5.9. Forest area in LMB provinces of Viet Nam, 2000–2020(a); and estimated timber production volume and value in the Lower Mekong River Basin in Viet Nam, 2000–2020(b)

Data source: National statistics from Viet Nam

5.3.10. Economic value of tourism and recreation

Since 1980, international tourism has developed rapidly in all the Mekong River Basin countries, with the exception of Myanmar, where access and political conditions are currently hampering the development of the sector. In the LMB in 2019, prior to the COVID-19 pandemic, tourism significantly contributed to GDP, accounting for 25.8% of GDP in Cambodia (WTTC, 2022a), 4.6% in Lao PDR (ADB, 2022), 20.3% in Thailand (WTTC, 2022b) and 7.0% in Viet Nam (WTTC, 2022c). The numbers of both domestic and international tourists to LMB provinces also demonstrate the rapid rise in tourism until 2019 and then the decline in 2020 due to the global pandemic (Figure 5.10).

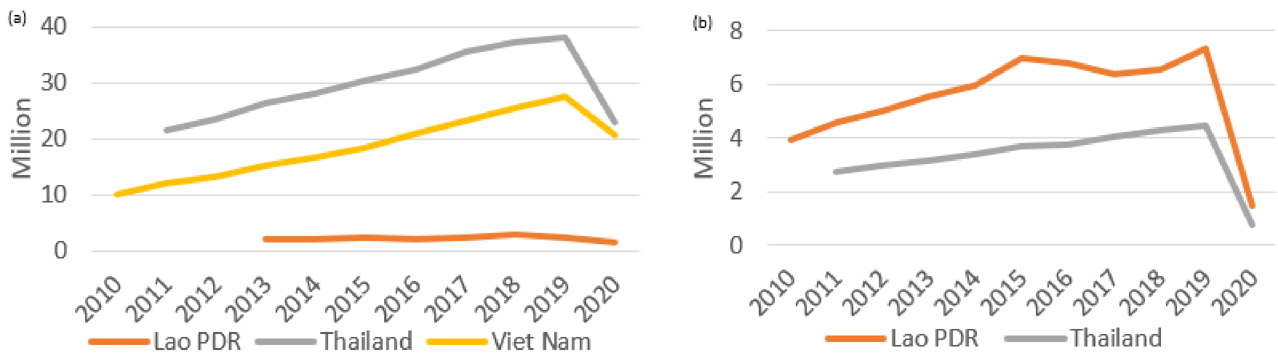


Figure 5.10. Number of domestic tourists (a) and international tourists to LMB provinces (b), 2010–2020

Data source: National statistics from basin countries

National receipts from tourism in the LMB are dominated by Thailand, but between 2009 and 2019, growth in tourism receipts was more rapid in Cambodia (11%), Lao PDR (10%) and Viet Nam (11%) than in Thailand (8%) (Figure 5.11). The recent pandemic led to a dramatic decline in the sector across all countries in 2020, but it is rebounding quickly and is expected to return to pre-pandemic levels over the next few years. In Thailand, domestic tourists are the most significant source of tourism revenue in the Thai part of the Mekong River Basin, and as a source of revenue grew much more rapidly between 2011 and 2019 than did revenues from international tourists (Figure 5.12).

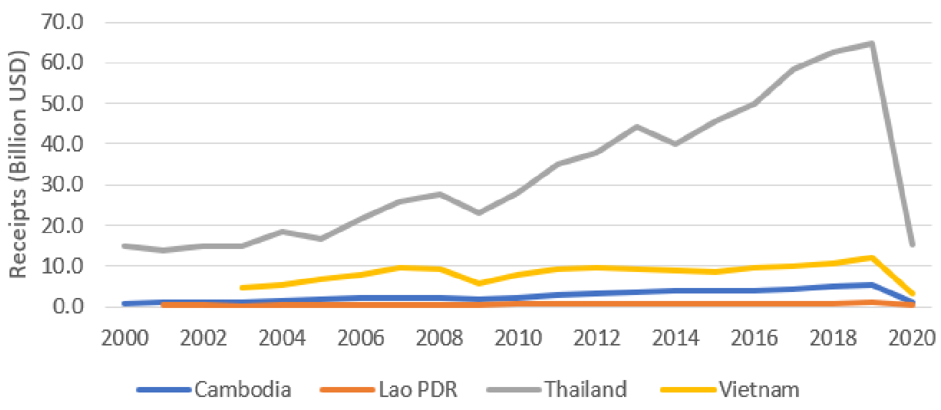


Figure 5.11. National receipts from international tourism by basin country, 2000–2020

Data source: World Development Indicators

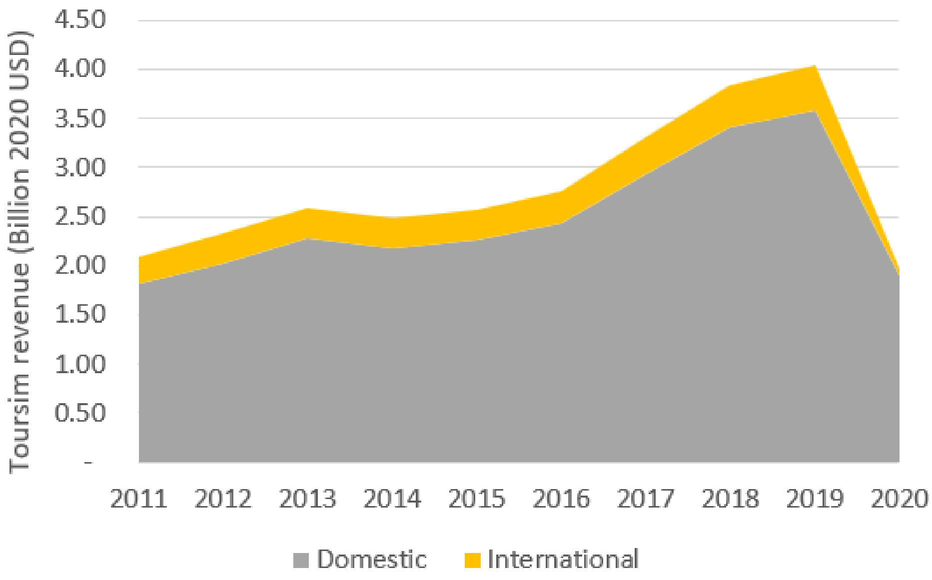


Figure 5.12. Domestic and international tourism revenues for the Mekong River Basin in Thailand, 2011–2020

Data source: National statistics from basin provinces provided by Thailand

With the majority of tourist attractions in Thailand and Viet Nam outside the LMB, national figures are a poor guide to the likely importance of LMB tourism in these countries. Nevertheless, the economic value of tourism to the Basin is clear from the national receipts from Cambodia and Lao PDR alone, as is the rapid growth in the sector at a national level and the growth in both domestic and international tourist numbers at the basin level. In this context, it is important to stress the significance of sustaining environmental assets to continue attracting tourists to the area. In the Chinese portion of the Basin there are two important tourist hotspots, Dali City and Xishuangbanna. However, detailed tourist and tourism revenue numbers are not available.

5.3.11. Economic cost of riverbank and coastal erosion

Land lost to riverbank and coastal erosion in the Mekong River Basin is of concern as are anthropogenic changes to the hydrology and geomorphology of the river, particularly due to sand mining, hydropower construction and climate , may be increasing the amount of erosion occurring. Moreover, as basin economies develop the value of assets at risk from erosion of riverbanks and coastal areas grows.

Estimates of riverbank and coastal erosion or suitable land values lost to erosion were not available for this SOBR (see Chapter Three). Therefore, the economic cost of riverbank and coastal erosion at a basin level could not be determined.

5.3.12. The economic cost of flood

The economic value of direct damages due to flooding is annually reported by Member Countries for the Annual Mekong Flood Reports. Damages and losses are indicated for floods in general, but damages and losses related to river floods or flash floods are not specified. Data for some years are not available, and it is unclear if this is due to the absence of flood damage or a reporting failure. Cambodia does not report damages in monetary values. No clear trend is discernible in the damage data, although 2013 and 2018 seem to be years that suffered particularly severe flooding, with high overall damage values (Table 5.13).

Table 5.13. Estimated economic value of annual flood damage by country in the Lower Mekong River Basin, 2012–2019 (USD million)

	2012	2013	2014	2015	2016	2017	2018	2019
Cambodia	-	-	-	-	-	-	-	-
Lao PDR	-	62.0	12.0	52.3	-	7.2	371.5	0.1
Thailand	177.0	210.0	6.0	1.2	2.0	26.8	26.8	-
Viet Nam	16.0	222.0	9.0	14.6	175.0	36.3	66.0	52.3
Total	**193.0**	**494.0**	**27.0**	**68.0**	**177.0**	**70.3**	**464.3**	**52.4**

Note: Cambodia does not report damages in monetary values.

Data source: MRC (2018b; 2019d; 2020b; 2021h; 2021i)

Flood impacts in the portion of the upper Mekong Basin in Myanmar are deemed relatively low when compared to other parts of the country (MIMU, 2022). Although damage is reported every year due to local flood events: 367,298 people are considered vulnerable to flooding in Kengtung, Tachileik and Monghsat districts (MIMU, 2022), but there is no available assessment of the economic damage caused by flooding in the area. In the portion of the upper basin located in China, the river is prone to flooding: severe floods occurred multiple times in the 20th century, seriously damaging croplands and causing loss of life and property (Yu et al., 2018). The most recent significant flood event occurred in 2006, affecting 100,000 people and causing USD 33.8 million in damages (ibid.).

Although the economic costs of flooding can be significant in terms of damage to lives and livelihoods, it is important to also consider the economic benefits from floods in relation to floodplain productivity, and the positive impacts on improved capture fisheries production (Section 5.3.7) and other ecosystem services from wetlands (Section 5.3.6).

5.3.13. Economic cost of drought

Impacts of droughts are not systematically reported or monitored. Basin-wide drought events occurred in 1992, 1997, 1998, 2002 and 2004–2005, with more localized events in 2015 and 2016, and most recently in 2019 and 2020. Estimates suggest that the 2004–2005 drought led to losses of at least USD 45 million in the Mekong Delta alone (MRC, 2021h). In a drought year, the loss of rice production is estimated at about USD 10 million in northeast Thailand (equivalent to about 78,000 tonnes). Meteorological drought is known to have a major impact on rainfed rice production in Cambodia, Lao PDR and Thailand (Table 5.14). Despite the lack of data on drought impacts, their relative frequency means that the average annual costs of droughts are probably larger than flood damages. Drought impacts multiple sectors, but the agricultural and fisheries sectors are particularly vulnerable and crucial for ensuring food security and income generation for people throughout the Basin.

Table 5.14. Drought-affected sectors in the Mekong River Basin

Activity	Sector	Affected by drought type	Parameter	Estimate of impact	Remark
Rainfed rice	Agriculture	Meteorological	Rain	78,000 t/year loss	Khorat Plateau
Capture fisheries	Fisheries	Hydrological	Inundated area	USD 45 million loss	Tonle Sap
Irrigated rice	Agriculture	Agricultural	Soil moisture, water availability	USD 45 million loss	Mekong Delta

Data source: MRC (2021h)

5.4. Progress towards BDS Outcomes

The BDS outlines two outcomes under the Economic Dimension Strategic Priority for achievement by 2030:

3.1 Increased economic growth of all basin countries from more proactive regional planning

3.2 Enhanced inclusive growth and sustainability in irrigated agriculture, hydropower, navigation, environment and fisheries sectors.

These outcomes seek to ensure that by 2030, the Basin's water and related resources continue to provide an important contribution to sustainable economic growth and wellbeing of basin communities, basin states and the greater Mekong region. The assessment of progress towards BDS 2021–2030 Outcomes in the Economic Dimension, which is summarized in Table 5.15, takes into consideration the alignment of strategic indicators with each BDS outcome in Table 1.3.

Generally, economic performance across water-related sectors in the Mekong River Basin is positive. Overall economic output of the Basin is increasing as sectors such as hydropower, rice production and tourism have seen substantial growth, especially in Cambodia and Lao PDR. Similarly, aquaculture and navigation in the Mekong Delta continue their rapid growth. Estimates of the value of capture fisheries and wetlands over time have not been possible due to changes in assessment methodologies and the lack of consistent time-series data. However, these two sectors contribute the most economic value of all water-related sectors, with a gross annual economic value of around USD 29 billion in 2021 for wetlands (not including water bodies) and around USD 17 billion in 2020 for fisheries (including aquaculture). There is no discernible increase in flood damages in the available data, and there is insufficient information from approved sources on the economic cost of riverbank erosion and the costs of droughts.

The performance in economic sectors suggests that the gap towards achieving the BDS outcome for increased economic growth is narrowing, even in the absence of new supplementary investment projects within the Basin. Nevertheless, a focus on identifying and developing joint projects that enable alternative development pathways for countries to follow will remain important to addressing the environmental and social trade-offs at a basin scale associated with water resources development.

Although economic growth in water-related sectors is evident, there are insufficient data to assess the extent to which this growth is sustainable, considering all three dimensions of sustainable development – Environment, Social and Economic. Further information is also needed on the extent to which the benefits of economic growth are inclusively shared among the population. Some of the indicators in the Social Dimension, where progress is slowing in some countries suggest that there remain groups within society that are not sharing equally in the economic success.

There remain significant gaps in data coverage across water-related sectors (e.g. in agricultural and hydropower production). Data on prices of sector output are sparse. In addition, gross output is a poor indicator of economic performance and productivity, because it does not take into account economic costs or the environmental externalities and trade-offs, which are central to IWRM. Increased input costs for fertilizer, fuel and agricultural chemicals, for example, can easily offset a large proportion of the value of increased agricultural yields. The expansion of agricultural areas, increased irrigation, the development of hydropower and sand mining may also imply significant external environmental costs not reflected in gross output figures. This is complicated further by the interconnected and long-term nature of these external impacts. For example, hydropower development may have had significant impacts on capture fisheries. Other impacts, however, may only be felt in the longer term, such as the depletion in the quantity of sediments reaching the delta due to hydropower development and sand mining. There is no clear agreement on how to treat these long-term impacts in economic analysis.

Table 5.15. Summary of progress towards BDS 2021–2030 Outcomes based on conditions and trends for aligned strategic indicators in the Economic Dimension

BDS Outcomes	Strategic indicators	Condition	Trend	Key Issues	BDS Progress
3.1 Increased economic growth of all basin countries from more proactive regional planning	Contribution to the basin economy	●	↗	Enabling increased benefits and reduced costs of development for all countries Identifying net economic benefits within sectors and accounting for externalities	↗
3.2 Enhanced inclusive growth and sustainability in irrigated agriculture, hydropower, navigation, environment and fisheries sectors	Economic performance of water-related sectors	●	↗	Ensuring inclusive growth and sustainability considering the impacts on the environment and the livelihoods of vulnerable people	●●●

Greater effort needs to be made in accounting for economic costs and production externalities which are central to the effective management of the Basin. A start would be to collect representative data on costs in key agricultural and fisheries subsectors, either through direct surveys or from a systematic review of secondary sources. The valued added of water-related sectors was available for Cambodia and Viet Nam, but not for the other countries. More emphasis is also needed on environmental and social externalities, although this will require an agreed approach to critical methodological questions such as discounting the value of future benefits and costs.

CHAPTER 6

CLIMATE CHANGE CONDITIONS AND TRENDS

CHAPTER 6: CLIMATE CHANGE CONDITIONS AND TRENDS

6.1. Introduction

The Climate Change Dimension of the MRB-IF reflects the significant challenge that climate change presents to the achievement of the objectives of the 1995 Mekong Agreement for the sustainable development, utilization, conservation and management of the Mekong Basin water and related resources. Adaptation capacity across Member Countries is variable, with many communities vulnerable to the effects of increased frequency of extreme events, particularly floods, droughts and storms, as well as sea-level rise. In their updated NDCs and National Communications to the United Nations Framework Convention on Climate Change (UNFCCC), all countries have identified adaptation priorities across a range of domains, in particular in areas of disaster preparedness, emergency response and in agriculture and other natural resource sectors.

Climate change conditions and trends are monitored through the routine hydro-meteorological monitoring activities and flood and drought monitoring of the MRC, as well as national meteorological datasets that are transmitted from the Member Countries to the MRC. Supplementary databases maintained by various international organizations and that draw on global and regional data products also contribute to understanding of climate change in the Basin.

To assess the status of climate change conditions and trends in the Mekong River Basin, the MRB-IF encompasses three strategic indicators and 11 assessment indicators, as reflected below (Table 6.1). This chapter provides an assessment of the status of conditions and trends in each of these strategic and assessment indicators.

Table 6.1. Strategic and assessment indicators in the Climate Change Dimension of the MRB-IF

Strategic indicators	Assessment indicators
Greenhouse gas emissions	Greenhouse gas emissions from water-related sectors
	Relative contribution to global emissions
Climate change trends and extremes	Changes in tropical storm intensity and frequency, and storm surge risk
	Changes in temperature
	Changes in precipitation
	Extent and severity of flooding
	Extent and severity of drought
Adaptation to climate change	Institutional response to the effects of climate change
	Flood protection measures
	Drought protection measures
	Vulnerability to floods, droughts and storms

The assessment of conditions and trends is undertaken taking into consideration the BDS 2021–2030 Strategic Priority for the Climate Change Dimension:

Strengthen resilience against climate risks, extreme floods and droughts

This BDS Strategic Priority recognizes that floods and droughts cause severe economic and social hardship, particularly on poor and marginalized communities. Climate change has the potential to exacerbate the frequency and severity of both floods and droughts where more people and assets are at risk due to population growth and floodplain development. The BDS therefore encourages basin countries to take steps to increase water security by mitigating the impacts both of too much water at certain times of year and not enough at other, and to ensure that communities are as well prepared as possible to adapt to the changing circumstances.

In order to strengthen the resilience of basin communities and adapt to climate change and climate variability, it is essential to improve information on changing river conditions through enhanced monitoring, forecasting and early warning systems. Progress on the harmonization of disaggregated data collection and sharing, notification of water releases, agreed infrastructure operating protocols, and integrated decision support systems will all be beneficial to achieving one overall basin planning and management system.

6.2. Greenhouse gas emissions

6.2.1. Assessment methodology

Data on greenhouse gas emissions from the Mekong River Basin countries are not available for individual water-related sectors, only for agriculture, energy, and land-use change and forestry. Emissions from the Mekong River Basin were estimated based on the Basin's per capita share of the national total and energy emissions, and by the proportion of land within the Basin for agriculture and land-use change and forestry emissions. Data were obtained from the country-level emissions database available through ClimateWatch, which uses a combination of sources including country submissions to the United Nations Framework Convention on Climate Change (UNFCCC) and global assessments by FAO and others.[23] The assessment indicators for this strategic indicator are:

- Greenhouse gas emissions from water-related sectors
- Relative contribution to global emissions.

6.2.2. Greenhouse gas emissions from water-related sectors

Very Good	Good	**Of Concern**	Requires Action	Requires Urgent Action

At the national level, the most recent reporting by basin countries to the UNFCCC in their National Communications indicated total greenhouse gas emissions of around 164 Mt CO2-e from Cambodia in 2016, around 9,551 Mt CO2-e from China in 2010, around 51 Mt CO2-e from Lao PDR in 2000, 68 Mt CO2-e from Myanmar in 2000, 286 Mt CO2-e from Thailand in 2018 and 284 Mt CO2-e from Viet Nam in 2014. These national figures clearly do not necessarily reflect emissions from the Basin and are mostly out-of-date, so estimates were derived from the ClimateWatch datasets for the basin area based on the proportion of the population and area of each country within the Basin, as mentioned above.

Based on this basin-scale estimate, total greenhouse gas emissions are rising in the Mekong River Basin in every basin country (Figure 6.1). Emissions from the basin are highest in Thailand, followed by Viet Nam, Cambodia, China, Lao PDR and Myanmar. Over the last ten years, the sharpest increases in total greenhouse gas emissions from the Basin were estimated to have occurred in Lao PDR and Viet Nam.

23 https://www.climatewatchdata.org/

Greenhouse gas emissions from agriculture and land-use change and forestry have been relatively stable over the last 30 years at the basin level but have increased rapidly from the energy sector (Figure 6.2). Greenhouse gas emissions from the energy sector are highest in Thailand, Viet Nam and China, reflecting their larger share of the basin economy. In these three countries, the contribution of energy to total emissions is also the highest in relative terms (respectively 57%, 68% and 88% of their total estimated basin emissions). The most rapid increase in greenhouse gas emissions from energy was estimated to have occurred in Viet Nam, approximately doubling over the 2010–2020 period.

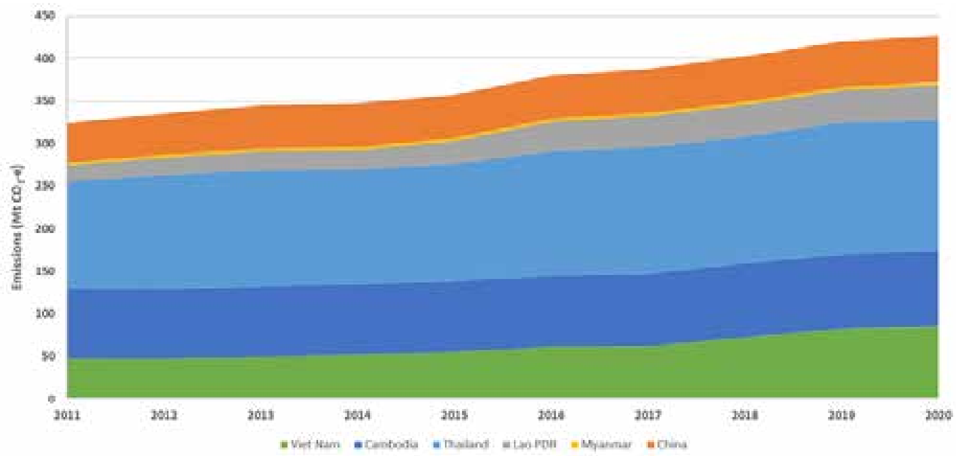


Figure 6.1. Estimated total greenhouse gas emissions from the Mekong River Basin by basin country, 2011–2020

Data source: ClimateWatch and MRC estimates, adjusted based on the proportion of the population of each country in the Basin

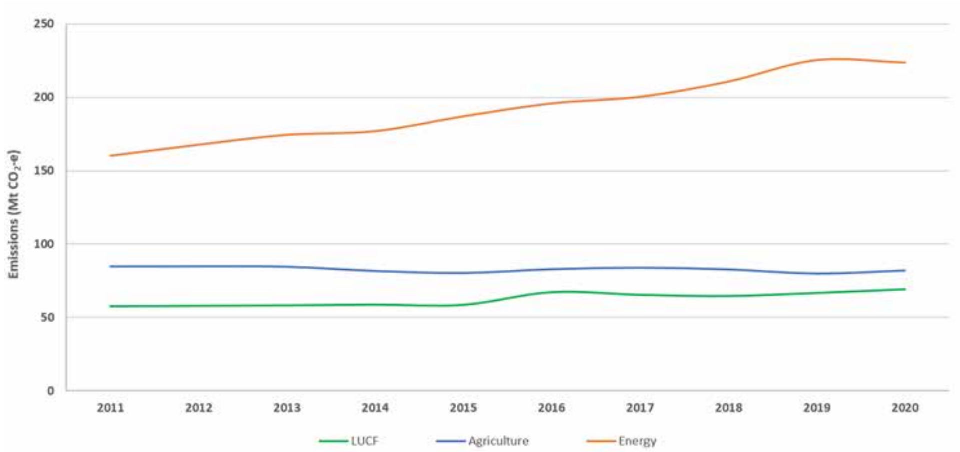
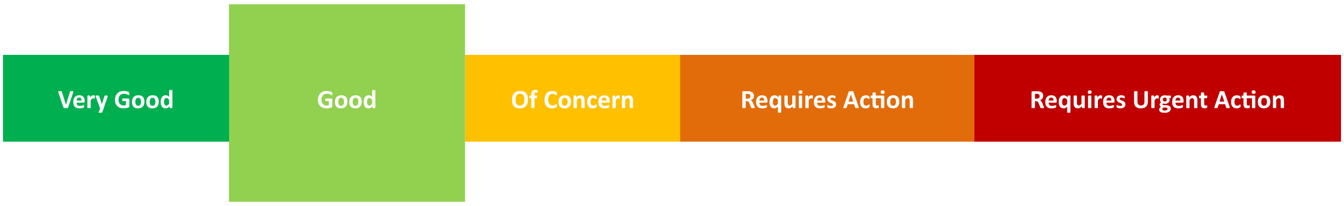


Figure 6.2. Estimated total greenhouse gas emissions by water-related sector from the Mekong River Basin, 2011–2020

Data source: ClimateWatch and MRC estimates, based on the proportion of the population (for energy) or basin area (for agriculture and land use change and forestry) of each country in the Basin

Greenhouse gas emissions in the Mekong River Basin are assessed as 'Of Concern' due to the relatively constant increase in estimated emissions including from water-related sectors in the Basin. Although emissions from energy are rising rapidly, it is likely that the increase would have been even greater without the contribution from hydropower. Greater efforts need to be made in coming years to transition to renewable sources of energy generation if basin countries are to achieve the commitments outlined in their Nationally Determined Contributions (NDCs).

6.2.3. Relative contribution to global emissions



The relative contribution of the Mekong River Basin to global greenhouse gas emissions was assessed for three of the major greenhouse gases: carbon dioxide (CO2), methane (CH4) and nitrous oxide (N2O). Overall, the contribution of the Mekong River Basin to global emissions of greenhouse gases is quite small. The Basin is estimated to contribute less than 1% to each of total carbon dioxide methane and nitrous oxide emissions (Figure 6.3). None of the basin countries contributes more than 0.3% of global carbon dioxide emissions, 0.1% of global methane emissions, or 0.02% of global nitrous oxide emissions from their part of the Basin.

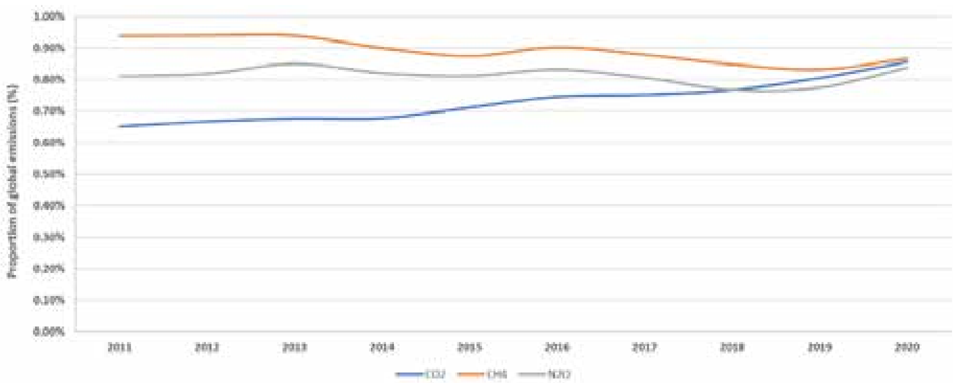


Figure 6.3. Estimated proportion of global emissions contributed by the Mekong River Basin, 2010–2020 by major greenhouse gases

Data source: ClimateWatch and MRC estimates, adjusted based on the proportion of the population of each country in the Basin

The proportional share of global carbon dioxide emissions estimated from the Basin is rising. However, the estimated proportional share of global methane emissions, in contrast, appears to have declined over the last decade. The decline in the share of global methane emissions is most pronounced in the countries with higher emissions, specifically Thailand, Viet Nam and Cambodia, and is relatively stable in the others. The proportional share of global nitrous oxide emissions from the Mekong River Basin is relatively stable.

The relative contribution to global greenhouse gas emissions is assessed as 'Good' in the Mekong River Basin. Although the relative contribution of basin CO2 emissions to the global total has increased over the last decade, it is still quite low, at less than 1% of global emissions, roughly equivalent to the Basin's share of the global population. In addition, the contribution of the Basin to global methane and nitrous oxide emissions has, respectively, decreased and remained stable. However, it is important to recognize that most jurisdictions around the world only contribute a very small proportion of the total global emissions, and the contribution of total carbon dioxide equivalent greenhouse gas emissions from the Basin would place it in the top 20 highest emitting economies, roughly equivalent to Pakistan and more than each of the United Kingdom, Spain and the Netherlands.[24] Clearly, this assessment does not consider historical contributions, where the basin contribution is likely to be significantly less.

6.3. Climate change trends and extremes

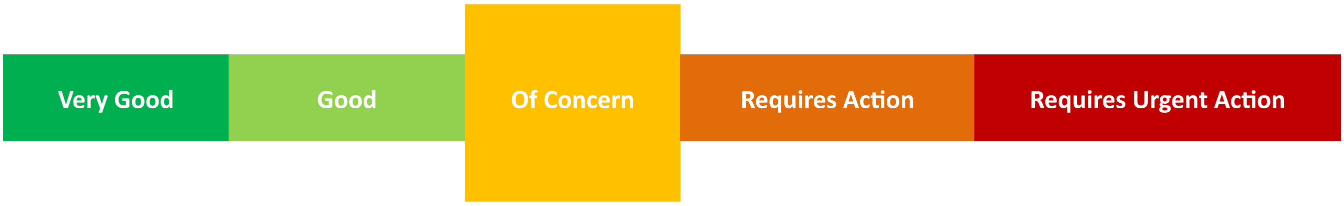
6.3.1. Assessment methodology

Climate change trends and extremes were evaluated based on data from a variety of sources, including global databases, analyses of satellite-derived information, and the MRC hydrometeorological station database. Several of these analyses were available from other recent MRC publications, which are cited where appropriate. The assessment indicators for this strategic indicator are:

- Changes in tropical storm frequency and intensity, and storm surge risk
- Changes in temperature
- Changes in precipitation
- Extent and severity of flooding
- Extent and severity of drought.

24 https://ourworldindata.org/grapher/share-global-ghg-emissions?tab=table

6.3.2. Changes in tropical storm frequency and intensity, and storm surge risk



The Tropical Cyclone Information System of the Japanese Meteorological Agency (JMA) was consulted to obtain data on the frequency of tropical storms over the Mekong region. The data indicate that the frequency of typhoon formation in the Western Pacific Ocean has decreased significantly ($p < 0.05$) over the past 30 years (Figure 6.4). The trend corresponds to an average of approximately eight fewer typhoons forming annually in the Western Pacific Ocean.

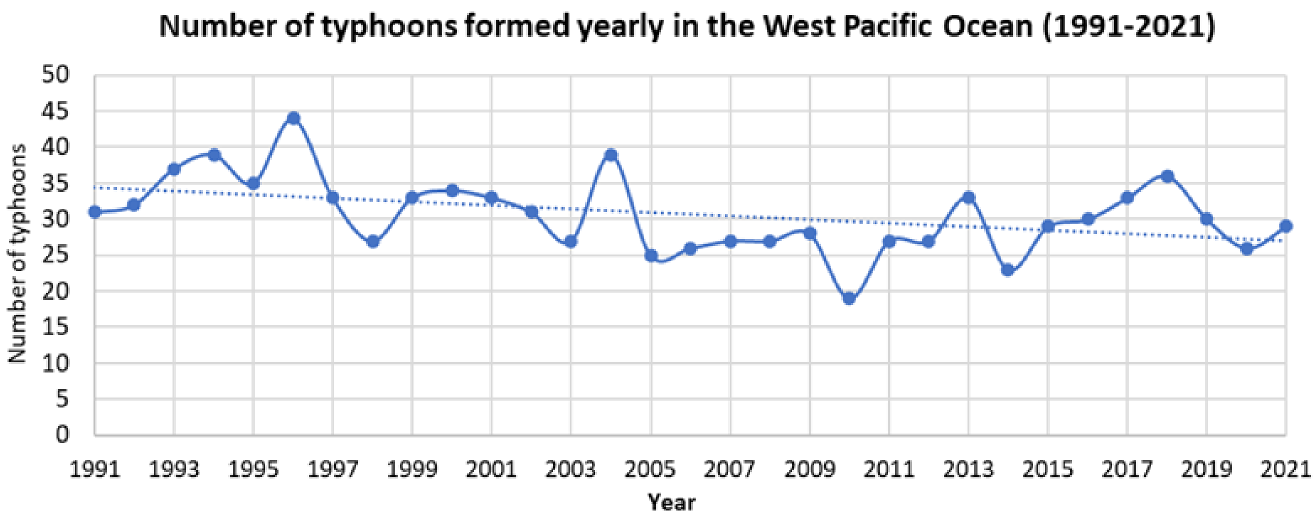


Figure 6.4. Number of typhoons formed in the West Pacific Ocean per year, 1991–2021

Data source: Japanese Meteorological Agency

The number of typhoons crossing the boundary of the Mekong River Basin is highly variable from year to year, with a minimum of 1 and a maximum of 9 typhoons for the 30-year period under consideration (Figure 6.5). The maximum intensity of these typhoons, as measured by wind speed, ranges from around 40 knots to 140 knots (Figure 6.6). There is no statistically significant trend in either the frequency or intensity of typhoons crossing into the Basin since 1991.

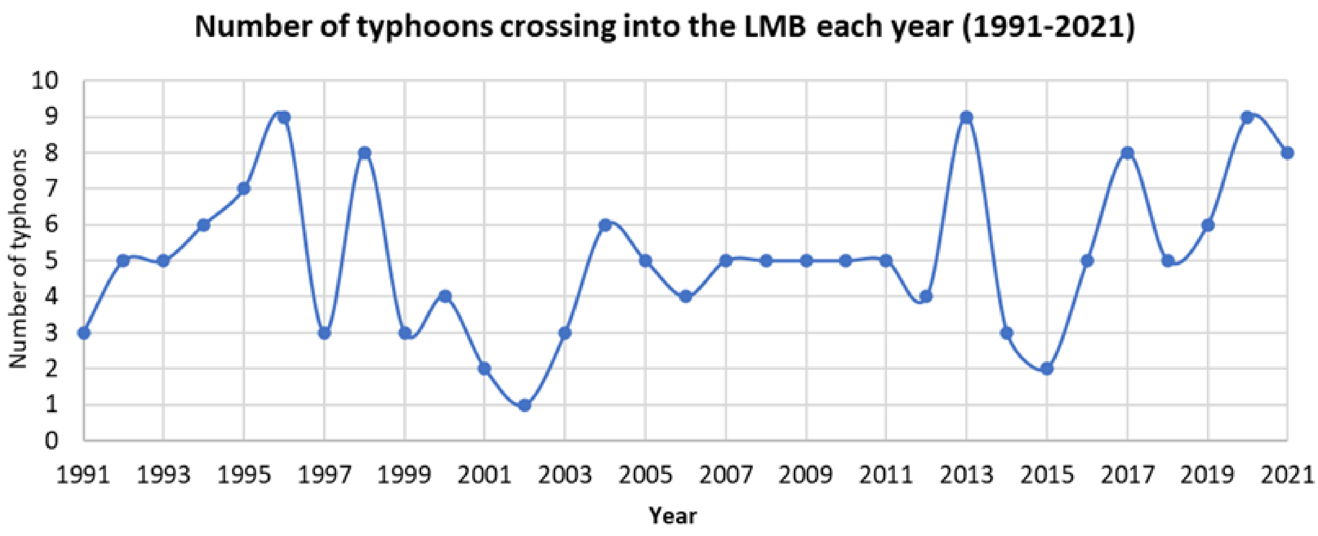


Figure 6.5. Number of typhoons crossing into the Lower Mekong River Basin per year, 1991–2021

Data source: Japanese Meteorological Agency

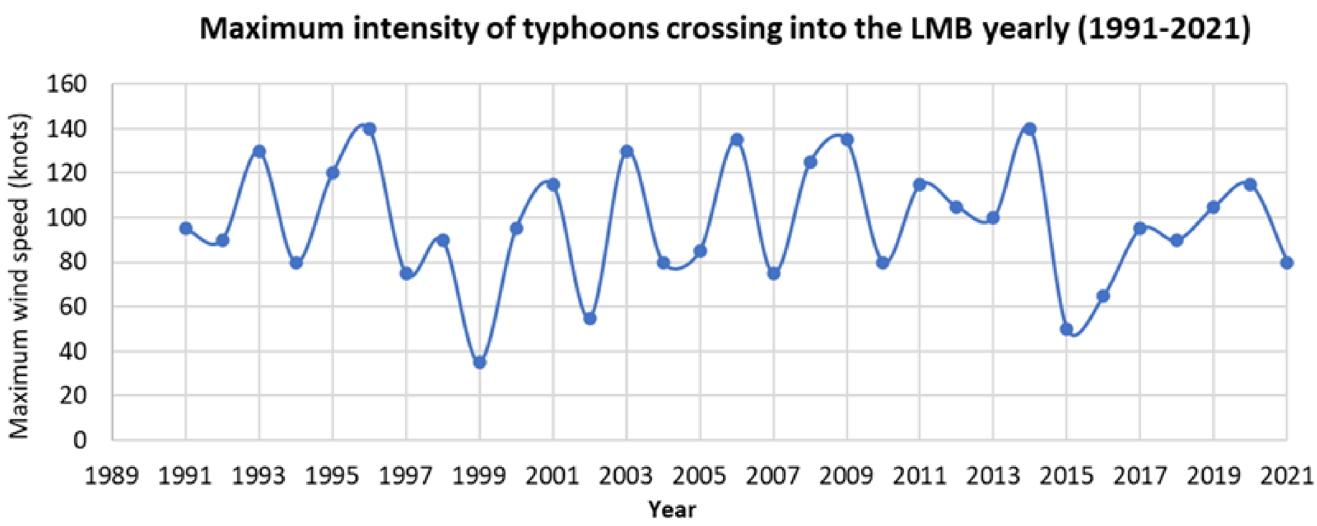


Figure 6.6. Maximum intensity of typhoons crossing into the LMB per year, 1991–2021, based on maximum wind speed

Data source: Japanese Meteorological Agency

Based on an analysis of in situ rainfall observations of 200 stations within the LMB region over a period of 32 years (1990–2021), the number of heavy (> 100 mm/d) and very heavy (> 150 mm/d) rainfall days in the LMB are decreasing (Figure 6.7). This is especially the case for the number of heavy rainfall days, at a reduction of approximately 50 days per year.

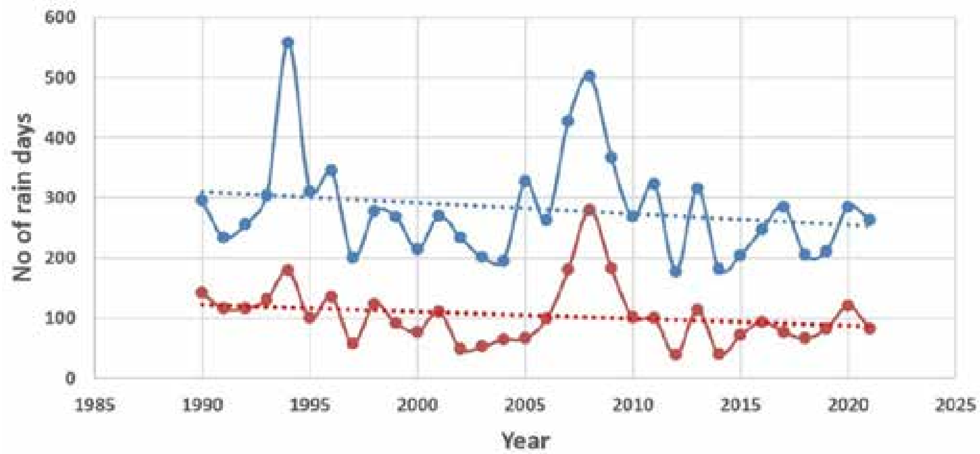


Figure 6.7. Number of heavy and very heavy (> 150 mm/d in red) rainfall days in the Lower Mekong Basin, 1990–2021

Note: Heavy: > 100 mm/d (blue); very heavy: > 150 mm/d (red).

The number of days reflects the cumulative number from multiple stations with the results normalized to account for changes in the numbers observations over time, which vary up to a maximum of around 22,000 observations from across the Basin in a year. For further details of the methodology, see the MRC report.

Data source: MRC (2022b)

In addition to the number and intensity of typhoons, storm surge risk is also determined by sea level. Data availability on sea-level rise is limited to the annual time series that is available until January 2016 for the Viet Nam coast through the World Bank Climate Change Knowledge Portal.[25] This shows a clear rising trend in observed sea level (Figure 6.8), which amounts to an approximate rise of 100 mm over the 23-year period (> 4 mm/year), when looking at the annual average sea level.

25 https://climateknowledgeportal.worldbank.org

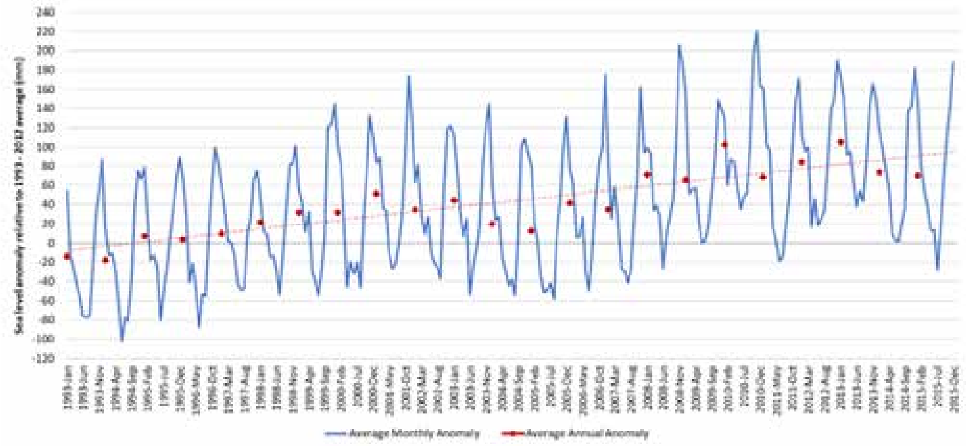


Figure 6.8. Observed sea-level anomalies off the coast of Viet Nam, January 1993–January 2016, relative to the average sea level anomaly of 1993–2012

Data source: World Bank Climate Change Knowledge Portal

Overall, the changes in tropical storm frequency and intensity, and storm surge risk are assessed as 'Of Concern'. The occurrence of heavy rainfall days and typhoons in the LMB is either declining or stable. However, at the Mekong Delta, current storm frequency and intensity combined with higher sea levels is likely to lead to more severe coastal flooding and erosion, considerably increasing the need for coastal protection (Wood et al., 2022). The problem is exacerbated by the loss of mangroves (Section 3.4.3) and land subsidence. The latter is affected by transboundary water resource management through the supply of sediments from upstream, which are needed to maintain delta-forming processes.

6.3.3. Changes in temperature

Very Good	Good	Of Concern	Requires Action	**Requires Urgent Action**

The World Bank Climate Change Knowledge Portal provides basin-level data on historical temperatures based on the global ERA-5 re-analysis dataset, which combines vast amounts of historical observations into global estimates using advanced modelling and data assimilation systems.[26]

26 Note that the ERA-5 reanalysis product incorporates observations from both satellite and ground stations through datasets continuously shared by countries with the World Meteorological Organization and others. However, without a local bias correction procedure using observations from within the area of interest, caution should be applied in referring to absolute values from global datasets such as these. The trends and change over time should nevertheless be accurate because they would ordinarily be maintained through an appropriate bias-correction procedure.

In addition to national and provincial levels, these data are also made available at the watershed scale. Following the guidelines of the MRB-IF, selected temperature indices were obtained from the portal for the 1970–2020 period, with values aggregated for the Mekong River Basin.

The annual patterns of the following four temperature indices were evaluated: (i) the average daily minimum temperature; (ii) the average daily maximum temperature; (iii) the number of hot days (days with a maximum temperature exceeding 35°C); and (iv) the number of tropical nights (nights with a temperature exceeding 20 °C). The trends for all four temperature indices point at warming conditions over the past 50 years. Both minimum (Figure 6.9) and maximum (Figure 6.10) daily temperatures rose by approximately 1.4 °C over this period, at the basin level. The number of hot days per year increased by more than 15 (Figure 6.11), and the number of hot nights by more than 25 (Figure 6.12). The increasing trends for all four temperature indices are significant at the basin scale (Table 6.2).

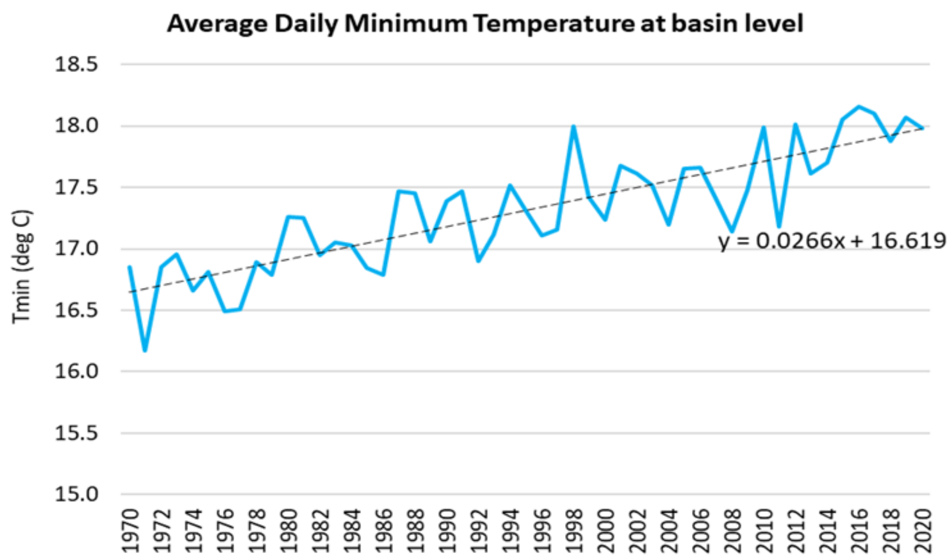


Figure 6.9. Average daily minimum temperature at the basin level, per year, 1970–2020

Note: The graph plots the average of the values for all ERA-5 pixels (0.25-degree resolution) that overlap with the Mekong River Basin.

Data source: World Bank Climate Change Knowledge Portal

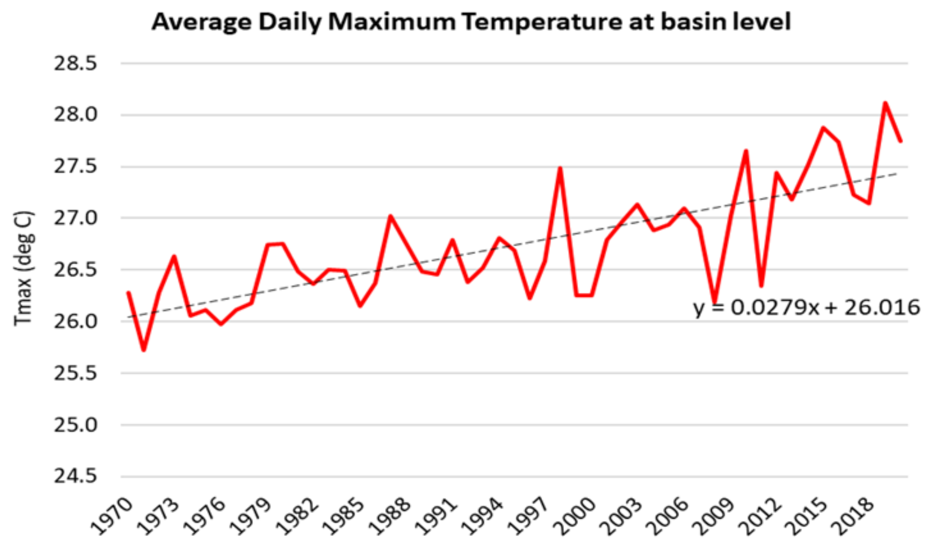


Figure 6.10. Average daily maximum temperature per year at the basin level, 1970–2020

Note: The graph plots the average of the values for all ERA-5 pixels (0.25-degree resolution) that overlap with the Mekong River Basin.

Data source: World Bank Climate Change Knowledge Portal

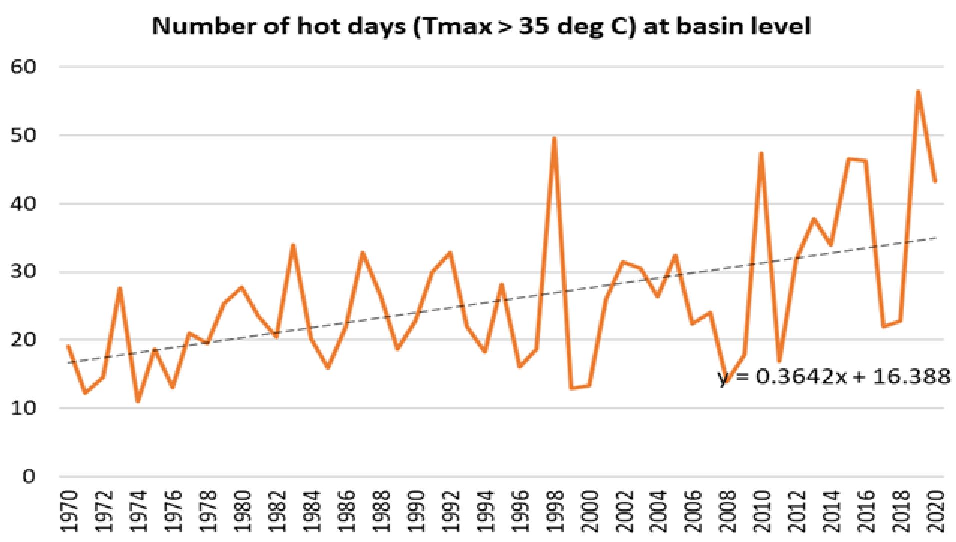


Figure 6.11. Number of hot days (Tmax > 35° C) at the basin level, per year, 1970–2020

Data source: World Bank Climate Change Knowledge Portal

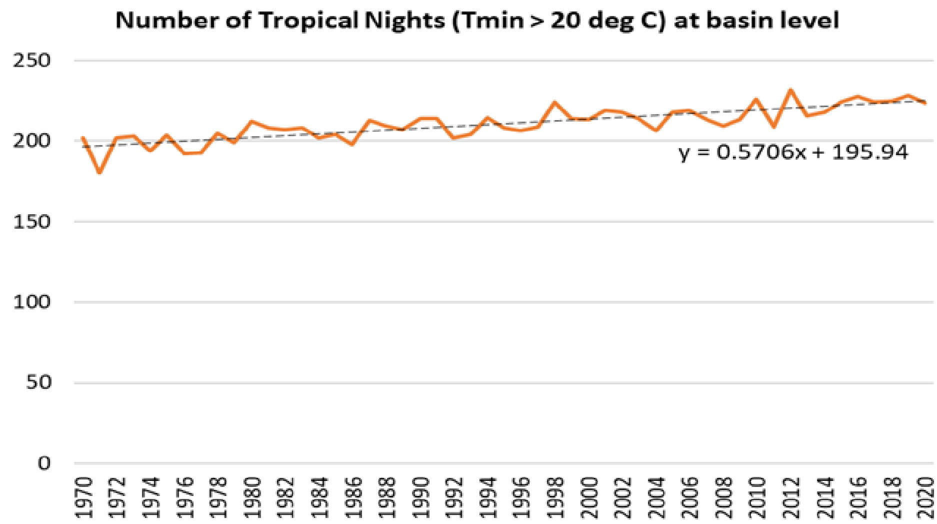


Figure 6.12. Number of tropical nights at the basin level, per year, 1970–2020

Data source: World Bank Climate Change Knowledge Portal

Table 6.2. Results of statistical analyses for each temperature parameter at the basin level, 1970–2020

Indicator	Trend	Slope	Significant
Number of hot days (Tmax > 35 °C)	Increasing	0.36	Y
Number of tropical nights (Tmin > 20 °C)	Increasing	0.57	Y
Average daily minimum temperature (°C)	Increasing	0.03	Y
Average daily maximum temperature (°C)	Increasing	0.03	Y

Changes in temperature are assessed as 'Requires Urgent Action'; however, it is recognized that only coordinated global action will make a material difference to the outcome. At the basin scale, a clear picture of warming conditions is evident. Both minimum and maximum temperatures are rising, and extreme temperatures occur significantly more frequently than before. The warming climate presents a range of challenges to the population of the Basin, including the need for adapting agricultural practices to increased crop heat stress and water consumption through evapotranspiration. Fragile ecosystems and human livelihoods and wellbeing may be negatively impacted by increasingly hotter conditions.

6.3.4. Changes in precipitation

Very Good	Good	**Of Concern**	Requires Action	Requires Urgent Action

Mean annual precipitation across the LMB from 2008 to 2022 ranged from less than 300 mm per year in parts of northern Lao PDR and coastal areas of the Mekong Delta, to more than 2,500 mm per year in more central parts of Lao PDR and border areas with Viet Nam (Figure 6.13). These estimates are based on data from 122 stations in the MRC's hydromet monitoring network.

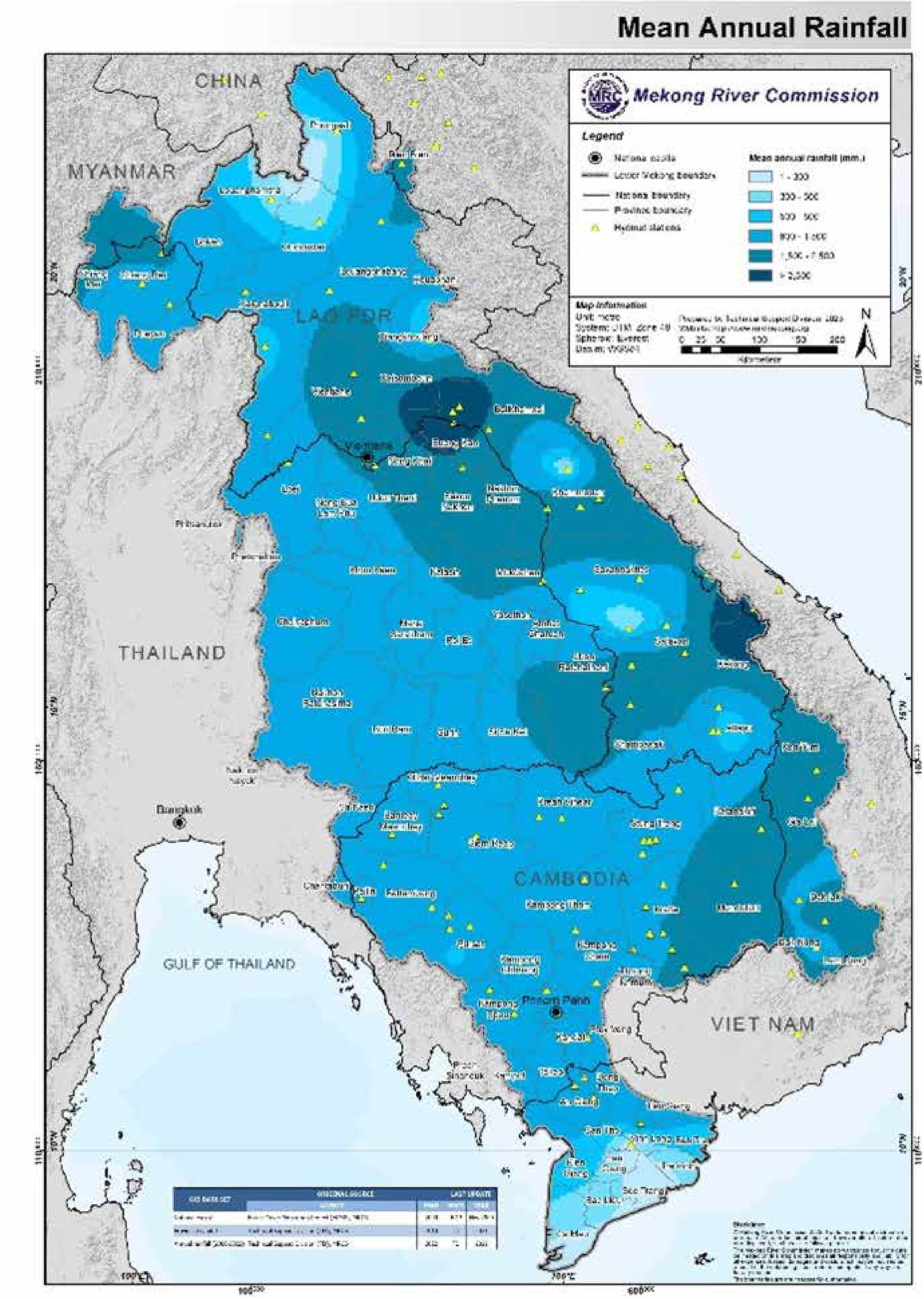


Figure 6.13. Mean annual rainfall across the Lower Mekong River Basin, 2008–2022

Data source: MRC hydromet monitoring

Over a longer time-period and for the whole Mekong River Basin, the World Bank Climate Change Knowledge Portal provides time series of a number of pre-defined rainfall indices, based on the global ERA-5 reanalysis dataset. Five indices were obtained from the portal for the entire basin for the period 1970–2020 period:

- Annual precipitation
- Maximum 1-day precipitation
- Maximum 5-day cumulative precipitation
- Number of consecutive dry days (CDD)
- Number of consecutive wet days (CWD).

Regression analysis was performed on the time series for each of the five indices, and trends were analysed for statistical significance (Figures 6.14, 6.15 and 6.16). A statistically significant trend ($p < 0.05$) was found only for annual precipitation (Figure 6.14) and CWD (Figure 6.16b). Both of these trends are decreasing, indicating overall drier conditions at the annual time scale and a decreasing length of wet periods during the year. This is consistent with results from the MRC-MLC Water Joint Study, which found a trend towards drier conditions over recent decades, based on similar global datasets that primarily use satellite data sources (MRC and MLC Water, 2023). No change was evident over the period for one-day maximum rainfall (Figure 6.15a), five-day maximum rainfall (Figure 6.15b) and CDD (Figure 6.16a).

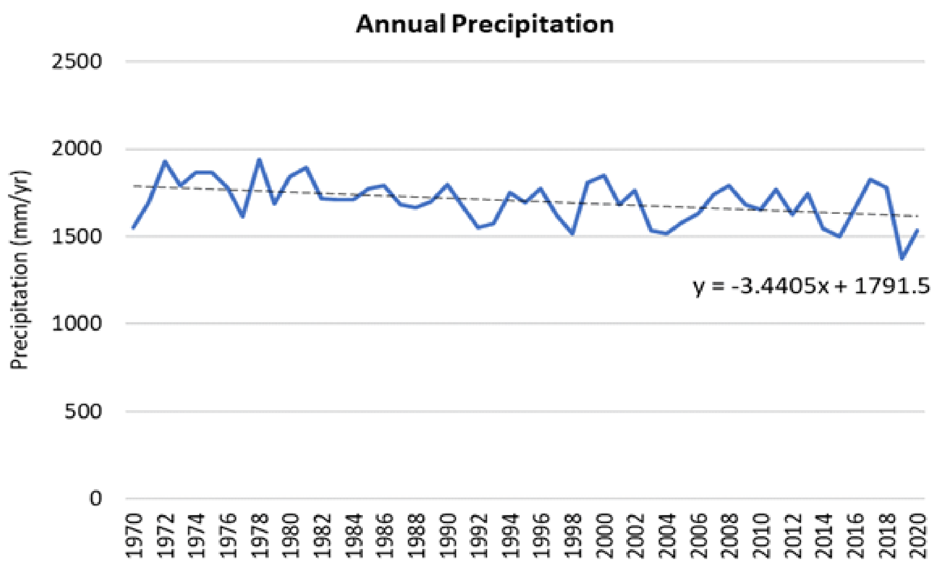


Figure 6.14. Basin-level annual precipitation for the entire Mekong River Basin as derived from the ERA-5 reanalysis data, 1970–2020

Note: The trend is statistically significant ($p < 0.05$).

Data source: World Bank Climate Change Knowledge Portal

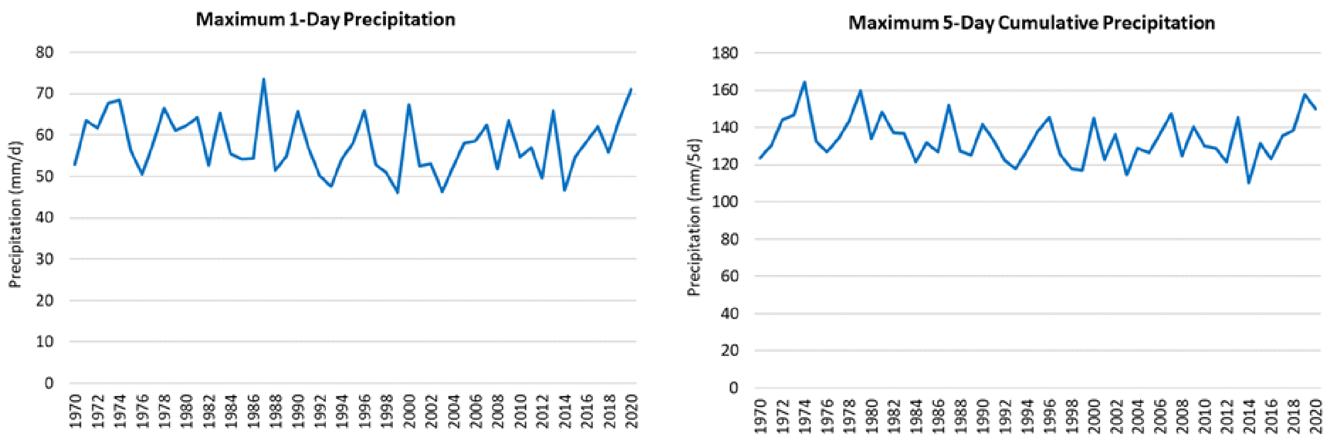


Figure 6.15. Basin-level maximum 1-day precipitation (a) and 5-day cumulative precipitation for the entire Mekong River Basin (b) as derived from the ERA-5 reanalysis data, 1970–2020

Note: Trendlines are only shown if found to be statistically significant ($p < 0.05$).

Data source: World Bank Climate Change Knowledge Portal

The ERA-5 data provide an opportunity to evaluate precipitation patterns according to the hydrological boundaries of the transboundary Mekong Basin, based on a consistent methodology. However, conclusions drawn from the data are not necessarily valid when zooming in on a particular region, due the wide range of climatologies occurring across the Basin. Therefore, station values from the MRC hydrometeorological database were also examined to identify trends at the local and national levels.

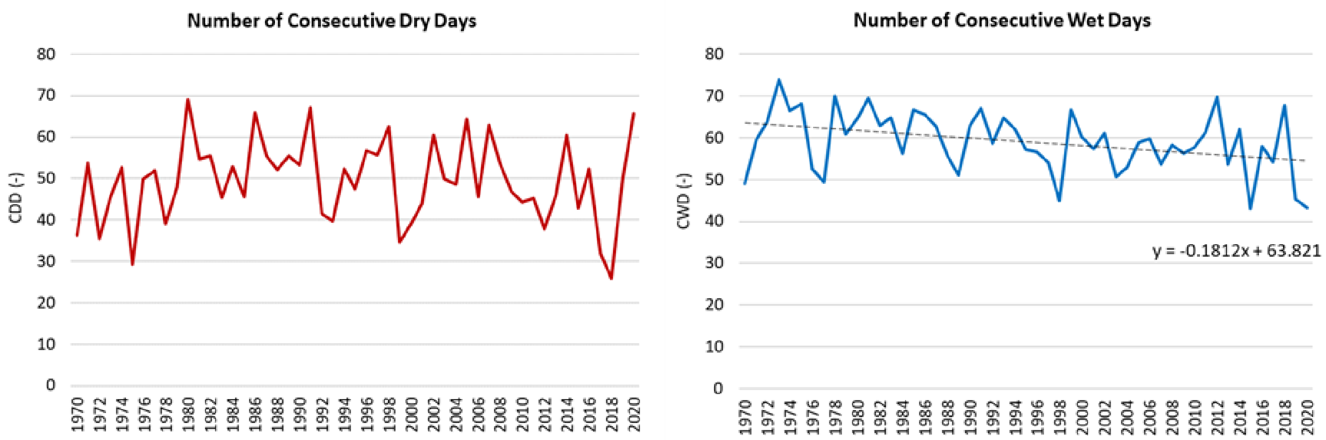


Figure 6.16. Basin-level number of consecutive dry days (annual maximum) (a) and consecutive wet days (annual maximum) (b) for the entire Mekong River Basin, as derived from the ERA-5 reanalysis data, 1970–2020

Note: For CWD the trend was found to be statistically significant ($p < 0.05$). Trendlines are only shown if they are found to be statistically significant ($p < 0.05$).

Source: World Bank Climate Change Knowledge Portal

For determining precipitation trends associated with a changing climate, it is important that only stations with extensive measurement records and a very limited number of data gaps are included. Therefore, the hydromet database was filtered to: (i) exclude, per station, years with over 10% 'no data' values; and (ii) exclude stations were less than 30 consecutive years were available in the 1981 –2021 period after applying criterion (i). This resulted in a total of 150 stations in the LMB to include in the analysis. In addition, data from three stations in the Chinese UMB (Chamdo, Dali and Lancang/Menglanba) were obtained from the Global Surface Summary of the Day (GSOD) database.[27] The considerable differences in data quality and coverage between the four LMB countries led to an over-representation of Thailand (79% of all LMB stations). Around 19% of all stations are situated in Viet Nam, while Cambodia and Lao PDR are only represented by three stations and one station, respectively (Table 6.3).

Based on the results presented above for each of the indices (Table 6.3), most of the stations do not show any significant statistical trend. A significant negative trend in annual precipitation is found for 28% of the stations in Thailand, which is in line with the basin-level aggregate derived from ERA-5 data (Figure 6.14). However, despite the limited spatial distribution of the stations considered, differences between the stations in Viet Nam and Thailand point to substantial spatial variation in changes in precipitation. While measurements at 29% of the stations in Viet Nam show a significant positive trend in annual precipitation, and a significant positive trend in annual CDD is observed at 25% of the stations in Viet Nam, this contrasts to a certain degree with the results in Thailand, whose stations exhibit a much stronger drying trend more consistent with global datasets.

Changes in precipitation are assessed as 'Of Concern'. In general, changing precipitation patterns due to climate change are complex and highly variable across the Mekong River Basin. For each of the five precipitation indices, no significant trends are evident at over 70% of the stations examined in this analysis. For the indices representative of extreme wet or dry conditions, both positive and negative trends were evident at different stations. However, at the basin scale, area-averaged rainfall from global datasets indicates that total annual precipitation decreased (by around 172 mm over the 1950–2020 period). Due to the lack of monitoring stations with sufficient data available in both the LMB (Cambodia, Lao PDR) and the UMB, it is not possible to obtain a comprehensive comparison with the global dataset; however, the drying trend across the Basin over recent decades is reported in other studies (MRC-LMC Water, 2023).

27 www.ncei.noaa.gov/access/search/data-search/global-summary-of-the-day

Table 6.3. Number of stations per basin country showing significant trends for each of the five precipitation indices

		Cambodia		Lao PDR		Thailand		Viet Nam		China**	
		-	%	-	%	-	%	-	%	-	%
No. of stations meeting data quality requirements*		3	100%	1	100%	118	100%	28	100%	3	100%
Annual precipitation	No. of stations showing a significant positive trend	1	33.3%	0	0.0%	4	3.4%	8	28.6%	0	0.0%
	No. of stations showing a significant negative trend	0	0.0%	0	0.0%	33	28.0%	0	0.0%	0	0.0%
Maximum 1-day precipitation	No. of stations showing a significant positive trend	0	0.0%	0	0.0%	8	6.8%	3	10.7%	0	0.0%
	No. of stations showing a significant negative trend	0	0.0%	0	0.0%	31	26.3%	0	0.0%	0	0.0%
Maximum 5-day cumulative precipitation	No. of stations showing a significant positive trend	1	33.3%	0	0.0%	6	5.1%	5	17.9%	0	0.0%
	No. of stations showing a significant negative trend	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Number of consecutive dry days	No. of stations showing a significant positive trend	0	0.0%	1	100%	1	0.8%	7	25.0%	0	0.0%
	No. of stations showing a significant negative trend	0	0.0%	0	0.0%	23	19.5%	0	0.0%	0	0.0%
Number of consecutive wet days	No. of stations showing a significant positive trend	0	0.0%	0	0.0%	0	0.0%	0	0.0%	1	33.3%
	No. of stations showing a significant negative trend	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%

Note: * Only stations with at least 30 consecutive years of data between 1981 and 2021 are included, with the requirement that these years should not contain >10% of data gaps at the daily scale.

** Data for China were obtained from the Global Surface Summary of the Day (GSOD) database for three stations distributed across the UMB – Chamdo (upper), Dali (central), Lancang/Menglanba (lower).

6.3.5. Extent and severity of flooding

Very Good	Good	Of Concern	Requires Action	Requires Urgent Action

The extent and severity of the annual Mekong flood is determined by several drivers. Although human activities increasingly affect flood occurrence in both space and time, climate is still the dominant factor. Climate change and associated changes in precipitation and temperature patterns are expected to impact the frequency, extent and duration of floods across the Basin, as well as the affected population.

Flood frequency and extent from 2016 to 2022 were derived from the Sentinel-1 satellite (MRC, 2023), which has a high spatial resolution and produces images that are not hindered by cloud cover. The data were processed using a recommended practice by the United Nations regarding flood mapping and damage assessment,[28] and consistent with mapping prepared for MRC Annual Flood and Drought Reports (e.g. MRC, 2023).

The map of water occurrence derived from this data source clearly highlights the floodplains along the Mekong and Bassac Rivers, and the rice paddies and flooded forests around Tonle Sap Lake and throughout the Mekong Delta (Figure 6.17a). Considerable interannual variation in spatial patterns of water occurrence is also evident with maximum and minimum extents over the 2016–2022 period illustrating how, even during years with relatively small flood extents (e.g. 2020), certain areas can be flooded that remain unaffected during years with larger flood extents (e.g. 2018) (Figure 6.17b). This is likely due to localized rainfall patterns in flood-affected areas and in different tributary catchments, as well as the management of water on the floodplain for different purposes. It is also important to recognize that some areas of water occurrence in the Mekong Delta may influence coastal inundation related to tidal and other sea-state conditions, in addition to river water levels.

The total annual extent of water occurrence on the LMB floodplain ranged between a minimum of 1.3 million hectares in 2020 and 2.3 million hectares in 2018 (Figure 6.18), although the period of coverage is too short to identify any meaningful trends. Unsurprisingly, the largest areas of water occurrence were observed in Cambodia and Viet Nam.

The occurrence of water on the floodplain does not necessarily indicate that basin communities are negatively affected by floods. Indeed, even where flooding does occur, it can have enormously beneficial impacts for

28 www.un-spider.org/advisory-support/recommended-practices/recommended-practice-google-earth-engine-flood-mapping/step-by-step

people throughout the Basin including for agriculture (depending on the timing and extent) and capture fisheries. The MRC is undertaking further work to evaluate the potential impacts of flooding on different land uses and floodplain activities; the results are expected to be available for the next SOBR in 2028.

To evaluate historical flood extents over a longer period, indexed values of the maximum flooded area per year are shown for 2000 to 2021 (Figure 6.19). These extents were calculated from dataset of the Joint Research Centre (JRC) Global Surface Water Explorer (MRC, 2023c), which is based on Landsat satellite data. Absolute values were not considered, because the original dataset includes inundated areas such as rice paddies and aquaculture ponds, leading to an overestimation of flooded area. However, the relative interannual dynamics allow years with relatively high and low flooded areas to be identified and a trend analysis can be performed. Overall, there seems to be a slightly decreasing trend in flooded area over this period, which would be consistent with a reduction in total annual rainfall across the Basin (Section 6.3.4), although this trend in flooded area is not statistically significant.

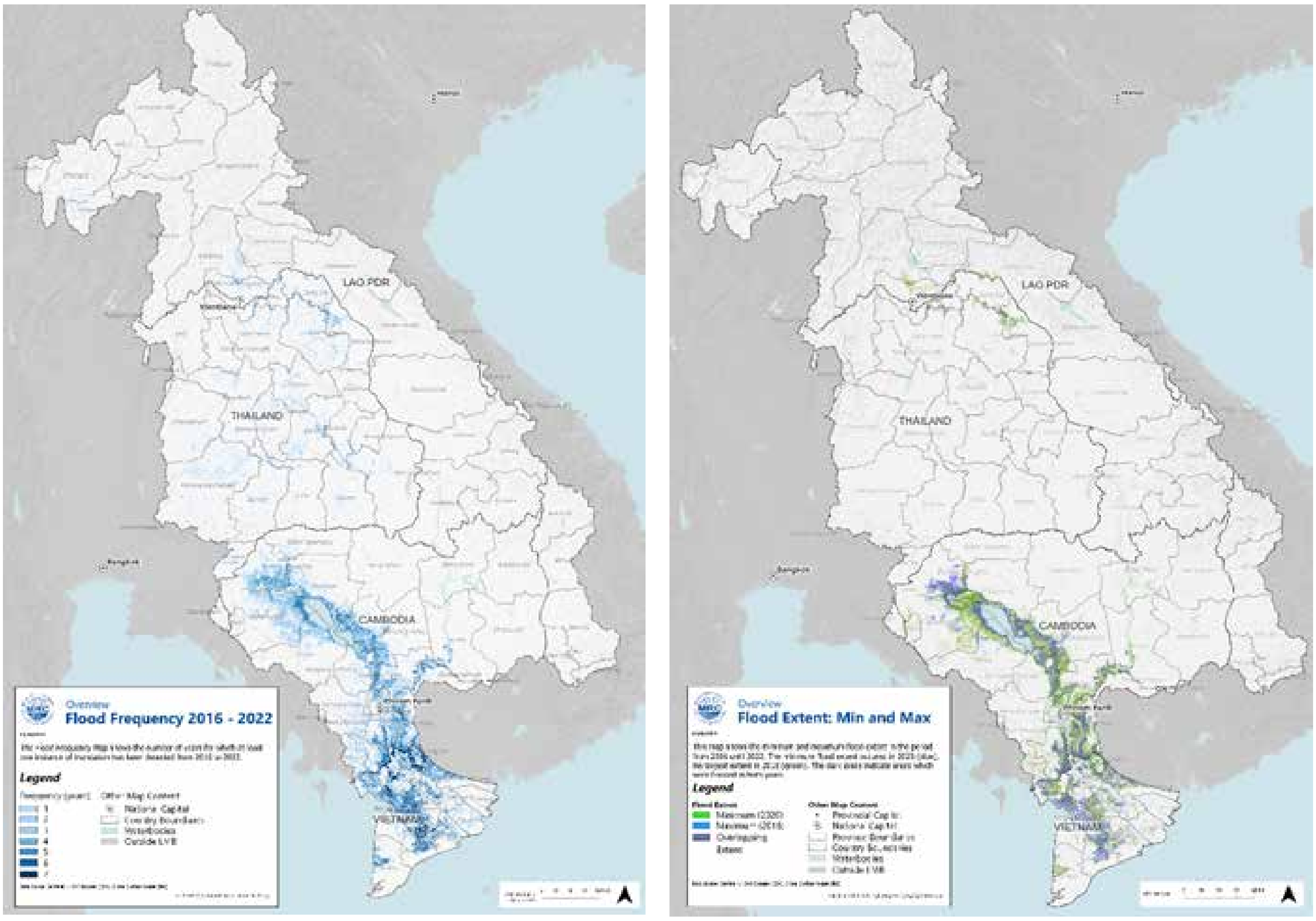


Figure 6.17. Flood frequency in the Lower Mekong Basin, 2016–2022 (a) and minimum and maximum annual flood extents, 2016–2022 (b)

Note: Flood frequency reflects the number of years for which at least one occurrence of inundation was detected.

Data source: Sentinel 1, with analysis from MRC (2023)

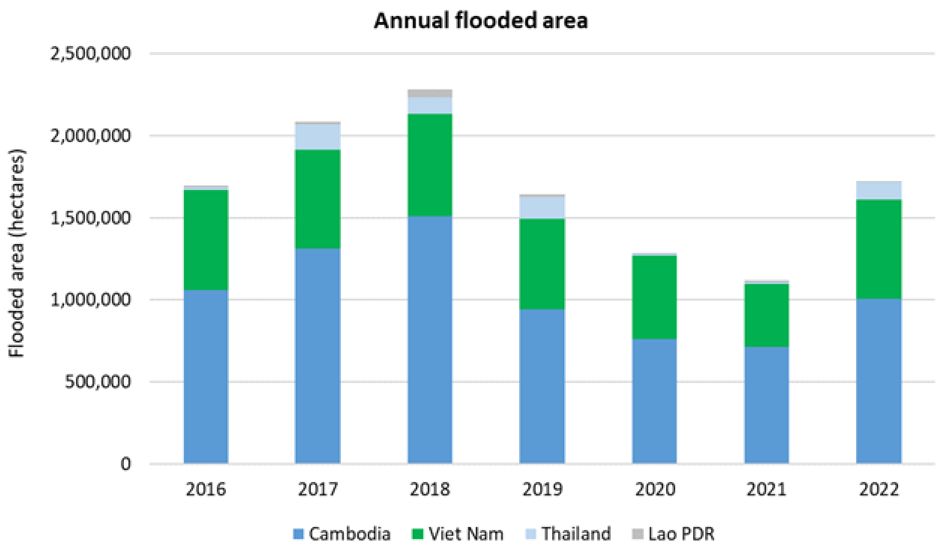


Figure 6.18. Annual flood area (area of water occurrence) in the Lower Mekong River Basin, 2016–2022

Data source: Sentinel-1 satellite data, with analysis from MRC (2023)

Comparing the flooded areas between two periods (1984–1999 and 2000–2021) using the JRC Surface Water Explorer illustrates that the Cambodian flood plains in particular have been more frequently inundated over the last two decades than in the earlier period, while the upper part of the Mekong Delta was less often inundated in the 2000–2021 period compared to the 1984–1999 period (Figure 6.20). This map of the change in water occurrence also clearly shows the development of aquaculture along the lower edges of the delta and on Ca Mau Peninsula.

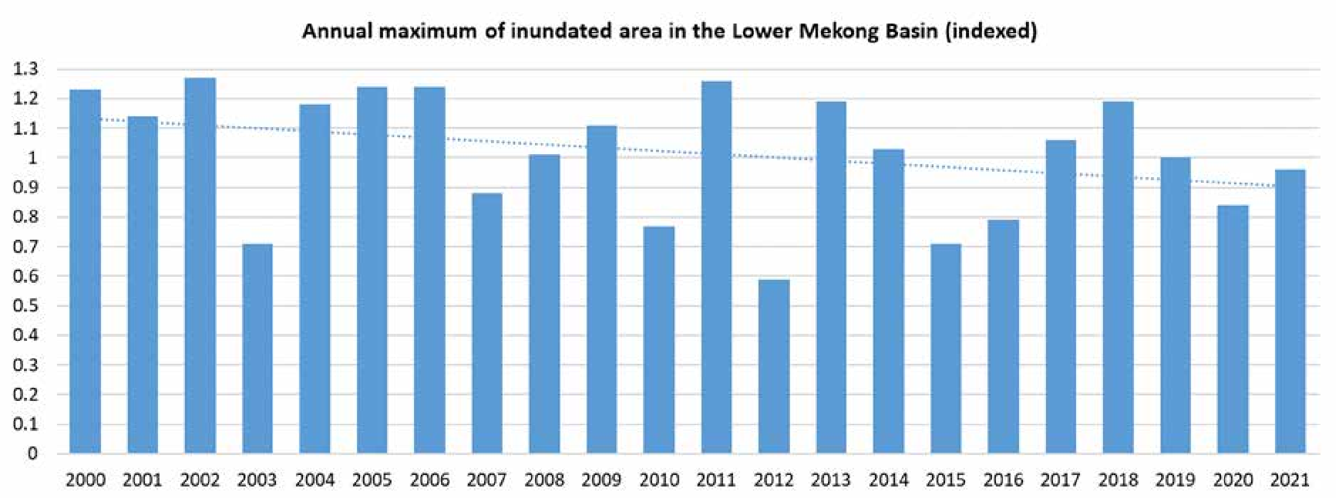


Figure 6.19. Difference in maximum flooded area per year, 2000–2021, relative to the average year in the Lower Mekong Basin, 2019 (indexed value)

Data source: JRC Surface Water Explorer

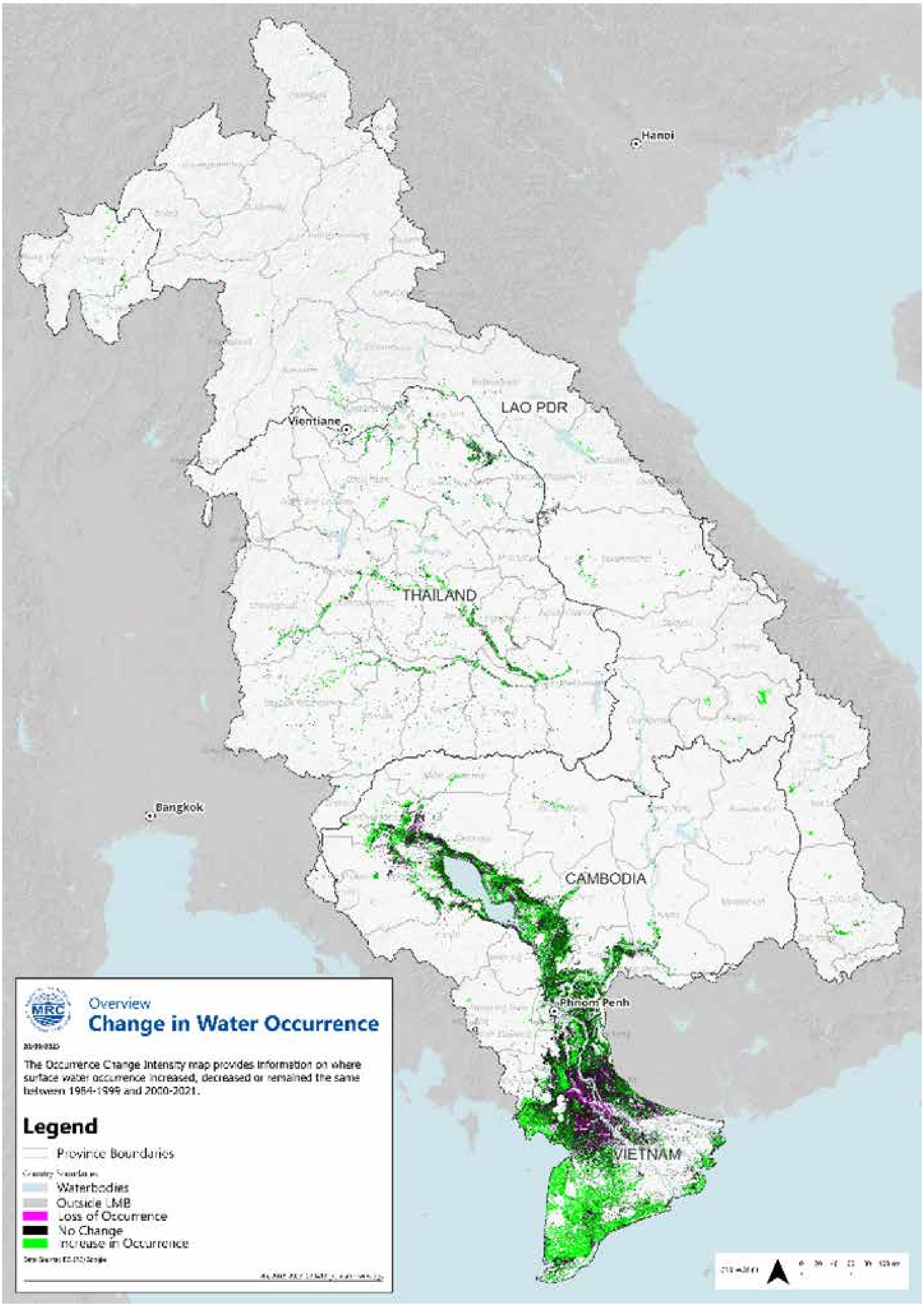


Figure 6.20. Change in water occurrence in the Lower Mekong Basin, 1984–2021

Data source: JRC Surface Water Explorer

Based on the water level measurements of the MRC hydrological monitoring network, the average duration of flood events was computed as the average number of consecutive days that the water level was above the flood threshold. Although there is no clear trend in the duration of flood events over the 1990–2022 period, there are more years without any flood events in the second half of the period than in the first (Figure 6.21). According to historical records for each measurement site, in general, the most frequent flood events and those of longest duration were observed in the stations located furthest downstream (Table 6.4).

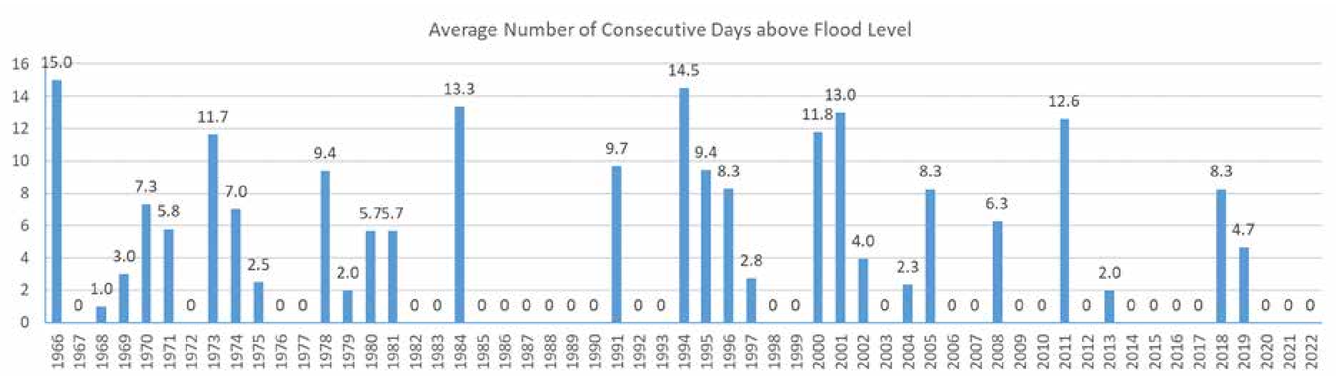


Figure 6.21. Average duration of flood events (days) along the Mekong mainstream annually, 1990–2022

Data source: MRC Hydromet monitoring

Table 6.4. Number of flood incidents and average duration of floods per monitoring site, 1919–2022

Station name	No. of years with flood incident (1919 - 2022)	Average duration in days
Chiang Saen	1	4.0
Luang Prabang	4	11.3
Chiang Khong	4	7.0
Vientiane KM4	5	4.8
Nong Khai	11	9.7
Paksane	6	4.0
Nakhon Phanom	17	8.8
Thakhek	8	8.5
Mukdahan	18	9.4
Savannakhet	2	3.5
Khong Chiam	19	9.4
Pakse	27	8.5
Stung Treng	8	4.6
Kratie	4	9.3
Kompong Cham	1	6.0
Phnom Penh Port	0	N/A
Koh Khel	0	N/A
Neak Luong	18	25.4
Prek Kdam	4	11.5
Tan Chau	9	32.3

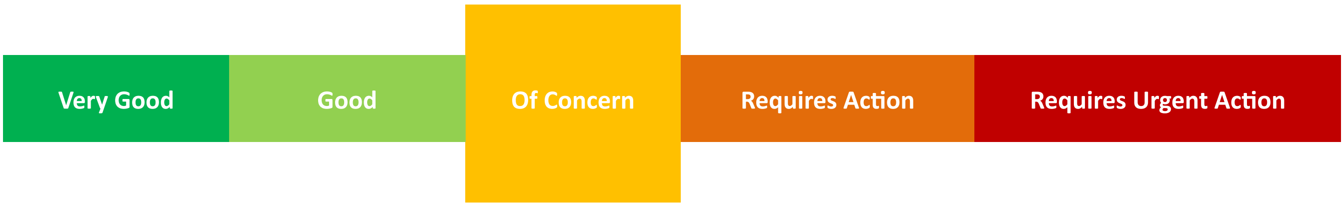
Note: Flood incidents are defined as water level conditions exceeding the Mekong mainstream station-specific flood level.

Data source: MRC Hydromet monitoring and historical records

The extent and severity of flooding is assessed as 'Of Concern'. Based on the analyses presented here, there is no sign of an increasing frequency or severity of flooding in the Mekong River Basin; rather, evidence more likely indicates less frequent flood events with somewhat smaller inundation extents and shorter durations. From the perspective of safety and a reduction of the flood hazard, reduced flood extent is a positive development. However, the Mekong flood needs to be considered in relation to all its facets, and reduced flood extents are associated with the lower reverse flows to Tonle Sap and declining wetland extents, as reported in Chapter Three. In a broader sense, maintaining the flood dynamics (including annual flood pulse) of the Mekong River is vital to the environment, biodiversity, food security and people's livelihoods.

The MRC-MLC Water Joint Study is considering potential flood management measures to support adaptation to climate change, including flood prevention (e.g. nature-based solutions in watersheds), flood protection (e.g. dykes and bunds or diversions) and flood preparedness (e.g. early warning and contingency planning for rescue, recover and rehabilitation). It calls for the development of an Integrated Flood Risk Management strategy for the Basin to mitigate the impacts of the most extreme events.

6.3.6. Extent and severity of drought



Droughts in the Mekong River Basin have significant economic, social and environmental impacts. Many different sectors, such as agriculture, navigation and fisheries, are affected by droughts. Economic damage from drought is typically underestimated and difficult to investigate because drought events develop gradually, can span large areas and long periods of time, and typically cause less directly visible damage to physical assets when compared to floods.

Under the MRC's drought monitoring and forecasting activities, drought stages are defined following the World Meteorological Organization's established indices: the Standardized Precipitation Index (SPI, for meteorological drought), Soil Moisture Anomaly (SMA, for agricultural drought) and the Standardized Runoff Index (SRI, for hydrological drought). The severity of drought (moderate, severe, extreme) in any given month is calculated based on the divergence from the long-term probability distribution or normal conditions (from 1981 to 2018) for each index. A Combined Drought Index (CDI) is computed by combining the SPI, the Soil Moisture Deficit Index (SMDI) and SRI, and provides an integrated picture of drought occurrence and severity. Data sources for quantifying these indices include satellite-based earth observation and hydrological modelling.

Based on the 2000–2022 period, areas of the LMB typically impacted by severe or extreme droughts include the upstream part of the LMB in northern Thailand and northwestern Lao PDR, Prusa and Battambang Provinces in Cambodia (west of Tonle Sap), Kratie Province in northeastern Cambodia, and the region of Khammouane Province in central Lao PDR (Figure 6.22).

The areas of the LMB affected by the three different types of drought in any given year is highly variable (Figures 6.23, 6.24 and 6.25). For all three types of drought, 2015 and 2019 are the most striking drought years over the last decade.[29] Due to the nature of drought, agricultural drought typically follows meteorological and hydrological droughts, because it takes some time for crops to become affected by insufficient soil moisture. This stage is not reached during every drought event. There is no distinguishable trend in areas affected by either of the drought types during the 1981–2022 period, especially since the years from 1999 to 2008 exhibited very low areas affected by drought.

Annual average areas affected in each of the basin countries by meteorological, hydrological and agricultural droughts illustrate that affected areas are mostly located in Cambodia, Lao PDR and Thailand, and distributed relatively evenly over these three countries (Tables 6.5, 6.6 and 6.7). Across the whole LMB, meteorological and hydrological drought on average affect a much greater area than agricultural drought (Table 6.8). The 2011–2020 decade experienced more drought than the 2001–2010 decade, but less than the 1991–2000 decade.

29 Historical drought years are also sometimes reported nationally as 2016 and 2020, which corresponds to the year in which the annual dry season ends.

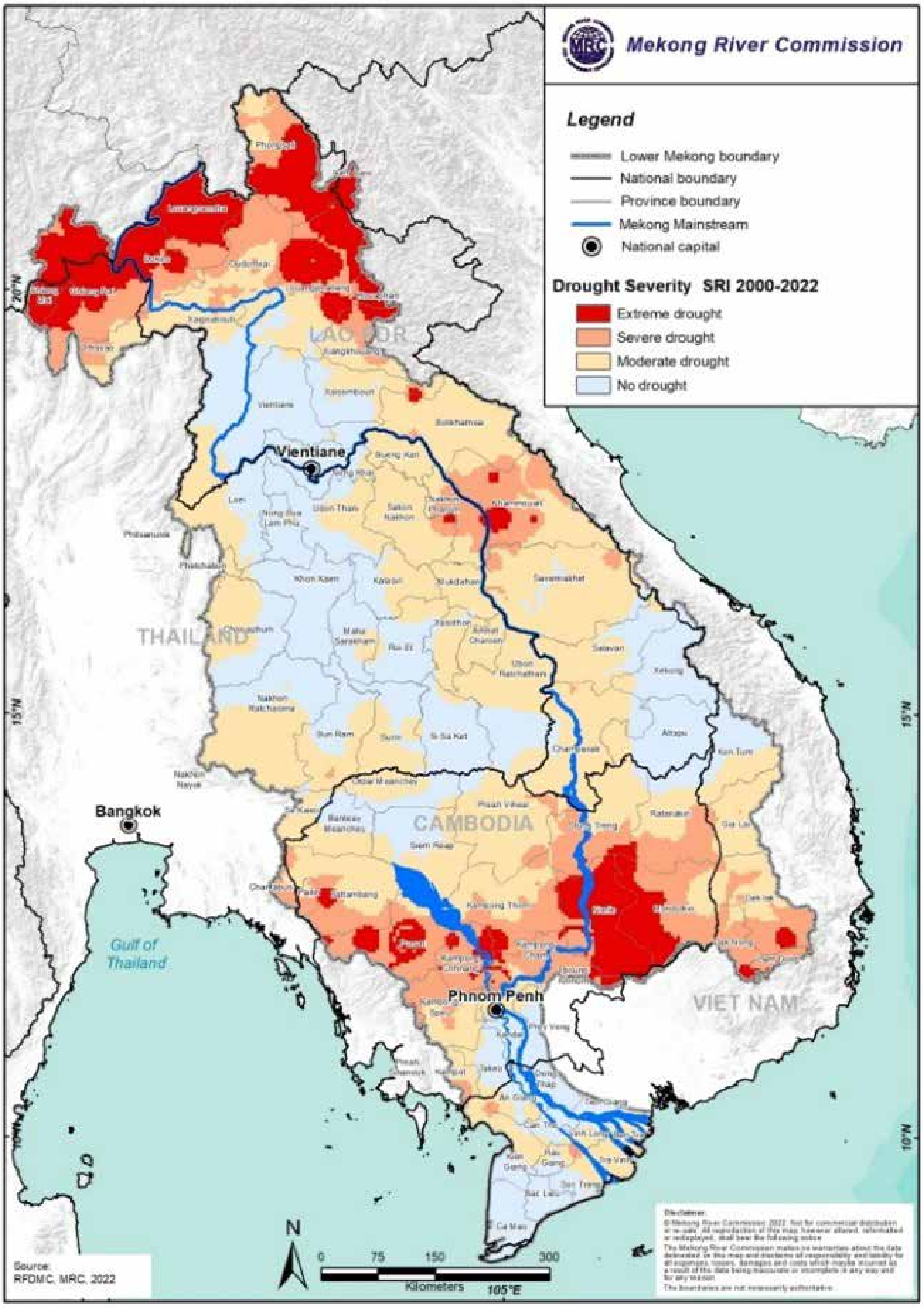


Figure 6.22. Meteorological drought severity based on SPI, 2000–2022 (a) and hydrological drought severity based on SRI (b), 2000–2022

Note: Extreme drought is defined as a minimum of three drought events with at least one severe or extreme condition; severe drought has two to three drought occurrence with maximum severe or extreme event; moderate drought as a maximum of two drought events with no extreme drought condition; and no drought as only one moderate or no drought event.

Data source: MRC Drought Monitoring

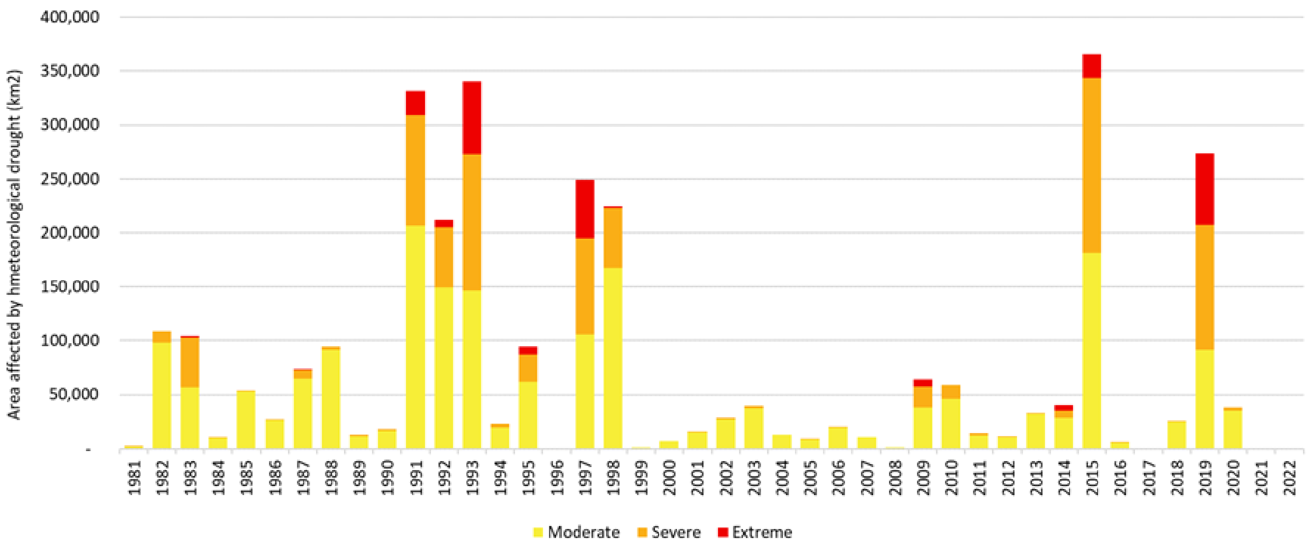


Figure 6.23. Area of the Lower Mekong River Basin affected by the different categories of meteorological drought annually, 1981–2021

Data source: MRC Drought Monitoring

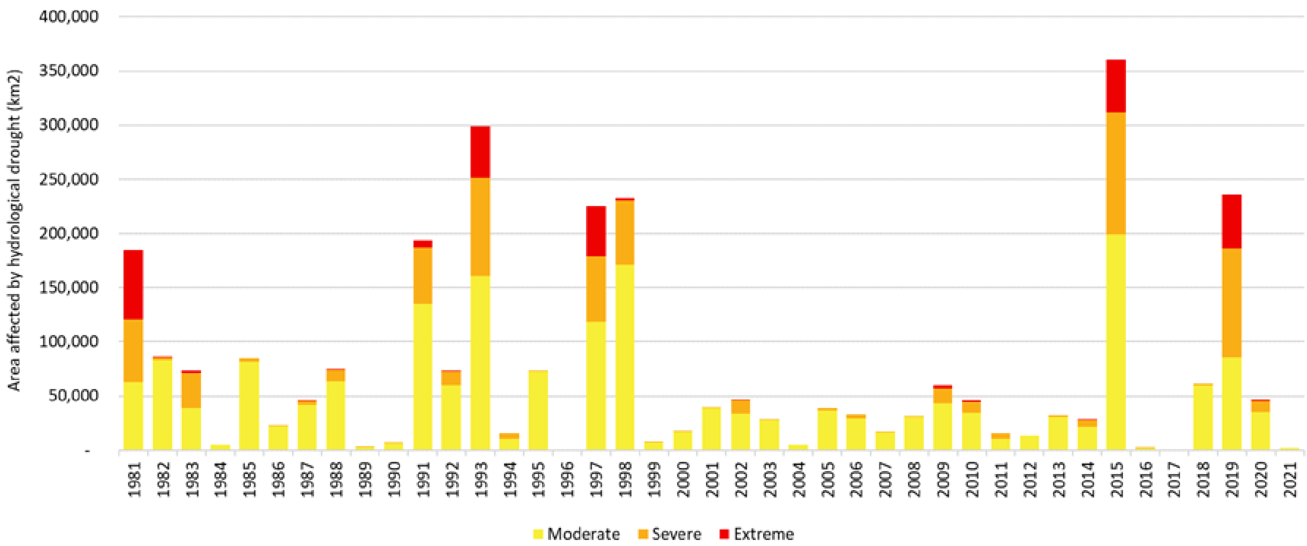


Figure 6.24. Area of the Lower Mekong River Basin affected by different categories of hydrological drought annually, 1981–2021

Data source: MRC Drought monitoring

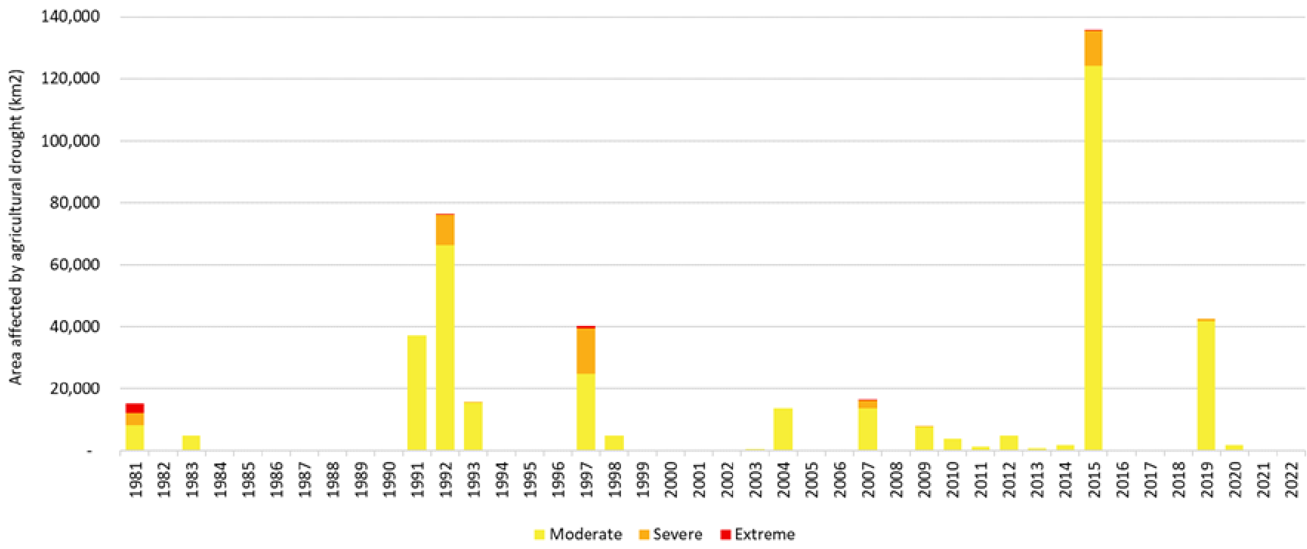


Figure 6.25. Area of the Lower Mekong Basin affected by different categories of agricultural drought annually, 1981–2021

Data source: MRC Drought monitoring

Table 6.5. Average annual area affected by meteorological drought in the LMB

Period	Area affected by moderate drought (km²)				Area affected by severe drought (km²)				Area affected by extreme drought (km²)			
	CA	LA	TH	VN	CA	LA	TH	VN	CA	LA	TH	VN
1981–1990	13,075	10,650	12,186	7,402	1,086	2,854	2,217	911	105	21	87	0
1991–2000	20,550	28,268	29,723	8,155	13,307	11,353	19,849	1,223	3,525	5,069	4,513	2,899
2001–2010	7,336	8,941	3,678	1,848	154	3,086	196	215	0	641	0	17
2011–2022	8,334	11,606	11,260	4,037	9,430	5,753	2,147	2,147	1,810	3,746	1,891	286

Note: CA=Cambodia; LA=Lao PDR;TH=Thailand; VN=Viet Nam.

Data source: MRC Drought monitoring

Table 6.6. Average annual area affected by hydrological drought in the LMB, by drought severity category and country

Period	Area affected by moderate drought (km²)				Area affected by severe drought (km²)				Area affected by extreme drought (km²)			
	CA	LA	TH	VN	CA	LA	TH	VN	CA	LA	TH	VN
1981–1990	11,386	12,393	11,409	5,640	3,217	3,746	3,528	723	1,414	186	4,043	1,111
1991–2000	18,840	25,565	25,845	5,083	5,358	10,054	12,434	359	1,402	4,449	1,720	2,806
2001–2010	11,715	13,172	3,449	1,418	1,387	2,735	60	221	43	444	0	0
2011–2022	9,989	13,494	11,018	3,922	6,287	7,335	2,064	2,477	3,629	1,640	2,245	812

Note: CA=Cambodia; LA=Lao PDR;TH=Thailand; VN=Viet Nam.

Data source: MRC Drought monitoring

Table 6.7. Average annual area affected by agricultural drought in the LMB

Period	Area affected by moderate drought (km²)				Area affected by severe drought (km²)				Area affected by extreme drought (km²)			
	CA	LA	TH	VN	CA	LA	TH	VN	CA	LA	TH	VN
1981–1990	538	395	145	328	268	5	5	135	78	0	0	205
1991–2000	4,435	6,233	2,815	1,395	95	1,003	10	1,353	0	3	0	95
2001–2010	288	2,868	210	610	0	245	0	0	0	8	0	0
2011–2022	3,077	4,683	6,473	492	48	710	4	5	0	2	0	0

Note: CA=Cambodia; LA=Lao PDR;TH=Thailand; VN=Viet Nam.

Data source: MRC Drought monitoring

Table 6.8. Average annual areas affected by different types of drought in the Lower Mekong River Basin

Period	Area affected by moderate drought (km²)					
	Meteorological	% of LMB	Hydrological	% of LMB	Agricultural	% of LMB
1981–1990	50,594	8.2%	58,797	9.5%	2,100	0.3%
1991–2000	148,432	24.0%	113,917	18.4%	17,435	2.8%
2001–2010	26,112	4.2%	34,644	5.6%	4,228	0.7%
2011–2022	67,226	10.9%	66,603	10.8%	15,731	2.5%

Data source: MRC Drought monitoring

The increase in the area affected by drought over the last decade in the LMB is consistent with the results of the MRC-MLC Water Joint Study, which reported an increase in drought severity for the 2010–2020 period compared to the 2000–2009 period for the entire Mekong River Basin (MRC and LMC Water, 2023). The change was associated with the lower precipitation recorded in this latter period and is consistent with the changes in annual precipitation using global datasets reported in section 6.3.4 of this SOBR.

Drought events occur regularly in the UMB, with potentially significant impacts on agricultural production and household water security (Jia and Pan; Wang, Wang and Wang, 2015). The drought event of spring to early summer 2019 is considered the most severe seasonal drought on record. It was characterized by an abnormally late onset of the wet season, coinciding with the second highest potential evapotranspiration observed in the past 40 years (Ding and Gao, 2020). Impacts of the extremely low flows during the 2019 drought were experienced both in the UMB and the LMB (MRC, 2022b). This severe drought event also had clear impacts on water supply to agriculture, as reflected in the official statistics of annual damage to crops due to drought (Figure 6.26). As illustrated, water shortage has had detrimental impacts on agricultural production during multiple recent years. Overall, the cropped area affected annually by droughts in Yunnan province in 2011–2020 ranged between 0 and 14,321 **km²**, with major interannual variability.

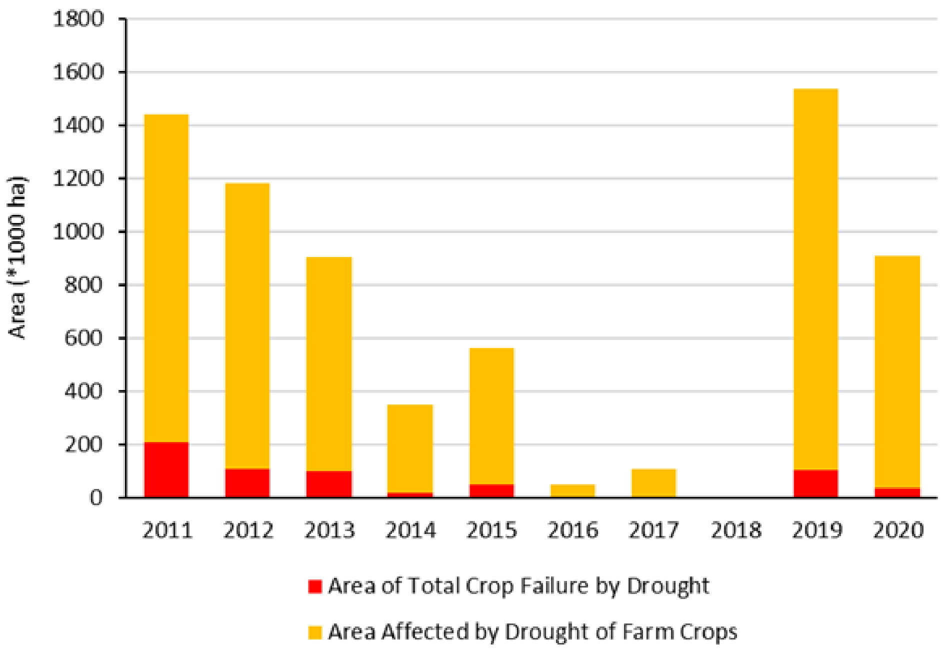


Figure 6.26. Annual area of drought-induced damage to crops in Yunnan Province

Data source: NBS (2021)

Analysis of climate projections for the UMB in China indicates that annual drought intensity, drought intensity in the wet season, and drought duration are all expected to increase in the future (Dong et al., 2022).

Enhanced evapotranspiration through higher temperatures is likely to increase drought severity, especially in the middle stretch of the UMB near the city of Dali (Yuan et al., 2017). The effects of drought in the UMB are likely to be felt downstream in the LMB through reduced river flows along the mainstream.

The extent and severity of droughts is assessed as 'Of Concern'. Several parts of the Mekong Basin are frequently exposed to droughts, particularly meteorological and hydrological droughts, and there have been more frequent and severe droughts over the last decade than in the decade before. Drought hotspots include sites in the UMB, the upper part of the LMB, and areas surrounding Tonle Sap Lake. Although there is no clear trend yet in drought occurrence over the longer term, the current levels of drought severity and frequency already have substantial economic, social and environmental impacts.

With expected impacts of increasing temperatures on water use and availability, the extent and severity of droughts are likely to increase in the future. It is therefore important for basin countries to cooperate in the identification of drought mitigation measures, including those regarding coordinated reservoir operations and active management of flows, as identified in the MRC-MLC Water Joint Study. Further consideration should be given to the potential release of upstream water at appropriate times based on identified drought triggers at Tonle Sap, while noting that the costs and benefits of such a strategy would need to be carefully weighed and codified in basin-wide operational rules to share the economic burden for responding to severe droughts (MRC-LMC Water, 2023). Continuing to improve basin-wide drought monitoring and forecasting capabilities will also be important.

6.4. Adaptation to climate change

6.4.1. Assessment methodology

In their NDCs and National Communications to the UNFCCC, all Mekong Basin countries have identified adaptation priorities across a range of domains. The institutional response to the effects of climate change was evaluated by reviewing the priority actions outlined in the NDCs, as well as by identifying key national policies and strategies, and funding received from multilateral climate funds for climate change mitigation and adaptation projects. The assessment indicators for this strategic indicator are:

- Institutional response to the effects of climate change
- Flood protection measures
- Drought protection measures
- Vulnerability to floods, droughts and storms.

An analysis of vulnerability to floods, droughts and storms was not available in time to inform this SOBR. Ongoing methodological development on the effects of floods and droughts, and further analysis of social and economic data transmitted by basin countries to the MRC should enable consideration of this indicator for the next SOBR.

6.4.2. Institutional response to the effects of climate change

Very Good	Good	Of Concern	**Requires Action**	Requires Urgent Action

Under the Paris Agreement, all Parties must prepare and submit an NDC and update it every five years, with an increasing level of ambition to reduce greenhouse gas emissions over time. To date, all Mekong Basin countries have complied with this requirement (Table 6.9).

Table 6.9. Status of each basin country's Nationally Determined Contribution submitted to the UNFCCC

	Cambodia	China	Lao PDR	Myanmar	Thailand	Viet Nam
First NDC submission	2017	2015	2016	2017	2016	2016
Updated NDC submission	2020	2021	2021	2021	2020	2020

All basin countries have committed to reducing greenhouse gas emissions by varying degrees (Table 6.10). Unconditional contributions reflect the countries' commitments based on currently available resources and capabilities. Conditional contributions are commitments subject to adequate and enhanced access to technology development and transfer, financial resources and capacity-building support. As a proportional reduction in emissions, China and Lao PDR have stated the most ambitious emission reduction targets in their respective NDCs.

Table 6.10. Greenhouse gas reduction targets made by each basin country in its updated Nationally Determined Contribution

Country	Mitigation contributions outlined in updated NDCs	
	Unconditional	Conditional
Cambodia	-	41.7% below BAU* by 2030
China	>65% per unit of GDP below 2005 levels by 2030	-
Lao PDR	60% below BAU by 2030	Targets by sector only (456.91 MtCO2-e in total by 2030)
Myanmar	Targets by sector only (244.52 MtCO2-e in total by 2030)	Targets by sector only (414.75 MtCO2-e in total by 2030)
Thailand	20% below BAU by 2030	25% below BAU by 2030
Viet Nam	9% below BAU by 2030	27% below BAU by 2030

Note: *BAU = business as usual, which generally involves a modelled increase in emissions consistent with expected increases in GDP.

Data source: Country NDCs submitted to the UNFCCC

All countries have multiple national-level strategies concerning climate change mitigation and adaptation, and related topics such as disaster management and water resources, and each has established institutional arrangements for the management of climate change responses (Table 6.11).

Table 6.11. Key national policies and strategies and institutional arrangements for climate change adaptation

Country	Mitigation contributions outlined in updated NDCs	
Cambodia	Rectangular Strategy Phase IV 2018 Pentagonal Strategy – Phase 1 for Growth, Employment, Equity, Efficiency and Sustainability 2023 National Strategic Development Plan 2019–2023 9th National Socio-Economic Development Plan 2021–2025 National Climate Change Strategic Plan 2014–2023 National Action Plan for Disaster Risk Mitigation 2019–2023 National Action Plan for Water Management and Development 2019–2023	National Council for Sustainable Development under the Prime Minister's Office Climate Change Department, under the Ministry of Environment
China	The 14th National Five-Year Plan for economic and social development and Long-Range Objectives for 2035 National Strategy for Climate Change Adaptation 2035	Leading Group on Carbon Peaking and Climate Neutrality Office within the National Development and Reform Commission National Center for Climate Change Strategy and International Cooperation
Lao PDR	National Socio-Economic Development Strategy 2015–2025 National Green Growth Strategy to 2030 Decree on Climate Change 2019 National Adaptation Plan (upcoming) National Strategic Plan for Disaster Risk Reduction 2021–2030 National Water and Water Resources Strategy 2022	National Environment Committee Disaster Management Committee Climate Change Department, under the Ministry of Natural Resources and Environment
Myanmar	National Sustainable Development Plan 2018–2030 National Climate Change Policy 2019 National Environmental Policy 2019 National Climate Change Strategy 2018–2030 National Climate Change Master Plan 2018–2030	National Environmental Conservation and Climate Change Central Committee Ministry of Natural Resources and Environmental Conservation
Thailand	The 20-year National Strategy 2018–2037 The 12th National Economic and Social Development Plan 2017–2021 Master Plan on Climate Change 2015–2050 Master Plan on Water Resources Management 2018–2037 National Adaptation Plan	National Climate Change Committee and related sub-committees Ministry of Natural Resources and Environment
Viet Nam	National Socio-Economic Development Strategy 2021–2030 National Green Growth Strategy 2021–2030 National Strategy on Climate Change to 2050 National Strategy on Environmental Protection 2021–2030 National Strategy on Natural Disaster Prevention and Control 2021–2030	National Steering Committee on Climate Change National Committee on Climate Change Ministry of Natural Resources and Environment

The implementation of climate change mitigation and adaptation measures has a significant cost; the NDCs of the basin countries generally do not specify these costs (Table 6.12). Only Cambodia has included estimates of the required finance for meeting its mitigation and adaptation targets, which amount to USD 7.8 billion in total. Viet Nam estimates a required 3–5% of its GDP to be spent on climate adaptation by 2030. From 2011 to 2016, Viet Nam state budget expenditure on climate change was 0.2% of GDP (at 2010 prices) from five ministries (Agriculture and Rural Development, Natural Resources and Environment, Transport, Industry and Trade, and Construction). This implies that a significant budget increase will be required to meet climate change adaptation needs.

Table 6.12. Finance needs for mitigation and adaptation specified in each basin country's updated Nationally Determined Contribution

Country	Finance needed (USD)	
	Mitigation	Adaptation
Cambodia	$5.8 billion	$2.0 billion
China	Not specified	Not specified
Lao PDR	$4.7 billion	Not specified
Myanmar	$1.4 billion in energy, agriculture, marine transport sectors only	Not specified
Thailand	Not specified	Not specified
Viet Nam	Not specified	>3–5% of GDP by 2030
	(financing gap of around $3.5 billion per year, 2021–2030)	

Each basin country has outlined in its NDC its main objectives and priority areas for action concerning climate adaptation (Table 6.13). The NDCs cover the key water-related sectors in the Mekong River Basin, such as agriculture, fisheries and forestry. The NDCs also identify adaptation priorities for disaster preparedness and emergency response, as well as on aspects such as governance, capacity building and strategic planning.

Table 6.13. Summary of objectives and priority action areas or strategic tasks for climate change adaptation specified in each country's updated Nationally Determined Contribution

Cambodia	China	Lao PDR	Myanmar	Thailand	Viet Nam
Sector priorities	**Strategic tasks**	**Sector priorities**	**Strategic tasks**	**Sector priorities**	**Strategic tasks**
▪ Agriculture, ▪ Coastal zones ▪ Energy ▪ Human health ▪ Industry ▪ Infrastructure ▪ Livelihoods, poverty and biodiversity ▪ Tourism ▪ Water resources **Enabling priorities** ▪ Education ▪ Gender ▪ Governance ▪ Information ▪ Knowledge sharing ▪ Policy and planning	▪ Strengthening climate change monitoring, early warning, and risk management ▪ Improving the climate change adaptation ability of natural ecosystems ▪ Strengthening the climate change adaptation ability of economic and social systems ▪ Creating a regional pattern of climate change adaptation	▪ Agriculture ▪ Forestry and land-use Change ▪ Water resources ▪ Transport and urban development ▪ Public health ▪ Energy	▪ Climate-smart agriculture, fisheries and food security ▪ Sustainable management of natural resources for a healthy ecosystem ▪ Resilient, sustainable and inclusive cities ▪ Climate risk management for people's health and wellbeing ▪ Education, awareness, science and technology for a resilient society	▪ Water resources management ▪ Agriculture and food security ▪ Tourism ▪ Public health ▪ Natural resources management ▪ Human settlements and security	▪ Improving adaptation efficiency by strengthening state management and resources ▪ Enhancing resilience and adaptive capacity of communities, economic sectors and ecosystems ▪ Reducing disaster risks and minimizing damage, increasing preparedness to respond to increasing natural disasters and climate extremes due to climate change

The database of Climate Funds Update[30] contains an inventory of multilateral climate financing initiatives reported at the country level. Although the database is not comprehensive (e.g. it does not include bilateral financing arrangements) and is at the national not the basin level, it provides insight into the number of climate change adaptation and mitigation projects being implemented in the basin countries over time, as well as the order of magnitude of the related funding (Table 6.14). Overall, there has been a clear increase in both the number of projects and the associated funding over the last decade compared to the one before, particularly in Cambodia, Lao PDR, Myanmar and Viet Nam. Thailand also reported to the UNFCCC that for the 2020–2022 period, it had received USD 48.7 million from multilateral and bilateral partners for 10 adaptation projects.

30 https://climatefundsupdate.org/

Table 6.14. Overview of multilateral climate funds approved per basin country, 2003–2022

Country	Number of projects			Amount of funding approved (USD million)		
	2003–2012	2013–2022	**Total**	2003–2012	2013–2022	**Total**
Cambodia	14	32	**46**	77.13	182.55	**259.68**
China	29	22	**51**	256.46	275.29	**531.75**
Lao PDR	6	26	**32**	25.13	102.14	**127.27**
Myanmar	2	20	**22**	8.11	69.38	**77.49**
Thailand	11	22	**33**	102.97	57.74	**160.71**
Viet Nam	11	23	**34**	68.49	367.43	**435.92**
Total	73	145	**218**	538.29	1,054.53	**1,592.82**

Note: Figures refer to the national level and are a total of both grants and loans.

Data source: Climate Funds Update

To summarize, all basin countries have submitted NDCs with clear objectives and priority action areas, which have been updated within five years of initial submission. Climate change and adaptation have been institutionalized in all countries, and dedicated government bodies have been formed to implement related activities. Funding from multilateral climate funds has doubled at the basin scale, when comparing 2003–2012 with 2013–2022. However, it is important to recognize the scale of both the mitigation and adaptation challenge ahead, as Viet Nam's assessment of its adaptation financing needs make clear. A substantial increase in financing, technology transfer and capacity building, together with improved policy coherence between sectors will be necessary if countries are to avoid the most significant consequences of climate change. As a result, the institutional response to the effects of climate change in the Mekong River Basin is assessed as 'Requires Action'.

6.4.3. Flood protection measures

Very Good	Good	Of Concern	**Requires Action**	Requires Urgent Action

The extent and severity of flooding in the Mekong River Basin are not increasing (Section 6.3.5), and indeed reduced flood season flows (Section 3.2.3) and Tonle Sap Reverse flows (Section 3.2.4) indicate that, in recent years, lack of flooding has been a more significant issue, particularly in the lower reaches of the Basin, with potential negative implications for capture fisheries (Section 3.4.4). Nevertheless, floods still cause significant losses, which averaged at around USD 166 million per year from 2015 to 2019 across the four LMB countries (Section 5.3.12), and all countries are implementing measures to mitigate these impacts. Although updated data were not available for this SOBR, the percentage of the length of riverbanks along the Mekong mainstream with some form of bank protection in 2015 ranged from 1.7% in Cambodia to 6.3% in Viet Nam (Table 6.15).

Table 6.15. Percentage of total river length with bank protection along the Mekong mainstream in each country of the Lower Mekong River Basin, 2015

Country	Percentage of total river length with bank protection (%)
Cambodia	5.8
Lao PDR	17.0
Thailand	1.7
Viet Nam	6.3

Data source: MRC Council Study (2017)

Figure 6.27. Bank protection measures along the Mekong mainstream of the Lower Mekong River Basin, 2015

Source: MRC Council Study (2017)

In addition to bank protection works, throughout the Mekong Delta, there is an extensive network of levees, channels and control gates for managing floods and controlling water flow to support agriculture and aquaculture production. As mentioned in Section 6.3.5, other flood mitigation measures being considered by basin countries include both infrastructure and nature-based solutions (MRC and MLC Water, 2023), as well as the ongoing improvements to flood monitoring and forecasting at the MRC. Coordinated reservoir operations may also have a role to play. The proposed development of an Integrated Flood Management Strategy for the Basin as suggested in the Joint Study will need to consider the full range of feasible options, their costs and benefits, and opportunities for transboundary cooperation to mitigate floods. Due to the ongoing high costs of flooding throughout the Basin, even under relatively drier conditions over the last decade, and the identified need for a comprehensive strategy to ensure that the countries are better prepared and can respond effectively, this indicator is assessed as 'Requires Action'.

6.4.4. Drought protection measures

Very Good	Good	Of Concern	Requires Action	Requires Urgent Action

One way of mitigating the impacts of droughts on agricultural systems is through irrigation. Table 6.16 lists the total area of irrigation reported by the Lower Mekong Basin countries for 2010, 2015 and 2020. Based on data from Lao PDR and Viet Nam, there was an increase of approximately 30% and 10%, respectively, between 2010 and 2020.

Table 6.16. Irrigated area by country in the Lower Mekong River Basin, 2010, 2015 and 2020

	Irrigation area (km^2)		
Country	2010	2015	2020
Cambodia[2]	-	4,798	-
Lao PDR[1]	3,273	5,338	4,263
Thailand[2]	-	9,036	-
Viet Nam[1]	24,749	26,429	27,167

Data source: [1] National statistics provided by basin countries; [2] MRC Irrigation Database

Similar data of irrigation area for the UMB are not available. However, southwest Yunnan is highlighted by Zhang et al. (2020a) as one of the key areas with a high vulnerability to drought. The main reasons are a relatively high water deficiency rate during the agricultural growing season, together with a low irrigation rate (Zhu et al., 2014).

Storage of water in reservoirs can be an effective measure to carry over water from the wet to the dry season, and thus provides a certain degree of protection against droughts. In general, the primary purpose of the reservoirs in the Basin, particularly the large ones, is hydropower generation, rather than irrigation or drought mitigation. As a result, they are probably not as effective in mitigating droughts as they could be. However, as discussed in Section 3.2.1, the construction of reservoirs has resulted in a considerable redistribution of river flows from the wet to dry season, likely reducing the incidence of hydrological drought on the mainstream for at least part of the year in some areas.

Overall, the increasing irrigated acreage and rapidly expanding storage capacity (Section 2.1.1) to carry over water from wet to dry seasons indicate increasing options for alleviating drought impacts in the Mekong River Basin. However, the proportion of cropped drought-prone areas that are equipped for irrigation remains relatively low (Section 4.2.2). Therefore, this indicator is assessed as 'Requires Action'. It should also be noted that a prerequisite for mitigation of drought impacts is the effective operation of this infrastructure, including from a transboundary perspective, and particularly in relation to reservoir management to coordinate the provision of flows while optimizing other benefits such as energy generation and environmental outcomes. The ongoing improvement of drought monitoring and forecasting at the MRC linked to national data sharing and early warning mechanisms, will be an important aid to the identification and implementation of drought protection measures by basin countries.

6.5. Progress towards BDS Outcomes

The BDS 2021–2030 outlines two outcomes under the Climate Change Dimension Strategic Priority for achievement by 2030:

4.1 Better informed and prepared basin communities against changing river conditions, and more frequent and severe floods and droughts

4.2 Better disaster management and adaptation to water resources development and climate risks.

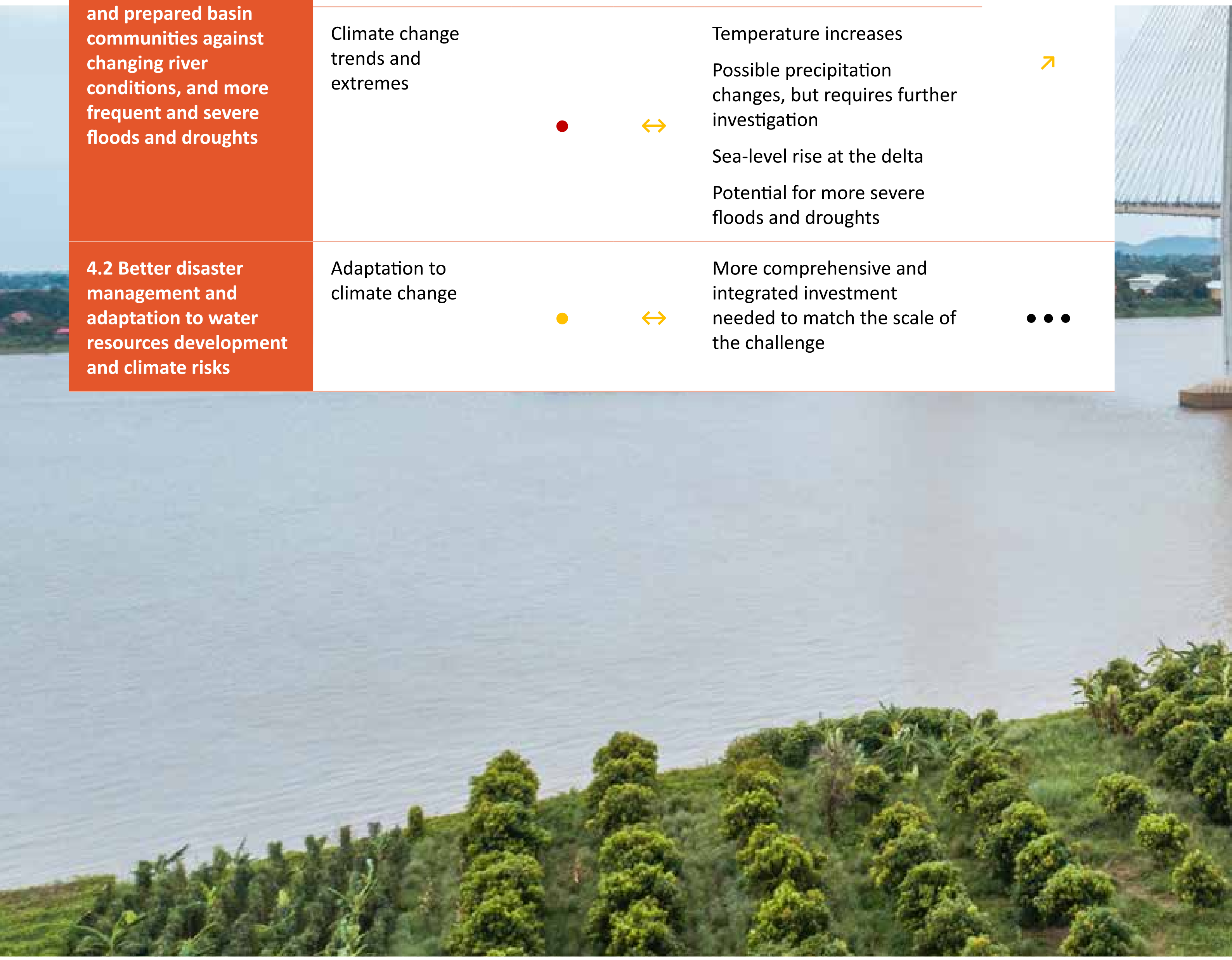
These outcomes seek to ensure that, by 2030, basin countries are better prepared for the impacts of climate change on water and water-related resources and the basin communities that depend on them. The assessment of progress towards BDS 2021–2030 Outcomes in the Climate Change Dimension is summarized in reflection of temperatures across the Basin and the sea level at the delta that are both increasing, and there is some evidence of declining precipitation and fewer intense rainfall events. The declining areas of mangroves reported in Chapter Three suggest that, in practice, adaptation to climate risks, especially the risk of higher storm surges, may not actually be improving. No significant joint investment projects between two or more countries to manage transboundary flood and drought risks have yet been identified or implemented on a scale that is likely to make a material difference. It will be important for the countries to focus on this issue through the regional planning activity now underway and through climate change adaptation measures identified in the MRC-MLC Water Joint Study.

Generally, good progress in adaptation has been made because all countries recognize the seriousness of the issue, have developed plans and priorities for action and put in place institutional arrangements to manage the response. However, these actions are unlikely to be sufficient given the scale of the expected change in climate in the future and the impacts that this will have on basin water and related resources and therefore basin communities that depend on these resources. This is illustrated in the gaps some countries have identified in their NDCs for their adaptation financing needs (Table 6.16).

Progress towards the BDS Outcomes in the Climate Change Dimension is difficult to assess. Greenhouse gas emissions from the Basin make a relatively small contribution to global emissions, and although drought conditions have been particularly severe over the last ten years or so, there is not much evidence of any significant increase in the frequency or severity of floods or droughts due to climate change. The extent to which basin communities are prepared for changing river conditions or undertaking better disaster management is also not evident from the data available for this SOBR. No information was available on flood protection measures. Drought protection, as indicated by the level of irrigation in the Basin, has increased in both Lao PDR and Viet Nam. However, it is likely many drought-prone provinces do not have sufficient irrigation protection, as reflected in Section 4.2.2.

Table 6.17. Summary of progress towards BDS 2021–2030 Outcomes based on conditions and trends for aligned strategic indicators in the Climate Change Dimension

BDS Outcomes	Strategic indicators	Condition	Trend	Key issues	BDS progress
4.1 Better informed and prepared basin communities against changing river conditions, and more frequent and severe floods and droughts	Greenhouse gas emissions	●	↔	Emissions are rising albeit they represent only a small proportion of global emissions	↗
	Climate change trends and extremes	●	↔	Temperature increases Possible precipitation changes, but requires further investigation Sea-level rise at the delta Potential for more severe floods and droughts	
4.2 Better disaster management and adaptation to water resources development and climate risks	Adaptation to climate change	●	↔	More comprehensive and integrated investment needed to match the scale of the challenge	•••



CHAPTER 7

COOPERATION CONDITIONS AND TRENDS

CHAPTER 7: COOPERATION CONDITIONS AND TRENDS

7.1. Introduction

The Cooperation Dimension of the MRB-IF reflects the commitments made by the parties to the 1995 Mekong Agreement to the sustainable development of the Mekong River Basin and its preamble, which reaffirms:

the determination to continu*e to cooperate and promote in a constructive and mutually beneficial manner in the sustainable development, utilisation, conservation and management of the Mekong River Basin water and related resources for … social and economic development and the wellbeing of all riparian States.*

To facilitate this cooperation, the 1995 Mekong Agreement to which all basin countries can join sets out mutually accepted, fair objectives and principles of cooperation for the sustainable development and utilization of the water and related resources of the Mekong River Basin. The Mekong Agreement also provides for an adequate, efficient and functional joint river basin organization to help the countries in its implementation.

Progress is monitored through the collection of data and information on basin developments, such as joint investment projects and projects of basin-wide significance, the implementation of MRC Procedures including the Procedures for the Notification, Prior Consultation and Agreement (PNPCA), and data and information on MRC stakeholder activities and on products accessed through the MRC data portal. Progress in this dimension is also considered based on the data collected and analyses for each of the other dimensions, with consideration given to the disaggregation of the results by basin countries.

To assess the status of cooperation conditions and trends in the Mekong River Basin, the MRB-IF encompasses three strategic indicators and eight assessment indicators, as reflected below (Table 7.1). This chapter provides an assessment of the status of conditions and trends in each of these strategic and assessment indicators.

Table 7.18. Strategic and assessment indicators in the Cooperation Dimension of the MRB-IF

BDS Outcomes	Strategic indicators
Self-finance of the MRC	▪ Proportion of the MRC budget funded by national contributions during current periods
Benefits derived from cooperation	▪ Joint efforts on projects of basin-wide significance and with potential transboundary impacts ▪ Extent of knowledge-sharing activities ▪ Partnerships between the MRC and other parties ▪ Proportion of benefits derived from cooperation to total net economic value of all water-related sectors
Equity of benefits derived from the Mekong River System	▪ Overall social benefits derived in each country's part of the Basin ▪ Overall environmental benefits derived in each country's part of the Basin ▪ Aggregated economic benefits derived from water-related sectors in each country's part of the Basin

The assessment of conditions and trends has been undertaken taking into consideration the BDS 2021–2030 Strategic Priority for the Cooperation Dimension:

Strengthen cooperation among all basin countries and stakeholders

This BDS Strategic Priority recognizes that the changing Mekong River Basin requires cooperation among all six basin countries to address issues of water security, fluctuating water levels from hydropower operations, and coordinating reservoir operations to mitigate floods, droughts and sediment loss. Building on good foundations, the BDS 2021–2030 encourages partnerships between all Mekong and regional water, energy and environment-related cooperation mechanisms to focus on areas of complementary strength and comparative advantage to minimize duplication and ensure a cost-effective response to achieving the outcomes articulated in the Strategy.

Strengthened cooperation among all basin countries and stakeholders leads to more effective implementation of the 1995 Mekong Agreement and a whole-of-basin approach. The most pressing issues to address in order to help ensure that the regional costs from floods and droughts are minimized, and that more optimal and sustainable development can be achieved are some of the important mechanisms identified in the BDS 2021–2030 are: (i) enhancing the capacity of basin countries; (ii) improving the operation of the MRC Procedures; (iii) negotiating and agreeing on new joint investment projects and national projects of basin-wide significance;

(iv) establishing year-round data-sharing between all basin countries; (v) and bringing together expertise from all countries. Enhanced, more coherent and systematic engagement of stakeholders on issues that affect them is also identified as necessary to improve confidence in basin water resources management and contribute to better outcomes.

7.2. Self-finance of the MRC

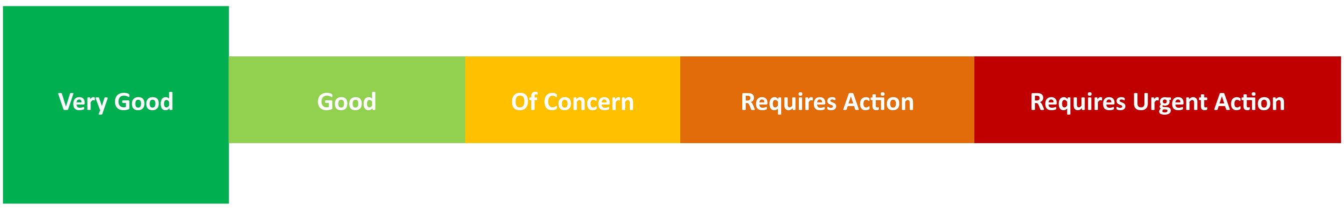
7.2.1. Assessment methodology

The directions set by the Prime Ministers of the four Member Countries at the first MRC Summit include full member country financing of the MRC by 2030. This commitment includes a move to full riparianization of the MRC involving the decentralization of the organization's core functions to Member Countries based on the principle of subsidiarity, and an associated shift in the role and functions of the MRC Secretariat to a leaner, more efficient river basin organization. The strategic indicator, 'self-finance of the MRC', is defined as "the extent to which the activities of the MRC are self-financed through national contributions, in line with the organization's 2030 objective". There is one assessment indicator for this strategic indicator:

- The proportion of total MRC budget funded by national contributions during the current period.

The assessment indicator is evaluated using data of relevant monitoring parameters to inform a judgment about the overall status of self-financing of the MRC. Data on financial contributions to the MRC are obtained from MRC annual reports, approved workplans and internal forecasts.

7.2.2. Proportion of the MRC budget funded by national contributions



The MRC budget is financed by contributions from both Member Countries and Development Partners of the MRC. The total annual budget in 2023 was USD 10.9 million, including both basket and earmarked funding. The amount funded by Member Countries has risen steadily over the last six years (2018–2023), from around USD 3.1 to 5.0 million, so that Member Countries are now contributing 46% of the total (Figure 7.1), up from 23% in 2017, as reported in the 2018 SOBR. This trend of increasing Member Country contributions is expected to continue in 2024 and 2025 during the remainder of the current Strategic Planning cycle, and together with anticipated reductions in the total MRC budget, is consistent with a pathway to self-financing by 2030.

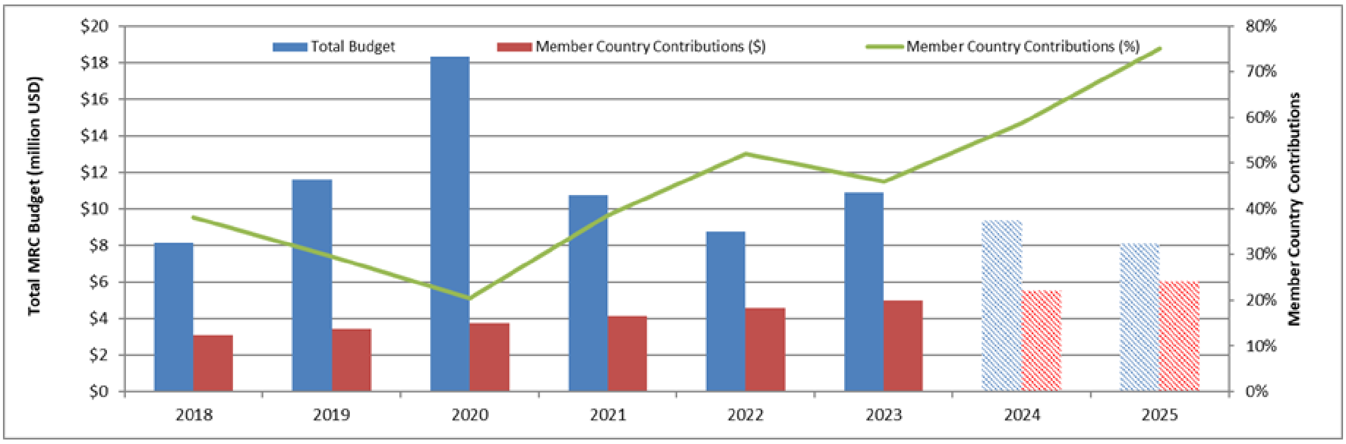


Figure 7.28. Total MRC budget and total proportional contributions from Member Countries

Data source: MRC records

The MRC's 2023 budget is made up of proportional contributions of 28% each from Thailand and Viet Nam, and 22% each from Cambodia and Lao PDR. The projected growth in Member Country contributions to 2030 (Figure 7.2) will see each country contribute an equal share of 25% of the MRC budget by that year. Despite the progress to date, the financing challenge to 2030 is considerable. Relative to the previous seven years, the amount that each country needs to contribute over the next seven years will increase substantially. For example, the required increase in contributions from Cambodia and Lao PDR over the next seven years is double the increase over the last seven years.

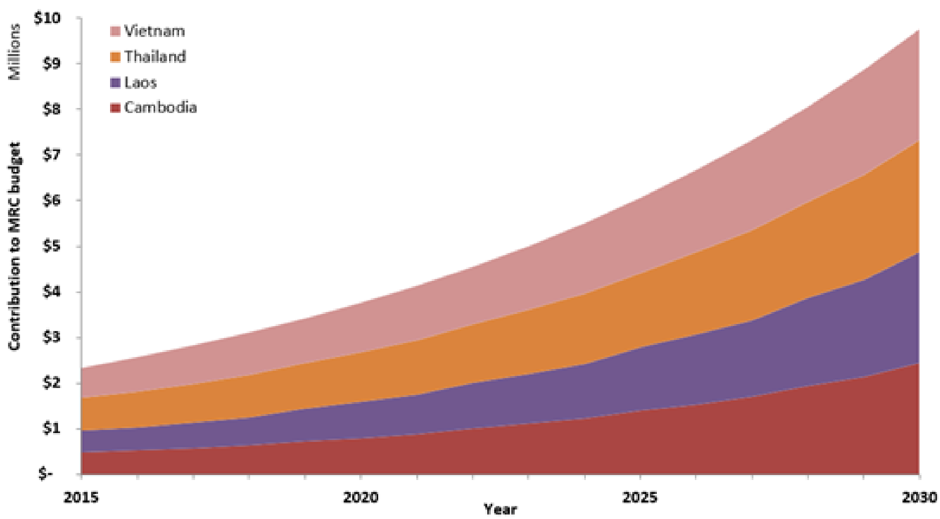


Figure 7.29. Projected growth in contributions from Member Countries to the MRC to 2030

Data source: MRC records

Part of the MRC reforms consistent with the riparianization of the organization involves efforts to increase the share of the total budget in the MRC basket fund. This allows greater flexibility in the programming of MRC activities consistent with Member Country priorities and helps to stabilize the resourcing of the MRC's core functions. Between 2018 and 2023, the average share of the MRC budget that was earmarked for specific activities based on agreements with Development Partners was around 33% (fluctuating between 30% and 45%). However, over 2022 and 2023, the proportion was below 20% annually, and the corresponding contribution to the basket fund was therefore over 80% of the total budget, signifying progress towards a more flexible financing goal.

Based on the progress to date and the forecast contributions by Member Countries to the MRC basket fund, but recognizing the challenges ahead, the self-financing of the MRC is assessed as 'very good'.

7.3. Benefits derived from cooperation

7.3.1. Assessment methodology

The benefits derived from cooperation are reflected in the MRB-IF mostly through cooperation on joint projects between two or more basin countries and on projects of basin-wide significance, and through notification and dialogue under the PNPCA. Cooperation also occurs through the sharing of information and knowledge, joint events with a range of stakeholder and partnership agreements with external parties. For the strategic indicator 'Benefits derived from cooperation'", there are four assessment indicators, as follows:

- Joint efforts on projects of basin-wide significance and with potential transboundary impacts
- Extent of knowledge-sharing activities
- Partnerships between the MRC and other parties
- Proportion of benefits derived from cooperation to total economic value of other sectors.

Data and information for these assessment indicators are generally sourced from the NIPs of Member Countries, and the MRC's project database, which includes joint projects and developments that have been notified under the PNPCA. NIPs are prepared in each country under the coordination of the respective National Mekong Committee. These plans seek to incorporate the basin perspective of the BDS into national planning, decision-making and governance processes. In doing so, each NIP seeks to capture the benefits envisaged under the 1995 Mekong Agreement that will flow from regional cooperation and collaborative effort by optimizing national and transboundary development opportunities, and minimizing harmful impacts.

7.3.2. Joint efforts on projects of basin-wide significance including with potential transboundary impacts

Very Good	Good	Of Concern	Requires Action	Requires Urgent Action

Projects of basin-wide significance including joint and transboundary projects

Projects of basin-wide significance can include those that are developed and implemented in partnership between two or more basin countries as 'joint or 'transboundary projects', or projects that are developed and implemented in one country but that have potential significance for other countries, either through beneficial or adverse impacts. Where transboundary impacts are expected, the MRC Member Countries have agreed to cooperate through the implementation of the PNPCA.

The number of projects being implemented that involve more than one basin country throughout the region, and their investment value provide an indication of the degree of cooperation between the basin countries, especially with regard to data collection, joint research, studies, and knowledge generation and sharing. Within the NIPs, national activities can also have basin-wide significance, since they may involve preliminary investigations, research, planning, feasibility studies and similar activities that have potential to lead to, or inform, decisions on proceeding with joint or national investment projects of basin-wide significance.

The total number of national projects and activities of basin-wide significance,[31] not including joint projects, identified in the NIPs for 2021–2025 is 98 (Table 7.2). This is an increase of 20 projects or activities (26%) compared to the 78 from the previous NIPs (2016-2020). The total estimated cost of these projects declined from USD 827 million to USD 459 million, a reduction of around 45%. The number of joint or transboundary projects identified in the NIPs for the current planning period is 12, with a total budget estimate of USD 20.5 million. The number of joint projects undertaken with the support of the MRC has increased from five already identified in previous NIP period (Table 7.3).

31 National projects of basin-wide significance are those that create development opportunities and/or have benefits or adverse impacts elsewhere in the Basin; national activities of basin-wide significance are generally preliminary studies and assessments to support the development of projects. Unlike projects, activities do not normally change conditions on the ground.

Table 7.19. Number and estimated budgets of projects and activities in the National Indicative Plans of Member Countries

	Joint or transboundary projects		National projects of basin-wide significance		National activities of basin -wide significance		Decentralized regional activities	
	No.	USD million	No.	USD million	No.	USD million	No.	USD million
Cambodia	8	8.3	6	42.5	2	0.3	7	0.7
Lao PDR	6	-	14	79.0	23	36.9	0	-
Thailand	4	10.8	0	0	13	4.4	8	0.5
Viet Nam	9	1.4	5	287.0	14	7.1	6	0.9
Total	**12**	**20.5**	**25**	**408.5**	**52**	**48.7**	**21**	**2.1**

Note: The number of joint projects in each country does not sum to the total, as joint projects occur in more than one country.

Data source: Member Country National Indicative Plans

It should be noted that the decline in the estimated budget of projects and activities of basin-wide significance from the previous NIPs to the current NIPs is not necessarily a negative trend. This is likely to represent a more realistic assessment by basin countries regarding what is feasible in relation to resource mobilization and implementation, based on experience with previous NIPs, where many projects and activities in some countries remained unfunded.

National activities of basin-wide significance constitute around 47% and national projects of basin-wide significance around 19% of the total of all projects and activities. Joint or transboundary projects constitute around 11%. The total estimated value of national activities of basin-wide significance is substantially higher than other project or activity categories as reflected in the NIP budgets (Table 7.2). Compared to the previous period, the share of national activities of basin-wide significance as well as national projects of basin-wide significance has increased, whereas the share of decentralized activities has decreased. This could be a positive sign of increased focus on regional and transboundary perspectives within the national activities of Member Countries.

Of the five joint or transboundary projects carried over from the 2016–2020 NIPs, only three (No. 3, 4 and 5) commenced implementation during that period (Table 7.4). The "3S Sustainable water resources development and management project" (No. 1) commenced in 2023, while the "Integrated flood management project" (No. 2) needs to be reformulated and has not yet been launched. With the new NIP period of 2021–2025, seven further joint or transboundary project concepts have been agreed by Member

Countries for implementation during the current NIP period (projects nos. 6 to 12). However, these still need to be clarified in terms of scope. In addition to the projects identified in the NIPs, the MRC is also progressing a project, "Transboundary Fisheries Management in the Lower Mekong Basin". Funding is being sought from global climate and environment funds in partnership with IUCN and FAO.

Table 7.20. Current and proposed new joint or transboundary projects between two or more basin countries under the auspices of the MRC with reference to the BDS Strategic Priority to which they would be expected to contribute

No.	Project	Basin countries	BDS Strategic Priority (SP)
Identified for implementation under the 2016–2020 and 2021–2025 National Indicative Plans (NIPs)			
1	3S Sustainable water resources development and management in the Sekong, Sesan and Srepok river basins (3S sub-basin)	Cambodia, Lao PDR, Viet Nam	SP3
2	Integrated flood management in the border area of Cambodia and Viet Nam (Mekong Delta) for water security and sustainable development	Cambodia, Viet Nam	SP4
3	9C-9T Transboundary cooperation in sub-basins (formerly the 9C-9T sub-basin project, with expansion to the 3S sub-basin)	Cambodia, Lao PDR Thailand, Viet Nam	SP4
4	Lao-Thai safety regulations for navigation	Lao PDR, Thailand	SP3
5	Cross-border water resources development and management, including environmental impact monitoring of Don Sahong HP	Cambodia and Lao PDR	SP3
Proposed or identified for implementation under the 2021–2025 NIPs			
6	Enhancing climate resilience of Mekong River communities	Cambodia, Lao, Thailand, Myanmar, Viet Nam	SP4
7	Transboundary cooperation for water quantity and water quality management in Lao-Viet Nam border area of Xebanghieng Basin	Lao PDR, Viet Nam	SP4
8	Nam Ma and Nam Neun Transboundary River Project	Lao PDR, Viet Nam	SP5
9	Joint Assessment on Flood and Drought	Thailand, Myanmar	SP4
10	Strengthening cooperation on flood and drought management in the 2S sub-basin	Viet Nam, Cambodia	SP4
11	Study of water security factors in the 2S sub-basin	Viet Nam, Cambodia	SP2
12	Study of water security factors in the Mekong Delta	Viet Nam, Cambodia	SP2

Data source: MRC records

Table 7.21. Progress in the implementation of joint or transboundary projects carried over from the previous National Indicative Plan period

No.	Project	Progress	Budget (USD million)	Commenced
1	3S Sustainable water resources development	Being designed with an inception phase with the support of Gesellschaft für Internationale Zusammenarbeit (GIZ) and the MRCS. Replication of the approach from the 9C-9T flood and drought management joint project. Commenced as part of GIZ funding support for 2023–2024.	3.16	2023
2	Integrated flood management in the Cambodia and Viet Nam border area	Needs to be reformulated and designed to attract funding (not yet started)	3.58	--
3	9C-9T Transboundary cooperation	Completed its first two phases, which involved joint planning and establishing appropriate governance. Phase III is being expanded as a model for cooperation in other transboundary sub-basins, such as for developing the Flood and Drought Master Plan, the 9C-9T Basin Atlas, and funding proposals to implement the Master Plan.	12.73	2018
4	Safety regulations for navigation	Led to a comprehensive set of regulations to improve safety of navigation. The joint safety and anti-pollution rules were established. The joint rules were established for port safety and emergency response. Other priority actions of mutual interest are identified.	0.10	2017
5	Cross-border water resources development and management	The Joint Environmental Monitoring of Don Sahong HPP was expanded from 2 to 4 Member Countries and included Xayaburi HPP. Monitoring methods and protocols were incorporated into the design of the MRC Core River Monitoring Network to be implemented as part of routine MRC monitoring activities.	1.50	2018
Total			**21.07**	

Data source: MRC records

Box 2: Flood and drought management in transboundary sub-basins

While the focus of Mekong cooperation is often on the mainstream, there are several transboundary sub-basins located throughout the Basin where cooperation between countries in integrated water resources management is essential for sustainable development and ensuring resilience to climate change. One such sub-basin is the 9C-9T shared between Cambodia and Thailand. The 9C-9T is one of 11 sub-basins feeding the Tonle Sap Lake, which is a World Heritage site, the largest freshwater lake in Southeast Asia, a United Nations Educational, Scientific and Cultural Organization (UNESCO) Biosphere Reserve and one of the world's most productive inland fishing waters. The drivers of watershed degradation, population pressures and climate change are increasing the risk of flood and drought for the residents and ecosystems of the sub-basin.

To address these issues, the countries have been working together for more than six years to identify and implement solutions, facilitated by the Mekong River Commission(MRC) with the support of Germany through the German Development Cooperation and Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ). To date, the project has resulted in preparation of a joint baseline assessment on flood and drought, establishment of a joint governance mechanism guided by the Regional Steering Committees and National Working Groups, identification of five joint priority areas, endorsement of the 5-year Flood and Drought Master Plan 2022–2026, and the completion of a gender and vulnerability assessment. The two countries have progressed with actions responding to the priority areas such as the establishment of a knowledge-sharing platform – the 9C-9T Basin Atlas DSS (https://9c9t.mrcmekong.org), field missions to document locations that are vulnerable to flood and drought, the conceptualization of a network of nature-based solutions to build watershed resilience, an economic analysis study of the nature-based solutions, development of an action plan for implementing the 9C-9T Flood and Drought Master Plan, and preparation of the transboundary early warning system for Cambodia and Thailand.

The further implementation of the project is building on this momentum to strengthen transboundary flood and drought risk management, reverse watershed degradation, and enhance the health of communities and ecosystems, with an expansion of some aspects to the 3S sub-basin shared between Cambodia, Lao PDR and Viet Nam. This aims to ensure that lessons learned are shared, and that appropriate application of flood and drought management can achieve broader basin-wide benefit. Funding to implement the strategic action plan is now being sought from the Global Environment Facility through a collaboration between the MRC Secretariat and the Food and Agriculture Organization of the United Nations (FAO) supported by GIZ to ensure that the positive country-to-country cooperation translates to real change for people and communities on

Projects notified under the MRC Procedures for the Notification, Prior Consultation, and Agreement

Under the PNPCA, seven additional projects have been notified since the 2018 SOBR (Figure 7.3). These include three projects in Lao PDR (Don Sahong hydropower extension, Bolikhamxai-Beungkan bridge, and Sekong A hydropower), two in Thailand (Huai Luang River Basin Development Project and Sri Song Rak irrigation flood gate) and two in Viet Nam (My Thuan II Bridge and Rach Mieu II Bridge).

In total, 53 projects have been notified since 1998. The number of projects notified ranges between zero and four in a typical year, or on average two projects per year; 2013 was an exception, with 12 projects notified, all of which were in Lao PDR. More projects were notified in the five-year period leading up to the SOBR 2018 (20 projects) than in the last five years (7 projects).

Notified projects cover a range of different types, although around 80% are hydropower projects and 62% of all notified projects are in Lao PDR. Six projects have proceeded under the prior consultation process, all of which were hydropower projects in Lao PDR (before 2018: Xayaburi, Don Sahong, Pak Beng; 2018 and later: Pak Lay, Luang Prabang, Sanakham). There is much great deal of cooperation between countries on transboundary projects and joint projects that increases knowledge and understanding, and supports planning at the sub-basin level. However, ultimately these preparatory efforts need to be translated into significant projects that have potential to change outcomes on the ground and contribute to more sustainable development of the water and related resources of the Basin (Table 7.5 and Figure 7.4). To date, each these six PNPCA cases has resulted in the development of an agreed statement from the MRC Joint Committee. Three of the projects (Pak Beng, Pak Lay and Luang Prabang) have an approved Joint Action Plan to be jointly implemented by the countries in order to minimize potential harmful transboundary effects from the project. There are no projects that have resulted in an agreement between the countries under the PNPCA.

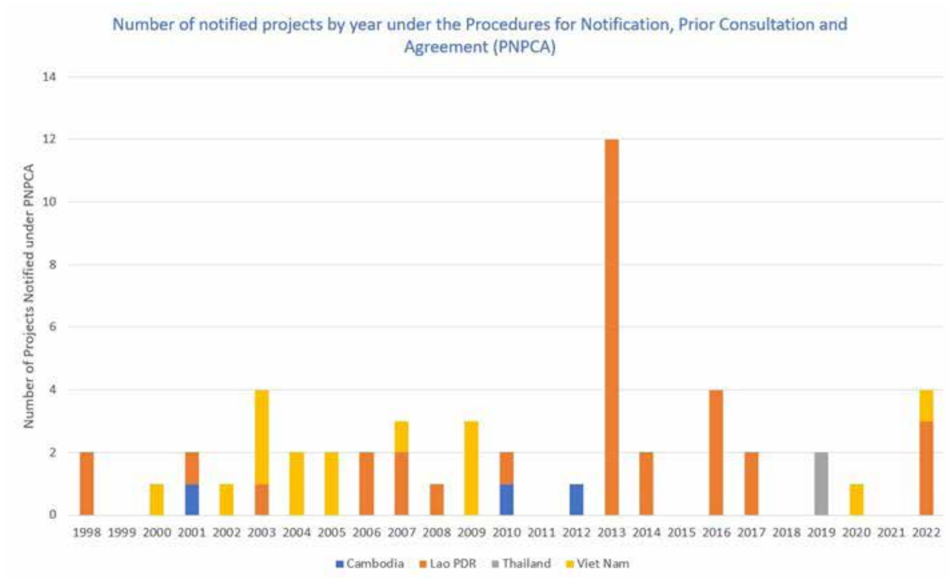


Figure 7.30. Number of projects by country notified under the PNPCA, 1998–2022

Data source: MRC records

There is a great deal of quality cooperation between countries on transboundary projects and joint projects, which increases knowledge and understanding, and supports planning at a sub-basin level. However, ultimately these preparatory efforts need to be translated into significant projects that have potential to change outcomes on the ground and contribute to more sustainable development of the water and related resources of the Basin.

Table 7.22. Number of project notifications and projects proceeding to prior consultation under the PNPCA, 1998–2022

	Bridge	Diversion	Hydropower	Irrigation	Multi-purpose	Water management	Total
Notification							
Cambodia	1		1	1			3
Lao PDR	2		30		1		33
Thailand				1		1	2
Viet Nam	2		11	2	1		15
Sub-total	**5**		**42**	**4**	**1**	**1**	**53**
Prior Consultation							
Cambodia							
Lao PDR			6				6
Thailand							
Viet Nam							
Sub-total			**6**				**6**
Total	**5**		**48**	**4**	**1**	**1**	**59**

Data source: MRC records as of 2022

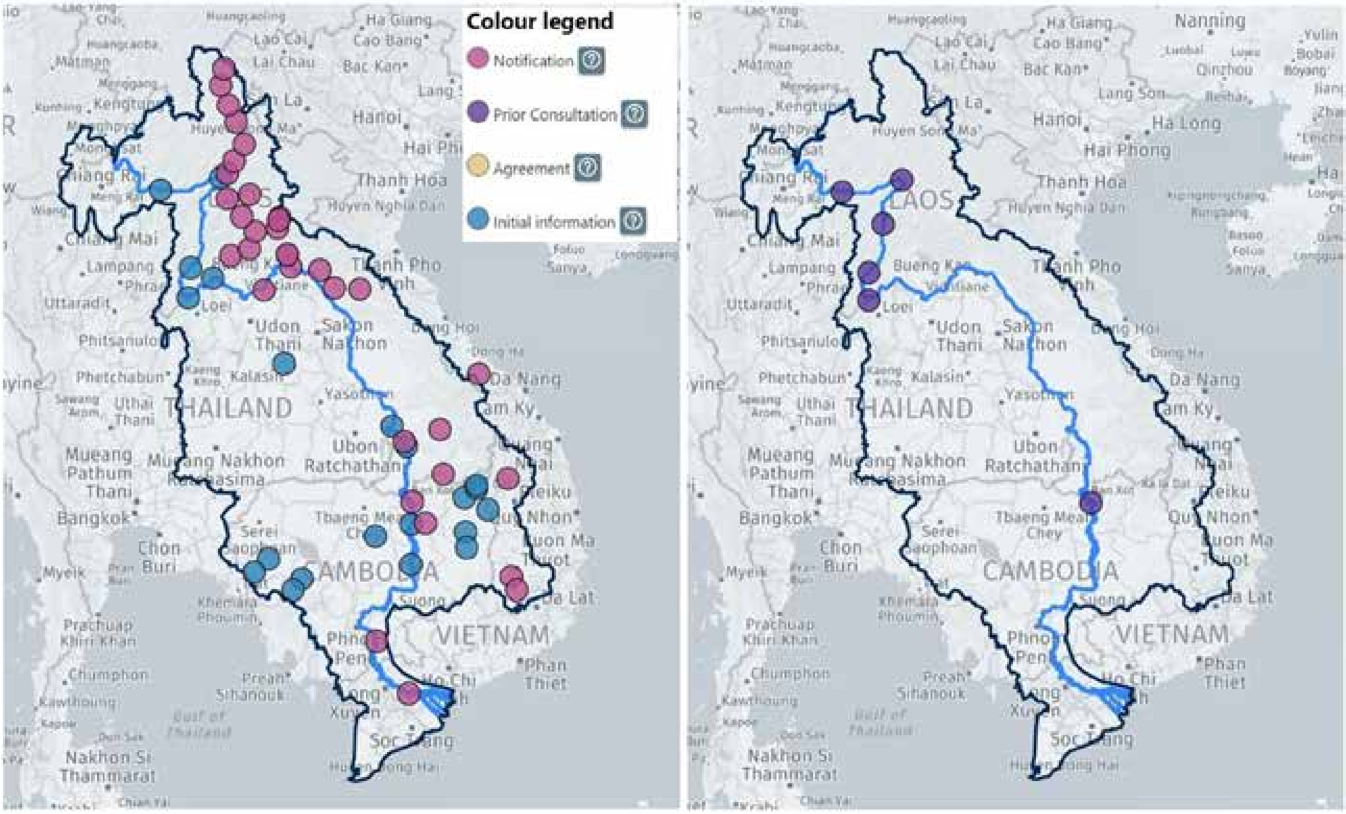


Figure 7.31. Location of projects notified (a), and proceeding to prior consultation under the PNPCA (b), 1998–2022

Data source: MRC records as of 2022

Based on the data and information presented above, this assessment indicator is rated as 'Requires Action'. This is mainly due to: (i) the lack of any significant joint investment projects between basin countries that have a strong potential to shift the dial on cooperation, and increase the overall benefits and reduce the overall costs of water resources development in the Mekong River Basin; (ii) the lack of progress implementing the current joint and transboundary projects; and (iii) the inability to effectively implement Joint Action Plans and reach an agreement on any projects with potential transboundary impacts that have been notified under the PNPCA. These two monitoring parameters are related, since without a more comprehensive basin-wide solution through the identification of supplementary investment projects in a proactive regional plan, agreements between countries about developments with transboundary impacts are likely to remain elusive.

7.3.3. Extent of knowledge-sharing activities

Very Good	Good	Of Concern	Requires Action	Requires Urgent Action

The extent of knowledge-sharing activities is assessed based on the number of events, the number of joint studies, the number of information products disseminated, and the number of data downloads from the MRC data portal.

Events and stakeholder meetings

In the six years from 2017 to 2022, a total of 12 regional stakeholder events (forums, symposiums, etc.) were organized by the MRC (Table 7.6); i.e. an average of two events per year. In total, almost 1,800 participants took part in all 12 events, i.e. around 150 people per event. Moreover, 64 stakeholder meetings with CSOs and non-governmental organizations (NGOs) were held during the same period, i.e. an average of about 11 meetings per year.

Table 7.23. Number of stakeholder events and participants and stakeholder meetings held by the MRC, 2017–2022

Notification	Stakeholder events		Hydropower
	Number	Participants	
2017	4	484	0
2018	1	191	10
2019	2	367	17
2020	2	261	7
2021	2	296	18
2022	1	176	12
Total	**12**	**1,775**	**64**

Data source: MRC records as of 2022

Joint studies and assessments

Over the last five years, since 2018, a total of 18 studies and assessments have been undertaken (Table 7.7) under the organization of the MRC. Two or more basin countries were involved in the implementation of all of these studies and assessments.

Table 7.24. Number of joint studies and assessments undertaken by or with the MRC, 2018–2022

Joint studies and assessments
Joint Study on the changing pattern of the hydrological condition in the Lancang Mekong River Basin
Mekong Low Flow and Drought Conditions in 2019–2021
Situation Report on Dry Season Hydrological Conditions in the Lower Mekong River Basin: November 2020–May 2021
Situation Report on Hydrological Conditions in the Lower Mekong River Basin in July–December 2020
Situation Report on Hydrological Conditions in the Lower Mekong River Basin in January–July 2020
Annual Mekong Hydrology, Flood and Drought Report 2018
"Understanding the Mekong River's hydrological conditions", commentary note by Alan Basist and Claude Williams (2020)
Drought Management Strategy for the Lower Mekong Basin 2020–2025
Joint Research on the hydrological impacts of the Lancang Hydropower Cascade on downstream extreme events
Flood Management and Mitigation Initial Studies to demonstrate the formulation of strategic directions to manage existing, future and residual flood risks in the Lower Mekong Basin (with three pilot studies)
Study to develop Reservoir Assessment Tool for LMB (RAT-Mekong).
Study to develop new operational precipitation data streams (GPM-BICO and CHIRPS-GEFS) and incorporate those fully into the MRC-RFFS.
Study to integrate supporting tools (Rainstorm Tracker, Mekong X-Ray) for enhancing the MRC Flash Flood Guidance System.
Study and apply the Regional Hydro-Extreme Assessment System (RHEAS) for the MRC drought monitoring and forecasting.
Annual Mekong Hydrology, Flood and Drought Reports, 2019, 2020, 2021 and 2022

Information products disseminated

In the 2018–2022 period, a total of 153 publications were issued by the MRC (Table 7.8), which is a reduction of around 8% from the 2012–2017 period, with the most significant decrease in strategies and work programmes (from 55 to 47 publications) and in policies, procedures and guidelines (from 22 to 16 publications). Over the last five years, an average of 31 publications per year have been issued. However, the number of publications has continuously decreased over this period, and in 2022, only 19 publications were issued.

The decline in the number of publications occurs within the context of the declining resources of the MRCS since 2015 and the increase in the decentralized work activities. However, the concurrent reduction in output indicates that the savings achieved by reduced resourcing at the regional level and the associated decentralization of core functions may not necessarily have translated into greater efficiency. Rather, declining resources means less output, at least of the traditional kind.

In addition to the more traditional products provided by the MRC, recent years have seen a significant shift to a more proactive engagement with the media and basin stakeholders through social media channels and with newer forms of information products such as video. These newer communication mechanisms average around 260 releases per year (Table 7.9) and are expected to be of continuing importance to the distribution to basin stakeholders of information on the management of the Mekong River Basin including changing river conditions.

Table 7.25. Number of information products disseminated by the MRC, 2018–2022

	Strategy	Report	Guideline	Governance	Glossary	Proceedings	Brochure/ Newsletter	Manual	Total
2018	3	13	2	11	1	1	15	5	51
2019	0	14	6	11	0	1	-	0	32
2020	0	11	3	9	0	1	3	0	27
2021	4	7	1	11	0	0	0	1	24
2022	7	2	4	3	0	2	0	1	19
Total	**14**	**47**	**16**	**45**	**1**	**5**	**18**	**7**	**153**

Note: **Strategies** (including Work Programmes), **Guidelines** (including Policies, Procedures), **Governance** (Annual Report, Mid-Year Progress Report, Financial Report and Minutes of Meetings), **Proceedings** (of Conferences and Workshops), **Brochures** (including leaflets) and **Manuals** (including Toolkits).

Data source: MRC records as of 2022

Table 7.26. Media engagement including social media releases by the MRC, 2018–2022

	Videos produced	Media releases	Facebook posts	Total
2018	40	56	-	96
2019	66	39	285	390
2020	41	28	207	276
2021	17	28	182	227
2022	33	24	255	312
Total	**197**	**175**	**929**	**1,301**

Data source: MRC records as of 2022

Number of data downloads

Downloads have increased substantial over the last five years, especially since the launch of the new and improved MRC data portal at the beginning of 2020 (Table 7.10). Since then, the average number of downloads has been around 570 per year, equivalent to around 11 downloads per week or two per working day. The highest number of downloads was generated by the representatives of research, the second most by the Member Countries, and the third most by the population, the latter having decreased in recent years.

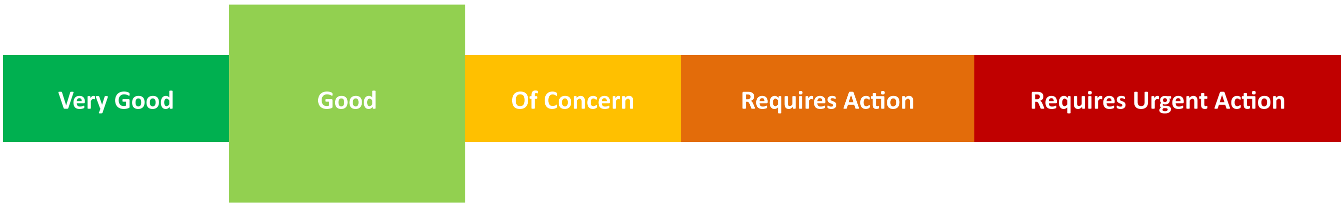
Table 7.27. Downloads from the MRC data portal by user group, 2018–2022

	MRCS / Member Countries	Research	Public	Commercial independent	Commercial partner	Directly contracted	Total
2018	43	-	153	-	-	-	196
2019	92	-	191	-	-	-	283
2020	181	150	39	75	24	25	494
2021	92	385	84	47	58	27	693
2022	179	239	33	26	31	12	520
Total	**587**	**774**	**500**	**148**	**113**	**64**	**2,186**

Data source: MRC records as of 2022

Overall, the extent of knowledge-sharing activities facilitated by the MRC in its role as a regional knowledge hub remains high. There has been renewed effort at the organization in engaging with external stakeholders in a more open and transparent way, particularly regarding the PNPCA process. This effort extends across the work activities of the MRC through the holding of regular regional stakeholder forums and meetings with CSOs and NGOs, which comprise a much more active social media presence. Although the number of publications produced by the MRC has declined over recent years, the number of data downloads has increased significantly, signifying the shift in the MRC's role as a facilitator of knowledge sharing and an enabler of the production of knowledge through other parties' resources rather than only its own. This is a shift that is likely to continue as the organization moves towards full riparianization and self-financing by 2030, and may offer opportunities for collaboration on publications with other organizations that have similar objectives. Although this assessment encompasses only the work under the MRC, the extent of knowledge-sharing activities within the Basin is considered 'Good'.

7.3.4. Partnerships between the MRC and other parties



There are three major types of partners with the MRC and other parties that are considered in this section:

1. MRC Development Partners, who contribute funding to the MRC basket fund or earmarked fund to support the implementation of the MRC Strategic Plan;
2. MRC Dialogue Partners, which are the basin countries that are not Member Countries because they are not signatories to the 1995 Mekong Agreement; and
3. Other Partners, who have partnership agreements in place with the MRC usually in the form of a MoU, for example, countries that are not Development Partners, NGOs or CSOs, research institutions, and other river basin organizations.

MRC Development Partners

The MRC Member Countries are increasing their financial contribution to the Mekong River Commission Strategic Plan (MRC SP) 2021–2025, in line with their commitment to self-financing (Section 7.2). However, a significant percentage of funding for the MRC still comes from the MRC Development Partners. Development Partners continue to provide strong support to IWRM in the region through cooperation with the MRC and various water-related regional platforms and other mechanisms (Chapter Two), and bilaterally with basin countries.

The Development Partners in the current MRC Strategic Planning cycle are: Australia, the European Union, Belgium (Flanders), France, Germany, Japan, Luxembourg, New Zealand, Sweden, Switzerland, and the United States, together with the UNEP and United Nations Office for South-South Cooperation (UNOSSC). MRC Development Partners are contributing a total of around USD 22.6 million, or 47% of the funding for the MRC Strategic Plan 2021–2025.

MRC Dialogue Partners – Cooperation with China

An analysis of news media coverage, paying particular attention to China, showed that, in recent years, there has been an overall increasing tendency towards water-related cooperation in the Mekong River Basin (Wei et al., 2021). This cooperation is manifested through various transboundary arrangements. One example is the Lancang-Mekong Water Resource Cooperation Centre (LMWRCC), which was established in Beijing in March 2017 as a cooperation platform to support Mekong-Lancang water resources cooperation between all six basin countries.

China is also a member of the Joint Committee on Coordination of Commercial Navigation (JCCCN) on the Mekong River. The JCCCN prepared a Development Plan of International Navigation on the Mekong-Lancang River 2015–2025, which aims to develop the Mekong River to carry increased shipping, trade and passenger transport from Pu'er in China to Luang Prabang in Lao PDR.

China participates in joint investment projects with LMB countries through the Greater Mekong Subregion (GMS) initiative supported by ADB. The GMS Economic Cooperation Program Strategic Framework 2012–2022 was implemented across several water-related sectors, most notably transport, agriculture and environment. Key actions included the promotion of inland waterways for domestic and international trade by providing and improving support facilities and services, the harmonization of standards related to good practices for crops, livestock and aquaculture, and project preparation support for integrated natural resources and land management for sustainable development, as well as regional knowledge sharing (ADB, 2018).

In 2015, China and Lao PDR signed the Cooperation Agreement on Fishery Resources Protection. The Agreement defines fishery resources protection efforts at a transboundary level in which the 40 km river border between China and Lao PDR is established as a common protected area. A framework was developed for future cooperation between the two countries with definitions of responsibilities and obligations. The two countries also cooperate in carrying out watershed fisheries protection (Yu et al., 2018).

As a Dialogue Partner of the MRC, China has a longstanding and continuously strengthening relationship whereby it exchanges and shares data, information and technical expertise. To this end, China participates in MRC Dialogue Partner, Joint Committee and Council meetings, as well as MRC summits. Additional sharing of technical knowledge and expertise takes place through visits and workshops, comparison of modelling and study results, and the Junior Riparian Professional Programme, in which China nominates and supports young professionals to work at the MRC.

In 2020, for the first time, China agreed to share year-round hydrological data with MRC from two of its dams (Jinghong and Ma'an). This builds on a data-sharing agreement that has been in place for 18 years, under which China has shared its water level and rainfall data during the June to October flood season. These data are crucial for countries across the LMB to more accurately monitor river flows and forecast flood events. After previously sharing only water level data, the sharing of annual stage-discharge relationships by China allows for more quantitative assessment of flow volumes from the UMB.

In another important step concerning transboundary cooperation, in 2020, China also agreed to share urgent information on any unusual rise or fall in water levels and discharges, as well as other relevant information on factors that might lead to sudden flooding in the lower reaches of the Basin. In practice, further improvements can still be made regarding sharing of information on rapid water level fluctuations. In its 2020–2021 Dry Season Situation Report, the MRC therefore encouraged additional efforts in data and information sharing and exchange by the MRC Member Countries and Dialogue Partners (MRC, 2021c).

The MRC Secretariat and the LMWRCC agreed to work together on further improving information sharing and joint activities in support of the six Mekong countries through the signing in December 2019 of a MoU that proposes collaboration on data and information exchange, basin-wide monitoring, and joint assessment on Mekong water and related resources. More specifically, the first stage of a joint study, "Changing Patterns of Hydrological Conditions of the Lancang-Mekong Basin and Adaptation Strategies", commenced in 2022 and is expected to yield actionable recommendations. The second stage will be implemented during 2023–2024, in coordination with the MRC Strategic Plan 2021–2025. The MRCS also participates as an observer in MLC Water Joint Working Group meetings.

MRC Dialogue Partners – Cooperation with Myanmar

Although Myanmar covers only a small part of the Mekong River Basin, it engages in several regional cooperation initiatives related to water resources management and development in the Basin. For instance, Myanmar is a member of the MLC framework, whose main objective is to create a community of a shared future, peace and prosperity in the Mekong sub-region.

The MLC Special Fund was established by the MLC to support small- to medium-sized development projects undertaken by the riparian countries. Several of these projects have been implemented in the UMB in Myanmar in water-related sectors. Recent projects include a feasibility study on Myanmar's Wan Pong Port improvement project, which aims at modernizing the facilities at Wan Pong Port for handling shipping containers and help to increase the trade in cargo between Myanmar and other Greater Mekong Subregion countries.[32] Another example is the water quality monitoring campaign implemented at the Mekong mainstream near Tachileik.[33]

Further involvement of Myanmar in regional cooperation initiatives includes its membership of the JCCCN on the Mekong River, which co-funded the feasibility study for improvement of Wan Pong Port. Myanmar also participates in joint investment projects with LMB countries through the GMS initiative supported by ADB.

As a member of the ASEAN, Myanmar is involved in the development of a regional vision and implementation of development projects across a variety of sectors, including fisheries and navigation (ASEAN, 2018). A further platform for regional cooperation involving Myanmar and the four Lower Mekong Basin Countries is the Ayeyarwady-Chao Phraya-Mekong Economic Cooperation Strategy (ACMECS). ACMECS aims to promote prosperity in the sub-region in a sustainable manner through its five-year action plan for regional development cooperation 2018–2023.

Myanmar is also a member of the Cambodia-Lao PDR-Myanmar-Viet Nam cooperation initiative (CLMV), which organized its most recent summit in December 2020.[34] During this event, the CLMV Development Framework was approved, with a vision for the CLMV region to become one of the world's business centres and for all economies to reach the upper-middle income status by 2030. The countries committed to boosting cooperation in sustainable management of water and natural resources, among others.

As an MRC Dialogue Partner, Myanmar has cooperated with the MRC in multiple areas, such as improving the MRC's hydro-meteorological coverage by exchanging relevant monitoring and water-quality data as well as technical expertise in flood prevention and management. A number of areas, such as navigation safety, strategic environmental assessment and continued sharing of hydro-meteorological data with Myanmar, have been explored with potential for future technical cooperation. The Government of Myanmar sends high-level participants to MRC summits, and Myanmar representatives endorsed the proposed Joint Study on the Changing Pattern of Hydrological Conditions of the Lancang-Mekong River Basin and

32 https://www.greatermekong.org/projects/projects/upgrading-wan-pong-port-500-ton-container-handling-facilities-4986

33 https://www.myanmaritv.com/news/outcome-cooperation-water-quality-assessment-project-shan-state

34 https://hanoitimes.vn/cooperation-is-the-only-way-forward-for-clmv-countries-vietnam-pm-315235.html

Adaptation Strategies, described above.

Cooperation with Other Parties

Partnerships between the MRC and other parties are assessed based on the number of partnership agreements reflected in a MoU and the level of exchange under these agreements as indicated by the frequency and magnitude of engagement.

There are currently 13 agreements with countries, ministries, organizations and research institutions located in Africa, Asia, Europe, North America and Oceania in active between the MRC and other partners (Table 7.11). A total of 17 agreements concluded between 2018 and 2023 generally focus on knowledge sharing at various policy and technical levels. The initial benefits derived from the cooperation were assessed based on the level of exchange under each agreement considering both the frequency of the exchange and its magnitude (Figure 7.5). According to the Level of Exchange Matrix, Agreements with a 'High' level of engagement involve frequent interaction or many initiatives, policy-level engagement and/or joint activities working together, whereas agreements with a 'Low' level of engagement involve infrequent interaction or few initiatives, mostly technical-level engagement and/or awareness-raising activities only.

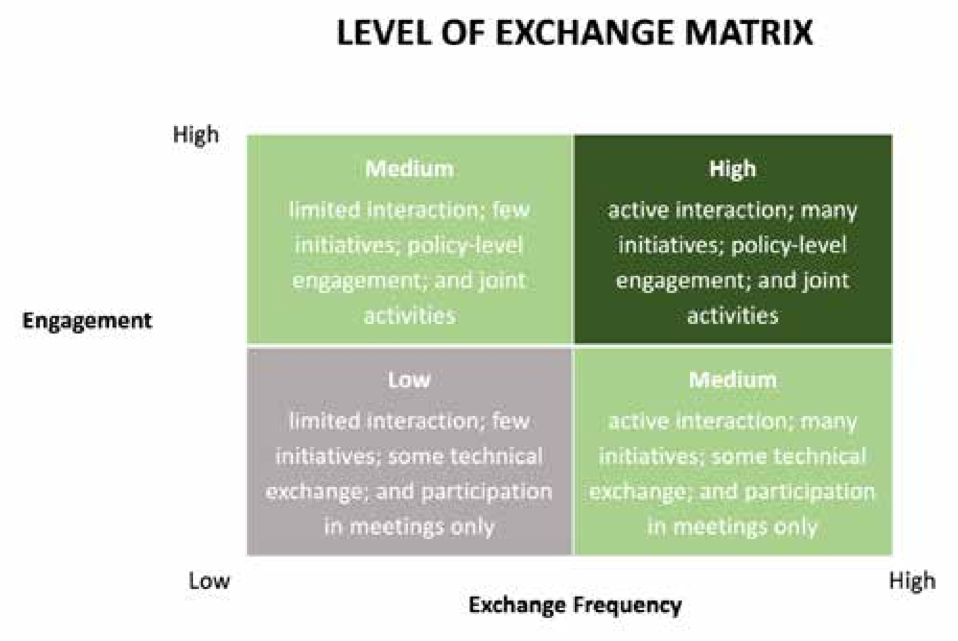


Figure 7.32. Level of exchange between the MRC and other parties under partnership agreements

The benefits of this cooperation can be seen in the joint initiatives, activities and projects that have resulted from the partnership agreement (Table 7.12). Different partnership agreements are used differently by the parties. While in some collaborations, there are frequent exchange, with many initiatives initiated and a comprehensive transfer of know-how or specific projects financed, in others, there may only be very limited or only a single activity or event implemented. Some involve high-level exchange on policy matters of critical import to the management and development of water resources in the Basin, while others are purely technical, providing access to new ideas and approaches that may have worked well in other river basins around the world, or to complementary resources that can assist in resolving specific problems.

Table 7.28. Partnership agreements signed by the MRC and other parties, 2017–2022

Year	Memorandum of Understanding
2017	Memorandum of Understanding (MOU) between the Ministry of Strategy and Finance of the **Republic of Korea** and the MRC on the Knowledge Sharing Programme (signed October 2017, expired 2022) MoU on **The Promotion of Sustainable Development of Fisheries and Aquaculture in the Lower Mekong Basin and Southeast Asia** (signed in 2017, expired 2022)
2018	MoU between the **Viet Nam National Space Center – Vietnam Academy of Science and Technology** and the MRCS, and on Using Satellite Data for Water and Related Resources Management and Development of the Mekong Basin (automatically expired in 2020) Memorandum of Agreement between **United Nations Economic and Social Commission for Asia and the Pacific (ESCAP)** and the MRC on the Promotion and Institutionalization of the ESCAP Regional Network of Knowledge and Innovation Centres in Disaster Risk Reduction (signed in 2018, terminated 31 December 2020) Cooperation Framework between the **Association of Southeast Asian Nations (ASEAN)** and the MRC (in force; renewed in 2018, no expiration date) Memorandum of Agreement between the **United Nations Office for Project Services** and the MRC (signed in April 2018, expired 2020)
2019	MoU between the **K-Water** MRCS, Phase II of the MoU with the Republic of Korea, 2017 (signed November 2019; valid until 2024) MoU between the **Lancang-Mekong Water Resources Cooperation Centre** and the MRCS (signed in December 2019; valid until 2024) MoU on Cooperation between the **Murray-Darling Basin Authority (MDBA)** and the MRC, supported by the Australian Department of Foreign Affairs and Trade (DFAT) (signed in June 2019; valid until 2024) MoU between the **Michigan State University** and the MRCS on "Research and Academic Exchanges to Promote International Collaborations on the Study of the Impacts of Climate Change and Large Dams on Hydrological, Ecological, and Socio-Economic Systems in the Lower Mekong River Basin" (signed in July 2019; valid until 2024)
2020	MoU between the **International Office for Water (OIEau)** and the MRCS on cooperation on water resources management (valid until 2025) General Collaboration MoU between the **Arizona Board of Regents** for and on behalf of **Arizona State University ("ASU")** and the MRCS (signed in August 2020; valid until 2025) MoU between the **United Nations Environment Programme (UNEP)** and MRC (signed in 2020; valid until December 2023)
2021	MoU of cooperation between the **State of Israel** and MRC on water resources development and management (signed in September 2021, valid until 2026 and automatically renewable)

2022	MoU concerning a partnership between the **Mississippi River Commission** and the MRC (renewed in 2022) MoU concerning a partnership between the **Kingdom of Morocco** and the MRC (renewed 2022, valid until 2027) MoU between the **Ministry of Oceans and Fisheries of the Republic of Korea** and the MRC on cooperation in the fields of inland waterway improvement (signed in April 2022; valid until 2027)

Table 7.29. Level of exchange under each agreement in place between the MRC and other parties

Partner	Projects /activities	Level of exchange
Republic of Korea (KDI)	2020/21 Knowledge Sharing Program (KSP) with the MRC: Flood and Drought Management and Communication 2022/23 KSP – Global Knowledge Exchange and Development Center (GKEDC)	Medium
Fisheries and Aquaculture in the Lower Mekong Basin and Southeast Asia	A regional consultation workshop was held to strengthen the institutional platform of the Sub-Expert Group on Fisheries Participation in a regional consultation on the development of a Project-Based Action Plan (PBAP) for implementing the Mekong Basin-wide Fisheries Management and Development Strategy 2018–2022 (BFMS) Participation in discussions on fisheries management and development with the ASEAN Secretariat	Medium
Vietnam National Space Center	Vietnam Datacube; no action since the MoU was signed.	Low
Economic and Social Commission for Asia and the Pacific (ESCAP)	The ESCAP Annual Meeting was held.	Low
Association of Southeast Asian Nations (ASEAN)	1st ASEAN-MRC Water Security Dialogue in August 2021 ASEAN's inputs into the update of the Technical Guidelines for Water Quality Emergency Response and Management (Chapter 4), and contribution to the implementation of the BDS. Discussions between the MRCS and the ASEAN Secretariat on capacity building for combating and reducing plastic pollution, and the preparation of ASEAN Environmental Situation Report and Mekong SOBR 2023. 2022 ASEAN Study Tour to Switzerland with the participation of senior representatives from the MRC Member Countries and the MRCS, supported by the Swiss Agency for Development and Cooperation, focused on transboundary water management, disaster risk reduction and Integrated Water Resource Management.	High

K-Water	2021–2022: A collaborative project was carried out between the US (US Army Corps of Engineers [USACE], NASA) and K-Water, "Water Data Utilization Capacity Building Project in the Mekong Region". The first Mekong-Korea International Water Forum was held on 5– 6 October 2022.	High
Lancang-Mekong Water Resources Cooperation Centre	A MRC-MLC Water joint study was conducted, "Changing Patterns of Hydrological Conditions of the Lancang-Mekong Basin and Adaptation Strategies".	High
Murray-Darling Basin Authority (MDBA)	MDBA's peer review of the draft Basin Development Strategy (BDS). Exchanges visits to MDBA in 2019 and 2023.	Low
Michigan State University	Michigan State University provided four data loggers for the groundwater activity in March 2023, although these data loggers have not yet been installed.	High
United States Army Corps of Engineers (USACE) with support from Arizona State University (ASU)	A web-based Shared Vision Planning (SVP) Tool was developed, aimed at helping to visualize information from studies and reports on an interactive map of the Mekong River, for example, the Council Study and the State of Basin Report (i.e. joint effort between the MRC and the USACE with technical support from the ASU).	High
UN Environment Programme (UNEP)	The project, "Promotion of Countermeasures Against Marine Plastic Litter in Southeast Asia" was carried out in the Member Countries, resulting in the MRC Riverine Plastic Debris Pollution Monitoring Programme. A Regional Training Workshop was held, "Assessment and Monitoring of Plastic Pollution in the Mekong River". Project deliverables were: a report on plastic pollution in the Lower Mekong River Basin as part of the MRC Riverine Plastic Monitoring (RPM); detailed methodology for the MRC RPM; and national training sessions on plastic leakage and plastic waste management at ports/ piers.	High
State of Israel	Israel's Agency for International Development Cooperation (MASHAV) and the MRCS (AI of PD) organized two professional exchange meetings (online), and a regional capacity-building workshop on groundwater for the MRC Member Countries (2022). There was a communication with the MASHAV team on what activities could be implemented in 2023.	Low
Mississippi River Commission	The Sister Rivers Exchange programme fosters the sharing of experiences through the promotion of international collaboration, technical exchanges, and the sharing of best practices for transboundary water resources.	High
Kingdom of Morocco	A 2017 visit was made to Morocco to share knowledge on renewable energy, including wind and solar energy. Morocco's planned funding of the MRC Educational Visitor Centre.	High

Republic of Korea, Ministry of Oceans and Fisheries	The project, "Establishment of Action Plan for Promoting Waterway Investment in regard to Vitalize the Cargo Transport Tourism in Mekong River Region", aims to consolidate the foundation of the peace and win-win prosperity among some Asian countries such as **Republic of Korea** through the pursuit of the safety and efficiency of Mekong Inland Waterway Transport system The Korean team conducted data collection and an analysis to identify suggested solutions and a possible feasibility study for specific river port and other infrastructures project in the Navigation Master Plan. A final report was issued in August 2023, which wrapped up the project.	Medium
United Nations Office for South-South Cooperation	The project, "Triangular Cooperation Project on Sustainable Development in the Lower Mekong Basin based on the Water-Energy-Food (WEF) Nexus" or Phase 3/P-LINK", supported by the United Nations Office for South-South Cooperation and the Republic of Korea's Ministry of Science and ICT, was jointly implemented by Mekong Institute (MI) and the Science and Technology Policy Institute (STEPI). The project aims to strengthen access to water, food and energy for vulnerable communities via the application of Korean technological solutions in MRC Member Countries. National pilot projects are set to launch by the end of 2023 and run until 2025.	High
Asia Disaster Preparedness Center (ADPC)	Current short-term flood and drought forecasting was enhanced, and technical collaboration initiated, also with support from the SERVIR Mekong programme, for the development of a Reservoir Assessment Tool (RAT-Mekong).	High

The MRC has been very active over the recent years building and extending engagement with strategic partners that can support joint efforts towards the BDS Outcomes 2021–2030. Partnership agreements are in place with various countries, cooperation platforms and organizations, including other river basin organizations and scientific institutions. These agreements have led to the implementation of a range of initiatives, projects and activities with varying degrees of intensity. Cooperation with MRC Dialogue Partners in the UMB is strengthening, as evident by the enhanced sharing of data on hydrological conditions and participation in joint research and studies on areas of mutual interest. Overall, the status of partnerships between the MRC and other parties is considered 'Good'.

7.4. Equity of benefits derived from the Mekong River system

7.4.1. Assessment methodology

Article 5 of the 1995 Mekong Agreement commits Member Countries to the reasonable and equitable utilization of the waters of the Mekong River system. Member Countries each seek to achieve their share of equitable utilization, recognizing that this may be achieved through different means appropriate to each country's national circumstances and interests. There are often, however, trade-offs between social, environment and economic conditions as a result of development, management and conservation decisions that countries take; these trade-offs may be felt both within a country and between countries. The strategic indicator of equity of benefits derived from the Mekong River system seeks to enable an open and transparent dialogue between countries on the equitable utilization of the common resource. There are three assessment indicators:

- Overall environment benefits derived in each country's part of the Basin
- Overall social benefits derived in each country's part of the Basin
- Aggregate economic benefits derived from water-related sectors in each country's part of the Basin.

Each assessment indicator is evaluated based on the country-specific data obtained from each assessment indicator in the Social, Environment and Economic Dimensions.

7.4.2. Overall environment benefits derived in each country's part of the Basin

Very Good	Good	**Of Concern**	Requires Action	Requires Urgent Action

Each basin country has a different endowment of natural resources and capacity to leverage the benefits that the basin environment provides through ecosystem services that vary in quality and quantity across ecosystem types. The environment of each country is also more or less impacted by development that occurs in different parts of the Basin, both within the country and beyond.

As indicated in Chapter Three, all countries are being affected by the change in flow regime that is occurring along the mainstream of the Mekong River. The flattening of the annual hydrograph with flows redistributed from the flood season to the dry season is occurring in all areas, from the north of the Basin to the south. While the proportional impact is greatest in the north, and in particular in China, Myanmar and the northern parts of Lao PDR and Thailand, the biggest absolute changes are occurring downstream, in Cambodia and Viet Nam. Cambodia and Viet Nam are also most affected by the reduction in Tonle Sap reverse flows, which is likely to have negative impacts on fish populations given the close correlation between reverse flows and fish catch in the lake, and the extent of wetland area around Tonle Sap and the Mekong Delta. Reduced reverse flows have also likely been a factor in high salinity intrusion evident in the delta over recent years, together with sea-level rise and other local factors, which mostly affect Viet Nam due to its coastal location.

Water quality and ecological health do not show any strong geographic trend, because stations in each basin country are more or less likely to exceed the PWQ thresholds for different parameters at different times. However, stations in Viet Nam are slightly less likely to have a rating of 'Good' for the Indices for the Protection of Human Health, Aquatic Health, and Agricultural Use. In 2021, the ecological health indicator of ATSPT was exceeded at all stations in Viet Nam for all taxa, indicating sites that are under stress and more favourable to biota that dominate in disturbed environments. But other countries also experienced a significant deterioration in these indicators across the biological groups assessed.

Reduced sediment flows are proportionally greater in the upper parts of the LMB, but also substantial along the length of the mainstream. Sediments carried from upstream are critical to floodplain rejuvenation, carrying nutrients that support fisheries and agriculture. These sediments also help maintain the integrity of the delta and buffer coastal erosion processes.

As reported in the 2018 SOBR, wetland areas have declined throughout the Basin, but the impact is proportionally the greatest in the expansive floodplains of the Mekong Delta, affecting Cambodia and Viet Nam the most. The reduction in wetland areas is likely to have flow-on effects on basin fish populations that depend on flooded areas to recharge the carbon and nutrient inputs to the system, which is the basis of all productive ecosystems. The ongoing decline in the area of mangroves exclusively affects Viet Nam and may have important implications for the resilience of coastal areas of the Basin in the face of rising sea levels due to climate change.

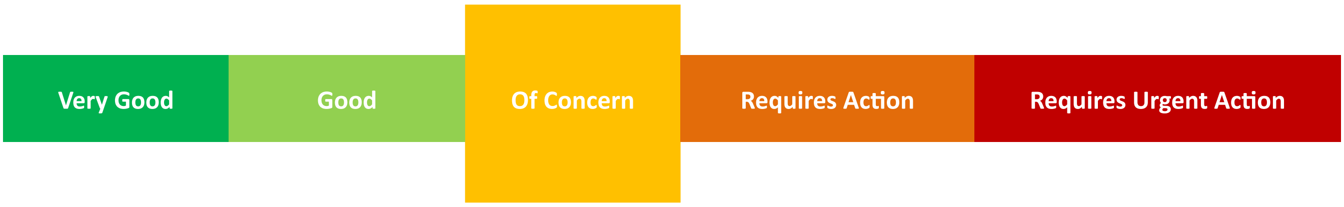
As reported in Chapter Five, Cambodian wetlands contribute between 55% and 58% of the total economic value of LMB wetlands (excluding water bodies) from which all basin countries and others outside the Mekong River Basin benefit. Wetlands in Lao PDR contribute between 14% and 15%; in Thailand, around 8%, and in Viet Nam, between 19% and 23%. Flooded forests contribute approximately 30% of the total economic value; marshes and swamps up to 1%; inundated grasslands up to 27%; and mangroves up to 42%.

As reflected in Chapter Three, fish populations are under stress throughout the Basin. The total fish catch has declined over the last five years, driven mainly by declines in the catch from Tonle Sap and the 3S sub-basin, while other ecological zones show either stable or increasing catch. There is evidence, albeit inconclusive, that fish caught are of a greater diversity and smaller size than in the past. There are declines in CPUE at some locations and increases at others, and a large number of fish species are listed as threatened. There are declines in CPUE at some stations in each country.

Fisheries are important for all basin countries as a source of food security and livelihoods for millions of people and are a major part of the economic value derived from wetlands. As outlined in Chapter Five, the economic value of basin fisheries was estimated from the MRC's updated habitat yield assessment at USD 7.1 billion – USD 8.4 billion per year in 2020, with USD 1.2 billion – USD 2.0 billion in Cambodia, USD 0.6 billion – USD 0.8 billion in Lao PDR, USD 3.4 billion – USD 5.1 billion in Thailand and USD 1.1 billion – USD 1.2 billion in Viet Nam. With regard to wild catch, this importance may be greater for Cambodia than the other countries, especially as a proportion of overall economic activity. Thailand and Viet Nam derive significant economic value from fisheries, although much of the total fisheries' value is derived from wild fish in rice fields and aquaculture production capabilities, respectively.

Overall, the environmental benefits derived from each country's part of the Basin are different and contribute not only to the country from which they are derived, but also to all basin countries and beyond. The impact of development, however, tends to disproportionally affect downstream areas as a result of the cumulative impacts from upstream and as well as those originating in the immediate vicinity from past and present development. This cumulative development impact is common in river basins throughout the world. For this reason, and due to the relatively poor conditions and trends across several indicators in the Environment Dimension, this assessment indicator is assessed to be 'Of Concern'.

7.4.3. Overall social benefits derived in each country's part of the Basin



Overall living conditions and well-being in the LMB have improved significantly over the last 15 to 20 years; all countries have experienced: improvements in access to food and in nutritional outcomes (as indicated by falling malnutrition levels); more extensive access to safe water for drinking and agriculture and to basic sanitation and health facilities; falling mortality rates and increased life expectancy; and improved access to electricity.

However, each basin country is at a different stage of development and therefore shows variation in performance against the different indicators of living conditions and wellbeing. Some significant gaps between countries remain. For instance, access to safe drinking water is much lower in Cambodia's and Lao PDR's areas of the Basin than it is in Thailand and Viet Nam.

The slowing of progress is more broad-based across the basin countries with regard to food security. Although the adequacy of dietary energy supply continues to increase across all countries, demonstrating that more than enough food is likely being produced, the decline in the prevalence of undernourishment has slowed and even stopped in almost all countries. As mentioned above, this may reflect that some groups within society are facing chronic food security with inequality of access and entrenched vulnerability.

With regard to access to basic sanitation services and to electricity, countries continue to increase services to a greater share of the population for both of these indicators. Employment in water-related sectors also varies by country, with the decline in the proportion of people employed in agriculture in Cambodia and Lao PDR lagging behind the other basin countries. Cambodia has almost twice as many people employed in agriculture than Viet Nam, although the difference in fisheries is small, and Viet Nam has a higher proportion of people employed in hydropower and forestry, albeit at much smaller percentages than for agriculture.

Overall, this indicator is assessed to be 'Of Concern'. Although differences between countries are to be expected, large gaps remain, and progress is slowing on some indicators of water, food and energy security in some countries at levels well short of 100% of the population, suggesting that remaining gains may well be increasingly difficult to achieve.

7.4.4. Aggregate economic benefits derived from water-related sectors in each country's part of the Basin

Very Good	**Good**	Of Concern	Requires Action	Requires Urgent Action

Each basin country has a different endowment of resources and capacity to exploit them for economic gain based on its level of technological development, supporting infrastructure and human capabilities. The basin area of all countries makes a substantial contribution to national food grain, protein and power supply. As expected, food grain supply from the Basin as a proportion of national supply is greater in Cambodia and Lao PDR given the larger overlap of the Basin with their national jurisdiction, while the proportion of national protein supply from the Basin is highest in Cambodia. However, the overall production of rice in absolute terms is much higher in Thailand and Viet Nam. Total fish production from the Basin is highest in Viet Nam, Cambodia and Thailand. Lao PDR produces by far the greatest share of national consumption from its hydropower resources, at over 500%, reflecting the export destination of much of its power generation especially to other basin countries including Thailand and Cambodia.

The annual economic value from rice production is around 1.5 to 3 times higher in Thailand and Viet Nam than it is in Cambodia and Lao PDR. The economic value of hydropower production is highest in China and Lao PDR, followed by Viet Nam; Cambodia, Myanmar and Thailand produce much lower economic value from hydropower than the other countries. Viet Nam dominates navigation movements for cargo and passenger transport, recording much higher volumes than in Cambodia and Thailand. Understanding the benefits derived from sand mining between countries in the Basin is hampered by difficulty in accessing data. No data on sand mining were available from Cambodia, Lao PDR or Thailand.

As described above (Section 7.4.2), Cambodian wetlands contribute between 55% and 58% of the total economic value of LMB wetlands (excluding water bodies) from which all basin countries and others outside the Mekong River Basin benefit. Wetlands in Lao PDR contribute between 14% and 15%; Thailand, around 8%; and Viet Nam, between 19% and 23%. In net present value terms, the economic benefits derived from wetlands in Cambodia are more than twice as high as the next highest country, Viet Nam.

The value of capture fisheries is highest in Thailand, followed by Cambodia and then Viet Nam, and lowest in Lao PDR. However, Viet Nam dominates the aquaculture sector, followed by Cambodia, and there is only a minimal value extracted by Lao PDR and Thailand.

Across the water-related sectors, the largest estimated economic values are derived from wetlands, followed by fisheries (including aquaculture) and rice production (Table 7.13). However, it is likely that there is significant duplication of estimates from wetlands with other water-related sectors, such as rice and fisheries production. In addition, much of the ecosystem services derived from wetlands can be difficult to monetize directly and are benefits that are often derived by countries well beyond where the wetlands are actually located.

Table 7.30. Estimated gross annual economic values by country and water-related sector in the Mekong River Basin

	Annual economic value (USD billion)				
Sector	**Cambodia**	**Lao PDR**	**Thailand**	**Viet Nam**	**Total**
Rice production	2.05	1.16	3.80	6.20	**13.20**
Hydropower	0.29	2.01	0.10	1.05	**3.45**
Sand mining	-	-	-	0.06	**0.06**
Wetlands	16.56	4.22	2.33	6.35	**29.46**
Capture fisheries	1.60	0.80	4.30	1.10	**7.80**
Aquaculture	0.80	0.23	0.23	6.94	**8.20**
Forestry	0.11	0.20	-	0.15	**0.46**
Total	**21.41**	**8.62**	**10.76**	**21.85**	**62.63**

Although only a partial assessment, considering that it has not been possible to calculate an annual economic value for each sector in each country (see Chapter Five), and given the limitations mentioned above, the total economic values derived from water-related sectors in the LMB are highest in Viet Nam and Cambodia, followed by Thailand and Lao PDR. On a per capita basis, the economic values are similar for Cambodia, Lao PDR and Viet Nam, ranging between USD 1,207 and USD 1,574, but are much lower in Thailand (Table 7.14). As stated earlier, gross economic output is not an ideal indicator of economic performance in terms productivity because it does not account for input costs or production externalities, both of which are important considerations for the sectors considered.

Some countries derive more benefits from some sectors than others. However, each basin country derives significant aggregate economic benefit from water-related sectors in the Basin; hence, overall, conditions regarding this indicator are assessed as ‘Good’.

Table 7.31. Partial estimate of gross annual economic value per capita derived from water-related sectors in the Mekong River Basin, by country

	Cambodia	Lao PDR	Thailand	Viet Nam
Economic value (USD billion)	21.41	8.62	10.76	21.85
Population (million persons)	13.6	6.8	23.8	18.1
Economic value per capita (USD billion)	**1,574**	**1,268**	**452**	**1,207**

7.5. Progress towards BDS Outcomes

The BDS 2021–2030 outlines two outcomes under the Cooperation Dimension Strategic Priority for achievement by 2030:

1.1 Strengthened MRC for more effective implementation of the Mekong Agreement

1.2 Increased joint efforts and partnerships for more integrated management of the entire river basin.

These outcomes seek to ensure that, by 2030, cooperation on water resources management and development is strengthened among all basin countries and stakeholders, enhancing sustainable development and increased benefits for all while enabling greater equity of benefits between countries across the Social, Environmental and Economic Dimensions. The assessment of progress towards BDS 2021–2030 Outcomes in the Cooperation Dimension is summarized in Table 7.15. It takes into consideration that the alignment of strategic indicators with each BDS Outcome in the alignment of strategic and assessment indicators with BDS 2021–2030 Outcomes is not always a one-to-one relationship. In many cases, the indicators provide relevant information to evaluate progress towards more than one BDS Outcome (Table 1.3). Where this is the case, commentary cross-referencing the results of evaluation against assessment indicators in other dimensions or for other strategic indicators is provided.

Progress towards the outcome of a strengthened Mekong River Commission for more effective implementation of the Mekong Agreement is generally on track. This is indicated by the progress that countries are making in their commitment to the financing of the MRC by 2030, the extent of knowledge-sharing activities, and work toward strengthening the implementation of the MRC Procedures, especially the PNPCA. Prime Ministers of the four Member Countries also restated their commitment to joint efforts to strengthen the MRC in the 2023 Vientiane Declaration.

To date, Member Countries are meeting their commitments to increase their financial contributions to the MRC. This is important for the organizational development of the MRC, providing greater financial sustainability, especially in relation to the MRC's core functions as a transboundary river basin organization. However, there are significant challenges ahead as the additional contributions required of Member Countries will be greater over the coming years than in the past. It remains to be seen whether public finances in each country can sustain the progress made to date, given competing priorities and strained national budgets following the COVID-19 pandemic. If high levels of inflation persist, this will also erode the benefits from greater nominal contributions.

Progress with knowledge-sharing activities is also good, with a high level of stakeholder engagement activity and a number of joint studies including with MRC Dialogue Partners. However, there has been a shift in the volume of information provided from published reports, with value-add from the MRC to more open and direct provision of information and data that might be expected to enable the work of others including through the MRC data portal.

Table 7.32. Summary of progress towards BDS 2021–2030 Outcomes based on conditions and trends for aligned strategic indicators in the Cooperation Dimension

BDS Outcomes	Strategic indicators	Condition	Trend	Key issues	BDS progress
5.1 Strengthened Mekong River Commission for more effective implementation of the Mekong Agreement	Self-finance of the MRC	●	↗	National budget pressures post-COVID-19	↑
	Benefits derived from cooperation	●	↔	Challenges in evaluating and communicating the benefits of cooperation and joint projects. Coordination of project activities across the Basin Identifying, financing and implementing joint projects that increase benefits and reduce costs for all basin countries.	
5.2 Increased joint efforts and partnerships for more integrated management of the entire river basin	Equity of benefits from the Mekong River system	●	↗	The need for joint investment and associated cost and benefit-sharing mechanisms between countries.	↗

Over recent years, there has been earlier engagement between countries on projects notified under the PNPCA, and greater supply of information and outreach by the MRC to basin stakeholders to support consultation on proposed projects. However, further cooperation and more intensive water diplomacy are needed to implement Joint Action Plans resulting from the PNPCA process if agreement on notified projects is ultimately to be reached. The identification of supplementary joint investment projects through the regional planning activities of the MRC should also contribute to more optimal solutions to basin challenges and an agreement of development pathways with greater potential for sharing the benefits and costs of water resources development. However, at the time of preparing this SOBR, the implementation of proactive regional planning was only just getting underway. Since the enhanced implementation of other MRC Procedures depends at least in part on outputs from regional planning activities, progress to date has also been limited.

With regard to the BDS Outcome on joint efforts and partnerships for more integrated management of the entire river basin, there are both positive developments and continuing challenges. Progress is evident in terms of the development of partnerships and knowledge sharing, as mentioned above. However, progress has been very slow on the identification and implementation of joint projects that have the potential to significantly change conditions on the ground in basin countries.

The MRC currently has 17 partnership agreements in operation, with around 10 involving a high level of exchange. In addition, with few exceptions the benefits of the joint projects agreed by the Member Countries are not sufficiently evident, due to, *inter alia*, slow resource mobilization and implementation. Although defining and evaluating the benefits of cooperation can be amorphous, intangible and difficult to determine, there would be value in the MRC developing an approach to monitoring and evaluating the benefits of cooperation. This would enable better measurement of progress over time and help guide improvement in the areas most likely to make a real difference. A better demonstration of the benefits of cooperation will also lead to more cooperation.

Closing the gap towards achieving the BDS outcomes in the Cooperation Dimension over the coming years will require the continued fostering of greater trust between the countries and the implementation of regional perspectives in national projects and activities. Significant joint investment projects are considered an essential foundational element to building trust and providing avenues for cost and benefit sharing. It is imperative that regional planning identify project opportunities that can be developed and implemented through agreement between countries. There would also be value in the MRC having greater visibility of the large number of projects and initiatives being undertaken outside the remit of the MRC so as to facilitate cooperation, reduce duplication, and improve the efficiency and focus of its activities in partnership with others. This need becomes greater as the Mekong Fund is developed in order to complement other funding mechanisms, including global environment and climate change funds operating throughout the region.

Other priorities that would help basin countries to achieve the BDS Outcomes are: additional capacity building for water diplomacy through the implementation of an organizational development plan; monitoring and follow-up on the implementation of the Joint Action Plans from the PNPCA; further improvement of the MRC Data Portal to support joint efforts towards achieving the BDS Outcomes; and greater prioritization of partnership opportunities that are better resourced for mutually beneficial activities.

CHAPTER 8

CONCLUSIONS AND RECOMMENDATIONS

CHAPTER 8: CONCLUSIONS AND RECOMMENDATIONS

8.1. Conclusions on the State of the Mekong River Basin in 2023

8.1.1. Overview of the state of conditions and trends

The 2023 SOBR follows a structured and systematic approach to assessing the current status of conditions and trends in the Mekong River Basin. The approach is based on the MRB-IF and its related Technical Guidelines, recognizing the need for flexibility in how the assessment of the status of each strategic and assessment Indicator is undertaken given data limitations and inconsistencies within and between basin countries and at the regional level.

The assessment of the status of conditions and trends is oriented towards considering progress towards the BDS 2021–2030 Outcomes in each MRB-IF Dimension in order to serve as the guide to the refinement of the implementation of the BDS over the remainder of the period to 2030. Recommendations are provided so that basin stakeholders working on water-related issues can consider them in updating their strategies, action plans and work activities over the remainder of the current BDS period and to facilitate cooperation among relevant parties towards common objectives.

The overall conclusions, challenges and recommendations are summarized in Table 8.1 and then described in subsequent sections for each dimension. Section 8.2 then provides an assessment of the conditions within the Mekong River Basin taking to consideration the relevant SDGs. Section 8.3 draws together recommended priority actions for consideration in improving the implementation of the BDS 2021–2030 and enhancing future State of Basin assessments.

Table 8.33. Summary of conclusions, challenges and recommended priority areas for basin stakeholders to refine the implementation of the BDS 2021–2030

Strategic indicators	Strategic questions		Status/condition	Challenges	Recommended priority actions to refine BDS implementation [Relevant BDS Output]
ENVIRONMENT					
Water flow conditions	Is the water flow in the Mekong mainstream adequate for maintaining the ecological function of the Mekong River Basin?	●	Partially compliant with the Procedures for Monitoring Flows on the Mainstream (PMFM), but severe dry season conditions at some stations and significant concerns about the reduction in Tonle Sap reverse flows, with potential implications for wetland areas, fish populations and salinity intrusion in the delta.	Balancing objectives implicit in the different PMFM thresholds, especially between lower flood season flows and reduced Tonle Sap Reverse flows Development impacts not readily reversible or mitigated, and potentially compounded by climatic variability and climate change.	Regional planning must identify supplementary measures and alternative pathways to help minimize further changes to Tonle Sap reverse flows. [3.1.1] Additional flow thresholds are needed to help countries minimize the environmental impacts of an increase in dry season flows and a reduction in flood season flows. [1.2.1] A holistic Tonle Sap management plan should be developed and implemented that addresses both local and transboundary threats and challenges. [1.3.1]
Water quality and sediment conditions	Is the water quality and sediment transport in the Mekong mainstream adequate for maintaining the ecological function of the Mekong River Basin?	●	Generally compliant with the PWQ but sediment transport is much reduced and there are concerning trends in some individual water quality parameters.	Identifying causes of water quality issues and implementing coordinated national policies and strategies to address issues, where necessary Development impacts on sediment transport not readily reversible or mitigated, once caused.	Regional planning must identify supplementary measures that minimize further loss of sediment from Mekong tributaries and mitigate current impacts. [3.1.1] The causes of concerning water quality changes in relevant parts of the Basin should be investigated. and a regional study undertaken on heavy metals in sediment, water columns and biota. [1.1.1]

Strategic indicators	Strategic questions		Status/condition	Challenges	Recommended priority actions to refine BDS implementation [Relevant BDS Output]
Status of environmental assets	Are key environmental assets in the Mekong River Basin adequately protected and conserved to maintain the provision of ecosystem services?	●	Loss of wetlands and increasing pressure on fisheries.	Floodplain development and flow regime changes continuing to reduce wetland areas. Instream barriers to fish migration continue to be constructed with mitigation measures of uncertain effectiveness.	The ecological conditions with protected areas in the Basin should be investigated, and the application of improved management guidance for priority regional assets at other important sites should be supported. [1.3.1 and 1.3.2] Methodologies should continue to be developed and improved for assessing the conditions of riverine, estuarine and coastal habitats. [1.3.2] Investment measures and alternative development pathways that minimize the need for further instream barriers, especially on any remaining free flowing rivers, and that promote synergies between wetland conservation and floodplain storage and flood flow, especially in the delta, should be identified and implemented. [3.1.1]
SOCIAL					
Living conditions and well-being	Is the utilization of the Mekong's water and related resources strengthening the water, food and energy security of basin communities?	●	Household water, food and energy security all improving, but insufficient information on equality of access for vulnerable groups and some concerning slowing of progress in some countries.	Data collection at an appropriate scale and level of disaggregation to identify inequalities between groups, potential chronic problems in some vulnerable communities, and to target national policies appropriately. Identifying the causes and identifying solutions for slowing of progress in some countries.	A plan should be developed and implemented to improve the collection and analysis of gender and vulnerability disaggregated data based on the MRC's review of current data availability. [2.1.4] Causes of slowing progress in some indicators of water, food and energy security should be investigated, and appropriate national policy responses developed. [2.1.1]

Strategic indicators	Strategic questions	Status/condition		Challenges	Recommended priority actions to refine BDS implementation [Relevant BDS Output]
Livelihoods and employment in water-related sectors	Are the livelihoods and employment conditions of basin communities helping increase economic security and reduce poverty among vulnerable people?	●	Livelihoods and economic conditions generally improving, but further information needed on gender equality and economic security of vulnerable groups.	Managing the transition from employment in water-related sectors to more productive economic activities. Supporting vulnerable groups' access to employment opportunities in growth sectors.	Given remaining data gaps related to household economic security, revised indicators may be needed or further effort to collect subnational data on employment and economic engagement, including by gender. [2.2.1 and 2.1.4]
ECONOMIC					
Contribution to basin economy	How important are the Basin's water-related sectors to the basin, national and regional economies?	●	Water-related sectors are important sources of national food grain, protein and power production, but likely a smaller component of overall economic activity since manufacturing and services sectors take a larger share.	Managing the change in economic structure to facilitate new opportunities and support community transition, especially for vulnerability groups dependent on natural resources	Supplementary investment projects that support inclusive growth, including of vulnerable communities and especially those facing food insecurity, should be identified and implemented. [3.1.1]
Economic performance of water-related sectors	To what extent are water-related sectors contributing to optimal and sustainable development of the Mekong River Basin?	●	The gross economic value of each sector is increasing, but there is insufficient information to identify net value-add or sustainability of growth in each sector, noting concerns in the Environment and Social Dimensions.	More systematic data collection on net economic values to understand value-add and therefore to evaluate the true costs and benefits of development and how sustainability can be improved.	A process should be implemented to identify and collect data on input costs for water-related sectors to enable a proper assessment of the economic value, possibly through a regional study identifying standard or benchmark rates in each basin country. This would improve cost-benefit evaluation of basin development. [3.1.1 and 4.1.5]

Strategic indicators	Strategic questions		Status/condition	Challenges	Recommended priority actions to refine BDS implementation [Relevant BDS Output]
CLIMATE CHANGE					
Greenhouse gas emissions	To what extent are greenhouse gas emissions from the Mekong River Basin contributing to global emissions?	●	The Basin's contribution to global emissions is small, but is also a potential carbon sink since overall forest and tree cover loss appears to have declined.	Decarbonizing a fossil-fuel heavy electricity grid and decoupling greenhouse gas emissions from economic growth. Watershed management for improved carbon sequestration.	Increased investment in renewable energy and supporting grid infrastructure are needed based on optimizing water-energy solutions that take sustainable development objectives into account. [3.1.1]
Climate change trends and extremes	What is the evidence of climate change within the Basin, and has there been a change in the frequency and severity of floods and droughts?	●	Temperatures are increasing. Severe floods may be less frequent, but there are growing concerns about changes in the timing and extent of drought. Rising sea levels at the delta are likely to be a significant problem.	Temperatures and sea levels will almost certainly continue to rise throughout the century. Climate change impacts on flood and droughts remains less clear, but still require action for increased resilience under conditions of deep uncertainty.	A comprehensive scientific assessment should be undertaken of the impact of climate change to date on floods and droughts in the Basin, distinguishing between climate change, normal climate variability and short-term trends. [4.2.2] Monitoring and forecasting of floods and droughts should continue to be enhanced at multiple scales, and links strengthened with national monitoring and early warning systems. [4.1.4]

Strategic indicators	Strategic questions		Status/condition	Challenges	Recommended priority actions to refine BDS implementation [Relevant BDS Output]
Adaptation to climate change	Are basin communities adequately informed and prepared for changing river conditions, and are they adapting to climate risks?	●	Strong awareness at the government level, but adaptation likely insufficient to meet the challenge posed by climate change to water and related resources in the Basin.	Moving from planning and priority setting to implementation. Financing for adaptation given the scale of the problem and increasingly likely and significant impacts. Capacity building, policy coherence and coordination between sectors and countries.	The redesigned MRC Core River Monitoring Network should be embedded into business-as-usual operations, and it should be ensured that ongoing funding for core monitoring activities is ring-fenced and secure for the foreseeable future. [4.1.5] Flood and drought solutions (including nature-based solutions) should be prioritized in regional planning to identify supplementary investment options under potential future climatic conditions and to cooperate on large-scale regional projects that contribute to climate resilience, with the support of a Mekong Fund and in coordination with enhanced access to global funds. [4.2.2 and 5.2.3] Mangrove protection and restoration should be emphasized as a cost-effective measure to buffer against rising sea levels and storm-surge risks at the delta coast. [4.2.2]

Strategic indicators	Strategic questions	Status/condition	Challenges	Recommended priority actions to refine BDS implementation [Relevant BDS Output]
COOPERATION				
Self-finance of the MRC	Is the strengthening of the MRC on track according to the commitments made by its Member Countries?	● On track with Member Country contributions meeting targets to date.	Ongoing pressures on public finances post-COVID 19 with significant increases in contributions still to come	Value should be demonstrated by implementing the MRC's contribution to the BDS 2021–2030 in full, and facilitating, coordinating and encouraging others to align effort and work towards common objectives throughout the Mekong River Basin. [5.2.3]
Benefits derived from cooperation	What are the benefits derived from cooperation between basin countries?	● Slow progress on developing, financing and implementing joint or transboundary projects between countries. Strong focus on knowledge-sharing activities and stakeholder engagement. Variable levels of engagement under partnership agreements between the MRC and others.	Lack of any significant joint investment projects that bind countries together in joint efforts to maximize benefits and minimize costs of development. Challenges in evaluating and communicating the benefits of cooperation and joint investment projects. Coordination challenges and opportunities of project activities across the Basin likely to grow with the implementation of a regional Mekong Fund.	Improved approaches should be developed to evaluate the benefits of cooperation so that effort can be targeted where it is most effective. [5.2.1] Regional planning must identify joint investment projects that ensure mutual interests and a common stake in sustainable development pathways for all countries. [3.1.1 and 5.2.2] To improve coordination and efficiency, awareness and visibility of projects and initiatives being undertaken by countries and partners throughout the Basin should be increased. [5.2.2]
Equity of benefits from the Mekong River system	Do the basin countries derive equitable benefits from the utilization of the Basin's water and related resources?	● Each country benefits to a greater or lesser extent in each dimension and from different water-related sectors.	Downstream areas are more adversely affected by cumulative development impacts combined with past and present local impacts of various opportunities to maximize economic and social welfare.	Benefit-sharing models are needed to facilitate joint investments between countries in economic activities and share the benefits from downstream wetlands and their ecosystem services. [5.2.2]

8.1.2. The Environment Dimension

Is the water flow in the Mekong mainstream adequate for maintaining the ecological function of the Mekong River Basin?

There has been a clear and significant change in the flow regime of the Mekong River Basin over the last decade. Dry season flows are higher and flood season flows lower than in the past. The changed flow regime is evident along the length of the river, with the proportional impact greatest in the upper parts of the Basin and the overall volumetric impact greatest downstream, likely reflecting the cumulative impacts of development throughout the Basin and recent climatic conditions, especially lower annual precipitation.

These changes are broadly consistent with the Joint Study, demonstrating a shift in the proportion of the annual flows in the dry season compared to the flood season, for example, at Chiang Saen, from 20% of annual flows in the dry season and 80% in the flood season during the 2000–2009 period to 40% of annual flows in the dry season and 60% in the flood season during the 2010–2020 period. The average change across nine mainstream stations is a shift between the two periods from 18% to 28% of annual flow now occurring in the dry season.

The change in the flow regime should make the PMFM thresholds easier to meet. Although dry season flows have become more stable in recent years at some stations (e.g. at Chiang Saen), with potential benefits for some agriculture and aquaculture activities, at other stations, flows and water levels (e.g. at Tan Chau) are more unstable, reflecting that, especially in dry years, unstable and even severe conditions still occur despite the increased regulation of flow. When unstable conditions do occur, it is mostly in the early part of the dry season, from December to February, although at some locations in recent years these unstable and severe conditions are extending even into March.

Lower flood season flows are causing reduced Tonle Sap reverse flows (especially when compared to the period prior to 2009), which is of significant concern given the importance of this hydrological mechanism to wetland areas, fisheries and OAAs, agriculture and rural livelihoods – not only around Tonle Sap, but also throughout the Mekong Delta, and with potential implications for food security more broadly. As reflected in the Joint Study, reduced reverse flow volumes also mean lower outflows to the delta in the early dry season, which is a likely contributing factor (in conjunction with sea-level rise and other local influences) to the increased riverine salinity concentrations, well above levels that would have severe consequences both for general irrigation, paddy rice and some aquaculture if control measures were not in place. Reduced Tonle Sap reverse flows over the last decade have been attributed by the Joint Study to be both from reduced wet season rainfall and increased storage and water withdrawal in the whole basin.

There has also been a change in the timing of the onset of flood season flows, with a delayed start and shorter flood season over the last decade compared to the 30 years prior. The delayed onset to the flood season also means a delay in the onset of reverse flows to Tonle Sap. Further investigation of the factors influencing the flow of the Tonle Sap Lake will be undertaken in a subsequent phase of the MRC-MLC Water Joint Study.

There is uncertainty about the extent to which climate change could exacerbate or offset the observed flow changes in future, or do both at different times, during cyclical wetter and drier periods. The change in flow nevertheless puts additional pressure on wetlands and fish populations with less wetting and drying of floodplain vegetation and flooded forests in particular, reducing the carbon and nutrient inputs to the system.

Are the water quality and sediment transport in the Mekong mainstream adequate for maintaining the ecological function of the Mekong River Basin?

Water quality in the Mekong River Basin generally meets the requirements of the PWQ, with indices for human health, aquatic life, and agricultural use rate as ‘Good’ at almost all mainstream stations. However, there are some concerning trends in some individual parameters that warrant closer inspection to better understand what is causing the changes and whether any actions can and should be taken. Of particular concern is the increase in water temperature, which may be linked to climate change or reduced flows at certain times of year. Other changes to investigate are total nutrient levels (nitrogen and phosphorous), pH, electrical conductivity and total suspended solids. Updated information would also be beneficial on toxic pollution, including on heavy metals and pesticides.

Ecological stress is evident by high ATSPT values and increasing trends for biological markers at many sites across the Basin. There is also a large amount of plastic waste pollution in the Mekong River system. It is estimated the Mekong River contributes between 17.4 tonnes/day and 101 tonnes/day of plastic debris to the ocean, which is the 10th largest amount contributed by rivers globally. In the UMB, local water quality issues occur due to, *inter alia*, contamination with heavy metals (through mining wastewater), pesticides and fertilizers (agricultural wastewater).

There has been a substantial decline in sediment transport throughout the Basin over the last two decades. The drop in sediment from the upper to the lower basin from around 2009 has been reported in previous SOBRs and, as evident at Chiang Saen, largely stabilized, albeit at a much lower level. Further downstream sediment loads continue to fall with statistically significant trends at five of 15 stations, likely due to ongoing water resources development throughout the Basin. The average annual daily load from the measured samples across all stations dropped by around half over the 2012–2022 decade, which is generally consistent with previous MRC analysis, suggesting that the reduction relative to historic sediment loads is continuing. The potential impacts of a loss of sediment include increased riverbank, bed and coastal erosion, reduced nutrient deposition on the floodplain, and an exacerbation of land subsidence issues in the delta, especially in combination with sand mining.

The length of the Mekong River affected by salinity intrusion is highly variable from year to year. Some high salinity results in recent years may be due to lower flow conditions upstream, which are resulting in reduced Tonle Sap outflows early in the dry season, along with sea-level rise and other local factors. Further investigation of this issue may be warranted to identify whether the current controls in place to mitigate the impacts of riverine salinity on agriculture and other activities are adequate, or if other suitable measures need to be considered to mitigate the potential impacts.

Are key environmental assets in the Mekong River Basin adequately protected and conserved to maintain the provision of ecosystem services?

Environmental assets throughout the Basin remain under threat. The loss of wetlands and pressure on fish populations remain mostly as reported in the 2018 SOBR. Total fish catch across the LMB is lower in recent years, mostly driven by declines in the catch from Tonle Sap Lake. Over the last five years, fish catch generally declined in six ecological zones, was stable in three zones, and increased in one. There is evidence, albeit inconclusive, that fish caught are of a greater diversity and smaller than in the past. There have also been declines in CPUE at some locations and increases at others, and a large number of fish species listed as threatened. In the last five years, CPUE declined in five ecological zoneshas been relatively stable in four zones and increased in one. Reduced flood season flows, and especially Tonle Sap reverse flows, including due to drier overall conditions contributing to less flooded habitat, have led to lower estimate of the overall economic value of basin fisheries in this SOBR than in the 2018 SOBR. Fisheries production is known to be highly dependent on the annual flood pulse. The lower estimate of USD 7.1 billion to USD 8.4 billion is also due to a change in methodology that takes better account of the variable amount of flooded habitat within the assessment period.

While areas of natural wetland are known from previous SOBRs to have declined significantly in the past, more recent changes are difficult to quantify due to changes in assessment methodologies and classification definitions in land cover mapping. However, a particular concern is the ongoing decline in mangrove areas in the delta, which is evident both from MRC Land Cover assessments and from Mekong SERVIR products. Mangroves play an important role in buffering coastal areas affected by sea-level rise and typhoon-induced storm surge. As one of the most cost-effective measures protecting against wind and wave action on coasts, greater efforts are needed to protect and rehabilitate mangroves to buffer the impacts of climate change.

There has been insufficient information available for this SOBR to report on changes in areas of riparian vegetation, sandy habitats, riverbank erosion, and tree loss in protected areas using data sources approved and ground-truthed by Member Countries; ongoing methodology development and testing at the MRC seeks to change this for further SOBR assessments. There have been impressive efforts by basin countries to put in place protected areas of varying categories, now covering around 20% of the total basin area. Further action will be required to continually improve management and enforce conservation measures in these areas, and to protect and conserve Mekong River Basin ecosystems and biodiversity.

There has also been an increase in areas of plantation including orchards and other forest types with potentially important economic benefits, but which are less beneficial for wildlife. As noted in the BDS 2021–2030, more sustainable management of watersheds and environmental assets where the transfer of new viruses from animal to human host is most likely to originate is critical to risk mitigation for future disease outbreaks and their potential to become pandemics.

8.1.3. The Social Dimension

Is the utilization of the Mekong's water and related resources strengthening the water, food and energy security of basin communities?

Overall, water, food and energy security of basin communities have strengthened significantly over the past two decades, as indicated by measures such as: access to improved water sources; basic sanitation; potential adequacy of dietary energy supply; and access to electricity. All countries have experienced improvements in access to safe water for drinking and agriculture, and to basic sanitation, as well as lower rates of water-related disease and improved access to electricity. Food availability has improved, and rates of malnutrition have dropped. Progress, however, appears to be slowing, suggesting that it is likely that there are some groups in society who are especially hard to reach with public services and through economic engagement, and who may be experiencing entrenched disadvantages due to multiple, intersecting dimensions of vulnerability.

Although more than enough food is produced in the Basin to meet the dietary energy needs of the population, the prevalence of undernourishment and of stunting in children suggest that, despite recent improvements, there are persistent barriers to affordable, nutritious meals in some sections of society. Access to sanitation and electricity have also both improved, but often, the last remaining communities are the most difficult to reach.

There are also some large differences in basin populations between countries, for example, in access to improved water sources, that recent trends indicate may take a long time to close. Considerable effort will be needed in some countries to close the remaining gap towards achieving universal access by 2030 for the SDGs to be met.

Are the livelihoods and employment conditions of basin communities helping increase economic security and reduce poverty among vulnerable people?

Employment in water-related sectors is falling but remains relatively high given the importance of sectors such as agriculture and fisheries to livelihoods within the Basin. The reduction in employment in these sectors nevertheless reflects the broader economic transition underway in basin countries as productivity improvements in agriculture and the growth of other higher value-added sectors such as manufacturing and services attract workers, including to urban areas outside the Basin. Employment in sectors such as tourism is also showing strong growth.

These broader trends are undoubtedly contributing to the significant reduction in poverty that has occurred in all basin countries over the last 20 years. The reduced poverty is evident as measured both against international benchmarks and national poverty levels determined by each country. However, the reduction in poverty is slowing, and chronic levels of poverty persist in certain geographic regions. Analysis of poverty data by the World Bank in Cambodia, Lao PDR and Viet Nam suggests that a significant portion of the population remains economically vulnerable. Rates of land ownership also remain very low in some countries, especially Cambodia and Viet Nam.

Expenditure rates, and by implication income, have generally increased over recent years. However, these national-level improvements can mask important differences between different groups in society, and the extent to which conditions of the most vulnerable people are improving is not clear. More granular data are needed to draw conclusions about changes in vulnerability, because the data are not sufficiently delineated to ascertain the extent to which vulnerable people dependent on river and wetland resources have access to the employment opportunities and can overcome entrenched disadvantage to improve their economic circumstances. Identifying these vulnerable people and supporting them in new sources of employment in growth sectors should be a focus of countries as they manage the transition to increased levels of manufacturing and services sectors.

As indicated by the share of employment in water-related sectors and the GPI for enrolment in primary and secondary education, gender equality is improving across Mekong River Basin countries. However, there is some slowing of progress or decline in the indicators of gender equality related to employment and education in some countries, and the ongoing lack of gender-disaggregated data for a broader set of indicators to inform a more complete assessment. It is noted that there are many aspects to gender equality not captured in the data available for this SOBR due to the mixed results by basin country based on equality of access to employment in water-related sectors and the GPI. These indicators based on national data do not pick up subnational differences or additional drivers of inequality such as differing roles and levels of pay, or other conditions of employment that occur within sectors. Continuing efforts to improve the collection and mapping of gender-disaggregated data across the Basin remain an important task for the implementation of the BDS 2021–2030.

8.1.4. The Economic Dimension

How important are the Basin's water-related sectors to the basin, national and regional economies?

Total GDP in the Mekong River Basin is now estimated at around USD 187.4 billion (excluding Myanmar), of which USD 133.7 billion (71%) is from the LMB. Around 30% of basin GDP comes from Thailand, 29% from China, and 22 per cent from Viet Nam.

The Basin's water-related sectors make an important contribution to basin, national and regional economies. Rice and fisheries sectors in particular contribute a very large share of national production in all LMB countries. The contribution of LMB rice production to the total national production of the four LMB countries for 2020 is around 54%, and the contribution of LMB fisheries is around 49% of national production. Hydropower in Lao PDR is essentially produced from within the Mekong River Basin, with much of it is exported to other countries.

The relative importance of different water-related sectors in the Basin is clearly different for different countries: the economic value of rice production from the Basin contributes the most proportionally to the national economic value of Cambodia and Lao PDR, and the economic value of fish production contributes the most proportionally to national production in Lao PDR, albeit at a much lower volume than in Thailand and Viet Nam. Despite a relatively low contribution to national production compared to other countries, the economic value of basin production is still highest in Viet Nam for the rice and fisheries (including aquaculture) sectors, while the economic value of hydropower is highest in Lao PDR. The sectors make an important contribution to food and energy security, not only within the Basin, but also throughout the region.

To what extent are water-related sectors contributing to optimal and sustainable development of the Mekong River Basin?

The economic performance across water-related sectors in the Mekong River Basin is generally strong, with a partial estimate of the total annual economic value of around USD 63 billion. Sectors including hydropower, rice production and tourism have seen substantial growth, especially in Cambodia and Lao PDR. Similarly, aquaculture and navigation in the Mekong Delta continue their rapid rise. Estimates of the value of capture fisheries and wetlands over time have not been possible due to changes in assessment methodologies and lack of consistent time-series data; however, the most recent estimates put their value at around USD 8 billion and USD 30 billion, respectively, while noting that the value of ecosystem services from wetlands also includes provisioning services such as fish production.

In addition to these improvements in economic value, there is no discernible trend in flood damages over the last decade or so, likely due to drier conditions across the Basin, lower flows, and therefore less severe flood events. Despite no systematic reporting or monitoring of impacts of droughts on multiple sectors in the Mekong River Basin, their relative frequency and severity, especially over the last ten years, indicate that the average annual costs of droughts are probably larger than flood damages. The agriculture and fisheries sectors are the most vulnerable to droughts and crucial for ensuring food security and income generation for basin communities.

Although strong overall economic growth and growth in water-related sectors are evident, there are insufficient data to assess the extent to which this growth is optimal and sustainable, considering all three dimensions of sustainable development – Environment, Social and Economic. The assessment of conditions in the Environment Dimension suggests that significant challenges remain before economic growth can be considered sustainable. Changes in the flow regime due to water resources development are likely contributing to reduced areas of wetlands, pressure on fisheries and salinity intrusion in the delta. Instream barriers and sand mining are contributing to reductions in sediment transport, and dams are also limiting opportunity for fish migration, spawning and recruitment. Further information is also needed on the extent to which the benefits of economic growth are inclusively shared among the population. Some of the indicators in the Social Dimension, where progress is slowing in some countries, suggest that there remain groups within society that are not sharing equally in the economic success of recent decades.

8.1.5. The Climate Change Dimension

To what extent are greenhouse gas emissions from the Mekong River Basin contributing to global emissions?

Greenhouse gas emissions from the Mekong River Basin are estimated to make a relatively small contribution to global emissions, with carbon dioxide, methane and nitrous oxide emissions each contributing around 0.85% of the total global emissions, roughly equivalent to the Basin's share of the global population. However, this is the case for most areas around the world. In addition, emissions from the Basin, especially from the energy sector, are rising in every country; emissions are highest in Thailand followed by Viet Nam, Cambodia, China, Lao PDR and Myanmar. There has been strong investment in recent years in renewable energy, especially hydropower, but further investment in a broader range of renewable technologies will be important for countries to meet their NDCs under the Paris Agreement.

What is the evidence of climate change within the Basin, and has there been a change in the frequency and severity of floods and droughts?

There is strong evidence of climate change within the Basin through changes in temperature and sea-level rise. across the Basin, both minimum and maximum daily temperatures have increased over the past 50 years by around 1.4 °C, and extreme temperatures are occurring more frequently than before. Since 1970, the number of hot days and hot nights per year has been increasing, the sea level at the Viet Nam coast has been rising by around 4 mm per year, and total annual precipitation has been declining.

There has been a decrease in the frequency of typhoon formation in the Western Pacific Ocean over the past 30 years, and no change in the number or intensity of typhoons that cross into the basin. There has also been a reduction in the number of heavy (>100 mm) and very heavy (>150 mm) rainfall days annually, but no apparent trend to date in the frequency or severity of floods or droughts due to climate change. Although areas of the Basin affected by meteorological, hydrological and agricultural drought are higher over the last decade (2011–2022) than the decade before (2001–2010), as confirmed by the Joint Study, they are lower than the previous decade (1991–2000). Continued hydrometeorological and drought monitoring will be important to assess whether drier conditions are becoming more prevalent, and to inform the identification and implementation of adaptation options as considered through the Joint Study and the MRC's proactive regional planning.

The rising sea level is of significant concern to the Mekong Delta due to the potential for higher storm surge and the compounding effects of land subsidence and increased coastal erosion. Reversing the decline in the area of mangrove forests is likely to be one of the most cost-effective ways to improve resilience in these areas, and as a nature-based solution, it is widely recognized that it will have significant co-benefits for coastal and marine fisheries, among others.

Although a long-term trend in the frequency or severity of floods and droughts is not yet confirmed, it is important that mitigating the impacts of the most extreme events remains a priority for regional planning activities and joint projects. Extreme events under current flood and drought conditions as experienced over the last decade, especially for droughts, already cause significant economic losses for basin communities, particularly for vulnerable people who are more directly dependent on water-related resources.

Are basin communities adequately informed and prepared for changing river conditions, and are they adapting to climate risks?

The extent to which basin communities are prepared for changing river conditions or undertaking better disaster management in response to floods and droughts is not evident from the information on basin conditions and trends available for this SOBR. For instance, no time-series information was available on flood protection measures that have been put in place in basin countries. Drought protection, as indicated by the level of irrigation in the Basin, has increased in both Lao PDR and Viet Nam. However, the proportion of irrigable land in basin provinces likely still leaves many provinces that are drought-prone without sufficient protection.

No significant joint investment projects between two or more countries to manage transboundary flood and drought risks have yet been identified or implemented on a scale that is likely to make a material difference. It will therefore be important for the basin countries to focus on this issue through the regional planning activity now underway and through climate change adaptation measures identified in the MRC-MLC Water Joint Study.

Although progress in climate change adaptation is generally good, i.e. all countries recognize the seriousness of the issue, have developed plans and priorities for action, and put in place institutional arrangements to manage the response, it is unlikely to be anywhere near sufficient given the scale of the likely change to the climate in the future and the impacts that this will have on basin water and related resources. This is illustrated in the gaps that some countries have identified in their NDCs for their adaptation financing needs.

8.1.6. The Cooperation Dimension

The strengthening of the MRC is on track according to the commitments made by Member Countries with respect to the financial sustainability and riparianization of the organization. Countries have met all targets to date for increasing their financial contributions to the MRC, and projections to 2030 suggest that 100% financing by Member Countries of core river basin management functions by that year is achievable. There is also an increasing proportion of the MRC's budget delivered through the basket fund, rather than being earmarked for specific activities, which provides more flexibility in relation to meeting country priorities at the regional level.

Despite the progress made to date, the full financing of the MRC by Member Countries remains a challenge as substantial further increases still need to be made. The public finances of all countries were negatively impacted by the COVID-19 pandemic and the policy responses to it, leading to difficult trade-offs to be made in national budgets over the coming years. Ongoing efforts to establish a regional Mekong fund that can support the achievement of BDS Outcomes, including greater investment in the environment, livelihoods and alternative economic opportunities on the ground in basin countries affected by water resources development, will likely be an important complement to the MRC's work in future.

What are the benefits derived from cooperation between basin countries?

All basin countries benefit from cooperation on water resources management and development in the Mekong River Basin, and there are strong statements of commitment to further cooperation from the highest levels of government. Much of the cooperation activity occurs on projects of basin-wide significance such as joint or transboundary (non-infrastructure) projects and in consultation processes under the PNPCA. While there has been an increase in project activity, progress has been slow on mobilizing financial resources, and developing and implementing joint and transboundary projects between Member Countries of the MRC. The projects underway are, in any case, unlikely to significantly change the development trajectory of the Basin to more optimal and sustainable outcomes because they do not address the fundamental trade-offs inherent in water resources development at the basin scale between water, food and energy security. As reflected in the BDS 2021–2030, increased efforts in identifying supplementary investment projects with opportunities for cost and benefit sharing between countries are urgently needed. At the time of SOBR preparation, progress made in proactive regional planning was insufficient to evaluate the extent to which these opportunities might improve cooperation outcomes in the Basin.

The MRC has made considerable efforts to facilitate improved consultation processes and engage stakeholders in the PNPCA process. However, the slow progress in implementing Joint Action Plans and the lack of formal agreement to any projects that have been notified under the PNPCA reflects an inability to reach an optimal solution and identify alternative development pathways that are acceptable to all countries. It is imperative that the more proactive regional planning approach address these issues.

Greater awareness and coordination between project activities across different cooperation frameworks, global funds and Development Partners may also be beneficial. This will become increasingly important with the development and implementation of the proposed Mekong Fund, which will need to complement, not duplicate, other funding mechanisms.

Knowledge sharing and partnership activities at the MRC are proceeding positively. Due to a shift in approach under the BDS where the MRC is now playing more the role of enabler and facilitator to allow other parties to contribute to the BDS outcomes, a more proactive and direct access to data and information provision is becoming increasingly important. This is supported by an active partnership- building effort by the MRC and deeper engagement with strategic partners such as MRC Development Partners, MRC Dialogue Partners, NGOs and CSOs, research institutions and other river basin organizations. The MRC data portal is an important part of this knowledge hub function of the MRC, and would benefit from further improvement in conjunction with the reinvigorated MRC Decision Support Framework to improve accessibility and the currency of data and information held.

The MRC has many partnerships in operation, enacted through MoUs, with varying levels of exchange taking place under each of them. Maintaining these partnerships requires appropriate resourcing, and as the MRC budget declines over time might warrant a prioritization of effort based on an improved approach to measuring and demonstrating the benefits of cooperation. Such an approach would help to target action where it can have the most impact and, by demonstrating the value of cooperation, help stimulate further engagement and cooperation among all parties.

Do the basin countries derive equitable benefits from the utilization of the Basin's water and related resources?

Each basin country has a different endowment of resources and capabilities to exploit them for social and economic gain, as well as different priorities for development. Each country is also affected differently through impacts on the environment and social conditions from water resources development and management. Even where there are common changes experienced, the implications for people and livelihoods will often be different due to different socio-economic contexts both within and between countries. Particular groups of people are more vulnerable to impacts than others based on the intersectional dimensions of vulnerability discussed in Section 2.3.3.

With regard to the environment, the conditions for some indicators have deteriorated throughout the Basin due to a range of factors (e.g. changes in flow conditions, loss of wetlands including mangroves, reduction in sediment transport, extensive salinity intrusion), but with particularly significant changes increasingly evident in downstream areas including in Tonle Sap and the Mekong Delta. This is because, as with all river basins around the world, the lower reaches of the river are often subject to the cumulative effects of changes upstream combined with the effects of developments (past and present) within the downstream areas.

With regard to social conditions, all basin countries have achieved significant gains over recent decades in living conditions, wellbeing and livelihoods. Progress in some countries, however, is slowing for some indicators, likely reflecting challenges in reaching more vulnerable groups in the community. Although differences between countries are to be expected given different levels of social and economic development, it is concerning to see progress stalling in some countries, especially on indicators of water, food and energy security. Further effort will need to be made to identify groups in the community where access to basic services remains low and vulnerability is high, and to develop and implement targeted policies that support their full social and economic engagement.

With regard to economic conditions, all basin countries derived substantial aggregate benefits from the Basin's water-related sectors. Different countries enjoy greater or lesser benefit in different sectors depending on their endowment of resources, technological and human capabilities, and supporting infrastructure. Although only a partial estimate, the total economic value derived from basin water-related sectors is at least USD 63 billion per year; rice production, wetlands and fisheries (including capture fisheries and aquaculture) are the most important sources of economic value. Based on a partial assessment from water-related sectors, the gross economic benefits generated per capita are roughly similar for Cambodia, Lao PDR and Viet Nam, at between USD 1,207 and USD 1,574 per person, but are significantly lower for Thailand, at around USD 452 per person.

Based on the available data at the basin level, all LMB countries except for Lao PDR derive the most economic benefit from rice production, fisheries (capture fisheries or aquaculture) and wetlands. Lao PDR derives greater economic benefit from hydropower than from fisheries. Considering the sectors in which countries derive the most benefit compared to other countries, Viet Nam derives a higher benefit from rice production, hydropower and aquaculture. Thailand derives a higher benefit from capture fisheries; Cambodia, from wetland ecosystem services; and Lao PDR, from hydropower and forestry. The economic benefits per capita are roughly similar for Cambodia, Lao PDR and Viet Nam, but significantly lower for Thailand. The lower figure for Thailand reflects both its higher basin population and possibly a more diverse economic base, including manufacturing, services and value-added industries such as food processing, which are not captured in this partial assessment.

8.2. Contribution to the Sustainable Development Goals

Progress is being made within the Basin towards the SDGs. Most indicators across the 12 Goals considered most relevant for water resources management and development in the Mekong River Basin demonstrate improvements (Table 8.2), with 16 indicators showing substantial progress that, if continued, would put the SDG within reach, and five indicators showing progress that is unlikely to be sufficient to meet the SDG. Five indicators show some improvement and some decline in relation to different aspects, making the SDGs increasingly difficult to achieve. Six indicators do not have sufficient data available to evaluate progress regarding the SDG indicator.

With regard to *SDG 6, Ensure availability and sustainable management of water and sanitation for all*, there has been good progress with respect to access to safe water supplies and sanitation, and the targets for IWRM and transboundary water management have largely been met. However, some concerning trends in some water quality parameters and the decline in extent of some water-related ecosystems, as reported in Chapter Three, suggest that some aspects of this goal may be increasingly difficult to achieve by 2030.

This assessment is made based on, in some cases, basin-level data, and in some cases, on national data in basin countries, depending on what was available in each dimension of the MRB-IF, as reported in Chapters Three to Seven. It should also be emphasized that the data available regarding the indicators of the MRB-IF are, in many cases, not an exact alignment with the data requirements of the SDG indicators. Challenges also arise in the assessment of broad basin-level conditions and trends, which, if more disaggregated data were available, might otherwise be made with regard to particular locations or groups in society, including vulnerable groups.

Table 8.34. Contribution towards achieving water-related Sustainable Development Goals within the Mekong River Basin

Targets		Indicators			Current status
SDG 6: Ensure availability and sustainable management of water and sanitation for all					
6.1	By 2030, achieve universal and equitable access to safe and affordable drinking water for all	6.1.1	Proportion of population using safely managed drinking water services	↗	Access to improved water sources is increasing in the Basin, however, not fast enough to achieve universal access by 2030, especially as progress in some countries is slowing. [Section 4.2.2]
6.2	By 2030, achieve access to adequate and equitable sanitation and hygiene for all and end open defecation, paying special attention to the needs of women and girls and those in vulnerable situations	6.2.1	Proportion of population using safely managed sanitation services, including a hand-washing facility with soap and water	↗	Access to basic sanitation is increasing in the Basin and universal access by 2030 is within reach. However, progress in some countries is slowing. [Section 4.2.4]
6.3	By 2030, improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally	6.3.2	Proportion of bodies of water with good ambient water quality	→	Although water quality is generally rated as 'Good' in accordance with the PWQ, trends for some key parameters suggest deteriorating conditions. In addition, there is insufficient information on changes in important pollutants, such as heavy metals, pesticides and other toxic substances that have not been assessed since 2011. [Section 3.3.2]
6.5	By 2030, implement Integrated Water Resources Management (IWRM) at all levels, including through transboundary cooperation as appropriate	6.5.1	Degree of IWRM implementation	↗	There is a high degree of IWRM awareness and implementation throughout the Basin including at national levels, but further effort may be warranted in transboundary areas of key sub-basins, including the transition zone from the Upper to the Lower Mekong River Basin, tributary areas of Tonle Sap, the 3-S sub-basin and the Mekong Delta. [Section 7.3.2]
		6.5.2	Proportion of transboundary basin area with an operational arrangement for water cooperation	↗	The Mekong River Basin is covered by the 1995 Mekong Agreement, and there are cooperation arrangements among all basin states. The strengthening of cooperation between Member Countries and non-Member Countries is a critical focus of the BDS 2021–2030, and progress is being made through joint studies and other engagement. [Section 7.3.4]

Targets		Indicators			Current status
6.6	Protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers and lakes	6.6.1	Change in the extent of water-related ecosystems over time	→	The Mekong River Basin has a high proportion of areas under some form of protection. However, the challenges are often much bigger than the management of individual sites, leading to a decline in the extent of water-related ecosystems over time. The rate of decline has slowed in some cases, although further effort will be required for restoration. [Section 3.4.2]
SDG 1: End poverty in all its forms everywhere					
1.1	By 2030, eradicate extreme poverty for all people everywhere, currently measures as people living on less than $1.25 a day	1.1.1	Proportion of the population living below the international poverty line by sex, age, employment status and geographic location (urban/ rural)	↗	The proportion of the population experiencing extreme poverty has dropped considerably over the last decade in all basin countries. Although progress is slowing, the goal of eradication is within reach. However, the extent to which progress is occurring across sex, age, employment status and geographic location is not clear. [Section 4.3.3]
		1.2.1	Proportion of population living below the national poverty line, by sex and age	↗	The proportion of the population below the national poverty line has dropped considerably over the last decade in all basin countries. Although progress is slowing, the goal of eradication is within reach. However, the extent to which progress is occurring across sexes and ages is not clear since considerable data gaps remain. [Section 4.3.3]

Targets		Indicators			Current status
1.5	By 2030, build the resilience of the poor and those in vulnerable situations and reduce their exposure and vulnerability to climate-related extreme events and other economic, social and environmental shocks and disasters	1.5.1	Number of deaths, missing persons and directly affected persons attributed to disasters per 100,000	→	No. of deaths and people directly affected by flooding declined in Cambodia (1996–2020) and Viet Nam (1990-2019), but increased in Lao PDR (1992–2012) and Myanmar (1990–2020), based on Sendai DesInventar data.
		1.5.2	Direct economic loss attributed to disasters in relation to global gross domestic product (GDP)	↗	The economic costs of floods vary from year to year but overall are significant. Over recent years, flooding has decreased, and the economic costs are a lower proportion of GDP due to economic growth.
		1.5.3	Number of countries that adopt and implement national disaster risk reduction strategies in line with the Sendai Framework for Disaster Risk Reduction 2015–2030	●●●	Insufficient data available to evaluate.
1.b	Create sound policy frameworks at the national, regional and international levels, based on pro-poor and gender-sensitive development strategies, to support accelerated investment in poverty eradication actions	1.b.1	Pro-poor public social spending	●●●	Insufficient data available to evaluate
SDG 2: End hunger, achieve food security and improved nutrition and promote sustainable agriculture					
2.1	By 2030, end hunger and ensure access by all people, in particular the poor and people in vulnerable situations, including infants, to safe, nutritious and sufficient food all year round	2.1.1	Prevalence of undernourishment	↗	The prevalence of undernourishment has declined in the Basin, and ending it by 2030 is within reach. However, progress in some countries is slowing. [Section 4.2.3]
		2.1.2	Prevalence of moderate or severe food insecurity in the population, based on the Food Insecurity Experience Scale (FIES)	↗	The prevalence of food insecurity appears to be declining based on estimates of the potential adequacy of dietary energy supply, rates of undernourishment and infant malnutrition. [Section 4.2.3]

Targets		Indicators			Current status
2.2	By 2030, end all forms of malnutrition, including achieving, by 2025, the international agreed targets on stunting and wasting in children under 5, and address the nutritional needs of adolescent girls, pregnant and lactating women and older persons	2.2.1	Prevalence of stunting (height for age <-2 standard deviation from the median of the World Health Organization (WHO) Child Growth Standards) among children under 5	↗	The prevalence of stunting is declining in all basin countries, although progress is slow, and there are considerable challenges to meeting the World Health Organization standards by 2030. [Section 4.2.3]
		2.2.2	Prevalence of malnutrition (weight for height >+2 or <-2 standard deviation from the median of the WHO Child Growth Standards) among children under 5, by type (wasting and overweight)	↗	The prevalence of wasting is declining in the Basin in countries, for which data are available. However, very high rates are still recorded in Cambodia (>10%) and Viet Nam (>20%), hence progress is slow. [Section 4.2.3]
2.4	By 2030, ensure sustainable food production systems and implement resilient agricultural practices that increase productivity and production, that help maintain ecosystems, that strengthen capacity for adaptation to climate change, extreme weather, drought, flooding and other disasters, and that progressively improve land and soil quality	2.4.1	Proportion of agricultural area under productive and sustainable agriculture	●●●	Insufficient data available to evaluate
SDG 3: Ensure healthy lives and promote well-being for all at all ages					
3.3	By 2030, end the epidemics of AIDS, tuberculosis, malaria and neglected tropical diseases and combat hepatitis, water-borne diseases and other communicable diseases	3.3.3	Malaria incidence per 1,000 population	↗	Incidence of malaria and dengue has declined significantly in Cambodia, Viet Nam and Lao PDR, and is likely to have also declined in other basin countries. [Section 4.2.4]

Targets		Indicators			Current status
SDG 5: Achieve gender equality and empower all women and girls					
5.a	Undertake reforms to give women equal rights to economic resources, as well as access to ownership and control over land and other forms of property, financial services, inheritance and natural resources, in accordance with national laws	5.a.1	(i) Proportion of total agricultural population with ownership or secure rights over agricultural land, by sex; and (ii) share of women among owners or rights-bearers of agricultural land, by type of tenure	●●●	Insufficient data available to evaluate. The total rate of ownership of land among all households is around 30–80%, but it was not possible to distinguish by sex of household head, and only Cambodia (17%) and Lao PDR (80%) identified the proportion of rural households owning land.
5.c	Adopt and strengthen sound policies and enforceable legislation for the promotion of gender equality and the empowerment of all women and girls at all levels	5.c.1	Proportion of countries with systems to track and make public allocations of gender equality and women's empowerment	●●●	Insufficient data available to evaluate, but work ongoing under the BDS 2021–2030 to improve the collection and mapping of gender disaggregated data among Member Countries of the MRC. [Section 4.3.4]
SDG 7: Ensure access to affordable, reliable, sustainable and modern energy for all					
7.1	By 2030, ensure universal access to affordable, reliable and modern energy services	7.1.1	Proportion of population with access to electricity	↗	Access to electricity is increasing in the Basin and universal access by 2030 is within reach. However, progress in some countries is slowing. No data were available on the affordability and reliability of supply. [Section 4.2.5]
7.2	By 2030, increase substantially the share of renewable energy in the global energy mix	7.2.1	Renewable energy share in the total final energy consumption	↗	Hydropower production from the Lower Mekong River Basin contributes around 22% of total national consumption among the countries. No data were available on other renewable energy sources. [Section 5.2.5]

Targets		Indicators			Current status
SDG 8: Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all					
8.1	Sustain per capita economic growth in accordance with national circumstances and, in particular, at least 7% gross domestic product growth per annum in the least developed countries	8.1.1	Annual growth rate of real GDP per capita	↗	Per capita GDP growth remains strong, although significant leadership and sound policy-making will be essential to ensure that the negative effects of the COVID-19 pandemic do not cause lasting damage. [Sections 5.2.2 and 2.3.2]
8.5	By 2030, achieve full and productive employment and decent work for all women and men, including for young people and persons with disabilities, and equal pay for work of equal value	8.5.2	Unemployment rate, by sex, age and persons with disabilities	→	The employment rate within the Basin by country was generally stable at 100% in Lao PDR and Viet Nam prior to 2020. However, the rate is relatively low in Cambodia and Thailand, and likely well short of full and productive employment, notwithstanding a potential underestimate of those in informal work [Section 4.3.2]
8.9	By 2030, devise and implement policies to promote sustainable tourism that creates jobs and promotes local culture and products	8.9.1	Tourism direct GDP as a proportion of total GDP and in growth rate	↗	The tourism sector is developing rapidly in all basin countries, although it took a significant hit from the COVID-19 pandemic. No data available on the sustainability of the sector. [Section 5.3.10]
SDG 9: Build resilient infrastructure, promote inclusive and sustainable industrialisation and foster innovation					
9.1	Develop quality, reliable, sustainable and resilient infrastructure, including regional and trans-border infrastructure, to support economic development and human well-being, with a focus on affordable and equitable access for all	9.1.2	Passenger and freight volumes, by mode of transport	↗	Navigation (IWT) including cargo and passenger movements is growing strongly in the Basin, especially in Cambodia and Viet Nam, with the development of infrastructure capable of supporting transborder shipments. [Section 5.3.4]
SDG 12: Ensure sustainable consumption and production patterns					
12.a	Support developing countries to strengthen their scientific and technological capacity to move towards more sustainable patterns of consumption and production	12.a.1	Installed renewable energy-generating capacity in developing countries (in watts per capita)	↗	The installed capacity of hydropower has increased significantly over the last decade and is now at 35,314 MW. [Section 5.3.3]

Targets		Indicators			Current status
SDG 13: Take urgent action to combat climate change and its impacts					
13.1	Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries	13.1.1	Number of deaths, missing persons and directly affected persons attributed to disasters per 100,000 population	→	No. of deaths and people directly affected by flooding declined in Cambodia (1996–2020) and Viet Nam (1990–2019) but increased in Lao PDR (1992–2012) and Myanmar (1990–2020), based on Sendai DesInventar data.
		13.1.2	Number of countries that adopt and implement national disaster risk reduction strategies in line with the Sendai Framework for Disaster Risk Reduction 2015–2030	●●●	Insufficient data available to evaluate.
13.2	Integrate climate change measures into national policies, strategies and planning	13.2.1	Number of countries with nationally determined contributions, long-term strategies, national adaptation plans and adaptation communications, as reported to the Secretariat of the United Nations Framework Convention on Climate Change	↗	All countries are taking steps to integrate climate change measures into national policies, strategies and plans, and have submitted Nationally Determined Contributions and National Communications to the UNFCCC. Adaptation Plans are in progress or already in place. However, greater efforts need to be followed through with implementation, especially in relation to adaptation, which requires a significant step-up in financing and capacity building and greater policy coherence between sectors. [Section 6.4.2]
		13.2.2	Total greenhouse gas emissions per year	→	Total basin greenhouse gas emissions are rising, although remain relatively small at a global scale. [Section 6.2.2 and 6.2.3]

Targets		Indicators			Current status
SDG 15: Protect, restore and promote sustainable use of terrestrial ecosystems, sustainable manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss					
15.1	Ensure the conservation, restoration and sustainable use of terrestrial and inland freshwater ecosystems and their services, in particular forests, wetlands, mountains and drylands, in line with obligations under international agreements	15.1.1	Forest area as a proportion of total land area	→	The decline in forested areas has been arrested throughout the Mekong River Basin. Further attention will be needed to restore degraded areas and enable contiguous areas capable of supporting large fauna. [SOBR 2018]
		15.1.2	Proportion of important sites for terrestrial and freshwater biodiversity that are covered by protected areas, by ecosystem type	↗	A high proportion of important sites in the Basin are covered by some form of protection, with around 175,000 **km²**, or 23% of the total land area, protected. Additional resources for improving management activities at these sites will be important for the conservation of biodiversity. [Section 3.4.5]
15.2	By 2020, promote the implementation of sustainable management of all types of forests, halt deforestation, restore degraded forests and substantially increase afforestation and reforestation globally	15.2.1	Progress towards sustainable forest management	●●●	Insufficient data available to evaluate.
15.5	Take urgent and significant action to reduce the degradation of natural habitats, halt the loss of biodiversity and, by 2020, protect and prevent the extinction of threatened species	15.5.1	Red List Index	→	No significant change in the number of threatened fish species since the 2018 SOBR.

Targets		Indicators			Current status
15.9	Integrate ecosystem and biodiversity values into national and local planning, development processes, poverty reduction strategies and accounts	15.9.1	(i) Number of countries that have established national targets in accordance with or similar to Aichi Biodiversity Target 2 of the Strategic Plan for Biodiversity 2011–2020 in their national biodiversity strategy and action plans and the progress reported towards these targets; and (ii) integration of biodiversity into national accounting and reporting systems, which is defined as the implementation of the System of Environmental-Economic Accounting.	↗	All countries have national biodiversity strategies and action plans aligned with Aichi targets and have committed to the Kunming-Montreal Global Biodiversity Framework.
SDG 17: Strengthen the means of implementation and revitalize the Global Partnership for Sustainable Development					
17.9	Enhance international support for implementing effective and targeted capacity-building in developing countries to support national plans to implement all the Sustainable Development Goals, including through North-South, South-South and triangular cooperation	17.9.1	Dollar value of financial and technical assistance (including through North-South, South-South and triangular cooperation) committed to developing countries	↗	There has been a significant increase in financial support to Mekong River Basin countries to assist with climate change mitigation and adaptation, and many projects have co-benefits for the SDGs. However, due to the scale of the adaptation financing gap, much greater efforts need to be made. [Section 6.4.2]
17.14	Enhance policy coherence for sustainable development	17.14.1	Number of countries with mechanism in place to enhance policy coherence of sustainable development	●●●	Insufficient data available to evaluate.

Targets		Indicators			Current status
17.18	By 2020, enhance capacity-building to developing countries … to increase significantly the availability of high-quality, timely and reliable data disaggregated by income, gender, age, race, ethnicity, migratory status, disability, geographic location and other characteristics relevant in national contexts	17.18.1	Statistical capacity indicator for Sustainable Development Goal monitoring	●●●	Insufficient data available to evaluate, although efforts are being made to improve data collection and analysis under the BDS 2021–2030, including in this SOBR, to support SDG reporting consistent with the BDS Strategic Priorities.

8.3. Recommendations

8.3.1. Recommendations to refine the implementation of the BDS 2021–2030

The BDS 2021–2030 was agreed by Member Countries of the Mekong River Commission in 2020, and implementation began in 2021. Progress in achieving the BDS Outcomes is at only a very early stage, with mixed results to date due to delays in starting some activities under each output; the need for further negotiation, agreement and implementation beyond the investigative and planning activities underway, and the long lag time before changes in basin conditions as a result of actions undertaken will actually become evident. The most important recommendation, therefore, is that the BDS 2021–2030 must continue to be implemented on time and in full. Given the issues identified in this SOBR, the strategic priorities, outcomes and outputs remain as relevant today as they were two years ago.

The assessment of the strategic and assessment indicators aligned with BDS Outcomes has nevertheless identified several areas where refinement of implementation may be warranted by relevant basin stakeholders. These are summarized as follows, together with reference to the relevant BDS 2021–2030 Outputs. The recommendations do not change the overall priorities, outcomes and outputs of the BDS 2021–2030, but aim to inform relevant parties about opportunities for them to shape how the outcomes and outputs are achieved, such as through updates to their plans over the remainder of the BDS 2021–2030 period, for example, through the development of the MRC Strategic Plan 2026–2030, national strategies and plans, and the strategies and plans of other actors involved in water resources management and development in the Basin.

The recommendations are divided into three categories: (i) short-term actions for implementation over the remainder of the MRC Strategic Plan 2021–2025; (ii) medium-term recommendations for consideration by the MRC and Member Countries in the preparation of the MRC Strategic Plan 2026–2030; and (iii) recommendations for consideration by other stakeholders working on Mekong water-related matters to support the implementation of the BDS 2021–2030.

Recommendations for MRC* to support achievement of BDS 2021–2030 Outcomes		
	Short-Term Actions for the MRC Work Plans 2024–2025	**Medium-Term Recommendations for the MRC SP 2026–2030**
Environment Dimension	**Action 1:** Strengthen the capacity of Member Countries to: (i) monitor riverine micro- and macroplastic for potential integration into routine Water Quality Monitoring; and (ii) implement Chapter 4 on Water Quality Emergency Response Management under the Technical Guidelines of the Procedures for Water Quality (PWQ).. [SP Activity 1.1.1.4] **Action 2:** Support the use of MRC fisheries monitoring data and assessment findings for the integration of inland capture fisheries into national basin development policies, plans and investments. [SP Activity 3.2.5.2] **Action 3:** Identify and assess supplementary water resources development options through proactive regional planning, which includes minimizing further environmental impacts from water resources development. [SP Activity 3.1.1.1, 3.1.1.2, 3.1.1.3] **Action 4:** Continue to monitor sediment transport throughout the Basin including by implementing the updated Core River Monitoring Network; undertake a study on sediment trapping and extraction activities, and the extent and distribution of bank erosion, as part of the Proactive Regional Planning and in cooperation with partners; and prepare a basin-wide sediment management plan to address the loss of sediment. [SP Activity 1.2.1.1] **Action 5:** Identify additional hydrological limits of change for key wetland assets and river flows as part of the Proactive Regional Planning to support sustainable development pathways that protect against the further loss of wetlands and their ecosystem functions, and consider updates to the PMFM flow thresholds including potentially with additional stations. [SP Activities 1.3.1.1, 3.1.1.2] **Action 6:** Review institutional, governance and regulatory arrangements, and undertake a gap analysis for the further development of a regional management framework for the protection of key regional watersheds of priority regional environmental assets. [SP Activities 1.3.1.2, 3.2.4.1]	**Recommendation 1:** Further assess water quality conditions in the mainstream including by: (i) investigating the causes and possible solutions to concerning trends in some key water quality parameters; (ii) updating the regional study on heavy metals and pollutants; and (iii) if necessary, re-evaluating the calculation of indices in the PWQ (considering current international standards), if these are shown not to be adequately identifying changing water quality conditions in underlying parameters. [BDS Outputs 1.1.1 and 5.1.1] **Recommendation 2:** Implement a holistic plan and concrete measures based on results of the proactive regional planning and of the Joint Study phase 2 for addressing environmental challenges at Tonle Sap. This encompasses transboundary issues arising from changes in water flow and sediment conditions, and the intersection with national and local management, as well as the combined impacts on wetlands, recession agriculture and capture fisheries. [BDS Outputs 1.3.1 and 1.1.2] **Recommendation 3:** Implement updated flow framework and thresholds (identified under the MRC SP 2021–2025) with agreed response protocols to help countries minimize any significant adverse environmental impacts of an increase in dry season flows and a reduction in flood season flows, and consider the implications for reduced flood season flows on the accumulated volume and timing of Tonle Sap reverse flows. [BDS Output 1.3.1] **Recommendation 4:** Use priority regional environmental assets as exemplar sites to extend improved management and further protections to other regionally important sites and hotspots throughout the Basin, especially those affected by water resources development and climate change. [BDS Outputs 1.3.1 and 1.3.2]
Social Dimension	**Action 7:** Enhance national disaggregated data collection and mapping on gender and vulnerability within the Data Acquisition and Generation Action Plan, including to inform SDG reporting. (SP Activity 2.1.4.2) Action 8: Formulate measures for improving equity for vulnerable groups, including recommended measures for regional and national plans. (SP Activity: 2.1.4.3)	**Recommendation 5:** Building on the MRC's review of gender and vulnerability data available across the Lower Mekong River Basin, implement concrete measures and action plans with each country to improve equity and access for vulnerable groups. Also, continue collecting and analysing agreed relevant national and subnational data disaggregated by gender and other dimensions of vulnerability at the national level through basin countries' existing national survey, and data collection systems and processing mechanisms, and update the MRB-IF accordingly. [BDS Outputs 2.1.4, 4.1.2, 4.1.4 and 4.1.5]

	Recommendations for MRC* to support achievement of BDS 2021–2030 Outcomes	
Economic Dimension	**Action 9:** Formulate the initial adaptive basin plan under Proactive Regional Planning by identifying joint investment projects and enabling activities to optimize water, food and energy security considering climate change impacts using alternative development scenarios. (SP Activities: 3.1.1.1, 3.1.1.2, 3.1.1.3)	**Recommendation 6:** Coordinate transboundary social, economic and environmental impact assessments of any proposed joint investment projects and adaptation measures identified through proactive regional planning and the MRC-MLC Water Joint Study. Also, facilitate the consideration of and agreement on joint projects by basin countries including to support inclusive growth among vulnerable communities. [BDS Outputs 3.1.1 and 5.2.3] Recommendation 7: Engage potential funding agencies and the private sector early in the assessment of any proposed joint investment projects and adaptation measures, and in discussions between countries to build support for potential investment decisions. [BDS Outputs 3.1.1] **Recommendation 8:** Implement a process to identify and collect data on input costs for water-related sectors to enable a proper assessment of economic value and changes over time including in response to water resources development, possibly through a regional study identifying standard or benchmark rates in each basin country that are occasionally updated. [BDS Outputs 3.1.1 and 4.1.5]
Climate Change Dimension	**Action 10:** Continue supporting the implementation of the joint project on flood and drought management for sub-area 9C-9T, working with Development Partners to seek additional support to implement other joint projects (including for the Mekong Delta and Sekong, Sesan and Srepok [3S]). Also, facilitate the implementation of transboundary projects on climate change adaptation and water resources management including joint National Indicative Plan (NIP) projects to improve knowledge, management, systems and cooperation in response to increased floods and droughts. [SP Activities: 4.2.2.5] **Action 11:** Continue work on cooperation arrangements and mechanisms for data and information sharing for dam operations, and for water-related emergencies. [SP Activities: 4.2.1.1, 4.2.1.2, 4.2.1.3, 4.2.1.4) **Action 12:** Finalize and implement the upgraded Decision Support Framework, providing countries and stakeholders with timely, better and integrated data, information and analysis on river conditions, dam operations, and flood and drought forecasting. [SP Activities: 4.1.4.2, 4.1.4.3] **Action 13:** Support the implementation of the Drought Management Strategy including by implementing the drought adaptation guidelines. [SP Activity 4.2.2.3] **Action 14:** Identify and evaluate adaptation strategies for the changing hydrological conditions for the sustainable management and development of the LMB under the Joint Study phase 2 with MLC Water, in line with strategic assessments under proactive regional planning. [SP Activity 5.2.3.1] **Action 15:** Conduct Phase II of the regional study to assess the conditions and trends in riverine, estuarine and coastal habitats, salinity intrusion, flood and drought extent and severity, and ecologically significant assets by ground-truthing activities with Member Countries' involvement. [SP Activity 4.1.5.1]	**Recommendation 9:** Building on the MRC-MLC Water Joint Study, periodically undertake a comprehensive scientific assessment of the impact of climate change on any long-term trends in floods and droughts in the Basin, and any change in damages as a result. Ensure that the methodology can be used to monitor change and impacts over time, including to account for variability between representative locations across the Basin with appropriate ground-truthing of global datasets. [BDS Output 4.2.2] **Recommendation 10:** Continue to enhance data sharing, monitoring and forecasting capabilities for floods and droughts at multiple scales (from the regional to the community level), and strengthen the links and ongoing cooperation with national monitoring, forecasting and early warning systems. [BDS Output 4.1.4] **Recommendation 11:** Implement agreed flood and drought solutions (including nature-based solutions and coordinated infrastructure operations) identified in regional proactive planning to enable resilience to potential future climatic conditions, and cooperate on progressing large-scale regional projects that contribute to climate change resilience with the support of a regional Mekong Fund and other funding sources. [BDS Outputs 4.2.2 and 5.2.3] **Recommendation 12:** Implement remaining periodic regional studies from the Data Acquisition and Generation Action Plan (DAGAP), particularly: (i) a drought risk assessment of water security (in all relevant dimensions); (ii) a multi-media contaminants assessment; and (iii) a review of threatened water-dependent species [BDS Output 4.1.5]

Recommendations for MRC* to support achievement of BDS 2021–2030 Outcomes		
Cooperation Dimension	**Action 16:** Implement and enhance partnerships between the MRC and Dialogue Partners (China and Myanmar) as well as the Mekong-Lancang cooperation on water, including year-round data sharing on river flows and dam operations through updated agreement and the Information-Sharing Platform. [SP Activity 5.2.3.2] **Action 17:** Implement the MRC organization development plan following the recommendations of the Mid-Term Review. [SP Activity 5.2.1.1] **Action 18:** Implement and enhance partnerships towards BDS Strategic Priorities between the MRC and all other relevant partners, including Development Partners, Association of Southeast Asian Nations (ASEAN) and other Mekong regional cooperation frameworks, relevant international organizations, river basin organizations, research institutes and universities, non-governmental organizations and the private sector. [SP Activity 5.2.3.3] **Action 19:** Facilitate the consideration of proposed joint investment projects and measures, and national projects of basin-wide significance including through discussions on trade-offs and benefit-sharing, and by comparing benefits and costs of existing national water-related development plans (SP Activity 5.2.2.1). In addition, support the preparation of agreed significant joint investment projects and national projects of basin-wide significance. [SP Activity 5.2.2.2)	**Recommendation 13:** Increase cooperation with MRC Dialogue Partners and Mekong-Lancang Cooperation on Water in order to align efforts and work towards common objectives throughout the Mekong River Basin through, *inter alia*, operational data sharing, joint studies and surveys, joint expert groups and information-sharing platforms, coordinated operation of water-related infrastructures, and joint development of basin-wide flood and drought management strategy for the Mekong-Lancang River Basin with infrastructure and non-infrastructure measures, with a particular focus on transboundary cooperation needs. [BDS Output 5.2.3] **Recommendation 14:** Prioritize partnership activities through, *inter alia*, improved approaches to measure and evaluate the benefits of cooperation so that effort can be targeted where it is most effective and achieve tangible benefits for riparian countries. [BDS Outputs 5.2.1 and 4.1.5] **Recommendation 15:** Develop and trial benefit-sharing models to facilitate joint investments between countries in order to, *inter alia*, share the benefits derived from wetlands and their ecosystem services.. [BDS Output 5.2.2] **Recommendation 16:** Implement and further raise funds for the Mekong Fund for all agreed purposes and windows.

Note: * MRC Member Countries with the facilitation and support of the MRCS.

Other stakeholders* in partnership with the MRC and/or basin countries to support the achievement of BDS 2021–2030 Outcomes	
Environment Dimension	**Recommendation 17:** Partners, International financial institutions and private sector investors should promote increased investment in renewable energy and supporting grid infrastructure in basin countries based on optimizing water-energy solutions that take sustainable development objectives for aquatic ecosystems into account and help them meet the commitments in their Nationally Determined Contributions. [BDS Output 3.1.1] **Recommendation 18:** Partners must provide further technical and financial support, and work with basin countries to protect and restore key environmental assets at regional and national levels through ongoing capacity building, systems and tools, as well as policy development and implementation assistance. [BDS Output 1.3.1]
Social Dimension	**Recommendation 19:** Partners should provide technical and financial support to national governments to enhance data collection mechanisms that enable disaggregated and spatially explicit data on gender and other aspects of vulnerability to be identified, filling gaps identified in the MRC's review of gender and vulnerability data. [BDS Output 2.1.4] **Recommendation 20:** Partners, international financial institutions, private sector investors and civil society organizations should identify, trial and promote alternative livelihood strategies that are sustainable and resilient to climate change for people affected by changes in river and other aquatic environments. [BDS Output 2.2.1]
Economic Dimension	**Recommendation 21:** Partners should contribute technical and financial support to develop joint projects between two or more countries in key transboundary locations, including the Mekong Delta, 3S sub-basin, transboundary Tonle Sap tributaries, and other border areas between countries. [BDS Outputs 3.1.1, 4.2.2, 5.2.3] **Recommendation 22:** International financial institutions and private sector investors should evaluate projects and measures identified through proactive regional planning and the MRC-MLC Water Joint Study for inclusion in regional and national investment plans, and project investment pipelines. [BDS Output 5.2.2] **Recommendation 23:** Financial institutions, lenders, private sector investors, developers and operators should integrate and apply MRC procedures, guidelines and data in the planning, design, monitoring and operation of water-related projects of transboundary significance.
Climate Change Dimension	**Recommendation 24:** Project developers and operators, and MRC Dialogue Partners should continue to enhance data cooperation and sharing and other parties including to support and supplement the MRC's Core River Monitoring Network. [BDS Output 4.1.2] **Recommendation 25:** Partners should continue to enhance systems and tools for monitoring, forecasting and early warning capabilities for floods and droughts at the national level, and to enhance mechanisms for data and information sharing and dissemination from the regional to the community levels, including by strengthening the links with upgraded MRC/regional monitoring and forecasting systems. [BDS Output 4.1.4] **Recommendation 26:** Partners should identify and support countries in mangrove protection and restoration (and other nature-based climate change solutions) as a cost-effective measure to buffer against rising sea levels and storm surge risks at the delta coast with co-benefits for fisheries and biodiversity. [BDS Output 4.2.2] **Recommendation 27:** Partners, international financial institutions and private sector investors should enhance the identification of and support to concrete climate change adaptation investment projects and measures at the national and local levels that change conditions on the ground by putting the MRC/regional and national policies and strategies into action. [BDS Output 4.2.2]
Cooperation Dimension	**Recommendation 28:** Partners should support the uptake and mainstreaming of MRC strategies, procedures, plans and guidelines in their regional and bilateral development cooperation programmes in countries. **Recommendation 29:** MRC Dialogue Partners, academic institutes, non-governmental organizations and civil society organizations should identify opportunities for collaboration and contribute to joint studies, publications and partnership approaches with the MRC and other water-related platforms. [BDS Output 5.2.3] **Recommendation 30:** International financial institutions and accredited entities should work with the basin countries, the MRC and other parties to progress opportunities through global and regional environment and climate change funds in support of transboundary and joint investment projects between two or more countries. [BDS Outputs 4.2.2 and 5.2.3] **Recommendation 31:** Partners, international financial institutions and private sector investors should consider opportunities to help capitalize on, or work in partnership through, coordinated investment with the Mekong Fund. [BDS Output 5.2.3]

Note: *These include Development Partners, Dialogue Partners, other water-related platforms, project developers and operators, lenders, non-government organizations, and public and private investors.

8.3.2. Recommendations to improve future State of the Basin Reports

The volume of data and information available for the analysis underpinning this SOBR has been much greater than any previous SOBR. The result is a more comprehensive assessment against the indicators than has been possible in the past, giving a clearer picture of current conditions and trends, and the capacity to draw linkages between changes in different indicators that are likely related. Nevertheless, there are some further improvements that could be made to enhance future SOBRs, as follows:

1. Remove and/or modify some assessment indicators where data are clearly not accessible to the MRC, as currently shown in the preparation of multiple SOBRs.
2. Develop, and ensure agreement among basin countries on, consistent basin-wide frameworks and methodologies for indicators where they do not yet exist, consistent with the DAGAP (e.g. for the assessment of vulnerability to floods, droughts and storms, and for estimating the benefits of cooperation).
3. Implement the DAGAP in full i.e. including: all the identified periodic regional studies on a regular but phased schedule; and the measures needed to address gaps in national data collection, including on critical aspects of gender and vulnerability. Gender and vulnerability should be informed by the review that the MRC has undertaken on gender and vulnerability data across the Basin, and by developing a more comprehensive action plan for improvements at the national level.
4. Every five years, continue the systematic implementation of social and economic data collection, processing and transmission from basin countries implemented for this SOBR through long-term agreements that are built into the MRC's core river management functions.
5. Develop and agree on a pathway to move from gross economic valuation of water-related sectors to net economic valuation by taking into consideration input costs from appropriate sources. Considering net economic values will provide a much better indication of the relative contribution and improvement over time of water-related sectors to the basin, national and regional economies.
6. Trial the full implementation of the MRC Technical Guidance to implement the MRB-IF and the DAGAP that informs the ratings applied to each assessment and strategic indicator in order to enable more transparent and traceable assessments in the future.

Resource constraints have prevented the full implementation of the assessment methodology in this SOBR. and further discussion is needed with basin countries on the thresholds and decision rules that apply to each indicator.

7. Integrate the MRC Dialogue Partners more fully into the systematic collection of data and analysis for the UMB used in the preparation of future SOBRs. Although this SOBR has increased the focus on the entire river basin consistent with the aim of the BDS 2021–2030 by integrating all basin countries into a single assessment for each indicator, enhanced cooperation between the countries could improve this much further, perhaps in a staged approach for each dimension, which could be developed collaboratively between the MRC and LMC Water.

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Annex

Methodology for the calculation of social indicators

1. Weighting of data to reflect share of province in the LMB and provincial population densities

Data provided by the LMB countries were at the provincial level. To achieve more accurate estimates, provincial-level data reported in either absolute or percentage terms were adjusted for the following reasons:

- For all data, the geophysical boundary of the LMB cuts across many provincial boundaries, and as a result, for a significant number of provinces, only a portion of the province is within the Basin. For example, only 41% of the area of Kampot province of Cambodia is in the LMB and only 4% of Long An province in Viet Nam is in the LMB. Table A1 gives the share of each LMB province that is in the LMB as calculated by MRCS using GIS analysis.
- Where percentage estimates are given for provincial socio-economic characteristics, they also need to be weighted to reflect the proportion of the LMB population for that country in that province. Without this adjustment, simply using an average of provincial percentage figures would result in an over-representation of provinces with low population densities and an under-representation of provinces with high population densities.

Table A1. Share of provincial area in the LMB

Country/province	Share of province in the LMB (%)	Country/province	Share of province in the LMB (%)
Cambodia		**Lao PDR**	
Banteay Meanchey	100	Attapeu	100
Battambang	100	Bokeo	100
Kampong Cham	100	Borikhamxay	100
Kampong Chhnang	100	Champasak	100
Kampong Speu	100	Huaphanh	9
Kampong Thom	100	Khammuane	100
Kampot	41	Luangnamtha	100
Kandal	100	Luangprabang	99
Koh Kong	1	Oudomxay	100
Kratie	100	Phongsaly	92
Mondulkiri	98	Saravane	100
Otdar Meanchey	100	Savannakhet	100
Pailin	100	Sekong	100

Country/province	Share of province in the LMB (%)	Country/province	Share of province in the LMB (%)
Phnom Penh	100	Vientiane	100
Preah Sihanouk	2	Vientiane Capital	100
Preah Vihear	100	Xayaboury	100
Prey Veng	65	Xaysomboon	100
Pursat	92	Xiengkhuang	56
Ratanakiri	100		
Siem Reap	100		
Stung Treng	100		
Svay Rieng	0		
Takeo	100		
Tboung Khmum	0		
Thailand		**Vietnam**	
Amnat Charoen	100	An Giang	100
Bueng Kan	100	Bac Lieu	100
Buri Ram	100	Ben Tre	100
Chaiyaphum	99	Binh Phuoc	5
Chantaburi	20	Ca Mau	100
Chiang Mai	10	Can Tho city	100
Chiang Rai	99	Dak lak	80
Kalasin	100	Dak Nong	54
Khon Kaen	100	Dien Bien	14
Loei	95	Dong Thap	100
Maha Sarakham	100	Gia Lai	40
Mukdahan	100	Hau Giang	100
Nakhon Phanom	100	Kien Giang	89
Nakhon Ratchasima	96	Kon Tum	85
Nong Bua Lam Phu	100	Lam Dong	13
Nong Khai	100	Long An	4
Phayao	59	Quảng Bình	0

Country/province	Share of province in the LMB (%)	Country/province	Share of province in the LMB (%)
Phetchabun	8	Quang Tri	16
Roi Et	100	Soc Trang	100
Sa Kaeo	42	Thua Thien Hue	10
Sakon Nakhon	100	Tien Giang	70
Si Sa Ket	100	Tra Vinh	100
Surin	100	Vinh Long	100
Ubon Ratchathani	100		
Udon Thani	100		
Yasothon	100		

Source: GIS analysis by the MRCS

To allow these adjustments, it was assumed that population distribution was uniform across the province and that therefore the share of the provincial population in the Basin would be directly proportional to the share or the physical area of the province in the LMB. According to this assumption, the provincial-level data were adjusted to achieve a more accurate representation of LMB characteristics for each country. Depending on the data available and the requirements of the indicator measure in question, a number of different approaches were used to estimate LMB values for each country.

Where values were given for share of population (%): ,[35] [36]

Step 1: Using the data on provincial population, calculate the absolute population number for the indicator/category in question.

Step 2: Multiply the absolute population number calculated in Step 1 by the share of the province in the Basin to achieve an estimate of the population in each province for the indicator/category in question.

Step 3: Sum the results of step 2 for each country to arrive at an estimate of total LMB population for the indicator/category.

To obtain a population share for each country (%), the LMB population for the indicator in question was divided by the whole population for the LMB for each country. This was estimated by multiplying the provincial population by the share of the province in the LMB and summing the results for each country.

Where values were given for a share (%) of a subset of the population, but the size of that subset is unknown:[37]

35 The same approach was used for households, or for different population segments, for example, female/male populations and urban/rural populations, where data were available.

36 This approach was used where provincial figures were reported in terms of percentage shares, including indicator metrics such as poverty rates, malnutrition rates, employment, and household access to services.

37 This approach was taken where the metrics were reported in terms of percentage share, but figures for the proportion of the population to which this applied was unknown, for example, in the case of infant malnutrition, where the share of the infant population was unknown.

Step 1: Calculate the provincial population in the LMB for each province.

Step 2: Sum the results of step 1 to achieve a total LMB population for the country.

Step 3: Divide the results of step 1 by the result of step 2 to estimate the percentage share of the LMB population in the province.

Step 4: Multiply the metric in question (% share) by the result of step 3.

Step 5: Sum the results of step 4 for each LMB province in the country to achieve a weighted estimate of that metric for the LMB population in that country.

Where average absolute values were given by province:[38]

Step 1: Multiply the average provincial figure[39] by the LMB population in the province.

Step 2: Sum the results of step 1 for each country.

Step 3: Divide the result of step 2 by LMB population for each country to arrive at an estimate of an average figure for the country LMB population.

In both cases, these steps were conducted for each year for which data were available.

Adjustment of prices

Where provincial and national economic data have been reported using current (nominal) prices, they have been adjusted to 2020 price levels. Adjusting nominal figures to real figures is a common practice in economics to account for the effects of inflation and to compare values across different time periods. The key reason for making this adjustment is to obtain a more accurate representation of the real value of economic indicators over time.

Prices were adjusted to reflect the effects of inflation as given for each LMB country in the World Bank's World Development Indicators database by using the following formula:

V^c= V^n·(1+i)

Where V^c is the value in constant 2020 prices; V^n is the nominal value in current prices; and i is the inflation adjustment factor, calculated for the compounded inflation from the year of the reported nominal price to 2020.

38 This approach was used where average household or population values were given, for example, income, expenditure and household assets.

39 Where necessary, these figures were adjusted to reflect changes in price level and purchasing power.





Mekong River Commission
For Sustainable Development

P.O. Box 6101, 184 Fa Ngoum Road
Unit 18, Ban Sithane Neua, Sikhottabong District, Vientiane 01000, Lao PDR
T: +856 21 263 263. F: +856 21 263 264
www.mrcmekong.org