Southeast Asia

Data Collection Survey for Dam Operation Considering Environmental and Social Impact in Mekong River Basin

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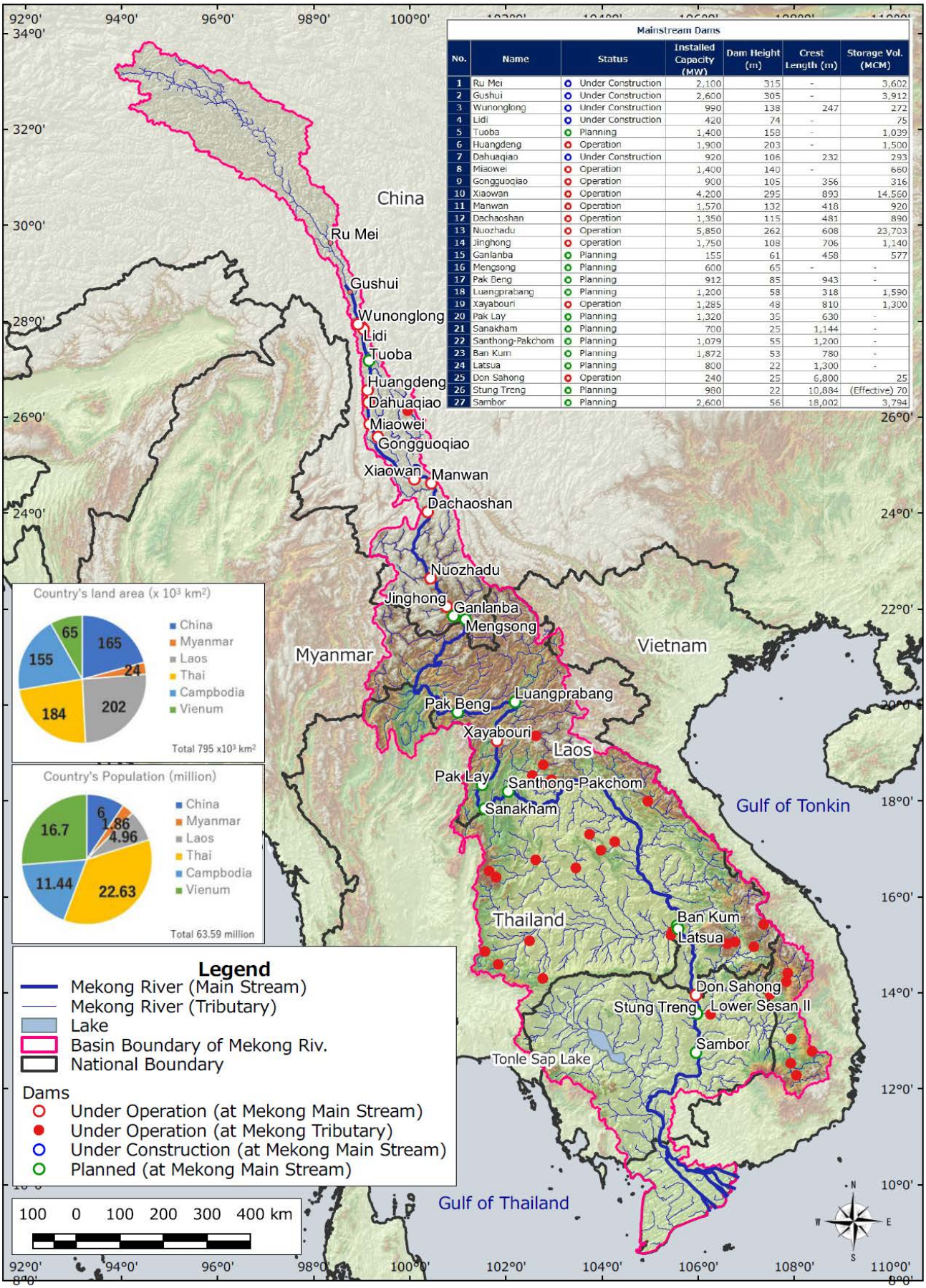

Location Map of Survey Area

SOUTHEAST ASIA

DATA COLLECTION SURVEY FOR DAM OPERATION CONSIDERING ENVIRONMENTAL AND SOCIAL IMPACT IN MEKONG RIVER BASIN

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Abbreviations

ACMECS	Ayeyawady-Chao Praya-Mekong Economic Cooperation Strategy
ADB	Asian Development Bank
AFD	Agence Française de Développement
AMPERE	Australian-Mekong Partnership for Environmental Resources & Energy Systems
ARI	Annual Return Interval
ASEAN	Association of South East Asian Nations
BDP	Basin Development Plan
BDS	Basin Development Strategy
BSM	Benefit Sharing Mechanism
CCAI	Climate Change and Adaptation Initiative (MRC)
COP	Conference of the Parties
CS	Council Study
CR	Council Report
DF/R	Draft Final Report
DNSH	Do No Significant Harms
DSF	Decision Support Framework
E(S)IA	Environmental (and Social) Impact Assessment
EMS	Energy Management System
ESG	Environment, Social and Governance
F/R	Final Report
GDP	Gross Domestic Product
GIS	Geographic Information System
GMS	Greater Mekong Subregion
HYCOS station	Automatic Hydrological Monitoring Station
ICEM	International Centre for Environmental Management
ICHARM	International Center for Water hazard and Risk Management under the auspices of UNESCO
ICOLD	International Commission on Large Dam
IC/R	Inception Report
IFC	International Finance Corporation
IPCC	Intergovernmental Panel on Climate Change
IPP	Independent Power Producer
IR	International Relations/ Investor Relations
IT/R	Interim Report
IWRM	Integrated Water Resources Management
JEM	Joint Environmental Monitoring
JBIC	Japan Bank for International Cooperation
JCOLD	Japan Committee of Large Dam
JICA	Japan International Cooperation Agency
JUMPP	Japan-US Mekong Power Partnership
Lao PDR	Lao Peoples' Democratic Republic

LMB	Lower Mekong Basin
LMC/MLC	Lancang-Mekong Cooperation/ Mekong-Lancang Cooperation
LMECC	Lancang-Mekong Environmental Cooperation Center
LMI	Lower Mekong Initiative
LMWRCC	Lancang-Mekong Water Resources Cooperation Center
LNMC	Lao National Mekong Committee
MRC	Mekong River Commission
MRC-IF	MRC-Indicator Framework
MRCS	Mekong River Commission Secretariat
NARBO	Network of Asian River Basin Organizations
NGO	Non-governmental Organization
NIPs	National Indicative Plans
NMC	National Mekong Committee
NMCS	National Mekong Committee Secretariat
PCM	Project Cycle Management
PDIES	Procedures for Data and Information Exchange
PNPCA	Procedures for Notification, Prior Consultation and Agreement
PMFM	Procedure for the Maintenance Flows on the Mainstream
PWQ	Procedure for Water Quality
PWUM	Procedure for Water Utilization Monitoring
SATREPS	Science and Technology Research Partnership for Sustainable Development
SEA	Strategic Environmental Assessment
SIWI	Stockholm International Water Institute
SOBR	State of the Basin Report（MRC）
SDGs	Sustainable Development Goals
SP	Strategic Plan
SWAT	Soil and Water Assessment Tool
TbEIA	Transboundary EIA
TNMC	Thai National Mekong Committee
UN	United Nations
UNDP	United Nations Development Programme
UNECE	United Nations Economic Commission for Europe
UNEP	United Nations Environment Programme
VNMC	Viet Nam National Mekong Committee
WB	World Bank

1. Outline of the Survey

1.1 Background

In the past 70 years, the development of water resources, hydropower, and infrastructure in the Mekong River basin (Thailand, Laos, Cambodia, Vietnam, China, and Myanmar) has progressed rapidly, and the participation of the private sector has accelerated, resulting in the diversification of stakeholders. While the water use and power supply of each country have developed in line with the development of large-scale dams, the environmental and social impacts have gradually become more pronounced since 2000.

In recent years the negative impacts of these dam construction and operation on ecosystems, agriculture and fisheries, and the social lives of people living along the river basin are becoming more serious. In addition to dam development and land use change in the upstream areas, the impacts of climate change have caused changes in the hydrological and hydraulic characteristics of the Mekong River, thus, mitigating the negative impacts in central Laos, Tonle Sap Lake, the Mekong Delta, and other areas has become a crucial issue.

Under these circumstances, Japan could contribute to formulate a feasible cooperation policy proposal and realize sustainable cooperation with the basin countries based on it, in order to effectively use water resources and mitigate negative environmental and social impacts in the basin, while taking advantage of its neutral position outside the basin and advanced science and technology.

1.2 Objective of the Survey

The objective of this study is to collect basic information in order to clarify the issues of water resource management faced by each country in the Mekong River basin and the environmental and social impacts of dam development on the main river courses and tributaries, and to consider what kind of stakeholders should be approached in order to develop a cooperative strategy that takes into account the environmental and social impacts of Mekong dams. Based on the collected information, a draft policy for cooperation on water resources management in the Mekong River will be prepared through verification of the local context of political dynamics and interests of each country in the basin and identification of the structure of issues and problems.

1.3 Duration of the Survey

From February 2020 to March 2022 (total of 26 months)

1.4 Field Survey

In compliance with the policy of basin countries for coping with the pandemic of COVID-19 pandemic, the field survey could only be conducted in Cambodia, which was open to the foreign travelers, from January 15 to February 13, 2021. The JICA Study Team performed major activities as follows:

- Mobilization : Jan.15
- Preparation of interview and field reconnaissance : Jan.16 – 24
- Interviews with the concerned agencies : Jan.26 – Feb.02
- Field visit : Tonle Sap Lake and surrounding areas : Feb.03 - 05
  : Kampong Cham~Kratie~Stung Treng : Feb.07 - 09
- Demobilization : Feb.13

2. Key Reports by MRC for the Mekong River Basin

2.1 The Council Study

The Mekong River Commission (MRC) decided to conduct the Council Study in 2011 to cope with the population growth and economic development in the Mekong River basin in the future. The study was undertaken by the MRC Secretariat from 2011 to 2017. In particular, a thorough study was required on how the development of infrastructure for large-scale hydropower generation in the upper reaches of the Mekong River would specifically affect the various related fields in the downstream areas in consideration of climate change. The objectives of the study were to:

1) further develop reliable scientific evidence of positive and negative environmental, social and economic impacts of water resources developments,
2) integrate the results into the MRC knowledge base to enhance basin development planning and;
3) promote capacity within, and ensure technology transfer to, the National Mekong Committees.

As for water resources development, development scenarios in four sectors (hydropower, fisheries, agriculture, and navigation) were envisioned, and six sectors were selected for comparative study, namely: (a) agriculture and land use change, (b) domestic and industrial water use, (c) flood protection facilities, (d) hydropower development, (e) irrigation, and (f) transportation including navigation. The Cumulative Impact Assessment (CIA) in the study summarizes the cost and benefits of the water resources developments included in the scenarios using the following main measures: (i) resilience and vulnerability, (ii) sustainability, and, (iii) cross-sector transboundary trade-offs.

In the Council Study, three basic core scenarios were established as follows:

M1: Development status of the six sectors as of 2007 (infrastructure, land use, etc.)

M2: Existing, under construction, and expected to be completed by 2020 development plans in the six sectors

M3: Development plans to be constructed by 2040 added to the contents of M2 in the six sectors

For M3, a sub-scenario that takes into account climate change (= M3CC, but some of the documents mention M4) was adopted. Table 2.1 gives an overview of the main scenarios:

Table 2.1 Parameter of Main Scenario in Development Areas

Main Scenario			Development Areas in Water Resources Management Sector						Climate Change	Inundation Areas
			ALU	DIW	FPI	HPP	IRR	NAV		
M1	2007	Baseline Scenario 2007	2007	2007	2007	2007	2007	2007	1985-2008	2007
M2	2020	Definite Future Scenario 2020	2020	2020	2020	2020	2020	2020	1985-2008	2020
M3	2040	Planned Development 2040	2040	2040	2040	2040	2040	2040	1985-2008	2040
M3CC	2040CC	Planned Development Scenario 2040	2040	2040	2040	2040	2040	2040	Mean warmer & wetter	2040

Note:ALU=Agriculture and land use, DIW=Domestic and industrial water supply, FPI=Flood management structure, HPP=Hydropower development, IRR=Irrigation, NAV= Navigation
Source: The Council Study- Key messages from the Study on Sustainable Management and Development of the Mekong River Basin, including Impact of Mainstream Hydropower Projects

The Council Study revealed that, in the absence of successful cross-sector benefit sharing, the sustainability index would drop substantially by six points from 30 points to 24 points if 2040 development plans were implemented (Cambodia -30%, Laos -28%, Vietnam -23%, Thailand -17%). The positive and negative impacts of development will be unevenly distributed, with most benefits accruing to energy companies and most impacts affecting by fishing households.

2.2 The MRC Hydropower Mitigation Guidelines

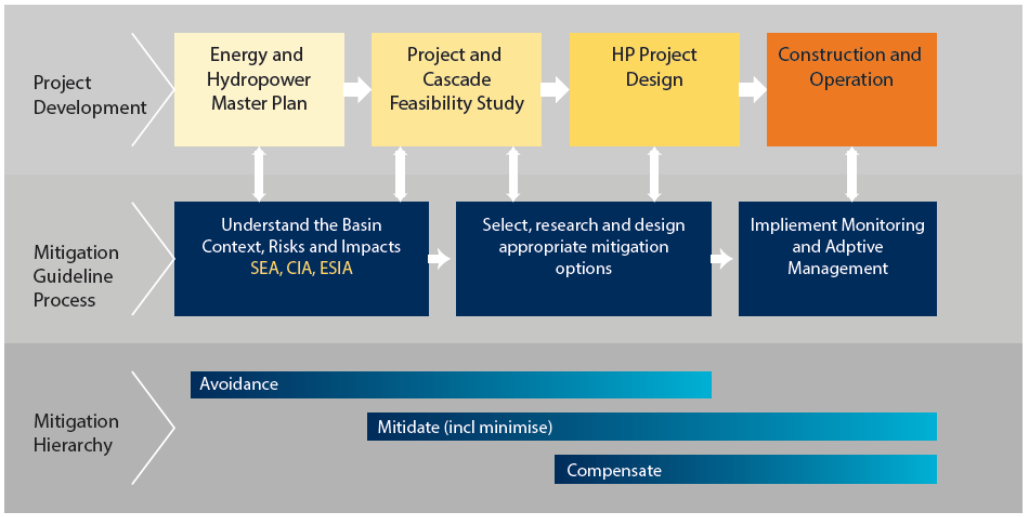
This guideline, which was prepared between 2015 and 2018, describes the risks, positive and negative impacts, and vulnerabilities of hydropower development. In particular, it proposes mitigation measures in the following five areas, taking into account the hierarchy of mitigation measures and the project cycle.

(1) Hydrology and flow regime
(2) Geomorphology and sediment
(3) Water quality
(4) Fisheries and aquatic eco-environment
(5) Biodiversity, natural resources and ecosystem services

The above mitigation measures are also categorized and organized by each of the five common flow regime changes caused by hydropower development as follows:

I : Seasonal changes within one year (due to construction of large reservoirs in the basin)
II: Short-term changes in flow and water level within one day (due to peak power generation)
III : Loss of channel continuity (due to construction of large dams)
IV : Waterlogging of reservoirs (due to conversion from rivers to lakes)
V: Channel replacement and basin alteration (some channel sections become unflooded)

The MRC Hydropower Mitigation Guideline points out the importance of member countries and developers applying mitigation measures based on best practices proposed in the Guidelines, while mitigating and minimizing the impacts of difficult trade-offs. The entire document consists of four parts, namely, guidelines, manual, case study, and knowledge base (data inventory and library of technical papers). The manual presents the relationship between risks, mitigation measures, and the project cycle as shown in Figure 2.1.



Source: The MRC Hydropower Mitigation Guidelines Vol.1, January 2019, P.4

Figure 2.1 Relationship between Project Cycle and Mitigation Hierarchy

2.3 The State of Basin Report 2018

This is one of the MRC's core reports, which is basically produced every five years based on the latest information. This is the third publication since the inception of the MRC. The MRC's Indicator Framework (MRC-IF), which covers the five areas of environment, society, economy, climate change and cooperation, describes the current status of the basin. The MRC-IF, which covers the five areas of environment, society, economy, climate change and cooperation, describes the current status of the basin. It also includes a review of the current status of the Lancang River basin in upstream China.

2.4 Basin Development Strategy (BDS) 2021-2030 & Strategic Plan (SP) 2021-2025

The MRC published the final version of BDS 2021-2030 & SP 2021-2025 in April 2021. The draft versions (complete second draft of Part I and first draft of Part II) were available as of April 2020. The revision from the draft to the final version is the addition of "Supporting COVID-19 recovery" in Chapter 8 MRC Results Chain of Part 2 MRC Strategic Plan. The BDS defines four priority areas of activities and core river basin management functions (CRBMFs) for the MRC, aiming at harmonious development of the entire basin, and including a budget for pandemic recovery activities. In order to achieve harmonious development of the entire basin, the following five strategic priorities have been identified, taking into account the State of Basin Report (SOBR), MRC-Indicator Framework (IF), Sustainable Development Goals (SDGs), etc.:

(1) Environment: maintaining the ecological functions of the Mekong River basin,
(2) Social: enabling access to and use of water and related resources in the basin,
(3) Economic: enhancing optimal and sustainable development of water and related sectors,
(4) Climate change: strengthening climate risks and adaptability to extreme floods and droughts, and
(5) Cooperation: strengthening cooperation among all basin countries and stakeholders.

Under each strategic priority area, specific activities, implementing entities, related outcomes and budgets are planned and described. The SP 2021-2025 can be regarded as the first phase of the BDS 2021-2030, and the BDS as a whole can be regarded as the priority action plan of the MRC for the next 10 years, and it is recognized as an important guideline for future basin-scale water resources management. It is recognized as an important guideline for future basin-scale water resources management. The next SP2026-2030 is expected to be developed in 2025.

3. Outline of Mekong River Basin and Environmental and Social Impact

3.1 Status of Hydrology and River Flow

(1) Current Flow Regime

The seasonal fluctuation cycle of runoff and the transition period from the rainy season (June to December) to the dry season (January to May) of the Mekong River are stable, and are almost constant every year. From the perspective of the entire basin, the runoff of the Lancang River, tributaries of Laos (Nam Ngum, Nam Theun, Nam Hinboun) and 3S basin (Sekong, Sesan, Sre Pok) accounts for a large proportion of the total of the river discharge.

(2) Typical Changes in Flow Regime

The MRC Hydropower Mitigation Guidelines show changes in hydrograph shape when dams and reservoirs under construction and planned in mainstream and tributaries are constructed. The changes in future flow regime of the entire basin are anticipated as listed below.

- Decrease in peak discharge and decrease in annual flood discharge
- Increased dry season flow rate
- Smoothing hydrograph by discharging from the reservoir
- Decrease in flood flow in the early rainy season and increase in flood flow in the late rainy season
- Delay of the start of the rainy season and delay of the end of the rainy season
- Annual average flow rate will become almost the same and constant

(3) Impact by Other Developments

Other than hydropower development, the irrigation development is an large scale water use in the Mekong River basin and can affect on water level fluctuation and flow regime of the Mekong River. In the Council Study, various conditions such as future expansion of irrigation area by irrigation development, irrigation efficiency, and amount of reduced water are set, detailed impact prediction analysis is performed, and the results are summarized in the thematic report [1]. As a result, the impact of irrigation development on main river flow during the rainy season is limited.

(4) Impact by Climate Change

In the Council Study, the intermediate scenario Representative Concentration Pathways (RCP) 4.5 is adopted as a representative concentration path scenario (greenhouse gas emission scenario) for climate change. As a result, the sea level rise at the mouth of the river due to climate change will be +0.21 m (2040). The temperature rise due to climate change will weaken the westerly wind of the Asian monsoon, and as a result, it is expected that the start time of the monsoon will be delayed by about half a month. It also suggests that as climate change progresses, the peak flow during the rainy season will be delayed on a basin scale, which is considered to be one factor that affects the pulsation of Lake Tonle Sap downstream.

(5) Current Status of Mitigation Measures

Regarding mitigation measures for dam development and operation, the MRC Hydropower Mitigation Guidelines have already presented a fairly wide range of measures according to the project cycle, including examples. There are two mitigation measures for current conditions introduced in the Council Study. However, it has not been clarified at this stage on what kind of measures are being taken to mitigate the actual impact.

[1] Report on the Positive and Negative Impacts of Irrigation on the Social, Environment, and Economic Conditions of the Lower Mekong River Basin and Policy Recommendations, 12 January 2018, MRC

Minimum Flow Rate for All Dams: A flow rate with an exceedance probability of 95% flow rate (Q_{95}) of annual flow rate (historical flow rate, i.e. the situation before dams in China and tributaries are put into operation) is secured, and it functions for the sustainable maintenance of the ecosystem. The Sambor Dam will be a small-scale development, where an adjacent waterway will be provided to allow sufficient flow with at least Q_{95} in the Mekong River.

Changes in Short Period Water Level Fluctuation due to Discharge by Dams: Generally, the rate of change in downstream water level is limited to 5 cm/hr or less. An exception (every year or once every multiple years) will be the rate of decrease during flushing, where it should be 0.1 m/hr or less, and the rate of increase during water storage should be 0.2 m/hr or less. (This regulation is considered to be a measure to mitigate the impact of peak power generation on the ecosystem in the immediate downstream area).

In the MRC Hydropower Mitigation Guidelines, there are six areas (economic benefits, maintaining of flow regime (flood pulse), maintaining of habitat in the existing river channels, maintenance of river connectivity, water quality, conservation of fish species) used as multi-criteria assessment indicators for the mitigation measures. A total of 33 evaluation indicators are specified, and continuous monitoring is recommended.

(6) Recent Low Water Level and Drought Phenomenon

The downstream of the Mekong River has experienced of extremely low river water level from the period of the rainy season in 2019 to the beginning of the rainy season in 2020. The 2019 rainy season arrived late compared to the average year. In 2020, a more serious water level drop was observed compared in 2019. This drop in water level is thought to be due to the low rainfall in the downstream area at the beginning of the rainy season (May-July 2020) and impounding of storage in some upstream Lancang Cascade dams. On the other hand, from August to October 2020, rainfall began to increase, and the water level rose above the long-term historical average.

Low water flow in in May to July 2020 is recognized to have had a significant impact on Lake Tonle Sap and the Mekong Delta, and the MRC's situation report mentions the impact on key sectors. For example, in the Mekong Delta, the decrease in flow rate had a negative impact on crops due to sea water intrusion. In the areas of Lake Tonle Sap and its floodplains, there was a negative impact on the ecosystem and socio-economics due to reduced sediment transportation which contains nutrient salt. The impacts on fisheries included the decrease in catches due to the changes in reverse flow with respects to the changes in the timing and duration that affected the flora and fauna in the region. However, the description in the situation report is limited to the presentation and sharing of primary information. The quantitative and in-depth analysis results have not been disclosed, yet. There is no publicly available information on the economic impact.

It is recommended to promote monitoring and information-sharing, and materializing discussions and analysis regarding changes in dam operation rules. However, it is necessary to consider that the negative impacts on the social and natural system of Lake Tonle Sap areas may relate to the development of activities other than the construction and operation of the hydropower dam. In addition, the plan to construct a river structure to regulate the flow of the Tonle Sap River should be carefully studied, as the desirable flow conditions for Tonle Sap Lake and its downstream Mekong Delta have not been clarified yet.

3.2 Sediment Transport and Geomorphology

(1) Sediment Yield

In the Mekong River basin, sediment monitoring has been conducted intermittently from the 1960s to the

2000s, and the MRC implemented the Discharge and Sediment Monitoring Programme (DSMP) from 2009 to 2013. The DSMP monitored sediment by sampling. Based on the survey and research on sediment yield in the Mekong River basin, the characteristics of sediment production in the Mekong River can be summarized as follows:

- In Luang Prabang, which is close to the upper reaches of the Mekong River, fine sand with a grain size of 0.25 mm or less is dominant because the bedload is trapped by the upstream dams. In the downstream area, medium sand (with grain size of 0.25 mm to 0.5 mm) and coarse sand (with grain size of 0.5 mm to 2 mm) are increasing due to sediment inflow from tributary rivers.
- The upper Mekong River basin has a high sediment yield due to the tectonic movements and steep topography, estimated at 450 t/km^2/yr.
- The northern highlands of Laos are composed of sandstone, limestone, granite and metamorphic rocks, and the sediment production is high in the basin.
- In the eastern part of Thailand, the Mun-Chi River basin has a low annual sediment yield of 40 t/km^2/yr, although the production is increasing due to irrigation and other development activities.
- Southern Laos, eastern Cambodia, including the 3S basin, and southwestern Vietnam were uplifted in the late Miocene and are expected to produce 280 t/km^2/yr of sediment due to erosion.

(2) Impacts of Dam Development

The Council Study estimated the amount of sediment flow from the upper Mekong River to Kratie. In 2007, the baseline year, 143 Mt/year of sediment was estimated to have reached the Kratie station. Due to the development of dams in the basin, the sediment reaching Kratie is expected to decrease to 47Mt/year (30% of total sediment in 2007) in 2020 and to 4.5Mt/year (3% of total sediment in 2007) in 2040. The impact of dams constructed on the main river in the upper reaches of China's territory and planned dams on the main and branch rivers in the downstream of the Mekong River will be significant. The planned Sambor Dam which is located at the lowest reaches of the main river will have a significant impact

(3) Challenges on Sediment Management

Since the Discharge and Sediment Monitoring Programme (DSMP) conducted by the MRC from 2009 to 2013, basin-wide observations of sediment transport have not been conducted. The Council Study also states that it is difficult to understand the detailed sediment dynamics due to the lack of data on the particle size distribution of sediment. Most of the existing studies rely on empirical equations for sediment yield, such as the universal soil loss equation (USLE), or on the Brune Equation for estimating sediment trapping in reservoirs, and the sediment dynamics of the entire basin are still within the realm of estimation. As development of dams in the basin progresses, continuous observation of sediment transport is necessary to quantitatively understand the impact of dam operation on sediment dynamics.

The Basin Development Strategy (2021-2030) and MRC Strategic Plan (2021-2025) propose the development of a basin-wide sediment management plan to maintain the ecological functions of the Mekong River basin. The basin-wide sediment management plan should be developed with the participation of relevant organizations in each basin country, based on the understanding of the characteristics of sediment dynamics.

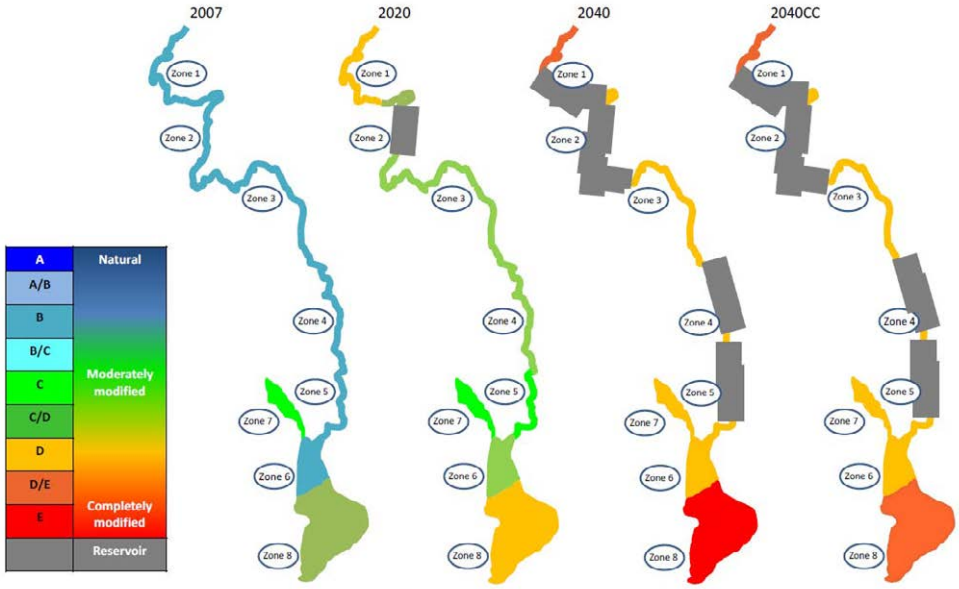
3.3 Ecosystems

Wetlands in the Mekong River basin are important biodiversity hotspots and also play an important role in the economic, social and cultural aspects of the region. However, between year 2003 and 2010, the area of mangroves has receded by 30%. In addition, the MRC estimates that the area of wetlands in the

downstream of the Mekong Delta has decreased from more than 100,000 km^2 in 2010 to less than 2% in 2010. Also, over the past 100 years, total biological resources have declined considerably due to massive expansion of rice cultivation and deforestation, intensive fishing pressure, hydropower development, gravel extraction, urbanization and industrial development, and agricultural development with associated pollution[2].

In terms of the ecological impact of dams, one of the biggest concerns is the impact on aquatic life, especially fish. The Mekong River basin boasts one of the most diversified freshwater environments in the world, with approximately 1,200 fish species registered, and the MRC's 2007-2018 fish monitoring of 25 downstream sites (MRC, 2021) [3] identified 617 fish species. In particular, the section from Nam Kam to Stung Treng and the 3S basin have high diversity with 115 species, while the Tonle Sap area has high diversity and biomass. Compared to other international rivers, the Mekong River still has a relatively good ecosystem (MRC, 2021). However, due to the fragmentation of the river by dams, fish species are expected to be greatly affected.

In the Council Study, the lower Mekong River basin is divided into eight zones and the impact on the ecosystem (biological resources) is predicted using the DRIFT model which focuses on environmental flows. An example of the prediction results is shown in Figure 3.1. In the middle reaches of the Mekong mainstream, the habitat environment has changed drastically due to dam development (changes in flow regime and changes in habitat due to erosion, sedimentation, etc.), and the level of ecosystem health in 2007 was Category B, but it projected to be Category D in 2040. In addition, the downstream areas of the mainstream, which have already been affected by human activities, are expected to be further modified by human activities, and the ecological health of Tonle Sap and the Mekong Delta is expected to go down from Category D to Category E.



Source: MRC, Council Study, Biological Resources Assessment, Technical Report Series, Volume 4: Assessment of Planned Development Scenarios, Final Report, p.83, 2017.

Figure 3.1 Predicted Ecosystem Health by 2040 in the Council Study

[2] MRC, Basin Development Strategy 2021-2030 and MRC Strategic Plan 2021-2025, 2021.
[3] MRC, Status and Trends of Fish Abundance and Diversity in the Lower Mekong Basin during 2007-2018 (MRC Technical Paper No.66), 2021.

Based on the observation above, the status and challenges of the ecosystems in the Mekong River basin are summarized below:

- Considering that the Mekong River basin is very large and has diverse ecosystems, it is highly commendable that the Council Study conducted by the MRC comprehensively assessed the impacts of various water resource developments including dams. At the very least, it is important that the Council Study has once again clarified that mainstream dams are likely to have enormous and widespread impacts on ecosystems. Although the assessment method was rough and insufficient for evaluating individual projects, there are very few cases where the combined impact of many projects was examined with little information on ecosystems. In addition to the involvement of many ecosystem specialists, the use of simulation models for hydrology, sediment, etc., and the use of DRIFT model to integrate these models also contributed to the assessment. It can be said that the importance of working on the assessment of the environmental impact of such wide-area and complex projects has been demonstrated. It would have been even better if the sensitivities of the parameters related to the conditions of development projects and ecosystem response to the results could have been examined from various angles.
- On the other hand, there is an extreme lack of information on ecosystem impacts. It can be imagined that there was probably very little basic information for constructing the response curve of the DRIFT model, and it had to rely on the experience and intuition of ecosystem experts. In countries such as Laos and Cambodia, there is little basic monitoring of ecosystems, inadequate information collection and assessment of ecosystem impacts of individual dams and irrigation projects, and lack of systems and human resources to manage this information in an integrated manner. In particular, there may have been little information on tributary dams. There is also little information on China-Myanmar, which is not included in the Council Study. It is impossible to determine how much basic information is available in China and how much is known about the impact on the ecosystem before and after the construction of dams, but it is possible that many dams were constructed without adequate ecological surveys. In order to avoid repeating such problems, the maintenance of ecosystem information for the entire watershed is one of the matters that need to be addressed as soon as possible.
- The Council Study is not the first time that the ecological impact of dams in the Mekong has been assessed. The Strategic Environmental Assessment (MRC, 2010) [4] for the mainstream dams also pointed out the seriousness of the ecological impacts. However, even when such information was provided, many stakeholders could not decide how to make decisions based on such information, and as a result the situation has not changed significantly for more than 10 years since the Strategic Environmental Assessment. It is difficult to incorporate issues such as loss of biodiversity into decision making, even when ecosystem services are incorporated into the decision making process. Infrastructures such as dams take a long time from planning to implementation and have a very long service life, but the sense of values of residents changes greatly during that time, so it is necessary to find a way to incorporate future values into current decision making.

3.4 Society and Economy

- As with the assessment of ecosystems, the MRC's Council Study can be commended for assessing

[4] MRC, Strategic Environmental Assessment of Hydropower on the Mekong Mainstream, Final Report, 2010.

the very complex social and economic impacts of a vast watershed. In particular, it is important to note the separate assessments of food security, water security, income vulnerability, and poverty. The future projections of the working population by sector are also very helpful from the perspective of poverty and income vulnerability. This type of assessment has not been done in project-level environmental and social impact assessments, but since the response of local residents to project impacts is very dynamic and complex, it is important to take into account the various surrounding developments and the potential for sectoral growth.

- It is very interesting to note that much of the impact on the population is attributed to the difference in the proportion of the working population and the sectoral income between the agricultural and industrial/commercial sectors. While this analysis may be correct in some aspects, it is not believed that a shift to the industrial and commercial sectors is desirable simply because of the current relative income levels. In addition, it is not easy for many people to change their means of livelihood, and it is desirable to conduct a more detailed analysis in which residents are more or less capable of coping with such social changes (existing means of livelihood, household composition and age, education level, need for cash income, etc.) and what measures are needed to address these differences.
- It is also unfortunate that the assessment is limited to the area along the Mekong River (15 km on both sides of the Mekong River). So, broader indirect impacts cannot be fully understood. Although macroeconomic projections[5] have been made separately for broader impacts, it would be good to have an analysis of not only the increase in net present value (NPV) by sector/country due to power generation and irrigation projects, but also to see which people in which regions/countries will receive the benefits and who will be affected by the impacts such as riverbank erosion and rising fish prices. Such an analysis may seem sensitive, but from the perspective of social and economic impacts, information such as the difference in benefits per capita, for example, would be useful to advance the discussion of benefit distribution.
- In the Council Study, in addition to socio-economic and macro-economic assessments, sustainability indices[6] are used to evaluate the SDGs. The results show that the value of the sustainability index decreases in the future development scenarios of 2020 and 2040, compared to the baseline of 2007. It seems very important to note that even if individual projects aimto generate benefits, they may lead to a decrease in sustainability as a whole.
- Although the Council Study did not analyze China and Myanmar, it is hoped that the social and economic impacts of the basin as a whole will be understood, the benefits and costs analyzed, and the sustainability assessed.

3.5 Flood Control Measures

(1) China

Responsible Organization/Agency: Flood control policy in China is focused on protecting the region which is important for the country's development. China's national flood management is under the jurisdiction of the State Flood Control and Drought Relief Headquarters of the State Council, which is located at the Ministry of Water Resources (MOWR) and is headed by the Vice Premier of the State Council. Flood and

[5] MRC, Council Study, Macro-economic Assessment Report, 2018
[6] MRC, Council Study, Cumulative Impact Assessment Key Findings Report, 2017

drought relief headquarters have been set up in each of China's major basins and lakes to implement flood and drought countermeasures in the areas under their jurisdiction. Hydropower dams owned by Chinese ministries and medium- and large-sized enterprises are also responsible for flood protection.

Policy/Planning: The central government has formulated the National Flood Control and Drought Relief Emergency Response Plan, and has developed flood protection and flood control plans for major basins. Local governments have established complementary regulations and rules in their respective areas.

(2) Laos

Responsible Organization/Agency:The National Disaster Prevention Control Committee (NDPCC), chaired by the Deputy Prime Minister, is responsible for disaster management, including water management, at the national level. Local, regional and village levels have their own Disaster Prevention Control Committees.

All of the dams in Laos are dedicated to power generation and therefore do not play a role in flood control. On the other hand, dams managed by EDL, such as the Nam Ngum 1 Dam, effectively perform flood control, such as storing a portion of the flood waters, since operation of the flood discharge during calamities requires permission from the NDPCC. The dams owned by independent power producers (IPPs) do not have flood control capacity and therefore do not play a role in flood control.

Policy/Planning: The Prime Minister's Decree No. 158 of 1999 established the national, local and regional disaster management committees, and in 2007, their role was changed from a disaster response-oriented structure to disaster risk management. Disaster management, including flood control, is covered by the National Strategic Plan for Disaster Risk Management and the National Disaster Management Action Plan.

(3) Vietnam

Responsible Organization/Agency: In Vietnam, the Ministry of Agriculture and Rural Development (MARD) is the government agency in charge of responding to disasters, including floods, and giving cross-cutting instructions to relevant ministries and agencies depending on the type of disaster. The Minister of MARD chairs the Central Committee for Natural Disaster Prevention and Control (CCNDPC). The CCNDPC is the supreme national disaster management authority and consists of representatives from relevant central ministries such as the Ministry of Natural Resources and Environment, the Ministry of National Defense, and the Ministry of Transportation. At the local level, the establishment of disaster preparedness and search and rescue committees is stipulated at the provincial, district and commune levels, and the local Department of Agriculture and Rural Development (DARD) is the executive body for local disaster management.

In the area of flood control, the Central Committee for Flood and Storm Control has been established under the MARD and is responsible for embankment management, flood control, disaster management centers, and collection of hydrological data.

Policy/Planning: The law on flood management in Vietnam is based on the Law on Disaster Prevention and Mitigation, which was formulated in 2013. In the same year, the Natural Disaster Prevention and Control Plan was also enacted.

(4) Thailand

Responsible Organization/Agency: The Department of Disaster Prevention and Mitigation (DDPM) of the Ministry of Home Affairs is in charge of disaster response, including floods. The National Disaster Prevention and Mitigation Committee (NDPMC) makes policy decisions on disaster management, and the

secretariat of the NDPMC is in charge of the DDPM. The Department of Construction and Urban Planning of the Ministry of Home Affairs is in charge of drainage and inland water flood protection in major cities, while the Bangkok Metropolitan Administration (BMA) is in charge of flood management in the capital city, while the Provincial Disaster Prevention and Mitigation Committee (PDPMC) is in charge of disaster prevention at the local level.

On the other hand, most of the dams in Thailand are owned by the Royal Irrigation Department (RID) or the Electricity Generating Authority of Thailand (EGAT), and there are several multipurpose dams with flood control functions in the dams owned by EGAT and RID. Many of the dams managed by RID are reservoir-type dams with a large storage capacity compared to the river flow rate, and they play a significant role in flood management. In 2017, the Office of National Water Resources (ONWR) was established as a cross-ministry organization.

Policy/Planning: The Disaster Prevention and Mitigation Act, enacted in 2007, defines the agencies and roles involved in disaster prevention. Based on the Act, a national disaster management plan has been formulated.

For long-term infrastructure development related to flood control, the National Water Resources Act of 2018 established the 20-year Water Resources Management Master Plan (2018-2037) under the leadership of ONWR and the National Water Resources Commission. In the master plan, a water resources management plan for flood control and water utilization for the next 20 years has been developed.

(5) Cambodia

Responsible Organization/Agency: The National Committee of Disaster Management (NCDM) is responsible for disaster management administration. Disaster management committees have been established at the provincial, regional, commune and village levels to deal with disasters, including floods.

Water resources administration, including water use, is under the jurisdiction of the Ministry of Water Resources and Meteorology (MOWRAM) (for river and water resources management and development, flood and drought management, etc.), the Ministry of Environment (MOE) (for water environment, wastewater regulation, etc.), the Ministry of Mines, Industry and Energy (MIME; water supply services in provincial capitals and small and medium-sized municipalities), and the Ministry of Rural Development (MRD) (for communal tap projects, etc.). The Ministry of Water Resources and Meteorology is in charge of planning and implementation of flood protection.

Policy/Planning: In 2015, the Disaster Management Act was enacted, which clarified the roles, responsibilities, and institutions of disaster management administration, including flood response. Based on this law, a national disaster management plan has been formulated.

In terms of water resources management, including water use, the Law on Water Resources Management (2007) provides for water resources management, including both surface water and groundwater, water use communities and flood management.

(6) Myanmar

Responsible Organization/Agency: The National Disaster Management Committee (NDMC) is a national-level body that formulates policies for disasters in general, including floods, and was established by Decree No. 30 of 2016. Under the NDMC, several committees have been established, including the Disaster Management Executive Committee and the Livelihood Support Committee. The Department of Disaster Management of the Ministry of Social Welfare, Relief and Resettlement is the implementing

agency for disaster management.

In terms of river basin management, including flood management, the Irrigation Water Use Management Department (IWUMD) of the Ministry of Agriculture, Livestock and Irrigation (MOALI) is responsible for the water use in the tributary basins of major rivers and the management of small and medium river basins.

Policy/Planning: Although directions have been set in disaster prevention planning and river basin management (RBM), including flood management, integrated management of the main river basin and tributary river basins of major rivers has not yet been realized and is still under construction.

3.6 Development Policy and Status of Dams and Hydropower

(1) Hydropower Development in the Mekong River

The water resources development in the Mekong River had been mainly for irrigation between 1950 and 1970. Hydropower development emerged in Thailand, Vietnam, and China began in the 1990s and 2000s, and a large number of hydropower projects have been developed in Laos between 2010 and 2020. The construction of several large hydropower plants in China since 2000 has led to a rapid increase in installed capacity, and it is assumed that more hydropower development will be under construction or planned after 2020. It is also assumed that hydropower development in Laos will be continued and will grow steadily until 2040.

(2) Hydropower Development in the Upstream of the Mekong River (Lancang River)

China has built 11 hydropower dams (two of which are large storage dams) along the Lancang River on the upper Mekong River and has also built or plans to build 11 more hydropower dams. The total capacity of hydropower facilities built on the Lancang River is 21,310 MW, and it will increase to 31,605 MW which includes hydropower under construction and those planned (MRC, 2021).

(3) Hydropower Development in the Downstream of the Mekong River

A total of 11 hydropower projects are planned on the downstream Mekong River, of which Xayaburi and Don Sahong will be completed in October 2019 and November 2019, respectively. The planned Pak Beng, Luang Prabang, Pak Lay, and Sanakham projects in Laos are under the Procedures for Notification, Prior Consultation and Agreement (PNPCA) process of the MRC.

Table 3.1 Hydropower Development in the Downstream of the Mekong River

Name of Project	Country	Status	Capacity (MW)
Pak Beng	Laos	Planned	912
Luang Prabang	Laos	Planned	1,460
Xayaburi	Laos	Operational	1,285
Pak Lay	Laos	Planned	770
Sanakham	Laos	Planned	660
Pak Chom	Laos	Planned	1,079
Ban Khoum	Laos	Planned	2,000
Pou Ngoy (Lat Sua)	Laos	Planned	651
Don Sahong	Laos	Operational	260
Stung Treng	Cambodia	Planned	980
Sambor	Cambodia	Planned	1,703
		Total	11,760

Source; MRC, "The MRC Hydropower Mitigation Guidelines, Guidelines for Hydropower Environmental Impact Mitigation and Risk Management in the Lower Mekong Mainstream and Tributaries, MRC Technical Guideline Series, Vol.1" 2019

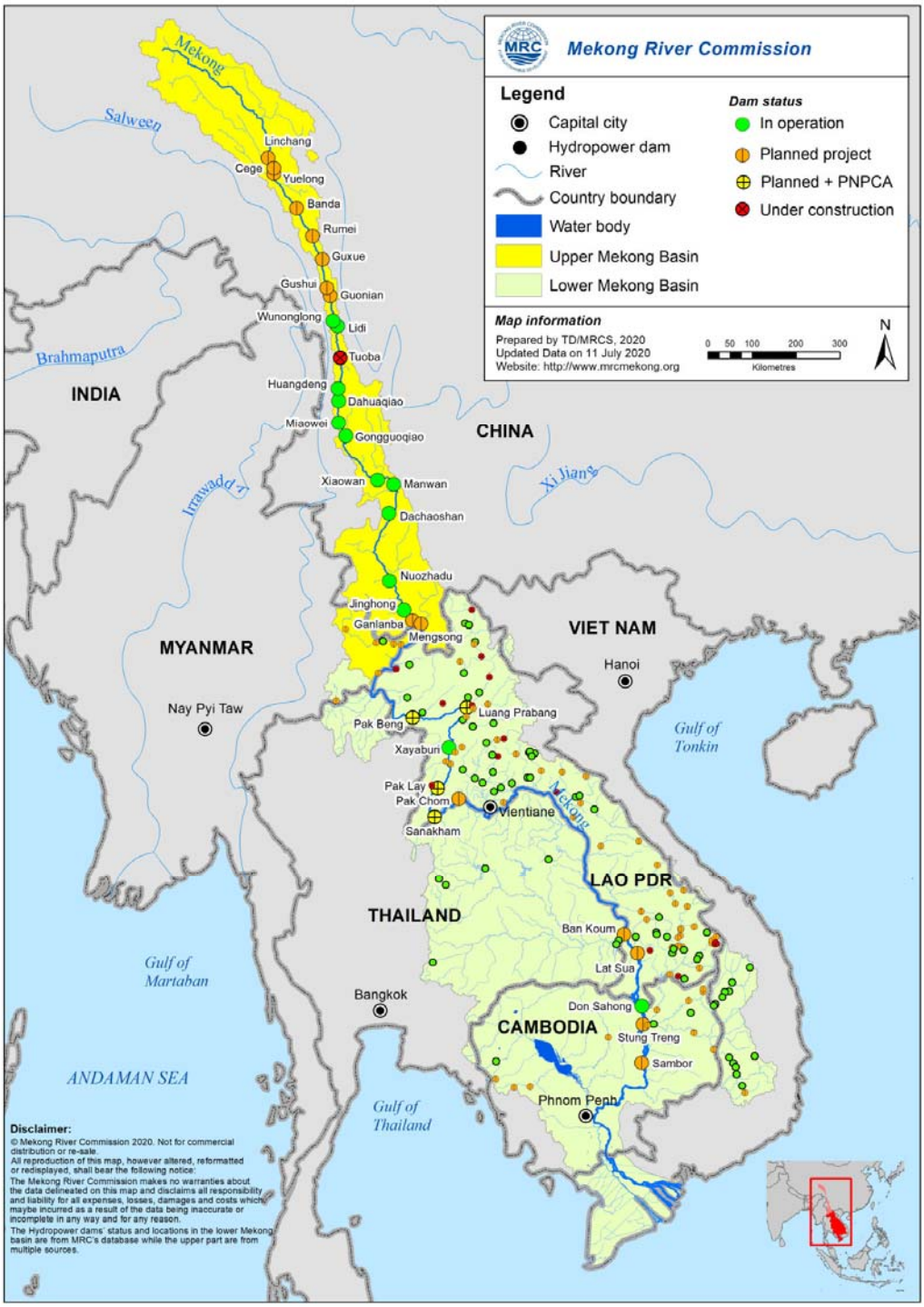
All the dams planned, constructed, and in operation on the Mekong River mainstream shown in Table 3.1 above are for export to Thailand. As Sanakham and Pak Chom are bordered by Thailand, Thai regulations also apply to their development. The number of existing and planned hydropower

development sites in the Mekong River tributaries is shown in Table 3.2. As shown in the table, Laos dominates the list with 126 sites.

Table 3.2 Number of Hydropower Development in Tributaries of the Mekong River

Country	Number of Existing and Planned Dams (No.)
Laos	126
Viet Nam	16
Thailand	7
Cambodia	4

Source: MRC, "The MRC Hydropower Mitigation Guidelines, Guidelines for Hydropower Environmental Impact Mitigation and Risk Management in the Lower Mekong Mainstream and Tributaries, MRC Technical Guideline Series, Vol.1" 2019



Source: MRC, Basin Development Strategy for the Mekong River Basin 2021-2030 & MRC Strategic Plan 2021-2025

Figure 3.2 Existing and Planned Hydropower Development

3.7 Dam and Energy Policies of Basin Countries

(1) Overview of Power Demand and Supply in the Basin Countries of the Mekong River

The status of power demand and supply in the Greater Mekong Subregion (GMS) countries, including the countries of the Mekong River basin, is summarized in Table 3.3 below:

Table 3.3 Power Demand and Supply in the Basin Countries of the Mekong River

Item	Thailand	Vietnam	Myanmar	Cambodia	Laos

Scale of demand	40 GW	41 GW	4 GW	2 GW	1 GW
Scale of existing power supply*1	41 GW	57 GW	5.4 (0.4)*2GW	2.2 GW	10 (6.6) GW
Composition of power supply	Thermal main	Hydro 40% Thermal 50%	North - Hydro South - Thermal	Hydro 50%. Thermal 50%	Hydro main
Role in interconnected grid	Demand area	Demand area	South - Demand area North – Power supply	Demand area	Power supply
Status of power system development	Demand growth rate as low as 3%.	Demand is increasing	Need for emergency power supply due to rapid increase in demand	Need for emergency power supply due to rapid increase in demand	Hydro surplus in rainy season
Trunk line	500 kV Grid	500 kV Grid	500 kV grid under construction	230 kV	230 kV
Future investment	Domestic 500 kV maintenance	Domestic 500 kV line Responding to the rapid increase in solar power (regional	Domestic 500 kV. Investment in domestic power system is required	Investment in domestic power system is required	Northern region:500 kV investment in domestic power system is required
System operation	Frequency control implemented	Frequency control implemented	Frequency control (insufficient due to large fluctuation)	No frequency control (synchronized with Vietnam)	No frequency control (synchronized with Thailand)
Implementation of grid code	Yes, and it has been complied.	Yes, and it has been complied.	None	None	Located in EDL. Not in compliance
Solar installation status	Increase in solar power for local supply	10 GW of solar power installed in the last 1-2	Installation of 0.2 GW in plan	Small investment	

*1: year 2020 in Thailand, estimated value of 2020 in PDP8 for Vietnam, year 2018 for Cambodia, year 2019 for Laos, year 2017 estimates for Myanmar
*2: Figures in parentheses() indicate export-only generation capacity out of the existing power supply scale.
Source: "JICA Lao PDR Electricity Master Plan Development Project Final Report" and Study Team

The power supply and demand status in each country in the Mekong River basin can be summarized as follows:

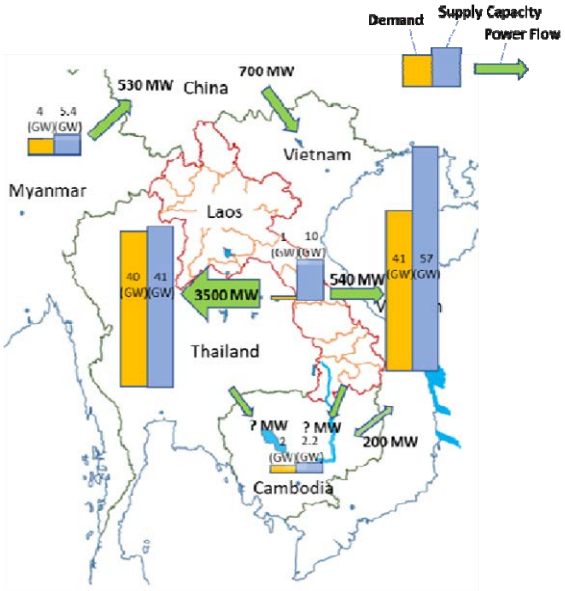
1) Myanmar and Cambodia have urgent power supply needs due to surging demand and both will continue to require new power sources in the future.
2) Thailand's demand is becoming saturated, and the growth rate is low (3%), so there is not much supply capacity from new power sources. Therefore, the surplus power in Laos to be transmitted to Thailand will be used to reduce the amount of thermal power generation in Thailand or be transmitted from Thailand to Myanmar and Cambodia.
3) Cambodia's experience with power shortages during the dry season has led it to shift its power supply structure from hydropower to thermal power supply, and it is also looking to importing coal-fired power in Laos.
4) Myanmar is currently seeking emergency power sources such as gas turbines and liquefied natural gas (LNG) due to a surge in power demand. Also, there are several plans for large-scale thermal power plants, but due to the cost of port development and fuel, Myanmar's thermal

power is considered to have a high cost of generation. Power development plan is mainly to transmit economical hydroelectric power from the north in the future.

In Vietnam, supply capacity greatly exceeds demand, but unstable renewable energies such as solar and wind power account for about1 10% of the electricity supply, and hydropower, which has a large difference in power output during the wet and dry seasons, accounts for about 40%. Reservoir-type hydropower has been playing a role to compensate the output of unstable renewable energy. However, the capacity of reservoir-type hydropower will be insufficient in the coming year 2030. Because of the large difference in output between the wet and dry seasons, the amount of electricity that can be generated during the dry season decreases, and the shortage must be covered by importing electricity from China and Laos.

(2) Status of Electricity Supply in Mekong River Basin Countries

In terms of the electricity supply in the basin countries along the Mekong River, Thailand and Vietnam, which have large electricity supply and demand and large power systems, are sandwiched between Laos and Cambodia, which have small electricity supply and demand and small power systems. Laos, which is sandwiched in between, exports electricity mainly to Thailand and also to Vietnam.



Source: Prepared by the JICA Study Team based on the JICA Lao PDR Electricity Master Plan Development Project.

Figure 3.3 Status of Power Sharing between the Basin Countries in the Mekong River

As for the future power supply, the Asian Development Bank (ADB) and the World Bank are leading the formulation of the Greater Mekong Sub-Region (GMS) Regional Cooperation Plan. For the project to develop a master plan for electricity in Laos, JICA has proposed the interconnection of electricity with Thailand and Vietnam, mainly in Laos, as a candidate for cooperation.

In the ADB study (Harmonizing the Greater Mekong Sub-Region Power System to Facilitate Regional Power Trade), Myanmar-Thailand, Laos-Vietnam, and Thailand-Cambodia-Vietnam were selected as the highest priority interconnection lines. In addition, Laos-Cambodia and China to Myanmar, Thailand, Laos and Vietnam were selected as the most suitable interconnection lines. The study presented the optimal power supply configuration after interconnection. It should be noted that this implies that the best mix of power sources should be considered when each system is connected by the interconnection line, and that this will affect the way the power sources are configured in each country in the Mekong River basin.

3.8 ESG Investment and Hydropower Development

In this study, the impact of Environment, Social and Governance (ESG) investment on large hydropower projects is examined. The results are summarized as follows:

- Up to now, hydropower development in the Mekong River basin has evolved into three types: (1) public investment type, mainly financed by donors (from 1970s to 1990s); (2) PPP investment type, relying on private investment from Thailand, Malaysia, and other countries (in 2000s); and (3) new bilateral investment type, based on funds from China, Vietnam, and implemented by donor and host countries (from 2000s to recent years). In these years, ESG was not mainstream in the financial markets, and it was not sufficiently recognized in PPPs. In the case of new bilateral country investments, various priorities of the countries have influenced the investments, and therefore the impact of ESG was considered to be limited.
- As far as it can be seen from the web pages of project owners and lenders involved in hydropower development, ESG has not been sufficiently recognized in Vietnam, Laos, and Cambodia even in recent years, and even in China. It seems that corporate social responsibility (CSR) ideas such as contributing to poverty reduction in the region have been mainly transmitted.
- However, ESG is rapidly promoted across Southeast Asia, and financial institutions and investors, especially those in countries affected by international financial markets such as Thailand and Malaysia, seem to be sensitive to ESG trends. Also in China, the government is taking the lead in developing non-financial information and clarifying the target areas for green investment, and ESG is becoming more widespread.
- The decarbonization of the energy sector has been accelerating rapidly since the Paris Agreement was adopted in December 2015, and it is being promoted by shifting from thermal power generation which emits a lot of CO_2, to renewable energy such as hydrogen, ammonia, other CO_2-free power sources or CO_2 storage and utilization, and the combination of storage batteries and other technologies.
- In Europe, in response to the Green Deal Policy, there is a growing trend to define a taxonomy to clarify projects which can be considered for responsible investment, and the taxonomy is shifting to include not only climate change mitigation and adaptation, but also circular economy, pollution, biodiversity, and blue economy. The taxonomy standard is a specific and legislated criterion for responsible investment, and may be used as a basis for investment decisions in regions outside the European Union (including the Mekong River basin). At the same time, there is a movement to define a global standard taxonomy, and China and some ASEAN countries are participating in this discussion. In addition to approaches that make a binary distinction between sustainable and unsustainable depending on the criteria, discussions are also underway on transitional financing to shift environmentally burdensome projects to sustainable ones.
- Access to international financial markets is also very important for China and ASEAN countries, and most institutional investors are also widely involved in other renewable energy and non-energy investments. Therefore, decisions on large hydropower investments need to be made with the whole market in mind. As can be seen from China's leadership in the Convention on Biological Diversity, there are a variety of ESG-related trends that will influence how countries respond to ESG issues.
- In view of these series of developments, the ESG implications for large hydropower projects will be

even greater. However, ESG developments will not happen all at once, but will be phased in according to the priorities of each country, business, and investor. Therefore, for businesses that are not open to financial markets, other priorities will take precedence, and the impact of ESG will be limited, at least for the time being.

- There is an overwhelming lack of ESG information on individual hydropower projects in the Mekong River basin, especially on tributary dams, because they have been promoted under the new bilateral country investment type. It is very important to promote the development and disclosure of ESG information for the Mekong River basin countries to access international financial markets.

In addition, there is a need for a framework to evaluate large hydropower projects from an ESG perspective. These include the EU taxonomy, the International Hydropower Association (IHA) Hydropower Sustainability Tools, and the MRC Hydropower Mitigation Guidelines. It is important that accurate and understandable information is made available to investors and politicians, especially on impacts on livelihoods, fairness of benefit sharing, ecosystems and biodiversity.

4. Current Status of Basin Countries and Cooperation Initiatives

The use of the Mekong River is influenced by various factors such as the position and dependence of each country in the basin, the relationship between upstream and downstream, the domestic situation, and the political situation among related countries. An overview of each country in the Mekong basin is presented below:

- In Laos, dam development is mainly aimed at hydropower generation. In addition, because of changes in hydrological conditions due to climate change, the Ministry of Natural Resources and Environment is trying to facilitate the effective use of the dams' water storage function, such as supply water during dry season, through the cooperation with key line agencies, local authority and the framework of MRC and Lancang-Mekong Cooperation (LMC).
- Thailand, which has the geopolitical significance of being located at the center of Mekong River, is aiming for the development of the entire region, trying to promote international cooperation with neighboring countries through the Thailand International Cooperation Agency (TICA), improving the connectivity of both hard and soft components, and promoting sustainable development centered on SDGs. Also, as the country that recommended the establishment of LMC, Thailand requests all the LMC member countries, for sustainable water resource management across national borders, to strengthen practical cooperation for information sharing and early warning system for water level fluctuations necessary for preparations in advance especially for downstream residents.
- For Cambodia, 86% of its population is in the Mekong River basin and approximately 90% of people live in the riverside basin. At the basin, which is facing economic development, cooperation of six basin countries is indispensable for effective utilization of water resources and energy and sustainable water resources management. In addition, there is emphasis on the importance of capacity development, system maintenance, promotion of comprehensive monitoring and evaluation, and cooperation of MRC member countries based on MRC BDS (2021-2030).
- Vietnam is expanding omnidirectional diplomacy and actively participates in various international organizations, as well as international and regional frameworks. Also, Vietnam has the characteristics of both upstream and downstream of the Mekong River since it is located upstream of Sesan and Sre Pok rivers which are tributaries of the Mekong River, and it also forms the Mekong Delta which is the downstream tip of the Mekong River.
- China has shared the year around hydrological information of the Lancang River with the basin countries through the LMC cooperation framework. Also, China is going to work together with other countries to promote cooperation between upstream and downstream countries and strengthen the capacity of integrated water resources management in the basin.
- For Myanmar, water resources management in Mekong River has limited importance compared to its domestic Ayeyarwady and Salween Rivers. The area of Mekong River basin is 24,000 km^2, which is about 3.5% of the total land area (680,000 km^2), and its Mekong basin population is less than 200,000 which is less than 1% of its total population.

The MRC is an intergovernmental organization for regional dialogue and cooperation in the Lower Mekong River basin, established in 1995 based on the Mekong Agreement. It consists of four member

countries from downstream, Cambodia, Laos, Thailand and Vietnam, and two observers from upstream, China and Myanmar.

The MRC consists of three permanent bodies: the MRC Council consisting of ministerial level of the four member countries, the MRC Joint Committee consisting of directors, and the MRC Secretariat providing technical and clerical services. The National Mekong Committee (NMC) is established in each member country and is composed of the members from relevant ministries and agencies of each country. As a method to implement the Mekong Agreement, the MRC has established the following five procedures:

(1) Procedures for Data and Information Exchange and Sharing (PDIES)
(2) Procedures for Water Use Monitoring (PWUM)
(3) Procedures for Notification, Prior Consultation and Agreement (PNPCA)
(4) Procedures for the Maintenance of Flows on the Mainstream (PMFM)
(5) Procedures for Water Quality (PWQ)

There are various cooperation frameworks in the Mekong Region as follows:

- Japan-Mekong Cooperation, in the "Tokyo Strategy 2018", is based on three pillars: namely, hard connectivity, soft connectivity, and industrial connectivity in the Mekong Region. Regarding water resources management, it is decided to include the cooperation for sustainable water resources management and strengthening the cooperation between Japan-Mekong Cooperation and MRC.
- LMC is based on the initiative for sustainable development on the Mekong basin proposed by Thailand. LMC is the cooperation framework of the six basin countries established in 2016 at the suggestion of China. China-led LMC is strengthening more its frameworks for cooperation with watershed countries.
- Lower Mekong Initiative (LMI) was established in 2019 under the initiative of the U.S. It is a regional cooperation framework consisting of five countries in the Mekong River basin excluding China. The U.S. side upgraded to partnership (U.S.-Mekong Partnership) in order to strengthen cooperation from the original LMI.
- ADB is launched the GMS program in 1992 under its own initiative. It is targeted at six countries in the Mekong River basin: Laos, Myanmar, Thailand, Cambodia, Vietnam, Yunnan Province-China, and later Guangxi Zhuang Autonomous Region and aims to further strengthen economic relations and promote economic cooperation. Its premise is operation under the informal framework, and discussions are held among countries to select priorities.
- Thailand-led Ayeyarwady-Chao Phraya-Mekong Economic Cooperation Strategy (ACMECS) has Thailand, Cambodia, Laos, Myanmar, and Vietnam as the participant countries, and its main fields of cooperation are promoting trade and investment, operation in agriculture and industry, transportation linkage, tourism, and human resource development.

Activities related to water resource management in the Mekong River basin by major development partners are as follows:

- World Bank has provided the continuous support since the inception of the MRC in 1995. From 2000 to 2006, under World Bank-Water Utilization Program (WB-WUP), WB supported to formulate the five procedures (PDIES, PWUM, PNPCA, PMFM, PWQ) of MRC. Also, from

2012 to 2021, support for Mekong-Integrated Water Resources Management Project (M-IWRM) was implemented and the project is about to be completed.

- ADB provided a loan to the Water Resources Management Sector Development Program, which was implemented from 2010 to 2021 by MOWRAM in Cambodia, with the main purpose of capacity building for water resources management and irrigation. As a part of this program, Rapid Assessments on the Status of Water Resources and Eco-hydrological Environments for the Tonle Sap and Mekong Delta River Basin Groups and River Basin Surface were conducted in 2019 for the basin around Tonle Sap Lake and Mekong Delta within Cambodian territory for the purpose of organizing and providing information necessary for MOWRAM's decision-making for future irrigation development.
- The Deutsche Gesellschaft fur Technische Zusammenarbeit (GTZ) has been supporting the Joint Environmental Monitoring (JEM) and published Inception Report in May 2020. It is conducting monitoring upstream and downstream of Xayaburi Dam and Don Sahong Dam. The items of monitoring are hydrology, sediment, water quality, ecosystem, and fish species. GTZ also funds the Mekong Basket Fund.
- The support of Agence Française de Development (AFD) covers a wide range of areas, including water resource management and irrigation water management. Its priority issue is climate change and approximately 75% of financial cooperation is devoted to climate change adaptation measures. The fields of support differ depending on the target country.
- Through the framework of US-Mekong Partnership, the US has supported the Stimson Center. It has developed the Mekong Dam Monitor to publish information of dam reservoirs and environmental impacts in the Mekong River basin utilizing semi-real-time satellite information and geographic information system (GIS). It has also developed the Mekong Infrastructure Tracker which can monitor infrastructure status, development impact, and forest status in the GMS area including the Mekong River basin.

As described above, with the activities of development partners and various frameworks of cooperation in the Mekong River basin countries and the MRC, where four downstream countries join, the Mekong Regions are diverse. International politics and trends also influence the content of activities. Although many institutions and frameworks have agreed to further promote integrated water resources management on the Mekong River, different responses to regional issues, conflicts of interest, information sharing, governance and coordination capabilities have become an issue for more desirable water resource management.

5. Environmental and Social Impacts on Tonle Sap Area

5.1 Hydrological and Hydraulic Characteristics of Tonle Sap Area

Tonle Sap Lake is in Cambodia and it has a total catchment area of about 81,700 km^2 including the surrounding watershed, with a total of 11 small rivers flowing into the lake. The average annual rainfall in the basin is 1,350 mm. The area and capacity of the lake fluctuate greatly due to the influence of the water level of the Mekong River mainstream, and reverse flow occurs from the mainstream to the lake during the rainy season. Table 5.1 shows the main indicators of the lake.

Table 5.1 Annual Average Water level, Area and Volume of Tole Sap Lake

Item	Annual Average		Difference (Annual)
	Lowest/Minimum	Highest/Largest	
Water Level (masl)	1.3	9.0	7.7
Area (km^2)	2,200	13,000	10,800
Volume (km^3)	1.5	57.5	56

Source: Procedure for PMFM, Comprehensive Information Report, Apr. 2018, MRC

The annual water balance of the lake is shown in Table 5.2, with the inflow from the Mekong River mainstream during the rainy season accounting for about half of the total, and the remaining half coming from the surrounding tributaries and rainfall into the lake.

Table 5.2 Annual Water Balance of Tonle Sap Lake

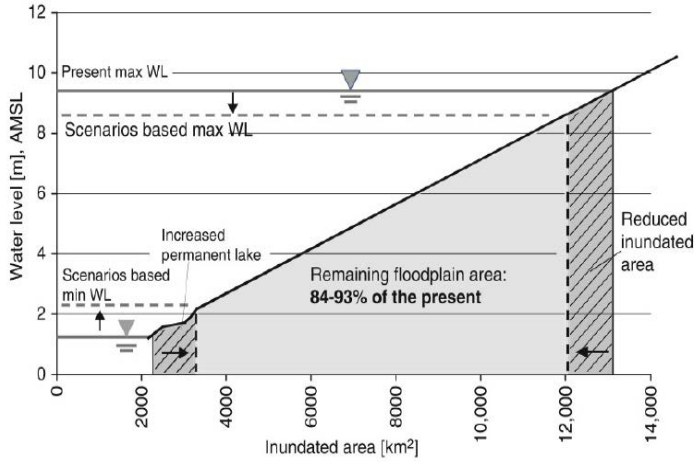
Item	Inflow to Lake				Outflow from Lake		
	Tributaries	Mekong Mainstream	Precipitation	Total	Mekong Mainstream	Evapo-transpiration	Total
Runoff (km3)	29	43	10	82	70	9	79
Ratio (%)	35	52	13	100	88	12	100

Source: Procedure for PMFM, Comprehensive Information Report, Apr. 2018, MRC
Original data from"Kummu, M., and J. Sarkkula, 2008. Impact of the Mekong River flow alteration on the Tonle Sap flood pulse. AMIBO 37: 185-192"

With regard to the reverse flow as a natural phenomenon into Tonle Sap Lake, the PMFM points out that water resources development will generally not change the mainstream flood flow to a detectable extent. However, it is also noted that waterlogging in the reservoirs (e.g., for the purpose of restoring the water storage level in the early stage after the start of the rainy season) may delay the start of the downstream flow increase and thus delay the schedule for the start of reverse flow.

On the other hand, it is said that changes in water level and flow due to changes in rainfall caused by climate change also affect the reverse flow phenomenon in Tonle Sap Lake, but the interrelationship between the effects of dam construction and operation has not yet been quantitatively understood, and the view at present seems to be undefined.

Figure 5.1 shows the characteristic feature of the Tonle Sap Lake.



Source: MRC Hydropower Mitigation Guidelines

Figure 5.1 Relationship between Lake Water Level and Inundated Area in Tonle Sap

The Sekong, Sesan, and Sre Pok river basins, known as the 3S basin, are recognized as important tributaries for transboundary water resources management due to the size of the basin area, the potential for hydropower development, and the fact that they span the territories of three countries: Laos, Cambodia, and Vietnam. The development of hydropower dams has progressed, and many dams have been built or are planned to be built in the future. Table 5.3 shows an overview of the dams in the 3S basin and Figure 5.2 illustrates its location map.

Table 5.3 Number of Dams in 3S River Basin

Status	By Country			By Sub-basin		
	Laos	Cambodia	Vietnam	Sekong	Sesan	Srepok
Operational	12	3	34	13	23	13
Under construction	5	0	0	5	0	0
Inventory, Proposed Pipeline	55	21	1	55	5	13
Total	72	24	35	73	31	29
Dam-cascade	21	13	13	21	15	13

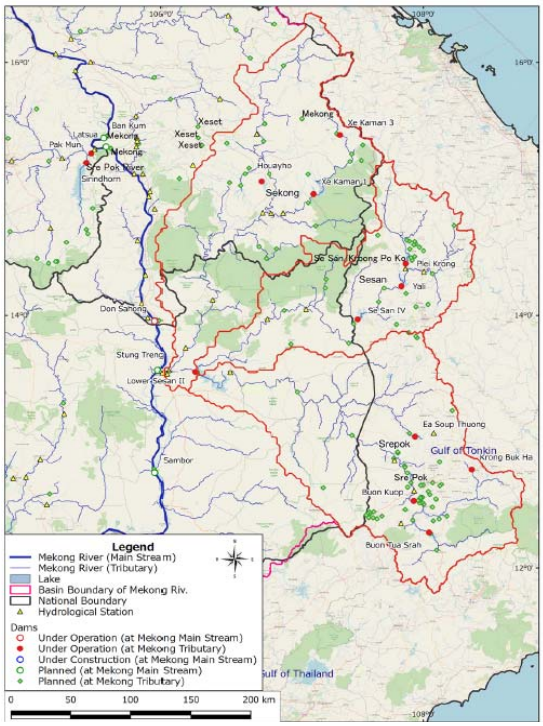


Figure 5.2 Location Map of 3S River Basin

5.2 Environmental and Social Impacts by Regional Development in Tonle Sap Area

The most potentially problematic issue on Tonle Sap Lake when considering the impact of dams in the Mekong River basin is the impact on fisheries. The findings on the impact of reduced fish catches on the livelihoods of local residents are summarized as follows:

- Most of the residents in the Tonle Sap area are engaged in fishing for income and self-consumption, and the socio-economy of the Tonle Sap area will be greatly affected by the decline in fish catches, but the manifestation of the impact is not simple.
- Currently, areas close to the national highway, which are more advantageous in terms of access to markets, have an advantage for livelihoods, but this does not necessarily mean that households that rely heavily on fishing, such as those in floating villages, have the highest poverty levels. Rather, poverty may be higher in areas that are a little farther from national highways and are not blessed with relatively high net income from fishing, aquaculture, livestock, vegetables, and other sources of livelihood.
- However, based on current sectoral net incomes, expected future agricultural and urban off-farm jobs may not necessarily be better livelihood options than current fisheries. This is especially true for fisheries-based livelihoods. In particular, households that depend on fishing as their main source of livelihood may experience a significant reduction in net income if they are unable to engage in off-farm livelihoods that are better than fishing.
- In addition to the current limited information on the socio-economic status of the existing communities, there is a lack of information on how much income the various livelihoods will generate in the future, and the extent to which residents will be able to shift their livelihoods.

Through the current study, it was clarified that the problems in the Tonle Sap area are influenced not only by the dam, but also by a variety of factors such as climate change, population dynamics, local economy, and development plans for agriculture, industry, and commerce, which are not easy to

understand properly. In addition, decision-making on regional development is formed on the basis of limited information on different sectors of various actors' perceptions of the issues and complex political dynamics, and not all decisions are based on sufficient information and paths.

5.3 Analysis of Current Issues and Proposed Countermeasures

In the Tonle Sap area, there are concerns about the various impacts of the dam, especially the significant decrease in fish catches and the following questions need to be answered:

(1) What extent do changes in flow conditions (reverse flow), impediments to migration, and overfishing contribute to the biology of various fish species?

(2) What extent of impacts do individual dams and structures in the Mekong River basin and around Tonle Sap Lake (especially the Sambor Dam near Tonle Sap Lake and the 3S basin) have, in particular, on the development of tributaries that flow directly into Tonle Sap Lake, and other factors (e.g., climate change, fisheries, etc.)?

(3) How can the objectives of expanding agricultural land, controlling floods, securing catches of various fish species, and maintaining ecosystems close to nature by suppressing seasonal fluctuations be balanced?

(4) What extent of human intervention should be carried out in the face of large seasonal and interannual fluctuations?

(5) Who should bear the costs?

Due to the lack of answers to these questions, the reality is that no concrete mitigation measures have been considered.

In addition, measures to deal with the decline in fish catches will be necessary, but the impacts will not manifest itself in isolation, but will be affected by the progress of urbanization and, regional developments such as roadway construction and changes in the population, including migrants to Phnom Penh and overseas. In this context, it is important for the local government to take action and there are social demands on the regional administration to address various issues other than adaptation measures to the decline in fish catches. These various issues need to be addressed simultaneously. Table 5.4 summarizes the results of the analysis of the current issues in the Tonle Sap area.

Table 5.4 Summary of Current Issues and Knowledge Gaps in Tole Sap Lake

Knowledge/ Background	Unknown/ Lacking Information	Direction of Improvement/ Countermeasures
Issue 1) Change of Floodplain Ecosystems		
● Floodplain habitats (including flooded forests) are expected to change due to increased minimum water levels during the dry season and decreased maximum water levels during the wet season due to dams. ● In addition to dams, climate change will also affect floodplain ecosystems. In addition to the effects of flow regime, the effects of logging of flooded forests and expansion of agricultural land are also considered problematic.	● The extent to which floodplain ecosystems are altered by changes in flow regime and land use change has not been quantified. ● The extent to which fish and other species that use floodplain habitats are affected is not known.	● The extent of impacts on floodplain ecosystems and possible secondary impacts (e.g., impacts on fish species and fish catches due to changes in habitat) need to be understood in more detail. ● It is desirable to establish a method for adaptive management while monitoring the ecological environment of the floodplain.

Issue 2) Attenuation Problem of Flood Pulse (Reverse Flow)		
● The contribution of releases from the cascade dams on the Lancang River to the reverse flow is very small. ● In recent years, there has been a noticeable delay in the start of the reverse flow and an earlier end, resulting in a shortening of the reverse flow period. ● Some research institutes have pointed out that there is a concern that this low water phenomenon will become a state (New Normal).	● The correlation between flood pulses and specific dam/ reservoir operation (tributary areas, dam locations, discharge and storage volume, etc.) has not yet been clearly grasped. ● For this reason, concrete studies on effective mitigation measures in mainstream and tributaries have been not progressed substantially.	● It is necessary to develop and improve the accuracy of hydrological/ hydraulic models that can take into account the operation of dams and gate structures. ● Comparison of analysis results using scenarios that combine various input and operation rules for mainstream and tributary dams and climate change factors (rainfall) is required. ● Detailed examination of the effects of coordinated operation of 3S basin dams is important.
Issue 3) Reduction of Fish Catches		
● Factors such as impediments to migration by dams and other structures, changes in flow regimes, reduction of habitats such as spawning areas and floodplains, overfishing, and degradation of water quality may reduce the catches by 1/3 to 1/2. ● This is expected to have a significant impact on fishermen and residents who live in subsistence and sustainable livelihoods.	● It is not clear how various factors such as impediments to migration, delays in the timing of floods that trigger migration, reduction in habitat, and overfishing specifically affect fish catches. ● It is not clear how the development of rivers that directly flows into the Tonle Sap Lake affects fish migration and flow conditions.	● A more detailed understanding of the factors and mechanisms that determine fish catches is needed. ● Measures to control the impact of declining fish catches on the population (e.g., promotion of managed aquaculture, vegetable cultivation for nearby cities, ecotourism, temporary compensation, and other safety nets) are needed.
Issue 4) Water Quality Changes (Development of Eutrophication, Pesticide Contamination and Microbial Contamination, etc.)		
● While sediment and nutrients flowing in from the mainstream of the Mekong River will decrease due to the dam, nutrients flowing from the Tonle Sap Lake basin may increase, and these combined effects may change the water quality. ● These combined effects may lead to changes in water quality. The influx of nutrients and lowered turbidity may lead to abnormal growth of blue-green algae, pesticide pollution, and microbial contamination due to the inflow of sewage.	● The dynamics of nutrients are not fully understood, and it is not clear how much the water quality will change in the future.	● Basically, nutrients, organic pollution, pesticides and other harmful substances, and microorganisms that enter from the watershed should be controlled through sewage maintenance, promotion of individual treatment, treatment of industrial wastewater, and promotion of non-point pollution control.
Issue 5) Progressive Overdevelopment in the Watershed		
● In addition to the above-mentioned problems, uncontrolled industrial and commercial development along national highways, promotion of mass tourism, uncontrolled agricultural development, and deforestation may hamper environmentally friendly, sustainable, and equitable regional development.	● There is no master plan for more sustainable regional development.	● The future vision of a sustainable region needs to be clearly defined to guide development. Source: JICA Study Team

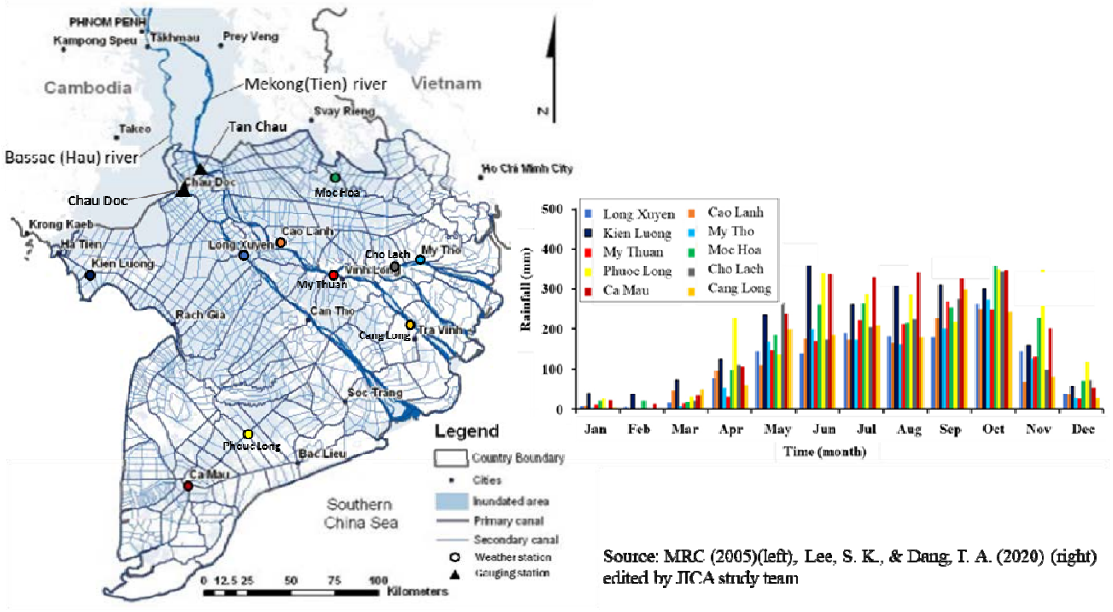
6. Environmental and Social Impacts of Upstream Dams in Vietnamese Mekong Delta

6.1 Background

Located at the mouth of Mekong River, the Vietnamese Mekong Delta has been affected by various activities taking place at upstream countries, including dam construction and operation. For the Vietnamese government, Mekong Delta has been strategically important in view of food security and gaining foreign currency as the region produces significant amount of rice since 1970s to date. Consequently, the current environmental and social condition of the Mekong Delta has been constantly influenced by the flow regime of the Mekong River and by actions at the local community and individual levels, using infrastructure developed in accordance with the government's agro-economic policies and in response to variety of factors such as changing flow regimes, sea level rise and climate change. Therefore, it is difficult to analyze the causal relation between the impacts of upstream dams and the consequences occurring in the delta. The MRC Hydropower Mitigation Guidelines Vol.3 (2020) also state that although the construction of dams in the upstream region, including China, is expected to have an impact on the Mekong Delta, fluctuations in flow rates will be negligible as they will be adjusted in the Tonle Sap Lake. As for mitigation measures, the analysis suggests that it would be more effective to adjust local activities, such as excessive use of groundwater, river sand mining and so on, than managing the impact of upstream dams. On the other hand, as mentioned in the previous chapter, some studies and reports suggest that the upstream dams caused the decrease in fish species identified in the Mekong Delta and the decline in fish catches to some extent.

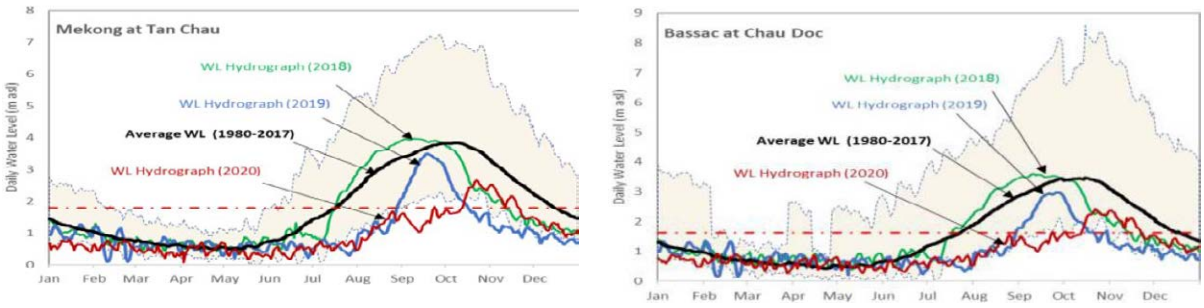
6.2 Environmental, Social and Bio-Physical Features of Mekong Delta

The Mekong Delta in the territory of Vietnam is a floodplain with an elevation of 0-4m above sea level and covers about 74% of the delta, or 39,700km^2. After flowing through Phnom Penh in Cambodia, the Mekong River splits into two distributaries, Mekong (Tien) River and Bassac (Hau) River, which contribute 85-80% and 15-20% of the flow respectively. As presented in Figure 6.1, the precipitation at monitoring points in Mekong Delta varies between 1500~2000mm/yr. Also, Figure 6.2 presents the declining water levels observed at both Tan Chau (Mekong River) and Chau Doc (Bassac River).



Source: MRC (2005)(left), Lee, S. K., & Dang, T. A. (2020) (right) edited by JICA study team

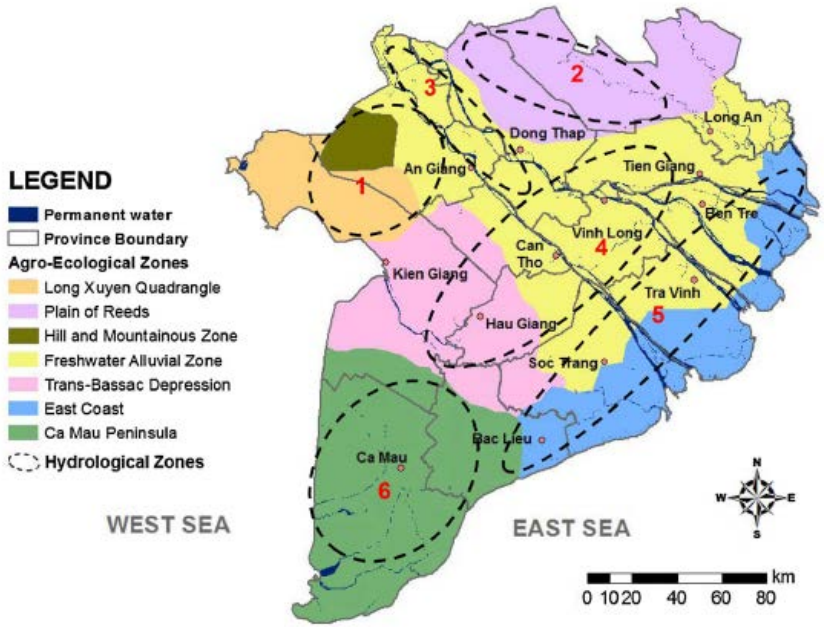
Figure 6.1 Map of Monitoring Stations (left) and Average Monthly Precipitation (1984-2015) (right)



Source: MRC (2021)

Figure 6.2 Daily Water Level Hydrographs Observed at Tan Chau and Chau Doc (2018-2020)

The current land use pattern in the Mekong Delta is the result of multiple factors, including the flow regime of Mekong River, rainfall and soil characteristics as presented above. In addition, engineering activities such as repeated construction and rehabilitation of dykes, irrigation channels and structures that contribute to the control of saltwater intrusion are other important factors. Figure 6.3 presents one of the typical classifications suggested by Le, T. N. et al. (2018) reflecting both bio-physical and man-made factors in the delta.



Zoning of Mekong Delta	
Highly Flooded Zone	
1	Long Xuyen Quadrangle:
2	Plain of Reeds
Freshwater Zone	
3	Upper Floodplains
4	Tide-affected Floodplains
Salinity Intrusion Zone: the zone consists of sand ridges unaffected by salinity intrusion, coastal flats, inter-ridges affected by salinity intrusion during dry season	
5	East Coast
6	Ca Mau Peninsula

Note: Zoning of the Mekong Delta is under discussion among stakeholders and subject to modification as effects of changing environments. Definitions and zoning boundaries should be updated accordingly.

Source: Le, T. N et al. (2018), edited by JICA Study Team

Figure 6.3 Agro-Ecological Zoning of Mekong Delta

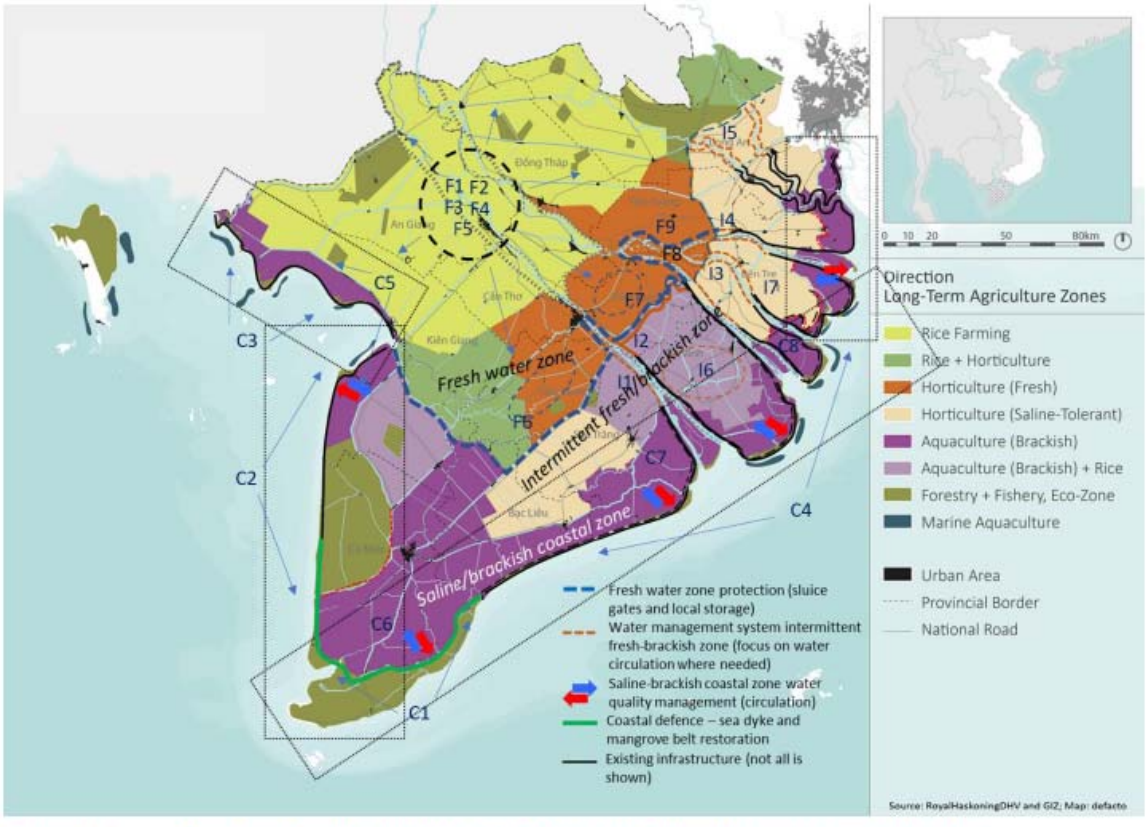
6.3 Impact of Development Activities in Mekong Delta

Based on studies conducted by MRC and academic researchers, it is commonly understood that the delta is negatively impacted by upstream activities. The modifications to the flow regime especially prolonged dry season and reduced sediment transport are severely affecting livelihoods in the delta. As presented in Figure 6.2, the water levels in both Mekong River and Bassac River have been declined in early 2020 due to low rainfall condition. Furthermore, although rainfall in the late 2020s recovered to higher than the long-term average, the water levels remained low throughout the year as surplus rainfalls recharged upstream reservoirs which were starving for water.

Various studies show significant decline of sediment transport to Mekong Delta due to dam construction ranging from 28% to 68% compared to without the dam (Kondolf et al. (2014)).

Moreover, MRC (2018) projected that the sediment loads at Kartie would decrease by 65% and 97%, respectively, as of year 2020 and 2040 compared to the baseline in 2007. It should also be noted that due to the proximity of the 3S basin, both mainstream dams and those of the tributaries, especially the 3S basin would affect the amount of sediment that reach to the Mekong Delta. Apart from the upstream development, building local infrastructure and activities play their roles in the delta making the entire system more complex. To name a few, construction of dikes, sluice gates, paddy fields and their operations, sand mining, and groundwater utilization are contributing to the complexity of Mekong Delta. As a consequences of the upstream and local activities, available water in the delta became more and more salty, and riverbanks and coasts are eroded, altogether making the life and production in the delta difficult.

Considering the situation, international partners lead by the World Bank and the German Embassy formulated the cooperation platform named "Mekong Delta Forum", where Japanese government also participates to share its own experiences and knowledge in water resources management. With the support of international partners, the Vietnamese government has been implementing the Resolution 120 to direct water resource management in the delta towards a sustainable and climate change resilient manner. Aiming at the same direction, the World Bank is financing the Mekong Delta Integrated Climate Resilience and Sustainable Livelihoods Project, and is developing the Mekong Delta Integrated Plan as presented in Figure 6.4.



Source: Mekong Delta Integrated Region Plan, (Version 14 July 2020)

Figure 6.4 Direction of Land Use and Hydro-Infrastructure Management in Mekong Delta

6.4 Analysis of Current Issues and Proposed Countermeasures

As discussed above there are many factors related to water resources management that affect the livelihood of Mekong Delta, and the entire system is complex. Table 6.1 presents the summarized knowledge and gaps to be filled as background information for proposing future cooperation programs in the following chapters.

Table 6.1 Summary of Current Issues and Knowledge Gaps in Mekong Delta

Knowledge/Background	Unknown/Lacking Information	Direction of Improvement/ Countermeasures
Issue 1) Modified Flow Regime of the Mekong River and Its Tributary		
● Quantitative assessments of current and future impacts have been developed. ● Economic benefits and losses of flow regime modification have also been modelled. ● In recent years, drought is more frequently observed than floods. ● Rainfall and discharge data from upstream are being shared for flood/drought forecasting and early warning.	● Although droughts have been prominent in recent years, there is also a risk of intensified magnitudes of drought and flood due to climate change. ● There are limitations on the accuracy of modeling flow regime of the Mekong River basin due to inadequate data ● Operation rules for each dam are not clearly defined nor coordinated. ● Mechanism for benefit sharing among upstream and downstream stakeholders does not exist yet.	● Reduced floods lessen the risk and damage by flood and also reduce nutrient supply and negatively impact ecosystems. ● Improving accuracy of analytical techniques may contribute better understanding of mechanisms. ● Building platforms for multi-lateral discussion on understanding flood would enhance mutual understanding. ● Establishing rules for equitable benefit/risk sharing among upstream and downstream countries especially for droughts would be required.
Issue 2) Reduced Sediment Transportation (Riverbank/Coastal Erosion)		
● Quantitative assessments on sediment transport reduction caused by dam development have been made. ● It is assessed that the 3S basin, especially the Lower Sesan 2 would significantly affect sediment flows into the Delta. ● Sediment dynamics simulation models within Mekong Delta and identification of riverbank/coastal erosion sites are well developed. ● The development of monitoring methods using remote sensing is in progress.	● It is unknown how lack of data affects accuracy of result obtained by modeling simulations. ● There is no monitoring or control of sand mining from river. ● There is no monitoring of the entire river channel in the Mekong Delta using remote sensing.	● It is desirable to increase the sediment discharge from dams and to maintain sediment dynamics close to natural flow conditions. ● Quantitatively assess the sediment supply from the 3S basin and secure the source of sediment supply to the Delta. ● Implementation of riverbank and coastal protection measures is recommended. ● Consider adaptation measures by land use planning in view of riverbank protection.
Issue 3) Multiple Consequences of Progressing Salinity Intrusion		
● Saltwater intrusion is progressing each year. ● Sea level rise may intensify saltwater intrusion. ● Saltwater intrusion becomes severe due to reduced flows during longer dry season or droughts. ● Recently, dry season water levels have increased due to upstream dam. However, in some cases surplus water would be captured by upstream dams.	● The contributions of sea level rise and dry season flow increases to saltwater intrusion are unknown. ● Unmonitored/uncontrolled groundwater extraction make it difficult to analyze/predict saltwater intrusion trends.	● Preventing and controlling saltwater intrusion with sluice and gates. ● Regulate excessive pumping of groundwater. ● Analyze the impact of flow and sea level rise on saltwater intrusion, and propose effective countermeasures.

Issue 4) Reduction of Agricultural Productivities in the Delta		
● Agriculture in the Mekong Delta is not expected to grow significantly in the future. ● Multiple cropping is more resilient to the impacts of climate change than monoculture and is expected to generate income.	● Contribution of nutrient supply due to floods is unknown. ● The amount of groundwater extraction for agriculture is not monitored. ● Multiple cropping farming requires a large area of farmland and requires initial investment.	● Update land use plan with consideration to areas vulnerable to changing environment. ● Properly allocate freshwater to agriculture and aquaculture with due consideration to existing water rights.

Source: JICA Study Team

7. Major Challenges and Grand Design of Mekong River Basin

7.1 Key Issues of Mekong River Basin

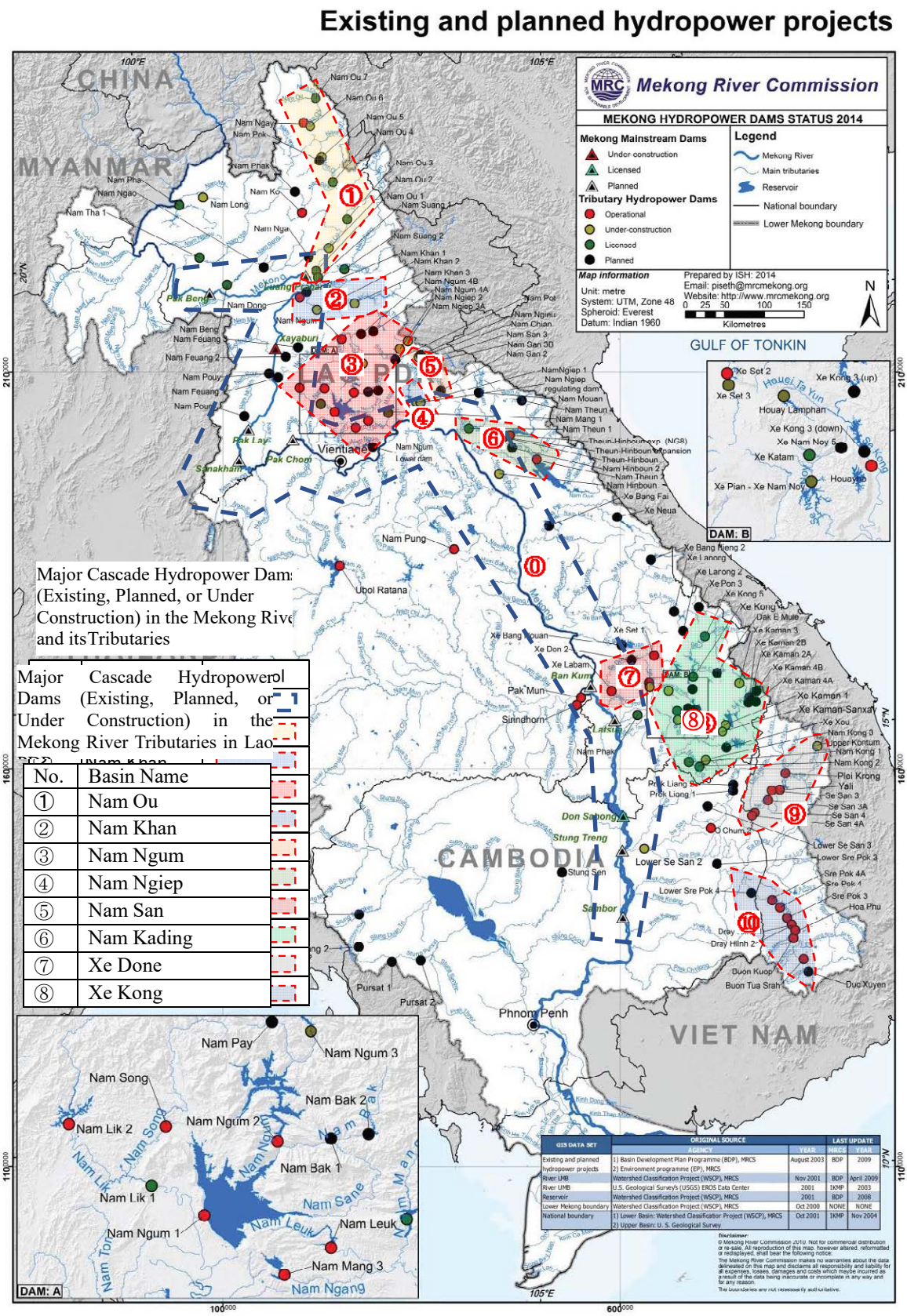
Based on the results of analysis on the current conditions in the Mekong River basin, seven key issues were identified under the three major issues (flow regime, sediment, and benefits) as shown below in relation to dam construction and its operation for water resources management in the basin. From a broader perspective, global issues such as the nexus (Energy-Water-Food) and contribution to the SDGs related to water resources are also relevant to the issues in the Mekong River basin, but in consideration of the purpose of this study, the following issues were identified by focusing on those involving dam construction and its operation:

(1) Improvement of flow regime (impact on ecosystems, drought, and floods)
- Impacts on ecosystems due to fragmentation of river channels
- Increased damage from droughts and floods
- Prolonged and widespread saltwater runoff in the Mekong Delta

(2) Strengthening of sediment transport management
- Increased damage from riverbank erosion and coastal erosion
- Impacts on ecosystems due to deterioration of water quality

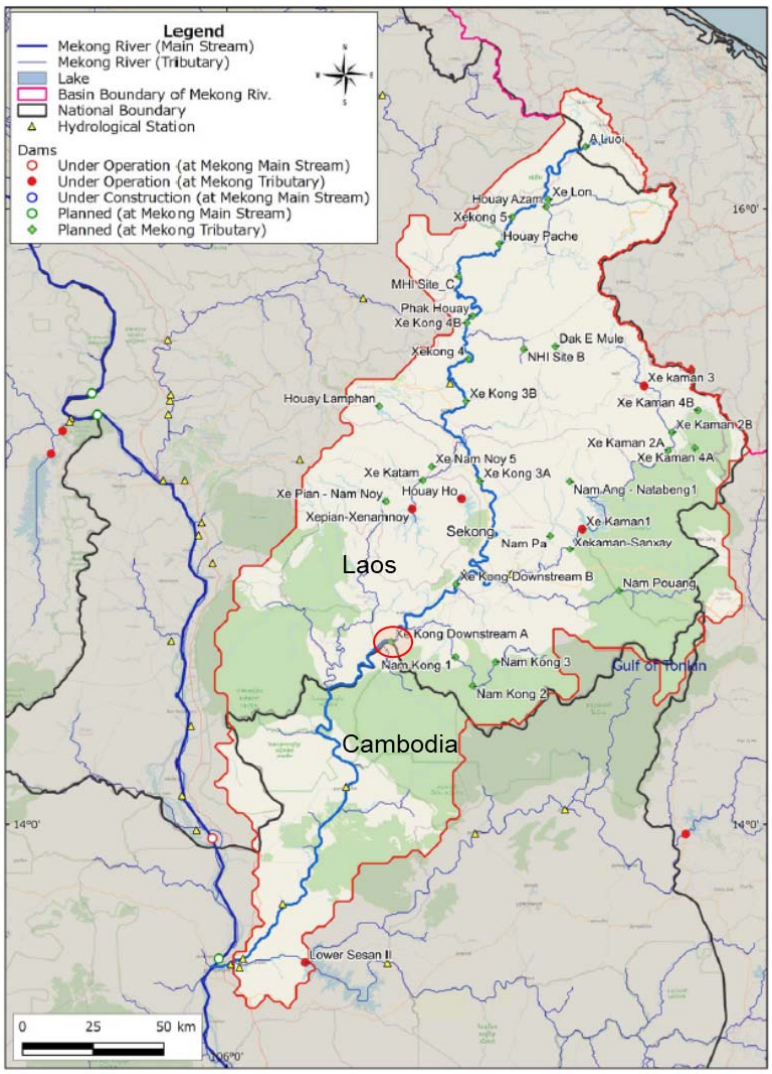
(3) Correction of imbalance in benefits
- Increased impact on livelihoods of affected residents
- Inequity in benefit distribution

Figure 7.1 shows the location of tributaries where cascade dam development is progressive in Laos. Figure 7.2 shows the location of Sekong Downstream A Dam in the Sekong River basin. Figure 7.3 illustrates the diversion of discharge (reverse flow) to Tonle Sap Lake with hydrographs.



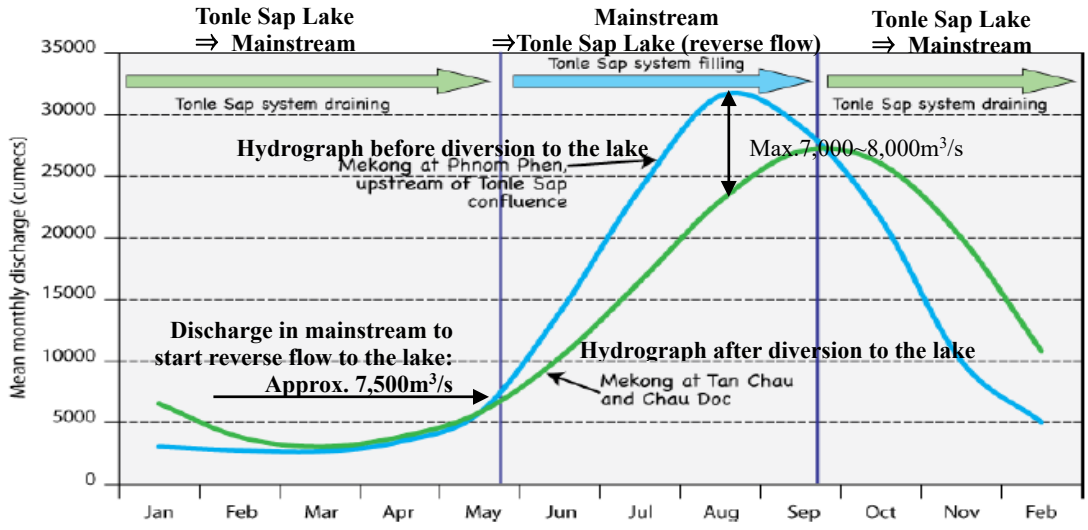
Source : Prepared by JICA Study Team based on the MRC Hydropower Mitigation Guideline

Figure 7.1 Tributaries Developed by Cascade Dam Construction in Laos



Source: JICA Study Team Sekong Downstream A

Figure 7.2 Location Map of Sekong Downstream A Dam



Source: MRC, PMFM Comprehensive Information Report, April 2018

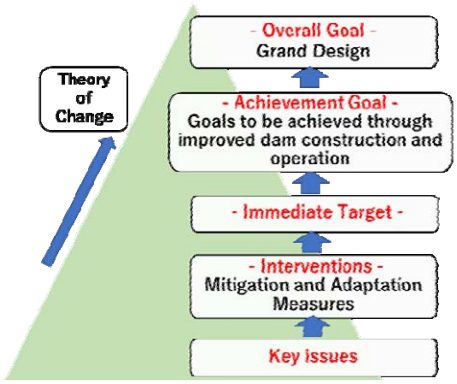
Figure 7.3 Comparison between Monthly Mean Discharge at Confluence with Tonle Sap River (at monitoring stations in Phnom Penh and Tan Chau)

7.2 Grand Design and Achievement Goal of Mekong River Basin

7.2.1 Procedure of Activities toward Achievement Goal

The future vision of the Mekong River basin that was set in the inception phase of this study was redefined in the final phase as "the realization of a society in which the natural environment of the Mekong River basin is preserved and all basin residents can experience the richness of life" in light of the major issues presented in the previous section. This will be positioned as the grand design (higher-level goal) for the basin. However, this is a long-term goal that can be reached only when energy, industrial and economic policies as well as comprehensive ecosystem and watershed conservation policies are realized, in addition to various measures for dam construction and operation. On the other hand, the purpose of this study is to show the direction of cooperation in water resource management so that dam construction and operation can be done in consideration of the environment and society. Therefore, based on the grand design, a goal that can be achieved through the implementation of the cooperation proposed in this study is set as follows: "to achieve water resource management that takes into account environmental and social impacts by improving dam construction and operation with the cooperation of basin countries" (goal to be achieved by improving dam construction and operation: called "achievement goal"). In order to achieve this goal, it was decided to study the cooperation policy plan necessary to achieve it.

In order to realize this achievement goal, the concept of Theory of Change was used as a reference when setting intermediate goals (intermediate outcomes) to resolve major issues and when considering mitigation and adaptation measures (interventions). Figure 7.4 shows an image of this concept.



Source: JICA Study Team Note: Not showing accurate logical form

Figure 7.4 Image of Theory of Change

Since all the measures required to realize the achievement targets will be implemented by the basin countries, the basin countries need a huge amount of support, which cannot be provided by Japan alone. Therefore, it is necessary to select high-priority cooperation items in which Japan can demonstrate its technological superiority. However, in the vast Mekong River basin, as seen, mutual development impacts are intricately intertwined, and it is difficult to show effects commensurate with the amount of input as expected. For this reason, the project outline and implementation system should include the collective impact of the government and Development Partners when forming the cooperative projects necessary to achieve the goals. For the major issues identified, mitigation and adaptation measures were examined to bridge the gap between the current situation and the ideal state, and a group of projects was classified under the four approaches of cause investigation, consensus

building, project promotion, and human resource development. The results of the study are summarized in Chapter 8.

7.2.2 Image of Achievement Goal

Based on the discussion up to Chapter 6, the following were considered to be the ideal situation of "better water resources management" (after achieving the goal) to be achieved by improving dam construction and operation in the Mekong River basin.

(1) Accumulation and sharing of highly reliable hydrological and meteorological information

Data from all hydrological and meteorological stations in the basin, including the upper reaches of the Lancang River, as well as information on major water resource infrastructure facilities and real-time hydrological and meteorological information at those locations will be shared among all basin countries 365 days a year. An organizational and cooperative system will be established to enable upstream and downstream countries to take coordinated action in the event of an emergency (drought or flood). Procedures and guidelines for this purpose will be developed, and lessons learned will be shared among basin countries and relevant organizations through actual experience in mitigating impacts.

(2) Sustainable use of water resources by improving operational rules for dams and reservoirs

For existing dams on the main and branch rivers (3S basin and major branch rivers such as Nam Ou) that have a significant impact on the basin ecosystem, it is possible to reduce the negative impact on the environment by improving the dam operation rules. In particular, the reduction of sediment supply to the downstream of the dams will be mitigated through the formulation and implementation of a comprehensive sediment management plan, and a long-term plan for the longevity and maintenance of the dams and reservoirs will be developed and implemented for sustainable use of water resources. In addition, although most dams are used exclusively for power generation, they are operated in consideration of their impact and benefits on other aspects (flood protection, irrigation, drinking water supply, water transportation, etc.) to optimize their utility as a key infrastructure.

(3) Promotion of environmentally, socially and governance-conscious development

In construction of new dams, the maintenance of biodiversity (including the review of protected areas and the establishment of new ones) and environmental conservation are taken into account from the planning stage with a view to the entire basin, and the process of considering alternatives, mitigation measures (especially ensuring the continuity of flow and river channels), and returning benefits to local communities are incorporated into sustainable development. Only sustainable development plans that properly incorporate the process of considering alternatives, mitigation measures (especially ensuring flow regime and channel continuity), and returning benefits to local communities will be implemented. The accumulation of this experience will strengthen the planning capacity and organizational structure of the relevant agencies. At the research and planning stage, the ESG and SDGs mechanisms will work effectively, and funds and businesses that are reluctant to take environmental and social considerations into account will be eliminated through market mechanisms and monitoring by NGOs and others.

(4) Establishment of a network of academic experts and practitioners

Through joint research and surveys by researchers from various countries in the basin, the accumulation of ecological, hydrological, and hydraulic data will be promoted, and more accurate scientific knowledge will be shared, the results of which will be effectively utilized for the optimization of water resources planning and environmental and social impact assessment. In addition, through these activities, diplomatic and trusting relationships among countries involved in water resources will be improved and strengthened, and more effective and efficient water resources management of the Mekong River will be realized, providing hints for other river basins facing conflicts among basin countries as a model case of international river management.

(5) Balanced distribution of development benefits to the affected population

A mechanism should be established and implemented to ensure that the benefits of development are not concentrated in a particular institution or group but are returned to the local people to improve their quality of life. On the other hand, in cases where negative impacts are unavoidable, compensation and support for residents who are foreseeably affected will be planned to match the actual situation and will be implemented by consensus through a participatory process.

(6) Formation of a platform (for discussion) in which a wide range of multi-stakeholders can participate

In the process of shifting to private initiative in hydropower development and dam construction, which play a role in energy policy, the flow of funds has become more complex, and the range of stakeholders has broadened and changed significantly along with it. In order to cope with these changes, an effective platform for the implementation of countermeasures will be formed. Through discussions, information sharing, and technical awareness raising, the key multi-stakeholder behavioral changes will be realized and environmental and social considerations will be widely spread. In addition, multi-stakeholder discussions on transboundary environmental and social impacts will be held on the platform to promote confidence-building among basin countries.

7.3 A Study of Roadmap to Reach the Achievement Goal

7.3.1 Procedure of Study

In this section, the Theory of Change is presented by examining the roadmap to reach the achievement target for the three major issues (improvement of flow regime, enhancement of sediment transport management, and correction of benefit imbalance) that encompass the seven major issues. Necessary cooperation was discussed in consideration of the following three chronological approaches, based on the image of gradual level-up to reach the goal:

(1) Clarification of cause and effect and development of information for decision making
(2) Consensus building and promotion of behavioral change based on the consensus building
(3) Promotion of specific mitigation and adaptation measures.

However, there is no clear break in each stage, and in fact, they are considered to proceed in parallel. The overlapping parts are indicated by dashed lines in the following roadmap diagram. The above three approaches are described in Section 8.2.

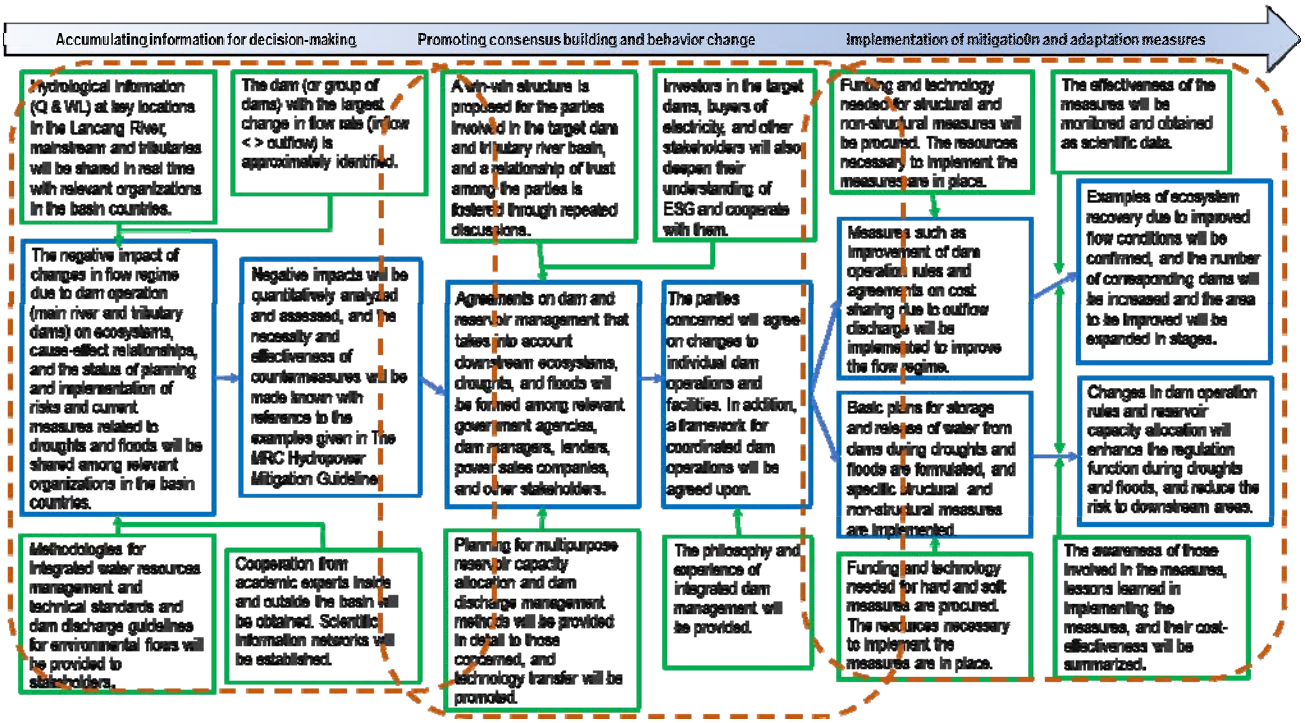
7.3.2 Roadmap for Improvement of Flow Regime (Impact on Eco-system, Droughts and Floods)

(1) Explanation of Roadmap (Flow Regime)

In the Mekong River basin, negative impacts on ecosystems due to changes in flow regime are still not well understood. Therefore, it is necessary to share the scientific knowledge among the basin countries on the fact of dam operation and cause and effect of negative impacts to recognize the seriousness of the problem. To do so, it is necessary to conduct flow simulation for various scenarios, taking into account rainfall patterns, runoff conditions, storage at the dam, discharge downstream, and water intake conditions downstream. Then, how the dam operation shall be is examined to secure the desired flow regime, And the results will be shared among the parties concerned. On the other hand, it is necessary to understand and evaluate the characteristics of each dam and share accurate information with all parties concerned. Particularly with regard to how hydropower dams on tributaries with large capacities were operated during past significant droughts and floods, and whether they benefitted or increased damage in the downstream areas (this is "Information for decision-making"). It is also important to provide a platform where the results of the studies can be discussed, such as the MRC SOBR 2018 (The State of the Basin Report) and The MRC Hydropower Mitigation Guidelines.

In order to achieve the improvement of dam operation rules, the key to promote behavioral change will be whether it is possible to reach a consensus on the importance and effectiveness of dam discharge, taking into consideration of the downstream ecosystem. (This is “Consensus building and promotion of behavioral change”). It is important to select dams and reservoirs with large improvement effects, but in order to lower the hurdle at the initial stage as much as possible, it is essential to select dams that can disclose the current operation rules and easily obtain cooperation. For example, it is necessary to confirm the relationship between the outflow from the 3S basin and the reverse flow phenomenon in Tonle Sap Lake through simulation analysis. A possible strategy is to first aim to improve the operation rules of the single dam, and then, further to confirm the effect of the improvement through continuous upstream and downstream environmental monitoring to gradually expand the operation by coordinated manner (this is “implementation of mitigation and adaptation measures”). However, from a scientific standpoint, considerable number of years and inputs will be required before the effects of the improvements can be demonstrated, so consensus building among the parties concerned is required regarding the implementation system and financing. The goal is to reach individual targets, such as gradually increasing the number of dams where similar improvements are made, resulting in an increase in the number of river sections where ecosystem recovery is observed.

Further, the changes in downstream flow conditions during droughts and floods due to climate change, etc., can have a positive impact depending on the operation of dams and reservoirs. During droughts, the release of water from dams can mitigate the lowering in water levels and flow rates downstream, and during floods, temporary storage can reduce peak flood flows. However, since many dams are dedicated to hydropower, it is necessary to verify the discharge capacity (e.g., drought discharge capacity, flood control capacity, etc.), change the capacity allocation of reservoirs, and reach an agreement on cost sharing. From the perspective of disaster prevention, it is also important to develop and introduce a flood forecasting and warning system in urban areas along the river. It is necessary to evaluate the effectiveness of both structural and non-structural measures, and examine the appropriateness of these measures. Figure 7.5 shows a roadmap for improving flow regime.



Source: JICA Study Team Legend: Activities and Cooperation Situation

Figure 7.5 Roadmap for Improvement of Flow Regime (Impacts to Eco-system, Droughts and Floods)

(2) Cooperation toward Implementation of Roadmap (Flow Regime)

The MRC has been sharing information among basin countries on changes in floodplain ecosystems (e.g., habitat impacts, changes in fish migration triggers, etc.) due to changes in flow regime caused by dam development and climate change in the basin, through the Council Study's Bio-resources Assessment (BioRA). As for international support, the World Bank Group has prepared and published a handbook on environmental flows for private hydropower developers. The handbook proposes how to logically define environmental flows for hydropower development projects from the perspective of sustainable development and includes case studies. However, the handbook does not address specific methodologies and implementation requirements for setting environmental flows. In this aspect, it is required to share research and empirical examples on the maintenance and formation of flow regime and river environment. It would be effective to support the cooperation of academics and government officials from Japan and other countries to share the latest technical information widely. At the same time, it will be necessary to build a platform for this purpose.

In addition, it is necessary to put into practice the principles of integrated water resources management to promote consensus building among the many stakeholders. The World Bank has taken the lead in helping basin countries in this area. Continued cooperation is required to reflect this experience in actual activities for improvement. The implementation of the process of integrated water resources management has been set as one of the clusters of JICA's Global Agenda in the field of water resource for engineers and experts of governmental organizations related to water resources management in developing countries, including the Mekong River basin countries. The project provides technical assistance in the short term and training in the long term. The sharing of knowledge and lessons

learned through the technical assistance in the short term and the training program in the long term will be effectively returned to the Mekong River basin through the counterparts (C/Ps) and trainees.

In addition, as one of the countermeasures against drought and flooding, improvement of dam operations and enhancement of coordination functions are effective in terms of use of existing infrastructure and mitigation of climate change risks. For this purpose, practical cooperation is required for the penetration and dissemination of reservoir management and dam management technologies, dam rehabilitation technologies including enhancement of discharge facilities, and fishway planning and design technologies.

7.3.3 Roadmap for Strengthening of Sediment Flow Management

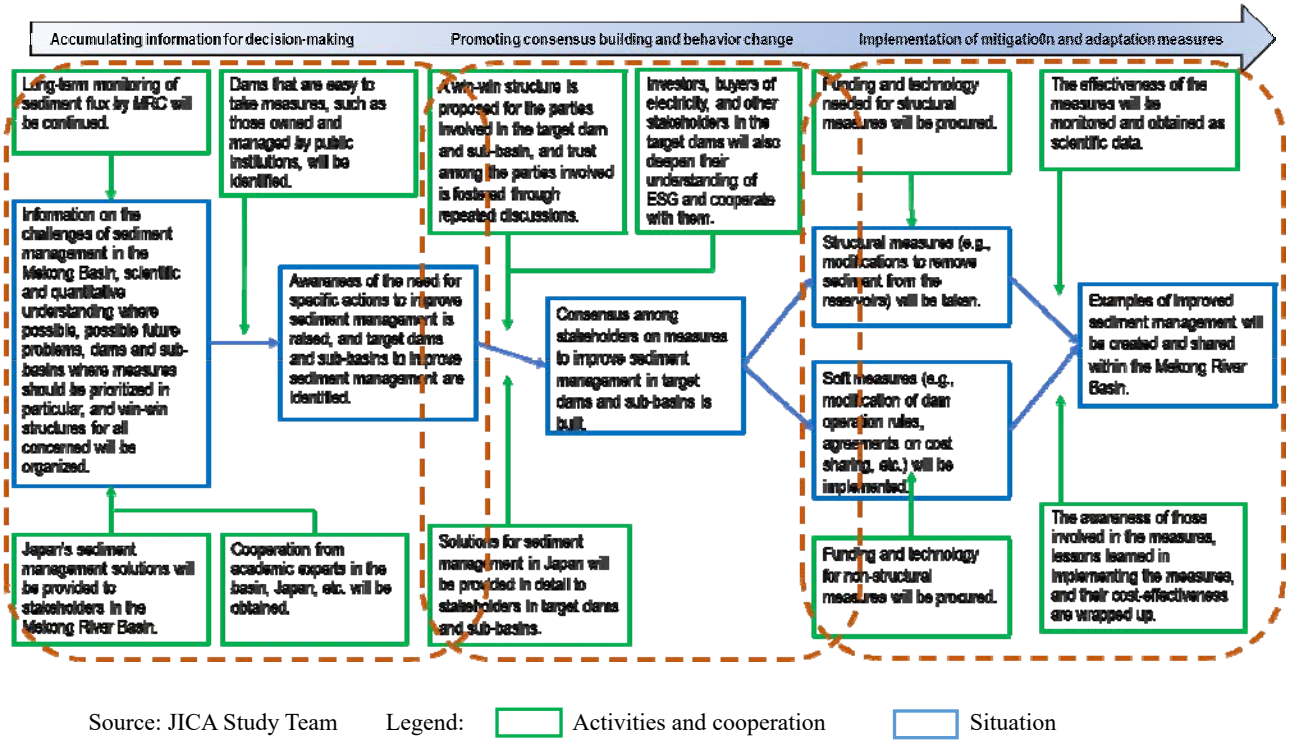
(1) Explanation of Roadmap (Sediment)

Sediment loss in the Mekong River due to dam development on the Lancang River and its tributaries is a serious issue, and the MRC's Council Study, various guidelines, and related research literature have already warned about the potential negative impacts based on possible future development scenarios. The MRC's Council Study have already warned of negative impacts of those concerns. According to the study, if the mainstream cascade dams are constructed as planned, the amount of sediment reaching the mouth of the Mekong River will be reduced to 3%. Although the importance of sediment management is shared by all parties concerned to a certain extent, there seems to be little progress among the countries in the basin in discussing which basins and river sections are (or are expected to be) in the most serious situation, what the sediment management plan and management targets should be, and where measures should be taken first. Therefore, first of all, it is necessary to collect, organize and share scientific and quantitative information on sediment management in order to facilitate decision-making on the implementation of response measures (i.e., information sharing for decision making).

As the sharing of such basic information progresses and the understanding of the improvement of sediment management in the watershed becomes more widespread among the parties concerned, the awareness of the need to formulate a comprehensive sediment management plan and to implement specific measures will increase. Through these surveys and studies, it is expected that dams and sub-basins to be targeted for planning will be identified and a consensus on measures to improve sediment management will be formed among the parties concerned. However, this consensus building will not be easy given the fact that most of the dam development and subsequent operation in the Mekong River basin is led by independent power producers (IPPs). Therefore, in addition to technical support, specific studies on organizational structure, financing, benefit sharing, and environmental and social impacts are very important to promote consensus building and behavioral change. As pointed out in the previous section on "improvement of flow regime", priority should be given to dams that are likely to cooperate in the implementation of countermeasures (see "Promoting consensus building and behavioral change").

Then, dams for which implementation of countermeasures is prioritized, structural measures such as improvement and upgrading of functions to promote sand flushing/sluicing and improvement of dam operation rules should be considered. If even one of these sediment management measures is realized and proven effective on a pilot basis, it is expected to accelerate various developments toward integrated sediment management within the basin and become a driving force for achieving the

improvement goals (this is "implementation of mitigation and adaptation measures"). A roadmap for enhanced management of sediment is shown in Figure 7.6.



Source: JICA Study Team Legend: Activities and cooperation Situation

Figure 7.6 Roadmap for Strengthening of Sediment Flow Management

(2) Cooperation toward Implementation of Roadmap (sediment)

The concept of integrated sediment management is to consider the watershed from its head to the estuary as an integrated area of sediment movement (sediment system), and to take necessary measures to address issues, such as controlling sediment production and runoff, not only in the individual areas of watershed erosion control, dams, rivers, and coasts, but also throughout the entire sediment system.

Suppose this concept is applied to the Mekong River, the key is figuring out how to overcome the information gap, formulate an effective management plan through consensus building, and lead toward implementation. Considering the speed of dam development in the basin, cooperation should be promoted by considering a time span of 5 to 10 years to complete the structural measures as shown in the roadmap, while having a long-term vision of 10 to 20 years ahead to solve the problems. Although many practical difficulties are expected to be involved, it should be promoted understanding and awareness sharing should be promoted among a large number of stakeholders, achieve behavioral changes should be achieved, and the initiatives should be put into practice.

In principle, the ideals and goals should be changed from qualitative to quantitative, and the level of maturity of the plan should be increased step by step in accordance with the progress of the integrated sediment management and the sharing of awareness among stakeholders. For example, it is important to change the plan from one that is appropriate for the current situation to one that is adaptable to the progress of integrated sediment management, and to bring it closer to the ideal image. Based on this basic principle, the key is to set a step-by-step improvement target based on the current situation of the watershed and to first aim for decision-making and consensus building to reach the initial target.

7.3.4 Roadmap for Correction of Imbalance in Benefits

(1) Explanation of Roadmap (Benefit Imbalance)

As what has been repeatedly pointed out in the Council Study and other study reports on benefit sharing, in addition to problems related to residents who suffer direct disadvantages such as relocation and loss of livelihoods as a result of dam projects, there are also problems with sector-level equilibrium, such as the creation of sectors that receive significant benefits (e.g., electricity) and sectors that suffer significant disadvantages (e.g., fisheries) in the use of rivers. In addition, many of the direct beneficiaries, such as power companies and investors are located overseas, and the impact extends widely downstream across national borders, making it difficult for the national legal system to fully correct the imbalance. For this reason, the MRC has been examining ways to correct the imbalance in benefits since around 2012, but the reality is that there is still no clear path forward. In order to correct the imbalance, it is necessary to review vested interests and consider the impact on future dam projects. Although it will take time to solve the problem, it is necessary to take immediate action in order not to postpone solving the problem.

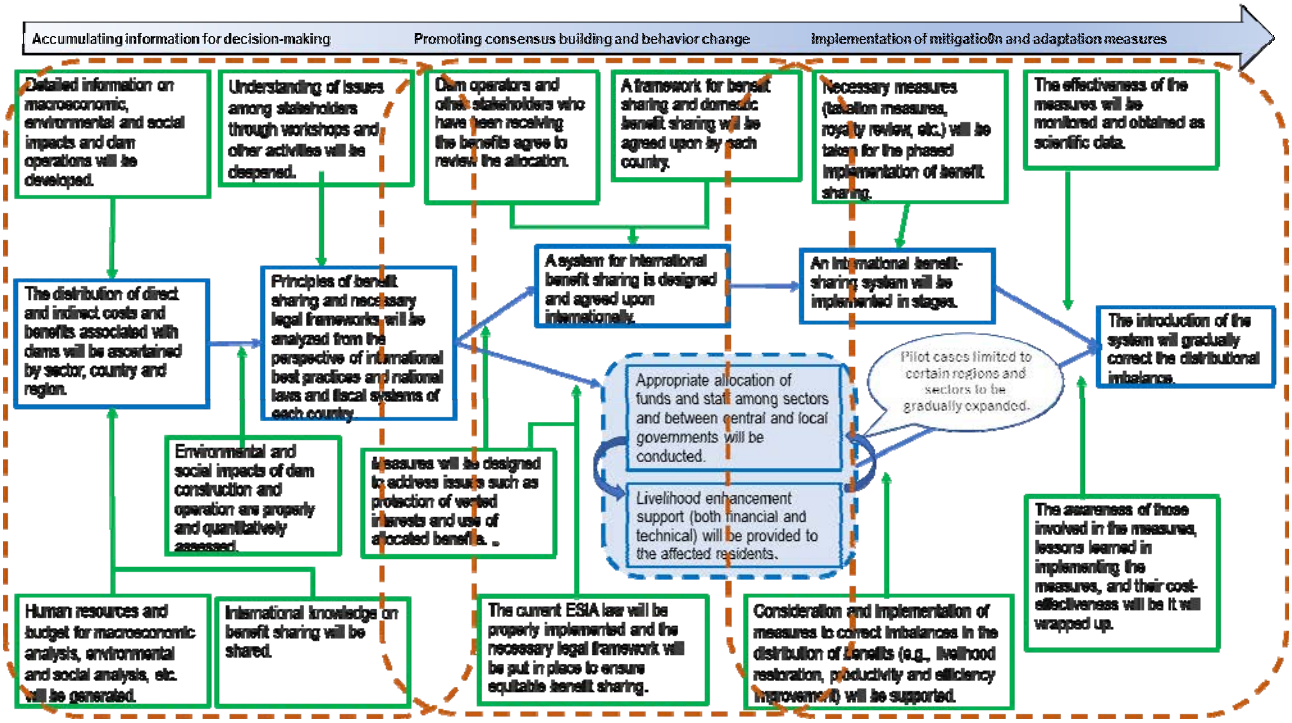
In order to proceed with this discussion, it is necessary to first clarify and visualize the direct/ indirect benefits and costs of the project as a whole, including the amount of damage as much as possible (e.g., cost of measures against riverbank and coastal erosion, cost of loss of livelihoods and conversion of subsistence livelihoods to those that require cash income, cost of securing alternative sources of protein, cost of compensation through fertilizer with nutrient supply, etc.). It is necessary to clarify and visualize the direct/ indirect benefits and costs of the entire project. This has been addressed in the Council Study, but it is desirable to have a broad study that includes the costs borne by the business, the benefits of the buyer, and the status of redistribution of benefits through taxes. Even if it is not possible to agree on specific values, just sharing the results of analysis from various standpoints, disclosure of undisclosed information, and estimates by experts is useful for promoting discussions on equity. (this is “Information for decision making”)

The next section examines the principles and institutions related to benefit sharing from the perspective of good international practices, relevant legal systems in the basin countries, and possible consensus frameworks among countries. While the MRC has been examining national systems, it is necessary to consider a wide range of issues, including the scope of existing compensation systems for environmental and social impacts, land expropriation, etc., tax incentives, various fiscal measures, and the possibility of developing new initiatives such as Vietnam's forest environmental service fees. At this stage, it is expected that there will be a division between the parts that need to be considered for international benefit sharing and the parts that need to be considered for domestic benefit sharing.

The next step is to design and agree on a system for international benefit sharing based on the results of the analysis in the previous step, and then to change the system and enact legislation in each basin country. Since it seems difficult to correct the distribution of benefits all at once, it is desirable to design a flexible system, for example, to conduct a pilot project to identify issues in actual operation before legislating, or to introduce the system in stages. In addition, care should be taken to ensure that the benefits are distributed to the disadvantaged parties. (this is “Promoting consensus building and behavioral change”)

The final step is to correct the imbalance through the operation of the system, and to monitor and confirm the status of correction. (this is “Implementation of mitigation and adaptation measures)

The roadmap for correcting the imbalance of benefits is shown in Figure 7.7.



Source: JICA Study Team Legend: Activities and Cooperation Situation

Figure 7.7 Roadmap for Correction of Imbalance in Benefits

(2) Cooperation toward Implementation of Roadmap (Benefit Imbalance)

The issue of compensation and benefit sharing for dam projects requires careful handling because it involves the sovereignty of each basin country. However, due to the various interests within and among the basin countries, it is not easy for the basin countries to solve this problem alone, and neutral support from a third party would be very beneficial.

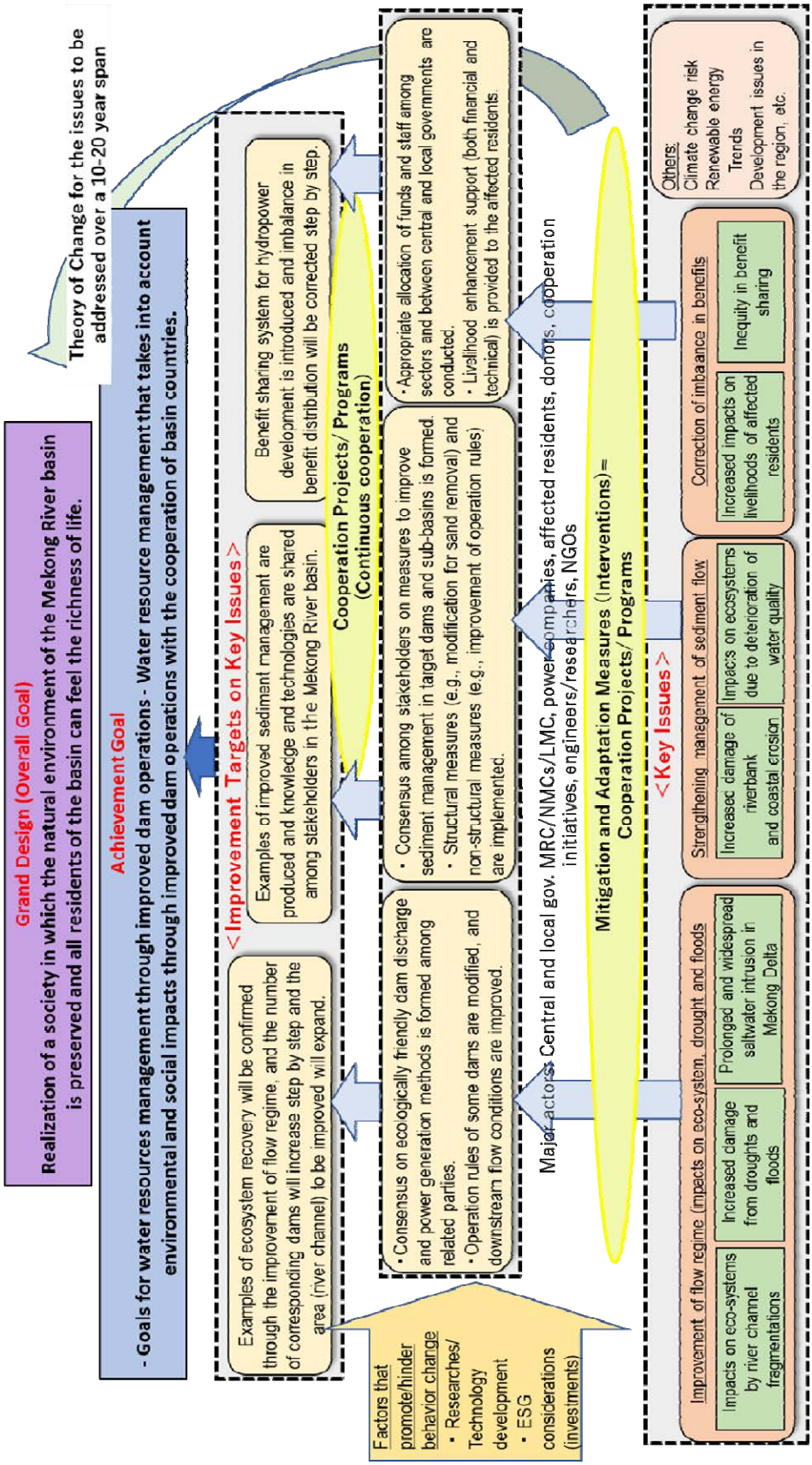
For the first step of cost-benefit analysis and the next step of legal analysis, advice on overall study design and economic analysis methods, assistance in damage assessment, and information from other countries on how to supplement incomplete information could be provided. External support can also be provided in the form of funding for research and the provision of a transparent and neutral forum for the publication of results. In addition, support for original research and estimation by overseas researchers, and support for the Convention on the Non-Navigational Uses of International Watercourses could be provided to promote the development of international best practices and indirectly support basin countries.

However, if a party expects support from abroad, or if external support is required due to the conclusion of a multilateral agreement, support related to the development of legal systems (capacity building and financial support for related research), e.g. dispatch of international law experts, and other experts should be provided. support), and dispatch of experts in international law. At the stage of institutional operation, support related to activities such as monitoring, evaluation, and information disclosure may be considered.

7.4 Procedure to Reach Achievement Goal and Grand Design

In Section 7.3, roadmaps to reach the achievement goals with Theory of Change (ToC) in mind were presented for the three major issues that encompass the seven key issues (improvement of flow regime, enhancement of sediment management, and correction of benefit imbalance). Figure 7.8 shows the process to reach the goals and the Grand Design by synthesizing the results of these roadmaps.

The mitigation and adaptation measures (interventions = cooperative projects) shown in Figure 7.8 are intended to be implemented by all stakeholders and supporting organizations (e.g. by the basin countries themselves, by development partners and by Japan) necessary to solve the major issues. It assumes that through the collaboration of all stakeholders, these interventions can be implemented and reach their targets. On the other hand, the results of the study focusing on Japan's cooperation will be discussed in Chapter 8.



Source: JICA Study Team

Figure 7.8 Procedure to reach Achievement Goal and Grand Design (Theory of Change)

8. Directions of Cooperation for Water Resources Management in the Mekong River Basin

8.1 Basic Policies of Cooperation

As discussed in Chapter 7, to fulfill the achievement goals (goals that can be achieved by improving dam operations), many issues should be resolved by the activities of the basin countries themselves, with support from development partners. Japan has various technologies and human resources with rich experience in water resources management. Support from Japan can contribute the basin countries for their effort to implement activities presented in the three roadmaps in Section 7.4. On the other hand, as Japanese resources are also limited, the following four basic policies are set for cooperation to make the most effective use of resources to improve water resources management in the Mekong River basin.

(1) Cooperation can be obtained from basin countries and international organizations such as MRC. (The activities are in line with the basic policies of the basin countries or strategies of MRC, and obtaining agreement for the activities is easy because they support and promote the implementation of their priority plans.)

(2) Cooperation that contributes to improve infrastructure facilities as well as policies that have transboundary impacts on proper water resources management. (The risk factors are related to the dam operation (including non-dam activities related to dam operation in a complex manner), and the improvement of the operation has potential to solve the issues caused by the dam operation.)

(3) Cooperation that contributes to improving the situation of important issues through practical behavioral changes of stakeholders. (In order to ensure significant development impact, projects should bring either practical short- to medium-term impacts or substantial medium- to long-term impacts, such as studies on important issues.)

(4) Cooperation for which Japan's technology, experience, and resources can be applied. Among the examples of technical know-how, experience, and resources that have a comparative advantage over other countries are; the deepened understanding of Tonle Sap Lake system through the Science and Technology Research Partnership for Sustainable Development (SATREPS) Project, advanced hydraulic analysis modeling tools (flow condition simulation), such as the CaMa-Flood model, practical experience in improving dam structure (dam regeneration) while operating dams and implementing measures against sedimentation, and a close relationship with the government agencies of the basin countries through related projects, such as the formulation of the electric power master plan (M/P) in Laos.

When considering specific projects in this study, above basic policies (1), (2), and (3) were taken into consideration. In addition, the application of Japanese technology that fall under policy (4) was assumed, and the roadmaps of the three major issues (flow regime, sediment, and benefit) discussed in Chapter 7 were followed. As a result, a total of 17 projects were proposed in Section 8.3 as cooperation projects (candidates) that can make a broad contribution to solving the issues in the basin. However, as mentioned above, there are various constraints on implementing these projects to achieve the achievement goals. Therefore, not all of these projects will be implemented under the leadership of Japan, but will be pursued in parallel under the leadership of other development partners and basin countries, with the aim of realizing the targets to be achieved. The combinations of projects for which Japan can take a leading role to resolve the key issues in the basin are presented in Section 8.4.

Table 8.1 Japan's Technology on Water Resources Management with Comparative Advantage

(a) Methodology of IWRM: (Integrated Water Resources Management)

Integrated Water Resources Management (IWRM) aims to maximize the benefits of water in an equitable manner without compromising the sustainability of ecosystems by managing water systematically. Although the concept of IWRM seems to have penetrated the Mekong River basin countries to a certain extent, continuous support for implementation is required because consensus building among stakeholders is indispensable to solve problems by putting the concept into practice. On the other hand, Japan has rich experiences in technical cooperation related to IWRM in many developing countries. In addition, the Japan International Cooperation Agency (JICA) has already contributed to human resource development by providing training programs to government officials and water resource experts in the Mekong Basin countries through the Knowledge Co-Creation Program (KCCP). JICA has positioned IWRM as one of the global agendas in the water resources sector and is further promoting its active development. Therefore, Japan's resources on IWRM can be effectively utilized in the Mekong River basin where consensus building, and behavioral change are required to mitigate transboundary environmental and social impacts.

(b) Related technologies for dam management and rehabilitation

Dam management requires operations such as releasing and replenishing stored water in times of drought and reducing storage capacity for water utilization in times of flood to mitigate damage downstream. In order to carry out such operations safely and smoothly, it is necessary to properly maintain the dam embankments and remove sediment from the reservoirs periodically. In addition, Japan has a variety of technologies for effective use of existing dams with added supplemental functions. In particular, technologies that make it possible to extend the service life of facilities and restore and improve flood control and water utilization functions while operating existing dams, are evolving as dam rehabilitation technologies and have potential for application

(c) Theory of integrated sediment management planning and related technologies

In the Mekong River basin, the decrease in sediment transport due to the fragmentation of the river channel has already become noticeable and has triggered many problems. In the BDS 2021-2030 & MRC SP 2021-2025, the development of sediment management plans is listed as one of the activities. In Japan, many river basins have already developed sediment management plans. In the Mekong River basin, the mitigation of dam sedimentation and the supply of sediment to downstream areas are urgent issues, and implementation of countermeasures is required based on a plan that sets numerical targets in stages. Therefore, continuous cooperation is expected for implementation and Japan's sediment management technologies can be applied.

(d) Accumulated knowledge on flow fluctuation and conservation of river environment

River flow fluctuations change the channel topography, and changes in the river channel change the habitat. Changes in the habitat further change the organisms. The flow change not only changes the channel topography, but also directly changes habitats and organisms as observed in the Mekong River basin. In the Mekong River basin, dam operations change the flow regime and affect the river environment downstream. Japan's research achievements, survey results, and accumulated knowledge and experiences can be effectively utilized to analyze the mechanism of the changes and consider and evaluate countermeasures.

(e) Accumulated knowledge on drought countermeasures and adjustment among stakeholders

In the Mekong River basin, excessive storing of runoff by dams during droughts causes extraordinarily lowering of water levels in downstream areas, which in turn affects water intake, fisheries, ecosystems, saltwater intrusion in the Mekong Delta, salinization of groundwater, and a wide range of other transboundary impacts. In addition to supporting the effective use and dissemination of the MRC’s Drought Management Guideline, experiences of the drought management liaison councils, knowledge on smooth coordination of water use during droughts and consensus building methodologies among stakeholders, etc. in Japan can be applied.

(f) Related technologies for flood management and damage reduction

In the Mekong River basin, most dams do not have flood control storage in reservoirs, because those serve a single purpose for hydropower generation. On the other hand, Japan has accumulated technologies, experiences, and adaptation measures to cope with frequent unexpected heavy rainfall caused by climate change, such as securing flood control storage through advance release of water and seasonal changes in reservoir capacity allocation. Japan also has technology for rainfall prediction over a wide area using satellite image analysis, technology for flood flow prediction using artificial intelligence (AI), and highly accurate flow simulation technology, etc. On the other hand, the concept of comprehensive flood management, which combines structural and non-structural measures to mitigate damage in the entire basin has already become a common manner. In the Mekong River basin, these technologies, knowledge and experiences can be applied to strengthen the flood management function of dams and other appurtenant facilities.

■ **Target Year**

The problems of the Mekong River are very complex, and it will take a considerable period of time for cooperation to produce tangible results. Meanwhile, the Mekong River basin is changing rapidly. The last decade has seen the Xayaburi and Don Sahong Dams in Laos come into operation, and the PNPCA for other mainstream cascade dams in Laos is underway, while the development of the Sambor Dam has been frozen for ten years. In addition, the collaboration between MRC and China-led LMC is progressing.

Furthermore, the environment surrounding the Mekong River basin is changing significantly, with the Paris Agreement on climate change came into effect, ESG investment and responsible investment became mainstream, and discussions on taxonomy to evaluate the sustainability of businesses from an investment perspective is progressing. Therefore, considering the time frame to foresee the future development, 2030 was set as the target year for designing the cooperation activities, which is the same target year as the MRC's BDS implementation (2021~2030).

8.2 Approaches to consider Proposed Cooperation Projects (Candidate)

(1) Four Approaches to consider Cooperation Projects (Candidate)

In the Mekong River basin, as summarized in Chapter 7, there are various issues in different sectors, such as energy, environment, social, and fisheries sectors, and they occur in different areas in the upstream, midstream, and downstream of the mainstream and tributary basins. Resolving these issues requires many activities, from policy improvement, legal system development, planning, and mitigation and adaptation measures. Various efforts have already been made to tackle these issues, but due to many obstacles, such as closed decision making with limited information and rigid organizational systems, it has not been possible to make sufficient improvements. In light of these, instigating behavioral change toward better water resources management is the most desirable outcome. Behavioral change can be fostered by creating interest that will trigger behavioral change, creating a situation where behavioral change must be committed, supporting the target people to understand the ways and means to make the change, and encouraging them to take the actions.

Hence, cooperation should be designed to (a) provide the information necessary to trigger behavioral change, (b) provide a place where people can commit to a specific behavioral change and put it into action, (c) implement mitigation and adaptation measures in line with the behavioral change, and (d) develop human resources capable of implementing these measures. Considering these, the following four approaches are emphasized in proposing the projects:

(a) Making information available for elucidation of causes and effects and decision making
(b) Promoting consensus building and promoting behavioral change based on the consensus
(c) Promoting concrete mitigation and adaptation measures
(d) Developing human resources

(2) List of Proposed Cooperation Projects (Candidates) and Their Positioning with respect to the Major Issues and Approaches

Based on the above, the seven key issues included in the three major issues (flow regime, sediment, and benefits) for achieving the Grand Design or the Achievement Goals will be resolved through the said four approaches. In selecting the necessary cooperation projects, as described in the basic policy of cooperation in Section 8.1, the following conditions were emphasized: obtaining active cooperation

from related organizations, contributing to the realization of appropriate water resources management policies, and contributing to improving the situation of important issues for which realistic behavioral change can be expected. In addition, the comparative advantage that Japan has was also considered in narrowing the list.

The proposed 17 cooperation projects are as listed below. They can be classified with respect to the three major issues and four approaches as shown in Table 8.1. The outline of each proposed project will be explained in the following sections.

[Making information available for elucidation of causes and effects and decision making]

1-1 Strengthening of the capacity to solve socio-environmental problems by improving the information on Tonle Sap Lake

1-2 Research on policy recommendations on sustainable water resources management in the Mekong River basin

1-3 Strengthening capacity to analyze causes of saltwater intrusion and to develop countermeasures

1-4 Technical cooperation for the establishment of protected areas for biodiversity conservation

1-5 Ratings of environmental and social consideration of existing dams from the perspective of responsible investment

1-6 Support for the establishment and operation of a scientific information network for academic experts

[Promoting consensus building and promoting behavioral change based on the consensus]

2-1 Workshops (series) on specific themes

2-2 Development of comprehensive sediment management master plan

2-3 Support for the formulation and implementation of National Indicative Plans (NIPs) by basin countries (responsible government agencies)

2-4 Research on electricity interconnections between basin countries and appropriate power supply mix

2-5 Workshops to promote the adaptation of MRC Hydropower Mitigation Guidelines

[Promoting concrete mitigation and adaptation measures]

3-1 Strengthening response capacity and developing warning systems for droughts and floods

3-2 Strengthening of adjusting downstream flow conditions and enhancing sediment supply capacity by improving operation rules of existing dams

3-3 Preparation of fishway planning and design guidelines for the Mekong River basin

3-4 Support for promotion of activities of the MRC SP 2021-2025 and development of SP 2026-2030

[Developing human resources]

4-1 Theme-based training on transboundary water resources management

4-2 Human resource development through scholarship

Table 8.1 Positioning of Proposed Cooperation Projects concerning Major Issues and Approaches

Major Issues	Approaches			
	Provision of Information	Consensus Building	Mitigation and Adaptation Measures	Human Resource Development
Improvement of Flow Regime	1-1, 1-2, 1-3, 1-4, 1-5, 1-6	1-6 2-1, 2-3, 2-5	3-1, 3-2, 3-3, 3-4	2-1, 4-1, 4-2
Strengthening of Sediment Management	1-3, 1-4, 1-5, 1-6	1-6, 2-1, 2-2, 2-3, 2-5	3-2, 3-4	
Correction of Imbalance in Benefits	1-2, 1-6	1-6, 2-1, 2-5	3-2, 3-3, 3-4	

Source: JICA Study Team

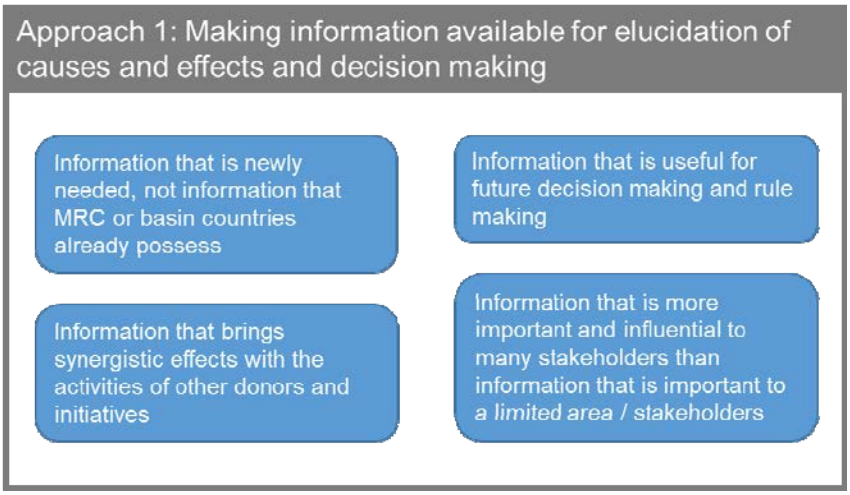
However, it should be noted that this study was heavily affected by the COVID-19 pandemic, and even though many virtual discussions were held, it was not possible to thoroughly exchange opinions with various related governments and organizations. It has to be admitted that the quantity and quality of the gathered information were less than ideal, and it was not easy to discuss the Theory of Change on the Grand Design and the content of the proposal with relevant organizations. Therefore, it is necessary to continue discussions and duly adjust the proposals in the future. In particular, the following surveys and activities are necessary for the implementation of the cooperation projects:

- To share information and exchange opinions with MRC and NMCs and water resource-related line agencies in each basin country through individual discussions and workshops on cooperation policies and cooperation contents.
- To review the progress and challenges of BDS 2021-2030 and MRC SP 2021-2025.

8.3 Synopsis of Proposed Cooperation Projects (Candidates)

(1) Making Information Available for Elucidation of Causes and Effects and Decision Making

There is a great deal of information on dams' environmental and social impacts in the Mekong River basin, including the MRC's Council Study, EIAs of individual dams, various academic studies, and reviews by NGOs and others. Nevertheless, the impacts of dam construction and operation are very complex, and the cumulative impacts of multiple dams and the combined effects of dams and other factors (e.g., climate change, urbanization, etc.) are largely unknown. There is a significant lack of information to resolve the environmental and social impacts of dams and to promote decision making on future water resources management. For this reason, making information available for elucidation of causes and effects of the environmental and social impacts of dams and for future decision making is important. Since the development of information requires a large amount of budget and time, the target information should be selected strategically, considering its importance and impact from the perspectives explained in Figure 8.1.



Source: JICA Study Team

Figure 8.1 Making Information Available for Elucidation of Causes and Effects and Decision Making

The projects and activities proposed under this approach are summarized below.

Table 8.2 Projects and Activities Proposed under the Approach of Making Information Available for Elucidation of Causes and Effects and Decision Making

Name of Project	**1-1 Strengthening of the capacity to solve socio-environmental problems by improving the information on Tonle Sap Lake**
Background and Reason for Proposal	The Tonle Sap Lake is expected to be affected by changes in flow conditions due to dam operation and the impact on fish due to river fragmentation, and there are concerns about the impact on fishermen and the millions of local people. But the lack of sufficient ecological information has made it impossible to evaluate the future impact. In order to review the PMFM, it is necessary to determine the flow regime (flow rate and timing of seasonal fluctuations and peaks) that can conserve the environment of the Tonle Sap Lake. Information for this purpose is needed. The PMFM related to the Tonle Sap is important because it can affect the operation rules of many dams in the middle and lower basins.
Objectives	A comprehensive survey of the habitats of fish, vegetation, mammals, etc., in Tonle Sap Lake. Prediction of changes in flow conditions due to dam operation and climate change on dynamics of sediment and nutrients and fish migration. Strengthening of the capacity for adaptive management and the decision-making process and supporting activities to solve socio-environmental problems.
Summary (Components) of Activities	- Ecosystem survey of Tonle Sap Lake and surrounding areas (Tonle Sap River and part of Mekong River) (about 3 years) - Prediction of habitat impacts due to environmental changes (changes in inundation patterns due to dams and climate change, and the resulting ecosystem impacts (especially inundated forest areas)) - Strengthening capacity related to adaptive management (fishing, etc.)
Expected Outcomes	Information on the reaction of the Tonle Sap Lake ecosystem to water level fluctuations. Clarification of environmental requirements related to the flow conditions of the Mekong River (including information related to the amendment of PMFM related to the backflow), information that becomes the basis for the arguments regarding dam operation and water resource management of the Mekong River.

Name of Project	**1-2 Research on policy recommendations on sustainable water resources management in the Mekong River basin**
Background and Reason for Proposal	The issues related to water resources development in the Mekong River basin are very complex, and despite the historical efforts by MRC and basin countries, many issues are yet to be addressed and resolved. It is important to understand in detail why some of the historical efforts were not able to resolve these issues, and what improvement on the policies, legal, institutional, and administrative systems is needed to make the changes.

	There are also new developments, such as the involvement of LMC, and those related to climate change, biodiversity, and responsible investment. Therefore, it is necessary to conduct a more detailed analysis of these issues to clarify further the histories, problem structures, and ways to elicit specific behavioral changes. Since there are many sensitive issues for the basin countries, it will be difficult to promote bilateral cooperation at once.
Objectives	Analyze policy issues critical to achieving sustainable water resources management in the Mekong River basin and furnish information for future policy dialogues and behavioral changes.
Summary (Components) of Activities	Selection of target issues (select one or more of the following themes) - International river management under the risk of climate change - Effective use of dams and reservoirs as watershed assets - Establishment of equitable water resource management through benefit-sharing - Establishment of a water resources management mechanism that takes into account transboundary environmental and social issues - Establishment of responsible investment in water resources management. - Establishment of water resources management that takes into account ecological security. - Clarification of medium- and long-term energy policy - Introduction of alternative energy sources (hydrogen, electricity storage, renewable energy, etc.) in the Mekong Region - Others - Information gathering and interviews with MRC, relevant organizations in basin countries, donors, and other related parties - Analyze the histories, problem structures, and directions of improvement of the target issues. - Discussions with MRC and basin countries on the results
Expected Outcomes	Policy-related issues (decision-making, legal system, budget, etc.) will be clarified, and specific directions for policy improvement and how to proceed with behavioral change will be identified.

Name of Project	**1-3 Strengthening capacity to analyze causes of saltwater intrusion and to develop countermeasures**
Background and Reason for Proposal	In the Mekong Delta, saltwater intrusion is one of the most important problems. In addition to sea level rise, land subsidence due to excessive pumping of groundwater for agricultural purposes is considered to be an important factor, but in the Mekong Delta region, a decrease in the amount of sediment transport from the watershed and the sand mining in the river channels are causing the riverbed to decline, which may also be a cause of saltwater intrusion. In the long term, there is a concern that the rise in sea level due to global warming will further amplify the negative impact of this phenomenon, and it is necessary to identify the dominant parameters and elucidate the causes based on the latest findings to take effective mitigation measures.
Objectives	Ministry of Natural Resources and Environment (MONRE) and Department of Natural Resources and Environment (DONRE) staff in Vietnam will analyze the groundwater pumping-recharge and sediment balance in the Mekong Delta and the mechanisms of saltwater intrusion, and support capacity building for developing mitigation and adaptation measures against saltwater intrusion in the Mekong Delta.
Summary (Components) of Activities	-Information gathering and interviews with MRC, MONRE, Southern Institute of Water Resources Research (SIWRR) and other relevant organizations of basin countries, donors and other stakeholders -Strengthening of hydrological and environmental observation facilities (groundwater level, groundwater pumping rate, salinity, sediment sampling rate) -Survey on current status of groundwater pumping volume -Survey on inventory and operation status of waterways and sluices -Assessment of impact of natural environment and human activities by sediment and water cycle analysis -Analysis of the relationship between inflow into the Mekong Delta and saltwater intrusion -Establishment of groundwater environmental capacity (allowable pumping rate, allowable groundwater level, allowable water quality standards) -Consideration of countermeasures for saltwater runoff
Expected Outcomes	-Equilibrium in sediment and water circulation in the Mekong Delta -Reduction of land subsidence by groundwater

Name of Project	**1-4 Technical cooperation for the establishment of protected areas for biodiversity conservation**
Background and Reason for Proposal	The Convention on Biological Diversity (CBD) is scheduled to adopt the Post-2020 Framework in Kunming, China in April-May 2022. The framework is expected to include the 30 by 30, which aims to conserve and protect at least 30% of the world's land and sea areas by 2030. In line with this, it is suggested to implement a cooperation project to designate protected areas in the Mekong River basin by clarifying and improving the information on areas where conservation is desired.
Objectives	Strengthening capacity to establish protected areas in consideration of the "Post-2020 Framework" of the Fifteenth Meeting of the Conference of the Parties (COP15) of the Convention on Biological Diversity
Summary (Components) of Activities	-Ecosystem surveys of the entire target country (land, water, vegetation, mammals, fish, etc.) -Establishment of geographic information systems -Promotion of development of the legal framework for protected area management -Strengthening staff capacity in model reserves
Expected Outcomes	Prevention of uncontrolled dam development by promoting discussions on establishing protected areas, building a model for protected area management, and contributing to the CBD

Name of Project	**1-5 Ratings of environmental and social consideration of existing dams from the perspective of responsible investment**
Background and Reason for Proposal	Disclosure of non-financial information has become essential for ESG/responsible investment, and the taxonomy now stipulates conditions of DNSH (Do No Significant Harms) in investment. Thus, it is desirable to establish criteria for understanding whether a project in the Mekong River basin is eligible for responsible investment by international standards. This can be achieved by conducting pilot activities to prepare non-financial information on several dams to examine what kind of non-financial information is necessary for future dam development and to examine the criteria to determine what kind of dams can be subject to responsible investment and what kind of dams should be excluded from investment.
Objectives	To establish criteria for judging dam development from the perspective of investors using international guidelines on dams (e.g., International Hydropower Association (IHA)) and the MRC Hydropower Mitigation Guidelines.
Summary (Components) of Activities	-Implement workshops related to dam investment (e.g. DNSH standards) -Implement rating of environmental and social considerations of existing dams by experts (preferably more than one dam) -Conduct workshops related to the results
Expected Outcomes	It will contribute to the establishment of criteria for examining dam projects on the Mekong River from the perspective of responsible investment. It is expected that future dam projects will be screened based on such criteria.

Name of Project	**1-6 Support for the establishment and operation of a scientific information network for academic experts**
Background and Reason for Proposal	Although many researchers in the Mekong River basin are engaged in research on water resource management, it is not easy for them to access such information (especially local scholars). Therefore, a network of these academic experts is built to promote information exchange. The network will function as the base to collect scientific information related to the basin and an arena for Track II diplomacy. Meanwhile, MRC is trying to promote decision-making by a wide range of stakeholders to increase transparency and accountability, and one of the measures to achieve this is to activate Joint Basin Expert Groups (JBEG). The network will also stimulate the activities of JBEG. It is also expected to serve as a framework for promoting cooperation with LMC.
Objectives	To build a scientific information network to promote information exchange among academic experts, and to support JBEG's activities to enable highly transparent Mekong River basin management.
Summary (Components) of Activities	-Create a list of academic experts -Develop tools (websites that enables matching of experts' needs, etc.) that enable networking of academic experts -Hold a virtual information exchange meeting once a year and compile the results as proceedings or a book -Promote new research by injecting research fund (small amount) -Support JBEG activities promoted by MRC

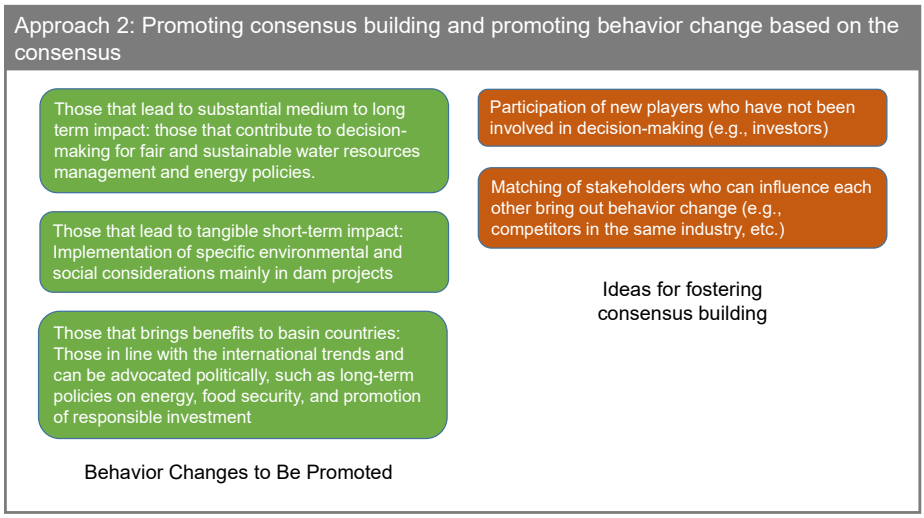
	(Sharing of data and knowledge related to basin management: Co-host JBEG subcommittees meetings with MRC and share results with Japanese experts who are engaged in research/SATREPS project in the Mekong basin. In response to this, hold a workshop for high-ranking government officials to foster a high-level common understanding of relevant issues.)
Expected Outcomes	A network will be established to enable the exchange of information related to the Mekong River basin. The information can be used to study mitigation and adaptation measures for environmental and social problems. In addition, experts and government officials from each country share a common understanding of the situation in the basin and integrated water resources management. Japanese academic research results will be used in the JBEG activities.

Source: JICA Study Team

(2) Promoting Consensus Building and Behavioral Change Based on the Consensus

In the past, the decisions for the development of dams and water resources in the Mekong River basin tended to be made by a limited number of decision makers without consensus building among broader stakeholders. This made it difficult to consider the benefits of a wide range of stakeholders in the basin and the overall sustainability of development. Regarding this challenge, country like Japan which is not a basin country, may actively create a transparent arena for consensus-building and promote behavioral change toward a more equitable and sustainable society that has been difficult in the past.

There are many issues in the Mekong River basin for which behavioral change is needed, such as securing environmental flows, securing the reverse flows to Tonle Sap Lake, securing fish migration, minimizing sediment trapped by dams, and dealing with saltwater intrusion in the Mekong Delta. The behavioral changes to be pursued in the proposed projects should have a substantial medium- to long-term impact or a tangible short-term impact on such issues and should bring benefits to the stakeholders in the basin countries. Since the key is how to break through the inertia of closed and rigid decision-making processes, consensus building should focus on the participation of players who have not been involved in the decision-making process in the past and on the matching of stakeholders who can stimulate behavioral change.



Source: JICA Study Team

Figure 8.2 Promotion of Consensus Building and Behavioral Change Based on the Consensus

In order to make behavioral change happen, it is necessary to give the concerned parties an interest that would trigger the behavioral change, support them in preparing to take new actions and provide an

environment where they can commit to the behavioral change. Such processes should be built into the activities. The following are the projects and activities proposed to promote consensus building and behavioral change based on the consensus.

Table 8.3 Projects and Activities Proposed for Promotion of Consensus Building and Behavioral Change Based on the Consensus

Name of Project	**2-1 Workshops (series) on specific themes**
Background and Reason for Proposal	In the past, decision-making on dam development in the Mekong River basin tended to be driven by the interests of a limited number of stakeholders without sufficient information. However, there are various international trends that could affect decision-making, such as medium- and long-term energy policy, ESG and responsible investment, more advanced dam planning and operation, and food security. The understanding of these trends by decision-makers of relevant countries can elicit their behavioral changes, and guide decision-making on water resources management in the Mekong River Basin in the desired direction.
Objectives	To conduct three to four workshops on topics that are important to decision makers who are involved in water resources management in the Mekong River basin to facilitate informed decision making.
Summary (Components) of Activities	-Decide the workshop themes based on interviews with decision-makers -Prepare for the workshops -Organize a workshop (about 20-30 people online, about half a day, local language, video lecture by top international experts with discussions from local experts, etc.; expect to select about three to four themes from the following topics) - ESG investment and responsible investment - Latest trends in energy development (solar, microgrid, wind, pumped storage, hydrogen, etc.) - Latest trends related to dam planning, construction, and operation - Climate change - Food security - Management of the world's transboundary rivers Prepare educational materials for stakeholders who could not attend the workshop
Expected Outcomes	This activity will help decision-makers understand the latest international developments in water resources management and guide decisions on water resources development in the Mekong River basin in a more desirable direction.

Name of Project	**2-2 Development of comprehensive sediment management master plan**
Background and Reason for Proposal	In the Mekong River basin. the MRC's Council Study estimates that the amount of sediment reaching Kratie will decrease by about 3% in 2040 compared to 2007, assuming that the cascade dams on the mainstream are built as planned. Although macroscopic studies using simulation models have been conducted, a comprehensive sediment management master plan for the entire basin that can serve as a guideline for the future has not yet been developed.
Objectives	To develop a comprehensive sediment management master plan that shows future management policies and measures based on sediment transport characteristics in the Mekong River basin and a comprehensive sediment management plan for priority basins.
Summary (Components) of Activities	-Study on spatio-temporal scale of sediment dynamics, watershed classification, evaluation of measuring points of sediment transport, etc. -Investigation of the actual condition of the hydrological and sediment observation system in the basin and proposals for improving the observation accuracy -Investigation of the actual conditions of riverbank erosion and sedimentation, and riverbed decline and rise over time (including analysis of river channel changes) -Investigation of the actual situation of sand mining (understanding of major mining stretches and annual extraction volume) -Rough calculation of the amount of sediment produced and discharged in the entire watershed (sediment balance), and selection of priority watersheds -Identify the current status and issues of the sediment transport system -Establishment of sediment management targets, study of sediment management measures, and formulation of an comprehensive sediment management master plan -Formulation of a comprehensive sediment management plan (priority watershed), F/S

	study of priority measures -Study on monitoring plan -Urgent action on Sekong Downstream A Dam (Sekong River basin)
Expected Outcomes	The macroscopic sediment transport characteristics (sediment transport system) of the Mekong River basin will be understood, priority basins will be identified, and F/S studies for priority measures will be conducted.

Name of Project	**2-3 Support for the Formulation and Implementation of National Indicative Plans (NIPs) by Basin Countries (Responsible Government Agencies)**
Background and Reason for Proposal	In addition to MRC BDS/SP, each basin country is supposed to formulate NIP to promote water resource management, but there is a need to support the formulation and implementation. Some components of the NIPs are expected to be closely linked (or part of) to the BDS/SP program, and delays in their implementation will affect the progress of the BDP/SP, and the implementation of various measures. NIPs serve as a place where different ministries and agencies jointly formulate plans related to water resource management and watershed management in the target country and provides various opportunities for consensus building.
Objectives	Support for development and implementation of NIPs
Summary (Components) of Activities	Collection of basic information Support of drafting of NIP Holding of workshops for implementation of the NIP
Expected Outcomes	This project will support the implementation of activities consistent with BDS / SP and the promotion of cooperation between related ministries and agencies.

Name of Project	**2-4 Research on electricity interconnections between basin countries and appropriate power supply mix**
Background and Reason for Proposal	In Laos, power development for domestic use is beginning to be curtailed due to slowing growth in domestic demand, but neighboring countries are planning to cover future power shortages by importing power from Laos, so power development in Laos is expected to continue. On the other hand, there is a difference in the amount of hydropower that can be generated during the wet and dry seasons, so the development of hydropower-based power sources will lead to power shortages during the dry season. In Vietnam, the introduction of renewable energies is rapidly increasing, and there are concerns that the capacity of reservoir-type power plants necessary to maintain power quality will be insufficient by 2030. In consideration of the latest power situation as described above, it is necessary to assume in advance the optimal power supply mix in the region when wide-area interconnection as recommended by JICA and ADB is realized to control excessive investment and to lead to an appropriate power supply configuration. Based on the above recognition of the current situation, it is important to study and predict the direction of future hydropower development (dam construction) under several scenarios of power supply configuration in order to evaluate the results of related studies (such as the Council Study of the MRC) and implement countermeasures.
Objectives	To propose an optimal power supply configuration for the basin countries, taking into account the highly feasible power convergence among the Mekong basin countries and the power supply issues that would arise if these were achieved.
Summary (Components) of Activities	-Organize energy and power policies, power supply and demand balance, and issues in each Mekong River basin country -Organize the current status and issues of grid interconnection plans promoted by donors and governments -Establish highly feasible wide-area interconnection scenarios -Study of the optimal power source configuration based on the above wide-area interconnection scenario (including intermediate stages) -Formulation of a roadmap and prioritization of projects
Expected Outcomes	(1) Optimal power supply configuration derived from future power convergence (2) Recommendations for the power development policies of each country with power sharing in mind

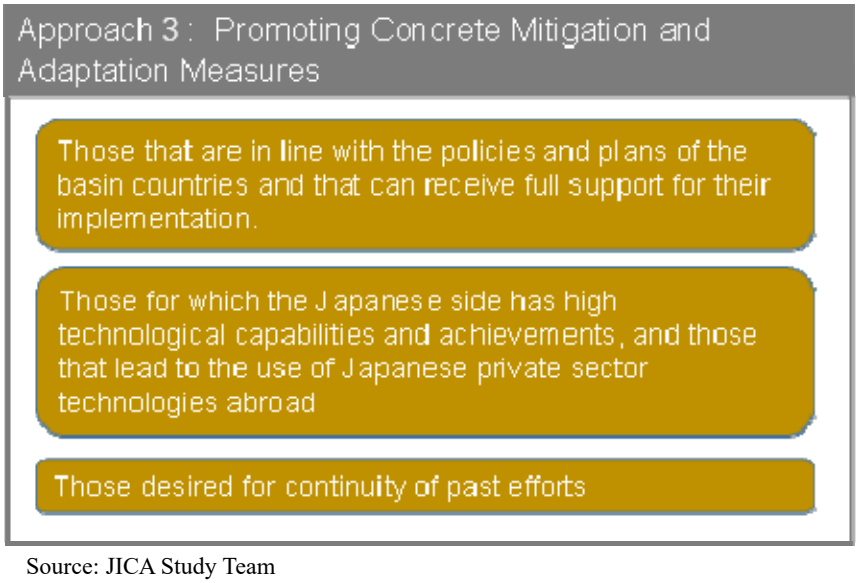
Name of Project	**2-5 Workshops to promote the adaptation of MRC Hydropower Mitigation Guidelines**
Background and Reason for	MRC has formulated "The MRC Hydropower Mitigation Guidelines" in 2019, which

Proposal	supplement the 2009 Preliminary Design Guidance. These new guidelines were developed largely for the environmental and social considerations of the cascade dams in the mainstream in Laos. But they should be used widely in future dam development projects in the whole basin, and how this is incorporated in the plans of each dam. However, how these guidelines are incorporated into the dam planning and what are in applying the guidelines have not yet been investigated in detail. Therefore, workshops are organized to exchange information. If a large number of dam designers and operators participate in the workshops, they might be able to compete for best practices and raise the level of technology by the front runner approach. Dialogue between authorities in charge of environmental issues and energy issues can also be expected.
Objectives	To hold workshops on the MRC Hydropower Mitigation Guidelines for dam designers, operators, environmental authorities, and energy authorities, widely disseminate the guidelines, and discuss issues related to the application of the guidelines.
Summary (Components) of Activities	Carry out a preliminary review of guideline application status, and design the workshops Hold the workshops on guidelines (preferably conducting a site tour as part of each workshop)
Expected Outcomes	Detailed contents of the guidelines are shared widely. In addition, practical issues of applying the guidelines and how to improve the guidelines are discussed and clarified among practitioners and relevant authorities.

Source: JICA Study Team

(3) Promoting Concrete Mitigation and Adaptation Measures

In this section, cooperation for promoting concrete mitigation and adaptation measures is considered. Implementing mitigation and adaptation measures requires information and experts in different disciplines to develop and implement the plan. Moreover, implementation requires an investment and coordination of many related organizations. Meanwhile, it brings about tangible outcomes, and the expectations of the basin countries are high. Therefore, this approach emphasizes the active participation of the basin countries, the comparative advantage of Japanese technologies, and the continuity of cooperation from the past. The proposed projects and activities focus on the improvement of dam operation rules and disaster prevention. Figure 8.3 summarizes these perspectives.



Source: JICA Study Team

Figure 8.3 Promoting Concrete Mitigation and Adaptation Measures

The projects and activities proposed for promoting the implementation of concrete mitigation and adaptation measures are shown in Table 8.4.

Table 8.4 Projects and Activities Proposed for Promotion of Concrete Mitigation and Adaptation Measures

Name of Project	**3-1 Strengthening response capacity and developing warning systems for droughts and floods**
Background and Reason for Proposal	In the lower Mekong River basin, an extraordinary water level lowering phenomenon occurred along the mainstream from May of 2019 to October of 2020. In April 2020, the U.S.-based Eyes on Earth published a report on this issue (April 2020), claiming that the biggest factor was the restriction of flow release at the cascade dams on the upper Lancang River. The MRC responded to the report, and an Australian think tank (AME) published an editorial. As for floods, although no major damage has occurred in the past few years, there is a need among basin countries to strengthen the monitoring of heavy rainfall and improve the accuracy of flood forecasting systems.
Objectives	To strengthen the adaptive capacity of basin countries in the lower Mekong River basin to cope with droughts and floods, contribute to mitigating damage, and build confidence among basin countries.
Summary (Components) of Activities	-Survey of drought conditions and review of previous research results -Status of application of Drought Management Strategy for the Lower Mekong Basin 2020-2025 (MRC, 2019) and understanding of issues -Review of PMFM (review of threshold values, etc.) -Understanding of flood inundation areas, flood characteristics, and flood damage (survey of recent flood inundation areas and flood damage) -Study on the feasibility of introducing the latest technology for flood forecasting (wide area rainfall calculation using satellite image analysis, AI-based flood runoff forecasting, ensemble rainfall forecasting, flood risk assessment, etc.) -Strengthening of the monitoring network (improvement of observation systems, equipment and software) -Improve warning issuing protocols and enhance cooperation (communication system, responsible system for observation and warning issuing, etc.) -Develop an early warning manual for droughts and floods -Implementation of early warning system in pilot basins (data transfer, analysis software, warning equipment, etc.) and trainings
Expected Outcomes	Improve the skills of meteorological and hydrological monitors and analysts in the basin countries in forecasting techniques for droughts and floods, thereby contributing to improved water resources management in the basin.

Name of Project	**3-2 Strengthening of adjusting downstream flow conditions and enhancing sediment supply capacity by improving operation rules of existing dams**
Background and Reason for Proposal	In the Mekong River basin, dams built in cascades on tributary rivers have affected the natural and social environment of downstream river sections by changing flow regimes and reducing sediment transport. Such dams developed in cascades have different operators who are making it difficult and challenging to improve the operation in coordination between the upstream and downstream dams. On the other hand, the MRC, in its Hydropower Mitigation Guideline (2019), introduces a method of sediment discharge, such as coordinated sand flushing, while introducing a case study from Japan. Meanwhile, a method for assessing transboundary environmental impacts, including the reduction of sediment supply, is being established and is expected to be effective. It is hoped that the methods presented in the Guideline should be appropriately applied.
Objectives	To improve the operation rules of the Mekong River tributary dams and make minor facility improvements to regulate flow conditions and enhance sediment supply capacity
Summary (Components) of Activities	-Survey on the operation of dams on the main river and tributaries of the lower Mekong River (baseline survey) -Establishment of improvement indices for adjusting flow conditions and evaluating sediment supply capacity through operational rules and improvements -Selection of rivers to be studied as pilots (rivers with dams that have a large impact on the natural and social environment downstream, especially the 3S basin and the Nam Ou River basin, will be studied and prioritized) -Establishment of a flow and sediment monitoring system for the target river -Improvement and proposal of operation rules of existing dams, including proposal of necessary facility repair (including dam rehabilitation), in order to adjust flow conditions and enhance sediment supply capacity in downstream areas -Trial changes in the operation of existing dams in the target river and verification of their effectiveness
Expected Outcomes	Development of operational rules for existing dams to improve downstream flow regime

	and enhance sediment supply capacity. In particular, CaMa-Flood can be applied as a highly accurate runoff simulation tool to assess the improvement of downstream flow regime. Further functional expansion of the model in combination with dam operation is expected to expand its application as a more versatile analysis tool for decision making.

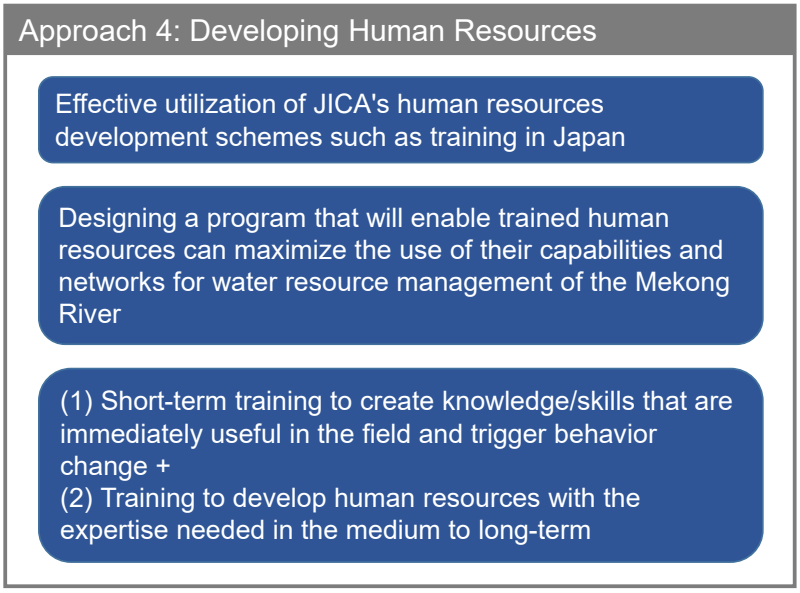
Name of Project	**3-3 Preparation of fishway planning and design guidelines for the Mekong River basin**
Background and Reason for Proposal	Many fishways have been constructed in the Mekong River basin, but unlike rivers where the target fish species are uniform (eg salmon, etc.), different fish species use the fishways at various times in the Mekong River. Therefore, the design is not simple and the effectiveness is not well understood. Therefore, this project will examine the usage status of the existing fishways, also examine possible ways to improve designs and construction of fishways in the Mekong River, and draft a fishway planning and design guideline suitable for the fish in the Mekong River. This project will allow more accurate estimation of the impact of migratory dams and will allow future dams to establish more desirable fishways.
Objectives	Drafting of fishway planning and design guidelines
Summary (Components) of Activities	Investigation of usage of existing fishways (2 years, ascending/descending directions) Drafting of fishway planning and design guidelines (If possible, trial installation and improvement of existing fishways should be considered)
Expected Outcomes	Improvement of migration by optimizing fishways

Name of Project	**3-4 Support for Promotion of Activities of MRC SP 2021-2025 and Development of SP 2026-2030**
Background and Reason for Proposal	The MRC Strategic Plan (SP) 2021-2025 is equivalent to the implementation plan of the Basin Development Strategy (BDS) 2021-2030 based on the concept of Integrated Water Resources Management (IWRM). It shows the contents of MRC's support to the four member countries of MRC. It will further give Japan an opportunity to grasp the overall picture of water resource management in the Mekong River basin, including the efforts of other donors, and reflect the knowledge obtained from each project in the next SP (and vice versa).
Objectives	To support monitoring and improvement of the implementation of SP 2021-2025, and to support for the drafting of the SP 2026-2030
Summary (Components) of Activities	-Support for monitoring implementation of Strategic Priority 1 to 5 of SP 2021-2025, drafting of measures to solve issues identified through the implementation of SP 2021-2025, support of implementation (including the development of two-year work plans and yearly improvement plans) -Support for development of SP 2026-2030
Expected Outcomes	Realization of integrated water resource management in the Mekong River basin by promoting the implementation of SP 2021-2025 Demonstrating the Japanese commitment to the Mekong River basin, including Japan's technology application Synergy effects with various projects, including Japan's support projects in the Mekong River basin Formulation of the next SP 2026-2030 aiming at the realization of integrated water resource management

Source: JICA Study Team

(4) Developing Human Resources

Trust among basin countries is essential for sustainable transboundary river management, and its foundation is the people. The project and activities for human resource development should be directly applicable to future water resources management of the Mekong River. Short-term programs are utilized for busy staff of relevant ministries, agencies, and other organizations, while medium- to long-term programs, such as study abroad programs, are used to develop human resources with special expertise competency. All of these programs should match the needs in the field. (see Figure 8.4).



Source: JICA Study Team

Figure 8.4 Human Resource Development

The projects and activities proposed for human resource development are summarized in Table 8.5.

Table 8.5 Projects and Activities for Human Resource Development

Name of Project	**4-1 Theme-based Training on Transboundary Water Resources Management**
Background and Reason for Proposal	Bilateral cooperation schemes such as technical cooperation projects and the dispatch of experts cannot cover multiple countries. But, if it is a theme-based training, participants from multiple organizations of the Mekong River basin countries or other countries in the world can jointly learn about transboundary water resource management and exchange experiences of different countries
Objectives	Conducted training on transboundary water resources management for mid-career engineers from different countries through theme-based training
Summary (Components) of Activities	Theme-based training (The program should be designed considering the issues of the Mekong River. Participation of relevant organizations in each basin country is expected.)
Expected Outcomes	Training on transboundary water resource management. In addition, it is possible to promote exchange of information and opinions among participants.

Name of Project	**4-2 Human Resource Development through Scholarship**
Background and Reason for Proposal	It takes time to develop human resources who have sufficient basic knowledge about water resource management. Moreover, in international river management, the development of trust among human resources in the basin countries is essential to build proper water resources management. Therefore, the study abroad system of Japan is used to develop human resources who will play a central role in future water resource management.
Objectives	Promote the development of human resources who will play important roles in future water resource management through scholarships from the Japanese Grant Aid and JICA Development Studies Program
Summary (Components) of Activities	Discussion with relevant organizations in each country on major fields that require human resources in the future (water resource management, dam development, energy, EIA, ecosystem management, fishery resource management, etc.) Mediation of study abroad opportunities using the JDS system
Expected Outcomes	Human resources who have studied abroad in Japan will be involved in water resources management of the Mekong River as a member of the Joint Basin Expert Group in their own country and will raise the level of water resources management.

Source: JICA Study Team

8.4 Other Items to be Considered

(1) Issues that Require Urgent Actions

The Sekong Downstream A Dam Project in the Sekong River basin in southern Laos, which is under construction, has a possibility of inflicting the widest (more than two countries) and irreversible negative impact. The Sekong River, which is one of the left tributaries of the Mekong River, is the last major river flowing into the main river and is extremely important as a migration route for fish and as a sediment supply route. There have been many reports about the environmental and social issues of this dam, such as impacts on the ecosystem and forced relocation of residents among others. Several sources have reported that construction has already began in early 2020s.

Technically speaking, the dam is not only a issue for upstream Laos and immediate downstream Cambodia, but also could cause transboundary environmental and social impact for Vietnam, since the reduction of sediment supply from the 3S river basin is likely to become one of the main causes of the long-term erosion of river beds, riverbanks and the coast in the Mekong Delta in Vietnam. It could further aggravate the damage by saltwater intrusion. In the future, the lowering of the riverbed of the mainstream could affect the reverse flow to Tonle Sap Lake, which plays a vital role in maintaining the ecosystem of Tonle Sap Lake.

Under these circumstances, there is an immediate need to confirm the facts and find possible solutions through dialogues with relevant organizations and build consensus for better water resources management.

(2) Responding to Local Development Issues

As mentioned in Section 8.1, one of the basic policies for formulating cooperation projects (candidates) in this survey is to propose projects that contribute to the improvement of infrastructure facilities and policies that have a transboundary impact. Therefore, the projects proposed in Section 8.3 consist mainly of projects targeting the mainstream and 3S river basin. Meanwhile, in the tributary basin whose area is limited to one country (e.g., left tributaries in Cambodia), the support of MRC and development partners tends to be scarce, and an approach different from those for a transboundary river is required. Furthermore, most of such basins lack river management plans and basin conservation plans due to insufficient involvement and cooperation of central government agencies and financial and human resource constraints in local governments. In such basins, it is not possible to implement appropriate water resources management based on a plan, and there is an urgent need to improve the situation of local development issues, regardless of the presence or absence of dams.

In order to promote the implementation of effective measures against such local development issues, it is necessary to strengthen the capacity of organizations and staff who are responsible for water resource development and management in the central and local governments. Technical cooperation for solving the issues in such areas and training targeting themes with high needs should be considered. From the viewpoint of the Theory of Change for the entire basin as shown in Figure 7.6, it is important to support not only transboundary water systems but also water resources management issues in individual tributary basins in each country.

Although local development issues are recognized as above mentioned, cooperation activities to contribute to solve the issues are involved in the human resources development (Project No.4-1 and 4-2).

8.5 Cooperation Projects (Candidates) with Support by Japan

JICA has set 20 issue-specific strategies ("JICA's Global Agenda") in order to resolve serious and complicated issues the world is facing and is trying to maximize its impact on solving such issues in the developing countries in collaboration and cooperation with various partners. The JICA's Global Agenda for the water sector is "Sustainable Water Resources Management and Water Supply" and one of the two Development Scenarios ("Clusters") is "practical integrated water resource management to resolve water-related issues in the field". Therefore, JICA's cooperation should focus on activities that lead to solving issues and maximizing the development effect together with the related organizations of the partner countries and other development partners.

In this context, the processes of solving issues should be in line with the approaches for considering cooperation projects (candidates) in Section 8.2, namely, (1) making information available for elucidation of causes and effects and decision making, (2) promoting consensus building and promoting behavioral change based on the consensus, and (3) promoting concrete mitigation and adaptation measures, and to realize these (4) developing human resources, is also essential.

From the above, the cooperation projects (candidate) should be the ones that will solve at least some of the issues or improve the issues by the target year 2030 (eight years from now). Hence, organizing a platform aiming at solving issues of specific themes is proposed by an integrated initiative of Project No.1-2 + No.1-6 + No.2-1. For example, information could be shared and opinions exchanged with MRC, NMCs and water resources-related organizations in the basin countries, important specific themes that are likely to lead to concrete changes could be selected for investigation and analysis (No. 1-2). These activities may be supported by establishing a scientific information network for academic experts (No.1-6). Then workshops and other events attended by both policy makers and academics (No. 2-1) to foster a common scientific understanding and to agree on the direction of problem solving. Such a set of comprehensive activities that becomes the core of long-term cooperation is needed. On the other hand, if the theme is too broad, the project becomes too large and complicated, and one cannot produce satisfactory results in the end. Hence, a better approach would be to start with themes that are relatively easy to draw a consensus, and then accumulate experience and gradually expand the themes.

If the direction of a solution can be agreed on such a platform, next is the stage to implement the solutions. However, a certain amount of time and effort will be required to form a fully functional platform. Therefore, to start cooperation at an early stage, it is also important to build a project on the historical cooperation by Japan and on specific themes in which Japan has a comparative advantage. In such projects, the achievements in the past and the advantages are used to improve the accuracy of investigation and analysis. When necessary, the above-mentioned comprehensive platform is used to foster consensus and promote problem-solving. Such synergistic use of different initiatives is effective.

For example, JICA has provided MRC with support for strengthening hydrological observation capacity for a long time, and recently, the Japanese government has provided hydrological observation equipment (a grant-aid of "The Project for Flood and Drought Management in Mekong River Basin", 2020). Therefore, Project No. 3-1 can be candidate. The purpose of this project, i.e., strengthening the capacity to respond to droughts and floods, is positioned as one of the expected outputs of MRC SP 2021-2025, and there is a high expectation for Japanese support in this area. In that sense, it will be more effective if Project No.3-1 is implemented together with Project No. 3-4, which is designed to promote the activities of MRC SP 2021-2025 and support the formulation of the next SP 2026-2030.

Again, it is vital to pursue consensus building, solve issues, and not simply formulate plans. Producing such outcomes requires realistic and effective cooperation with related countries and organizations.

As for themes with comparative technological advantage, JICA has implemented the project for "Establishment of Environmental Conservation Platform of Tonle Sap Lake", under the Science and Technology Research Partnership for Sustainable Development (SATREPS) scheme, in order to conduct hydrological and environmental assessment to fill the science policy gap in the conservation and sustainable development in the Tonle Sap Lake. In the future, there is room to consider for further new research on flow simulation of the entire Mekong River basin, including dam operations. Further, Japan has a high technical advantage on dam sedimentation, sediment removal, and comprehensive sediment management in the basin. It is recommended to select such specific themes, investigate and analyze them comprehensively, propose countermeasure options, promote consensus building, and contribute to problem-solving.

Human resource development is common to all issues, and again Japan has an advantage. Education and training in Japan for human resources from related countries and institutions are highly effective in strengthening capacity and building trust. Support for human resource development for each country in the Mekong River basin (Project No. 4-1 and No. 4-2) is an indispensable mode of cooperation for strengthening sustainability, and it is important to proceed in parallel with the other projects.

Based on the above, the following list of projects (candidates) would be considered to be supported by Japan:

(1) A set of projects which become the core of consensus building for problem-solving
- 1-2 : Research on policy recommendations on sustainable water resource management in the Mekong River basin
- 1-6 : Support for the establishment and operation of a scientific information network for academic experts
- 2-1 : Workshops (series) on specific themes

(2) Projects that contribute to the promotion of specific mitigation measures and adaptation measures
- 3-1 : Strengthening response capacity and developing warning systems for droughts and floods
- 3-4 : Support for Promotion of Activities of MRC SP 2021-2025 and Development of SP 2026-2030

(3) Projects that contribute to human resource development
- 4-1 : Theme-based Training on Transboundary Water Resources Management
- 4-2 : Human Resource Development through Scholarship