Report on Experiences and Opportunities for Coordinated Operating Rules and Cooperation Arrangements on Dam Operations

February 2023
Report on Experiences and Opportunities for Coordinated Operating Rules and Cooperation Arrangements on Dam Operations

February 2023
The MRC is funded by contributions from its Member Countries and Development Partners, including Australia, the European Union, Finland, Flanders/Belgium, France, Germany, Japan, Luxembourg, the Netherlands, New Zealand, Sweden, Switzerland, and the United States of America.
Title: Report on experiences and opportunities for coordinated operating rules and cooperation arrangements on dam operations

DOI: https://doi.org/10.52107/mrc.b193up

Keywords: riverine plastic/plastic pollution/Mekong River

For bibliographic purposes, this volume may be cited as:

Information on MRC publications and digital products can be found at http://www.mrcmekong.org/publications/

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


Authors

MRC Secretariat

*Project management*
Mr Bountieng Sanaxonh, Director of Planning Division
Mr Thim Ly, Chief Basin Planner

*MRC Secretariat’s technical experts*
Mr Palakorn Chanbanyong, Sustainable Hydropower Specialist
Mr Sopheapin Chea, Regional Water Policy Consultant

*International expert*
Mr Simon Krohn, International Consultant, Contracted under Australian Water Partnership, Australia
## CONTENTS

### EXECUTIVE SUMMARY

1.1 Completion of the Scoping Stage
Progressing the recommended next steps
Recommended steps to scope and analyse joint action Opportunities (Stage 2)

### INTRODUCTION

2.1 Purpose of this report
2.2 Need for operational coordination for integrated water resources management
2.3 Basin Development Strategy 2021–2030: Moving from planning toward operational management
2.4 Linked Basin Development Strategy and Strategic Plan activities
2.5 Implementation Plan for the BDS 2021–2030 and MRC SP 2021–2025 under Output 4.2.1
2.6 Outline of the report

### REGIONAL AND INTERNATIONAL EXPERIENCE

3.1 Benefits of cooperation
3.1.1 Types of benefits
3.1.2 The cooperation continuum
3.2 International examples – lessons learned from international case studies
3.2.1 Basin-wide institutions for co-ordinated hydro-power development and management
3.2.2 Specific agency for dam operations
3.3 Regional implications for the Mekong
3.4 Ongoing MRC efforts for coordinated water infrastructure operations
3.4.1 The aim of the 1995 Mekong Agreement and Procedures
3.4.2 Statement on operational rules that emerged from the PNPCA process for mainstream dams
3.4.3 The Procedures for Data and Information Exchange and Sharing
3.4.4 Cascade operation in the Preliminary Design Guidance 2009
3.4.5 Cascade operation in the updated Preliminary Design Guidance 2022
3.4.6 The MRC and Lancang Mekong Water Resources Cooperation Centre
3.4.7 MRC data systems invigoration project (BDS 2021–2030, Outcome 4.1)
3.4.8 Initiative for Sustainable Hydropower Study: Improved Environmental and Socio-economic Baseline Information for Hydropower Planning (ISH11)
3.4.9 The Joint Environmental Monitoring Programme
3.4.10 The Core River Monitoring Network
3.5 Important Regional Initiatives on Hydropower Cascade Optimization and Management
3.5.1 The Cascade Optimisation Study
3.5.2 Lao PDR operations and information sharing
4 OPPORTUNITIES FOR COORDINATED OPERATING MECHANISMS FOR WATER INFRASTRUCTURE OPERATIONS 37

4.1 Conceptual framework for consideration of opportunities 37

4.1.1 Scope of integrated water resources management-based operations 37

4.1.2 Purpose and elements of cooperation on water infrastructure operations in the Mekong Basin context 38

4.1.3 Specific considerations associated with operations in the Mekong 40

4.2 Matrix of opportunities for water infrastructure cooperation 44

4.2.1 Prioritization of opportunities 49

5 SCOPING THE OPPORTUNITIES 50

5.1 Coordination opportunity – Information and decision support 50

5.1.1 Linked MRC Initiatives – SP Outcome 4.1: Better informed and prepared basin communities against changing river conditions, and more frequent and severe floods and droughts 51

5.1.2 Decision support systems 52

5.1.3 Current information sharing platforms 55

5.1.4 Guiding framework defining information needs 56

5.1.5 Monitoring locations 57

5.1.6 Parameters 59

5.1.7 Timing of data collection 61

5.1.8 Sources and information management 61

5.1.9 Gap analysis of information needed 62

5.1.10 Information use 63

5.1.11 Recommendations to promote coordination opportunities 64

5.2 Collaboration Opportunities – Adapting operations for regional benefit 64

5.2.1 Operating Requirements within Existing PNPCA Statements and Joint Action Plans 65

5.2.2 Flood and emergency management mechanisms 67

5.2.3 Drought management mechanisms 69

5.2.4 Tonle Sap reverse flows 70

5.2.5 Engagement with China and Myanmar 70

5.2.6 Summary of opportunities 71

5.2.7 Recommended steps to scope and analyse collaboration opportunities 73

5.3 Joint Action Opportunities – Planning development, design, and operations for regional benefit 74

5.3.1 Recommended steps to scope and analyse joint action opportunities 74

6 GOVERNANCE AND COMMUNICATION ARRANGEMENTS FOR WATER INFRASTRUCTURE OPERATIONS 76

6.1.1 Mirrored national and regional processes for coordination of operations 76

6.1.2 Regional information-sharing platform and decision support systems 79

6.1.3 The role of the MRC Expert Groups on Basin Planning and on Environmental Management 79

6.1.4 Formal MRC operations coordination sub-body 79
6.1.5 Coordination with the Mekong Lancang Cooperation Centre 79
6.1.6 Mekong Basin stakeholder engagement 81

7 PROPOSED PILOT TESTING OF PRELIMINARY OPERATING AND COMMUNICATION PROTOCOLS 82

7.1 Pilot Project 1: Cooperation mechanisms for data and information sharing for existing dams (integrated operational water infrastructure data available on MRC data portal) 82

7.1.1 Scope 83
7.1.2 The regional focus of Pilot Project 1 86
7.1.3 Proposed output 86
7.1.4 Timeline for Pilot Project 1 87

7.2 Pilot Project 2: Information sharing and communication mechanisms for water-related emergencies (operational coordination and emergency response in the 3S Basin during the 2022/2023 flood season) 87

7.2.1 Scope 88
7.2.2 Regional Focus – Pilot Project 2 89
7.2.3 Proposed outputs 89
7.2.4 Timeline for Pilot Project 2 90

7.3 Implementation approach to the pilot projects 90

7.3.1 Expert resources 90
7.3.2 Reporting 91

8 CONCLUSIONS, RECOMMENDATIONS AND NEXT STEPS 92

8.1 Conclusions 92
8.2 Recommendations to advance coordination opportunities 92
8.3 Recommended next steps to scope and analyse collaboration opportunities 93
8.4 Recommended steps to scope and analyse joint action opportunities (Stage 2) 94

REFERENCES 95

ANNEX 1: DEFINITIONS OF THE COLLABORATION CONTINUUM 97


ANNEX 3: INTERNATIONAL CASE STUDIES ON OPERATIONAL MANAGEMENT OF WATER INFRASTRUCTURE 101

ANNEX 4: MEMBER COUNTRY’S PRELIMINARY PRIORITIZATION OF OPPORTUNITIES 105

ANNEX 5. THE MEKONG RIVER COMMISSION’S PROCEDURES AND GUIDELINES 107
FIGURES

Figure 0.1. IWRM based water infrastructure operations ................................................................. 3
Figure 1.1. Map of existing and planned hydropower projects ...................................................... 8
Figure 1.2. Trends in hydropower development in the Mekong Basin .......................................... 9
Figure 1.3. Mainstream and tributary hydropower cascades in northern Lao PDR ..................... 10
Figure 1.4. Linkages to relevant BDS and /SP activities ............................................................... 15
Figure 2.1. Types of cooperation — the ‘cooperation continuum’ ................................................. 21
Figure 2.2. Cascade Joint Operating Rule from the PDG 2022 .................................................. 29
Figure 2.3. Scope of information flows and governance for the proposed Lao PDR CMC .......... 36
Figure 3.1. Roles of water infrastructure operations in IWRM ..................................................... 38
Figure 3.3.2. The accumulative reverse flows at Prek Kdam on the Tonle Sap River ............... 42
Figure 4.1. MRC River Basin integrated data and information systems ...................................... 51
Figure 4.2. Operational information integrated with (draft) design of invigorated MRC data systems ................................................................................................................. 53
Figure 4.3. Concept for drought management decision support systems ..................................... 54
Figure 4.4. ISH11 Proposed baseline monitoring locations (excluding water infrastructure locations) .......................................................................................................................... 58
Figure 4.5. The Emergency Management Continuum ................................................................. 68
Figure 5.1. National and regional operational coordination ............................................................ 78
Figure 5.2. Outline of interactions between Lancang-Mekong Cooperation and Mekong operations ............................................................................................................................ 80
Figure 6.1. Thailand water situation website ............................................................................... 83
Figure 6.2. Reporting arrangements for the management of the pilot projects ........................... 91
TABLES

Table 1.1. Basin Development Strategy /Strategic Plan Strategic Priority 4 ........................................ 13
Table 1.2. Basin Development Strategy 2021–2030 and Strategic Plan 2021–2025 under Outcome 4.2 ............................................................................................................. 14
Table 2.1. Types of benefits arising from cooperation on infrastructure operations ...................... 19
Table 3.1. Opportunities for Operational Cooperation ........................................................................ 45
Table 4.1. Operational data needs and potential sources ................................................................ 59
Table 4.2. Sample layout of gap analysis for information requirements ......................................... 62
Table 6.1. Estimated budget for both pilot projects implementation. Error! Bookmark not defined.
## ACRONYMS AND ABBREVIATIONS

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASEAN</td>
<td>Association of Southeast Asian Nations</td>
</tr>
<tr>
<td>BDS</td>
<td>Basin Development Strategy</td>
</tr>
<tr>
<td>CA</td>
<td>Concession Agreement</td>
</tr>
<tr>
<td>DSS</td>
<td>Decision support systems</td>
</tr>
<tr>
<td>EAP</td>
<td>Emergency Action Plans</td>
</tr>
<tr>
<td>EGAT</td>
<td>Electricity Generating Authority of Thailand</td>
</tr>
<tr>
<td>GMS</td>
<td>Greater Mekong Subregion</td>
</tr>
<tr>
<td>HPP</td>
<td>Hydropower plant</td>
</tr>
<tr>
<td>IWRM</td>
<td>Integrated water resources management</td>
</tr>
<tr>
<td>ISH</td>
<td>Initiative on Sustainable Hydropower</td>
</tr>
<tr>
<td>JEM</td>
<td>Joint Environmental Monitoring</td>
</tr>
<tr>
<td>LMB</td>
<td>Lower Mekong Basin</td>
</tr>
<tr>
<td>LMC</td>
<td>Lancang-Mekong Cooperation</td>
</tr>
<tr>
<td>MRC</td>
<td>Mekong River Commission</td>
</tr>
<tr>
<td>PDG</td>
<td>Preliminary Design Guidance</td>
</tr>
<tr>
<td>PDIES</td>
<td>Procedures for Information Exchange and Sharing</td>
</tr>
<tr>
<td>PMFM</td>
<td>Procedures for the Maintenance of Flow on the Mainstream</td>
</tr>
<tr>
<td>PNPCA</td>
<td>Procedures for Notification, Prior Consultation and Agreement</td>
</tr>
<tr>
<td>PRP</td>
<td>Proactive Regional Planning</td>
</tr>
<tr>
<td>PWQ</td>
<td>Procedures for Water Quality</td>
</tr>
<tr>
<td>RFMMC</td>
<td>Regional Flood Management and Mitigation Centre</td>
</tr>
<tr>
<td>SHDS</td>
<td>Sustainable Hydropower Development Strategy</td>
</tr>
<tr>
<td>SP</td>
<td>The MRC Strategic Plan</td>
</tr>
<tr>
<td>UMB</td>
<td>Upper Mekong River Basin</td>
</tr>
</tbody>
</table>
EXECUTIVE SUMMARY

Mekong River Commission (MRC) studies as well as regional and international research recommend that basin-wide cooperation, integrated planning, development and operational management are essential for the sustainable development of the Mekong Basin. This is also highlighted in the Siem Reap Declaration of 5 April 2018, adopted by the leaders of the MRC Member Countries: The increasing development in the mainstream and tributaries highlight the increasing need for the sustainability and coordinated operational management of tributary and mainstream water resources development projects.

The Basin Development Strategy (BDS 2021–2030) for the Mekong River Basin and the MRC Strategic Plan (SP 2021–2025) note that, as the Mekong River Basin becomes more developed and regulated by dams, and susceptible to more extreme weather events due to climate change, there is increasing need for more data and information sharing and transboundary coordination of operations regarding:

- River flow management;
- Sediment and environmental management;
- Management of emergencies;
- Design and management of hydropower cascades.

The BDS further notes that the responsibility for the above operations lies with the designated agencies in the individual basin countries. However, the Mekong River is an international river governed by the 1995 Mekong Agreement; the basin countries have agreed to cooperate, not just in the development, but also in the management of water and related resources.

International experience in transboundary basins indicate that the MRC under the 1995 Mekong Agreement provides a suitable governance structure within which operational coordination can be managed for basin-wide benefits. Existing Procedures and associated Technical Guidelines, which are to be reviewed under the SP 2021–2025, form a foundation on which cooperation mechanisms for operations can be based. The recent reviews of mainstream hydropower developments undertaken through the Procedures for Notification, Prior Consultation and Agreement (PNPCA) highlight the requirement for the development of joint cascade operating rules. In addition, the Procedures for Data and Information Exchange and Sharing (PDIES) provides an important agreed framework to be used in the further sharing of information to facilitate water infrastructure operations.

The aims of this report are to highlight beneficial opportunities for coordinated water infrastructure operation mechanisms across the cooperation continuum from coordination (information sharing) through collaboration (adaptation of operations) to joint action (mutually advantageous planning, design and operations). The report also provides recommended actions and a forward plan to develop: “Coordinated water infrastructure operation mechanisms for multiple benefits, including gender and vulnerability-sensitive disaster mitigation and management”, as set out in the SP (2021–2025) Output 4.2.1.
The key requirements for operational information sharing and coordination of operations are:

- the MRC Joint Committee and national agencies must be immediately notified of short- and medium-term risks emerging in the Basin regarding floods, droughts, environmental emergencies that may affect, or be affected by water infrastructure operations;
- information on the potential for water infrastructure to assist in the mitigation of these conditions through the information provided by the data systems and decision support systems (DSS) in the short or medium term must be available and can be acted upon;
- water infrastructure operators must be fully informed of upstream and downstream operations and constraints to allow alterations to their operations in response to changed conditions if required (e.g. hydropower operators);
- vulnerable communities must be allowed adequate warning time of changed river conditions (e.g. spillway gate operations, sediment flushing operations) so that they may take appropriate emergency response actions.

These operational responses require timely and readily available information from a range of sources presented on a range of platforms (e.g. web-based, phone applications). These sources should be transparent and trusted by all stakeholders. The MRC already has in place relevant data-sharing platforms, for example, data portal, Procedures for the Maintenance of Flow on the Mainstream (PMFM), Regional Flood Management and Mitigation Centre (RFMMC), that may form the basis of a wider operational support system.

In order for this information dissemination to occur seamlessly, the information platform and communication processes must be clear and resilient to organizational changes within agencies and be tested and utilized by the Member Countries and water infrastructure operators. The institutional arrangement proposals are set out in Section 5.

**Integrated water resources management-based operations**

The key focus areas for water infrastructure operations, to ensure integrated water resources management (IWRM), is depicted in Figure 0.1 below.
Implementation as a phased approach

At the regional consultation meeting on coordinated operations held in October 2020, the Member Countries agreed to take a **phased approach** to develop the coordinated water infrastructure operation mechanisms for multiple benefits, as follows:

- **Scoping Stage**: This stage commenced in 2020 and was completed in 2021. The opportunities for cooperation on operations and information sharing were explored with Member Countries to consider the mutual benefits of these potential mechanisms. This includes urgent requirements for data and information sharing by Member Countries as a pilot project through existing MRC platforms and procedures to address urgent community safety needs.

- **Stage 1**: LMB Member Countries first concentrate on practical and implementable mechanisms that they can readily and urgently apply, with their resources, especially on flood and drought management, as well as dam and community safety. This stage began in 2022 to develop preliminary operations and communication processes for existing dams and information sharing for water-related emergencies.
Stage 2: LMB Member Countries then broaden the cooperation to reflect more detailed operational requirements, for example, operational needs and community and environmental requirements, taking into account the gender and vulnerability aspects in order to close some gaps remaining from Stage 1 implementation. In addition, this stage will expand in scope to cover new dams and other water infrastructure that may be proposed through the proactive regional planning (PRP) process included in the BDS and SP. Stage 2 is planned for 2023/2024 to develop the operating and communication processes for existing and newly identified dams and other water infrastructure.

1.1 Completion of the Scoping Stage

Deliverable under SP Activity 4.2.1.1

The finalisation and endorsement of this report by the Joint Committee in November 2021 completes the Scoping Stage of this Activity 4.2.1.1 under the SP 2021–2025. This has been achieved through:

a. National Consultations – September – October 2021;
b. Regional Consultation – December 2021;
c. Joint Committee endorsement – November 2021.

As noted in this report, the following next steps are therefore endorsed:

1. **Pilot Project 1**, “Cooperation mechanisms for data and information sharing for existing dams (Integrated operational water infrastructure data available on MRC data portal)”: By Q4 2023 (i.e. SP Activity 4.2.1.2);

2. **Pilot Project 2**, “Information sharing and communication mechanisms for water-related emergencies (Operational coordination and Emergency response in the 3S Basin during the 2022/2023 flood season)”: By Q4 2023 (i.e. SP Activity 4.2.1.4).

Progressing the recommended next steps

Deliverable under SP Activity 4.2.1.2 and 4.2.1.4

In order to refine, prioritize, and advance these collaboration opportunities (Stage 1 by 2022), the following steps are proposed:

1. The water infrastructure operational collaboration opportunities involving alterations to operations (Section 4.2.6) will be further discussed with Member Countries and necessary stakeholders and formulated into prioritized operational scenarios (e.g. for flood and drought mitigation). (Timeline to be confirmed);

2. These operational scenarios are to be shared with the team working on PRP (SP Output 3.1.1) to allow for their inclusion in the operational analysis using the
enhanced operational DSS proposed under the first phase of the PRP. (Timeline to be confirmed);

3. The implications, benefits and impacts of these revised water infrastructure operations options on a range of economic, environmental, and social indicators will be analysed. They will be discussed with Member Countries and relevant stakeholders to ensure understanding of the potential improved operational management outcomes. (Timeline to be confirmed);

4. Agreed collaboration proposals, where clear mutual net benefits for the basin and stakeholders are illustrated, may then be tested and the outcomes reviewed through agreed ongoing operations governance mechanisms;

5. The proposed institutional and governance arrangements documented in this report (Section 5), and documented and tested under the proposed pilot projects (Section 6) will be further enhanced and tested to facilitate cooperation for implementing these revised operational collaboration proposals.

Recommended steps to scope and analyse joint action Opportunities (Stage 2)

*Deliverable under SP Activity 4.2.1.3*

The following implementation steps are proposed:

1. Hold consultations with National Mekong Committees, Expert Group on Basin Planning on the scope of Joint Action Stage 2 cooperation mechanisms and objectives;

2. Based on lessons learned from Collaboration Stage 1 activities, define the scope of additional information sharing required for the PRP;

3. Identify conceptual options for information sharing and coordinated design and operations. This may include, for example:
   - the design and operation of new hydropower storage to combine with flood and/or drought management;
   - the operational coordination of flood/drought management, the transmission of sediment, and other environmental management activities of the new proposed dams and existing hydropower dams; and
   - dialogue and joint research with China and the Upper Mekong River Basin (UMB) operators to assist with the above imperatives.

4. Conduct modelling and an analysis on proposed conceptual options to test economic feasibility and sustainability: – the operational scenarios will be tested alongside, or included in, the proactive regional planning scenarios;

5. Promising opportunities for joint action will be developed through the MRC governance arrangements.
2 INTRODUCTION

Summary of this Chapter

- The Siem Reap Declaration reinforced the MRC Member Countries’ determination to focus on sustainable and coordinated operational management of tributary and mainstream water resources development.
- River flow management, environmental management, management of emergencies, design and management of hydropower cascades are key focus areas for MRC operational coordination.
- This report is the first deliverable under Strategic Plan Output 4.2.1, Coordinated water infrastructure operations for multiple benefits including gender and vulnerability sensitive disaster mitigation and management, which aims to be delivered by 2021.

2.1 Purpose of this report

This report sets out to scope opportunities and benefits of cooperation on water infrastructure operations in the Mekong Basin. The opportunities for coordinated operations cover a wide range of issues but are focused on those needs raised by Member Countries in the development of the Basin Development Strategy (BDS) 2021–2030 and included in the MRC Strategic Plan 2021–2025. These main areas of concern are:

- Efficient and effective (reasonable and equitable) use of the resource through coordinated operations and management of river flows;
- Mitigation of the environmental impacts of the water infrastructure;
- Impact of water infrastructure operations on river basin communities including gender and vulnerability-sensitive disaster mitigation and emergency management; and
- Adaptation of operations to mitigate floods and droughts, and the effects of climate change.

Cooperation for the operation of water infrastructure in transboundary river basins can take many forms. These may range from the sharing of information on operations only to the joint investment in infrastructure for basin-scale benefits. Examples of international experiences are summarized in this report to illustrate the opportunities for coordinated water infrastructure operations along this ‘cooperation continuum’.

The report also seeks to clarify the link between this activity and related BDS and SP activities focusing on proactive regional planning (PRP) and the invigoration of the MRC data and modelling systems to “better inform and prepare basin communities of changing river conditions, and more frequent and severe floods and droughts”.

Ultimately, the document will explore and report on opportunities for coordinated operating rules and governance arrangements on dam operations as well as provide recommendations on the next steps for further implementation in line with SP output 4.2.1.

2.2 Need for operational coordination for integrated water resources management

Current and future hydropower development

MRC studies and regional and international research recommend that basin-wide cooperation, integrated planning, development, and management are essential to achieve basin scale sustainable development for the Mekong Basin. This is also highlighted in the Siem Reap Declaration adopted by Prime Ministers of the MRC Member Countries on 5 April 2018: *The increasing development in the mainstream and tributaries highlight the increasing need for the sustainability and coordinated operational management of tributary and mainstream water resources development projects.*

Figure 1.1 shows the extent of existing and planned hydropower development across the Mekong Basin. Major hydropower storage developments in the Upper Mekong Basin (UMB)/Lancang are known to have a marked effect on the seasonal distribution of flows with increased dry season flows and reduced wet season peaks, which has benefits and impacts. Downstream hydropower operators in northern Lao PDR may experience increased production in the dry season. However, lower down the basin, with the addition of multiple, smaller storages in the Lower Mekong Basin (LMB), this alteration of the seasonal pattern reduces the inflows and outflows from Tonle Sap, with substantial impacts on fisheries. Sediment flows down the Mekong have been reduced by 50–80%.
Figure 1.1. Map of existing and planned hydropower projects

Source: BDS 2021–2030
The trends in hydropower development have accelerated in recent years. Figure 1.2 indicates the trends in the Greater Mekong Basin.

![Figure 1.2. Trends in hydropower development in the Mekong Basin](image)

Source: BDS 2021–2030

The developments within the Mekong system contain an increasing number of tightly linked cascades of dams. This linkage has a number of positive and negative consequences. As noted above, if upstream projects have substantial storage, then there is the possibility for a coordinated operation where downstream projects benefit from managed seasonal flows and therefore increased production. As shown below, with regard to the dams in northern Lao PDR, the mainstream cascade from Pak Beng to Sanakham may benefit from storage operation, both in the UMB/Lancang and in the Nam Ou as a major tributary. However, this also requires a degree of cooperation in the timing and quantity of releases, which are more difficult when projects are owned by different developers/operators who may sell to markets and customers with different demand patterns.
Benefits and impacts of hydropower development

As it has been shown through the PNPCA process for the northern Lao dams, there is a range of environmental impacts associated with this cascade of dams. In addition to the efficient and effective use of the water resource for power production, cooperation is essential to assist in the mitigation of these impacts. For example, the transmission of sediments, trapped in the reservoirs, will require seasonal flushing (MRC, 2018b). Studies have shown that coordinated flushing across multiple seasons will be needed to effectively transmit flushed sediments and preserve the river channel and delta downstream.
Navigation has been enabled through these mainstream dams. In order for the economic value of this navigation infrastructure to be realized, communication and clear operational protocols\(^1\) are needed.

Moreover, management of floods and emergencies in populated areas will also need close coordination to ensure safety and minimize the risk of further detrimental incidents, especially the recent safety incidents and dam breaches in Lao PDR. This issue is important, for example for the Xe Kong sub-basin where flooding and planned cascade operations are under investigation.

### 2.3 Basin Development Strategy 2021–2030: Moving from planning toward operational management

The approved Basin Development Strategy (BDS) 2021–2030 emphasizes a shift towards operational management options, noting that:

> the basin countries, with their partners as appropriate, will finance and manage the resulting redesigned network of monitoring and sampling locations, and collect the data according to agreed protocols and methodologies and share those with regional water actors for regional flood/drought forecasting and coordination of transboundary flow management, sediment management, management of hydropower cascades, and emergency situations in accordance with agreed Procedures.

The BDS has emphasized that, with the increased development of hydropower on the tributaries and mainstream, a higher level of cooperation and coordination on hydropower operation will be needed to address integrated water resource management (IWRM) needs. These IWRM challenges will increasingly involve technical, environmental, financial, and economic aspects.

According to the BDS 2021–2030, as the Mekong River Basin becomes more developed and regulated by dams and other infrastructures, as well as susceptible to more extreme weather events due to climate change, there is increasing need for more data and information sharing and transboundary coordination of operations regarding the following:

- River flow management:
  - There is need to design and operate water storages to manage the overall Mekong flow volume for equitable socio-economic development, environmental flow needs, and mitigation of floods and droughts.
  - This requires the sharing of information on irrigation and domestic supply abstractions and hydropower reservoir inflows and operations.
  - Coordinated design and operation of water infrastructure is needed.

\(^1\) Protocols in this report refers to both processes designed to facilitate sharing of information and agreed governance arrangements for cooperation and decision making.
- Sediment management:
  - There is need to mitigate of the consequences of diminished sediment concentrations on the river’s morphology, riverbank erosion, delta building processes, and the productivity of coastal waters.
  - This requires monitoring and information sharing to improve sediment transmission through dams, and to manage sediment extraction and riverbank erosion.

- Management of emergencies:
  - These emergencies include water quality (e.g. chemical spills) and water quantity (e.g. extreme floods, spillway gate operation, or an equipment or structural failure of a dam, droughts).
  - This requires communication mechanisms followed by coordination of the emergency response, based on national practices and available regional guidelines.
  - This requires a gender- and vulnerability-responsive approach.

- Design and management of hydropower cascades:
  - There is a need for the coordinated design and operation of cascading hydropower dams in order to improve the benefits and lower the costs of the full utilization of the water resource, which includes the safe passing of flood waves and flushed sediments through cascades.
  - This requires transboundary coordination to support the implementation of existing design guidelines, which relate to, inter alia, fish passages, navigation facilities, dam quality and safety. This also requires accurate and timely information sharing among the cascading plants in place for smooth cascade operations as well as transboundary emergency situations.

The BDS further notes that the responsibility for the above operations for basin management rests with the designated agencies in the individual basin countries. However, since Mekong River is an international river governed by the 1995 Mekong Agreement, the basin countries have agreed to cooperate not just in the development, but also in the operations and management of water and related resources.

It should be noted that this work is embedded in SP Strategic Priority 4. The outputs and activities of this Strategic Priority will need to be closely linked to deliver effective outcomes for the MRC Member Countries.
### Table 1.1. Basin Development Strategy /Strategic Plan Strategic Priority 4

<table>
<thead>
<tr>
<th>Outcomes</th>
<th>Outputs</th>
<th>Contribution to other outcomes</th>
</tr>
</thead>
</table>
| 4.1 Better informed and prepared basin communities against changing river conditions, and more frequent and severe floods and droughts | 4.1.1 A core river monitoring network for the mainstream and remaining national river monitoring networks is consolidated  
4.1.2 Integrated data and information systems for more effective basin-wide data management and sharing are in place  
4.1.3 Compatible decision support systems building on reinvigorated data, modelling, forecasting, and communication capabilities are set up  
4.1.4 Integrated basin-wide flood and drought forecasting and early warning are operational  
4.1.5 The Joint State of Basin Report is produced. | Outcome 1.1, 1.2, 1.3  
Outcome 2.1, 2.2  
Outcome 3.1, 3.2  
Outcome 4.2 |
| 4.2 Better disaster management and adaptation to water resources development and climate risks | 4.2.1 Coordinated water infrastructure operations are implemented for multiple benefits, including gender- and vulnerability-sensitive disaster mitigation and management  
4.2.2 Climate change adaptation and flood and drought management are mainstreamed at the national levels | Outcome 1.1, 1.2, 1.3  
Outcome 2.1, 2.2  
Outcome 4.1  
Outcome 5.2 |

### The Sustainable Hydropower Development Strategy

The Sustainable Hydropower Development Strategy (SHDS), approved at the end of 2021, focused on how best to manage these major economic, environmental, and social considerations associated with the intense hydropower development in the Mekong.

MRC studies and regional and international research indicate that basin-wide cooperation, integrated development planning, development, and management are essential to achieve basin-scale sustainable development and are critical for the Mekong Basin.

Building on prior technical works carried out by MRC at the regional level, the SHDS 2021 has the following aims:

- **Enhance transboundary benefits.** Enhancing benefits entails looking for opportunities to increase the range of services and the value of services offered by hydropower and by exploring multi-sector development options;

- **Minimize adverse transboundary impacts.** Minimizing adverse impacts entails adopting some form of mitigation measures. The MRC has previously established the guiding principles for mitigation as being *avoid, minimize and mitigate harmful*
effects” (Mekong Agreement Article 7) and cease substantial damage, and to assume state responsibility for substantial damage (Mekong Agreement, Articles 7 and 8).

During the process for the update for BDS 2021–2030 and Strategic Plan 2021–2025, the SHDS provided major inputs regarding sustainable hydropower development and management in LMB. This includes its strategic priority: “Enhanced Cooperation on processes for operational coordination and management of HP cascades”, which is being delivered through the BDS 2021–2030 and the SP 2021–2025 under Outcome 4.2 and Output 4.2.1, as shown in Table 1.2.

Table 1.2. Basin Development Strategy 2021–2030 and Strategic Plan 2021–2025 under Outcome 4.2

<table>
<thead>
<tr>
<th>BDS Strategic Priority 4: Strengthen resilience against climate risks, extreme floods, and droughts</th>
<th>BDS Outcome 4.2: Better disaster management and adaptation to water resources development and climate risks</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Output 4.2.1:</strong> Coordinated water infrastructure operations for multiple benefits, including gender- and vulnerability-sensitive disaster mitigation and management</td>
<td></td>
</tr>
<tr>
<td><strong>MRC SP Deliverables</strong></td>
<td></td>
</tr>
<tr>
<td>▪ Report on opportunities for coordinated operating rules and governance arrangements on dam operations (2021)</td>
<td></td>
</tr>
<tr>
<td>▪ Cooperation mechanisms for data and information sharing for existing dams (2022/2023)</td>
<td></td>
</tr>
<tr>
<td>▪ Information sharing and communication mechanisms for water-related emergencies (2022/2023)</td>
<td></td>
</tr>
<tr>
<td>▪ Cooperation mechanisms for data and information sharing for existing and newly identified dams and other water infrastructure (2024).</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>MRC SP Activities</th>
<th>Lead</th>
<th>Related to Outputs</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.2.1.1 Continue the review of existing dam operating rules and governance arrangements, and identify opportunities for coordinated flow management to increase efficiency, reduce impacts and help mitigate floods and droughts</td>
<td>PD</td>
<td>All activities implemented in conjunction with outputs 3.1.1, 3.2.2</td>
</tr>
<tr>
<td>4.2.1.2 Develop and implement cooperation mechanisms for data and information sharing for existing dam operations (linked to Joint Action Plans) to optimize regional benefits and minimize regional costs</td>
<td>PD</td>
<td></td>
</tr>
<tr>
<td>4.2.1.3 Develop and implement cooperation mechanisms for data and information sharing for new dams and other water infrastructure to optimize regional benefits and minimize regional costs</td>
<td>PD and TD-RFDMC</td>
<td></td>
</tr>
<tr>
<td>4.2.1.4 Develop and implement information sharing and communication mechanisms (including consideration of gender and vulnerability) for water-related emergencies including water quality, navigation and dam safety</td>
<td>OCEO NIPS (PD)</td>
<td></td>
</tr>
</tbody>
</table>
2.4 Linked Basin Development Strategy and Strategic Plan activities

As noted in the BDS 2021–2030 and the SP 2021–2025, there are numerous linkages between outputs and activities. The main linkages are shown in Figure 1.4.

Figure 1.4. Linkages to relevant BDS and /SP activities

**Strategic Priority 1: Maintain the ecological function of the Mekong River Basin**

Operational protocols\(^2\) will need to be designed to ensure that the outcomes envisaged under this SP can be delivered. The information shared under these mechanisms must allow to assess the basin indicators to issue notifications under the Procedures for Water Quality (PWQ) and the PMFM. Operating protocols should be aimed at the adaptive management of the operations of water infrastructure in order to improve water quality, sediment transport, and fisheries outcomes. The thresholds and guidance being investigated through the activities under this SP will need to be practically achievable through these operational protocols and within project commercial constraints.

---

\(^2\) Protocols in this report refers to both processes designed to facilitate sharing of information as well as governance arrangements for cooperation and decision making.
Strategic Priority 2: Enable inclusive access and utilization of the basin’s water and related resources

The outcomes for communities living upstream and downstream of the water infrastructure should be enhanced through information sharing on changes to water levels, floods and/or water quality emergencies. Operational coordination protocols should reduce risks to these communities, and wherever possible, facilitate water, food and energy security.

Strategic Priority 3: Enhance optimal and sustainable development of water and related sectors

PRP is a major strategic initiative being advanced by the MRC BDS. The aim is to seek opportunities where Member Countries may be able to improve their desired national development goals while also enhancing the basin and regional development outcomes. The scenarios to be assessed under the related activities will include operational scenarios that may be proposed within Output 4.2.1 on operational protocols. These scenarios may include opportunities for flood and drought management through alternative operational protocols and transboundary coordination of water infrastructure operations for increased net benefits of Member Countries. In addition, opportunities for the development of new, perhaps jointly owned, infrastructure will be explored. The operations of these new infrastructure will need to be coordinated with existing hydropower infrastructure to ensure economic outcomes and basin-scale outcomes for all parties.

Strategic Priority 4: Strengthen resilience against climate risks, extreme floods, and droughts

A key outcome and set of activities within this SP are associated with the Outcome 4.1, Better informed and prepared basin communities against changing river conditions, and more frequent and severe floods and droughts. The establishment and enhancement of the core river monitoring network and the associated reinvigoration of the information systems to manage and share this information are tightly linked to the Output 4.2.1 discussed here. These enhanced systems will facilitate the information sharing needed for the coordinated operational protocols being developed.

Strategic Priority 5: Strengthen cooperation among all basin countries and stakeholders

An important element of this SP is the need for the implementation of enhanced MRC Procedures and associated Technical Guidelines to assist in the implementation of these operational protocols. The implementation of the PDIES, the PMFM, the PNPCA and the PWQ will all be vital for successful coordinated operations. In addition, the cooperation with dialogue partners and particularly the Mekong Lancang Cooperation will be important. The linkages to other regional multilateral organizations, such as those associated with the Greater Mekong Subregion (GMS), will also assist in a coherent and consistent regional approach.
2.5 Implementation Plan for the BDS 2021–2030 and MRC SP 2021–2025 under Output 4.2.1

This Plan was presented to National Mekong Committees at the Regional Consultation on 16 October 2020. It covers the overall scope of the work needed to achieve the deliverables within this output.

The meeting agreed to take a **phased approach** as follows:

- **Scoping Stage:** This stage was commenced in 2020 and finalized in 2021. The opportunities for cooperation on operations and information sharing are explored with Member Countries to consider the mutual benefits of these potential mechanisms. A proposed pilot project seeks to implement for data and information sharing by Member Countries through the MRC platforms and procedures in place to address urgent community safety needs. By 2021, the report on experiences and opportunities for coordinated operating rules and cooperation arrangements on dam operations had been finalized.

- **Stage 1:** Concentrate on practical and implementable mechanisms that can readily and urgently be applied within the resources of the LMB Member Countries, especially on flood and drought management, as well as dam and community safety. This stage will start from 2022 to develop cooperation for data and information sharing mechanisms for existing dams as well as information sharing and communication mechanisms for water-related emergencies.

- **Stage 2:** Broaden the mechanisms and content to reflect more detailed operational requirements for example operational needs, and community and environmental requirements taken into account the gender and vulnerability aspects in order to close some gaps that remained from Stage 1 implementation. In addition, this stage will expand to new dams and other water infrastructures to also support PRP purpose. This stage is planned for 2023/2024 in order to develop the cooperation mechanisms for data and information sharing for existing and newly identified dams and other water infrastructure.

Finally, this Output 4.2.1 will gather relevant information and inform the scope of necessary decision support tools that will be needed to support the cascade operational management. To achieve the Output 4.2.1, the MRC will need to ensure strong support from Member Countries and stakeholders. The proposed approach will therefore be as follows:

1. Gather reference material from existing research and experience both locally and globally;

2. Consult widely on existing and proposed formal and informal mechanisms for communication and operation of the hydropower plant (HPP) cascades in the Mekong;
3. Document and agree on the key priority cascade management requirements based on discussions with key governments, developers, communities and wider basin and energy market stakeholders;

4. Set out and plan to implementation take up priority actions.

### 2.6 Outline of the report

Following the introduction in Chapter 1, this report consists in the following chapters:

- **Chapter 2: The Cooperation Continuum: Regional and international experience.** This chapter outlines the benefits of cooperation on water infrastructure operations and describes a “cooperation continuum” for integrated water resources management (IWRM). International and regional experience is described with lessons learned for application in the Mekong. The ongoing efforts and initiatives within the MRC are also set out and show the progress already made towards cooperation on operations.

- **Chapter 3: Conceptual Framework for Considering Opportunities.** This chapter outlines a conceptual framework within which to consider opportunities for cooperation on water infrastructure operations. The priority areas for cooperation are described, and a matrix of opportunities, along the cooperation continuum, is provided for discussion.

- **Chapter 4: Scoping the Opportunities.** This chapter presents the core opportunities for cooperation in more detail, particularly regarding coordination through information sharing. Initial frameworks for determining information required for operational coordination are proposed. In addition, some detail is provided on the scope of opportunities for collaborating on adapted operations for regional benefits. A broad scope for joint action is described for further analysis under the PRP.

- **Chapter 5: Pilot Projects.** This chapter will present an outline of possible pilot projects that Member Countries may deem urgent to implement regarding hydropower information sharing and emergency response.

- **Chapter 6: Conclusions, Recommendations and Next Steps.** This chapter summarizes the key conclusions from the scoping stage, sets out recommendations for advancing to the next stages of the work.
3 Regional and international experience

3.1 Benefits of cooperation

Summary of this chapter

- The benefits arising from cooperation on water infrastructure operations can lead to reduced impact on the river and increased value from the resource.
- As cooperation deepens, further benefits arise through reduced geo-political risk and improved regional energy and food security.
- International experience provides evidence of these benefits and indicates that the 1995 Mekong Agreement and the MRC Procedures are a sound foundation for basin-scale operational coordination.
- The international experience also finds that specific dedicated agency for operations management is valuable.
- Existing MRC and regional initiatives supporting operational management provide a valuable starting point as the MRC moves towards operational management.

There are a wide range of benefits that arise from cooperation in transboundary river basins. MRC Member Countries are well aware of them and have continued, since the 1995 Mekong Agreement, to work together on shared river basin challenges. The cooperation around water infrastructure operation extends the more traditional cooperation on basins planning and assessments.

3.1.1 Types of benefits

Table 2.1, which is adapted from Sadoff and Grey (2002), sets out the types of benefits that may arise from this cooperation around water infrastructure operations in the Mekong Basin context.

<table>
<thead>
<tr>
<th>Type of benefit</th>
<th>Operational challenges (issues to be addressed)</th>
<th>The opportunities from cooperation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type 1: Increasing benefits to the river</td>
<td>Sediment trapping, changed seasonal flow regime, water quality degradation, and degraded biodiversity and ecosystems</td>
<td>Coordinated sediment flushing, maintenance of minimum flows (Procedures for the Maintenance of Flow on the Mainstream), consistent environmental flows and fish passage operations</td>
</tr>
<tr>
<td>Type of benefit</td>
<td>Operational challenges (issues to be addressed)</td>
<td>The opportunities from cooperation</td>
</tr>
<tr>
<td>----------------</td>
<td>-------------------------------------------------</td>
<td>----------------------------------</td>
</tr>
<tr>
<td>Type 2: Increasing benefits from the river</td>
<td>Sub-optimal water resources management, inefficient energy generation, community safety risks, and flood and drought risks</td>
<td>Efficient resource utilization, cost effective energy security, transboundary flood and drought risk management, cooperative emergency, and disaster management</td>
</tr>
<tr>
<td>Type 3: Reducing costs because of the river</td>
<td>Perceptions of unreasonable and inequitable use of the resource, tensions over dam break, and slower socio-economic development</td>
<td>Resolution of operational trade-offs, reduced economic and geo-political risk, regional food and energy security</td>
</tr>
<tr>
<td>Type 4: Increased benefits beyond the river</td>
<td>Unilateral action by Member Countries and fragile alliances</td>
<td>Integration of regional infrastructure, markets, and trade</td>
</tr>
</tbody>
</table>

Source: Adapted from Sadoff and Grey (2002)

3.1.2 The cooperation continuum

In addition, Sadoff and Grey also proposed a useful “cooperation continuum” concept, where increased cooperation leads to wider (Type 3 and 4) benefits. The Member Countries of any river basin organization will take the approach and level of cooperation that best suits their shared goals. It is never possible to directly apply the experience from other basins; the Mekong will have specific requirements that the Member Countries will need to confront. Figure 2.1 illustrates the increasing level of cooperation. Definitions of the different levels of cooperation (i.e. unilateral, coordination, collaboration and joint action) are provided in Annex 1.

For the MRC, ‘coordination’ currently includes communication and notification (e.g. Procedures for Notification, Prior Consultation and Agreement, or PNPCA), information sharing (e.g. PDIES on flood forecasting, water data, hydropower database, etc.), and assessment (e.g. the State of Basin Report, Basin Development Plan Scenario Assessment). The opportunities described in this report include recommendations to strengthen this area of information sharing with respect to water infrastructure operations.
For some time, the MRC has been proposing to move cooperation on Mekong water infrastructure operations beyond “coordination” towards “collaboration”, where national plans and operations are adapted to reap regional benefits and reduce regional costs. The BDP/SP proposes a substantial assessment towards PRP, where the costs and benefits of potential alternative regional plans can be considered by the Member Countries.

This report is focused on exploring opportunities for coordination and collaboration on water infrastructure operations to adapt these operations for additional benefits and to reduce costs. In addition, concepts associated with joint action on operations are scoped. These concepts will be further investigated through the PRP assessment as a part of SP 2021–2025.

3.2 International examples – lessons learned from international case studies

There are a number of useful examples of cooperation on water infrastructure operations from international river basins that can be taken into account in Mekong River context. These experiences go across the cooperation continuum and are specific to the particular basins and the river basin organizations. GIZ (2012) carried out research on global practices in managing the development and operation of hydropower in shared river basins. The case studies covered a wide range of different examples and highlighted both the success and challenges associated with these schemes. A summary of the key findings is shown below. More detail and additional case studies are included in Annex 2.

3.2.1 Basin-wide institutions for co-ordinated hydro-power development and management

The case studies clearly show that coordinated planning and operation of multiple hydropower schemes are essential in order to achieve a combination of optimal hydropower
output in the whole basin (rather than for individual projects) and requirements for environmental and social mitigation. The Columbia River Basin case study also provides evidence that it is possible to synchronize the operation of dams for dam safety, hydropower generation, flood and drought management, as well as to meet social and environmental needs. Transparency and trust on all sides are necessary to accomplish such a complex task. Institutions covering large parts, or at best, the entirety of the river basin, provide essential frameworks for cooperation. Where basin-wide institutions do not exist or are ineffective, arrangements with affected states that are not directly involved in the project can be of additional value for regional hydro management:

- **Canada and the United States of America** established the International Joint Commission in 1909 in order to address the increasing economic development of the border rivers. The Commission could later be drawn on in order to negotiate the coordinated development of dams in the Columbia River Treaty;

- In the **Senegal River Basin**, the Senegal River Basin Development Organization (OMVS), was created before any dams were planned. Therefore, when planning began, a functioning organization was in place that could coordinate basin management for irrigation, hydropower production, and navigation; however, the navigation component was never developed. Due to the coordinated management from the start, conflicts between the Member Countries arising from water use could be avoided;

- In the **Parana Basin**, where there is no basin institution, Brazil and Paraguay had to conclude a separate agreement with Argentina in order to determine the minimum water levels that are discharged from the Itaipu reservoir to allow hydropower production at the Yacyreta Dam, which is located downstream from Itaipu on the border between Argentina and Paraguay;

- In the **Zambezi River Basin**, there was no basin institution until the formation of an interim secretariat of the river basin organization in May 2011, the Southern African Development Community (SADC) Water Protocol functioned as a substitute; however, it proved to be of limited effectiveness. One factor that explains why the SADC Water Protocol failed to be effective is the continuing lack of trust between Zambia and Zimbabwe, as well as the use of the SADC Water Protocol by Zimbabwe as a foreign policy tool;

- In the case of **Kosi (Nepal/India)**, a lack of trust between the two riparian countries prevented the generation of maximum benefits from the development of the river, despite the existence of joint institutions.

### 3.2.2 Specific agency for dam operations

Frequent consultation between riparian countries is necessary for decision-making in day-to-day dam operations as well as to flexibly respond to upcoming management challenges (e.g. floods and drought). Designating or creating a specified agency for dam operations management can facilitate day-to-day cooperation in dam operation. Where there are basin-level organizations, agencies mandated with dam operations management are regularly established as subordinate bodies.
The case studies show that an entity to manage the dam was created in cases where dams are located on national borders or where dams are co-owned, co-financed or built with compensation and benefit-sharing mechanisms. This holds true for dams located in the sovereign territory of a country and for dams located on the border between two countries as follows:

- Dams located in sovereign countries:
  - The dams built in accordance with the Columbia River Treaty are located in national territories. Here, a joint commission and national entities act as the keepers of the treaty and continuously coordinate dam management;
  - With regards to the Manantali Dam located in Mali, the member states of the river basin organization created a co-owned company to manage the co-financed and co-owned dam.

- Dams located on national borders:
  - Brazil and Paraguay created the co-owned company Itaipu Binacional in order to manage the co-financed Itaipu Dam;
  - The Zambezi River Authority, a bi-national, quasi-government institution, manages the co-owned Kariba Dam.

### 3.3 Regional implications for the Mekong

Due to the large number of dams proposed in the Lower Mekong, coordination of these projects is necessary in order to ensure dam safety, optimal hydropower generation, and flood and drought management, as well as meet social and environmental needs. To this end, the MRC provides a suitable framework. Although the entirety of the Mekong Basin is not covered by a basin organization, cooperation with China, which is already an MRC Dialogue Partner, has been enhanced through significant, recent discussions on sharing of information with the Lancang-Mekong Cooperation (LMC).

In the LMB, if decisions are made by the riparian nations for the coordinated operation of hydropower or other water resources management projects, then sub-institutions or agreements under the framework of the MRC may be established to facilitate operations management for specific dams or cascades of dams. This may be applicable particularly to projects that may be built as part of a cost-benefit sharing mechanism, and/or where dams are located on a shared national border, for example, on the Mekong along the Lao-Thai border. These sub-institutions or agreements would need to be in line with the 1995 Mekong Agreement, and should be limited to dam- or cascade-specific issues to prevent overlap with the mandate of the MRC. A recent example of a sub-institution is the Navigation Facilitation Committee between Cambodia and Viet Nam.
3.4 Ongoing MRC efforts for coordinated water infrastructure operations

3.4.1 The aim of the 1995 Mekong Agreement and Procedures

In a recent draft working paper presented to the Joint Platform in September 2020, the MRC emphasized that the aim of 1995 Mekong Agreement and Procedures (MRC, 2020) was to address the operational aspects of basin management.

The draft working paper highlights that, in Article 6 of the 1995 Mekong Agreement, the MRC Member Countries have agreed:

To cooperate in the maintenance of the flows on the mainstream from diversions, storage releases, or other actions of a permanent nature; except in the cases of historically severe droughts and/or floods:

A. of not less than the acceptable minimum monthly natural flow during each month of the dry season;

B. to enable the acceptable natural reverse flow of the Tonle Sap to take place during the wet season; and

C. to prevent average daily peak flows greater than what naturally occur on the average during the flood season.

The wording of Article 6 implies the intention to proactively manage flows on the mainstream, by releases from storage and by reducing diversions.

The draft working paper also notes that Technical Guidelines for the PMFM (TG-PMFM) have interpreted the ‘natural condition’ based on a statistical analysis of the flows from 1986 to 2000. The TG-PMFM propose that the mainstream flows should not decrease to less than the 5th percentile of these historical flows. Similarly, the total wet season reverse flow volume between June and November should be within the 90% confidence limits around the ‘natural condition’. The Technical Guidelines also propose these minimum flows both for planning and monitoring.

The draft working paper indicates that according to Article 6 of the 1995 Mekong Agreement, Member Countries will cooperate on:

- the upstream development and management of storage and irrigation that may compromise existing uses of water, or the environmental flows required by the Tonle Sap system;

- the prevention of any increased flooding due to releases from storage:

However, the Member Countries accept that in force majeure situations (severe drought and floods) active management of flows within acceptable limits may not be possible.
The draft working paper highlights a number of important challenges that need to be dealt with when applying Article 6 and the PMFM and PWUM Procedures as follows:

*The PMFM and PWUM are therefore not well-suited to operational management of floods and droughts. The Mekong River Commission Secretariat is therefore proposing a re-examination of the PMFM thresholds so that they can support operational management. This process will have to be underpinned by agreed water policies or principles if it is to avoid the same pitfalls as the existing Technical Guidelines.*

**Note:** The working paper referred to above remains under discussion. The PMFM and TG-PMFM are also under continued discussion and review, and are not fully agreed by all Member Countries. Due to the effects of the rapidly increasing development of water infrastructure in the basin, the PMFM targets need review and adaptation to the new conditions. The above issues are to be dealt with under a number of relevant activities under the SP 2021–2025 (Activity 1.1.1.1) in parallel with the activities contained in this paper.

### 3.4.2 Statement on operational rules that emerged from the PNPCA process for mainstream dams

Five mainstream dams have undergone the PNPCA process with Member Countries (Xayabury, Don Sahong, Pak Beng, Pak Lay, Luang Prabang). One additional dam (Sanakham) is currently under consultation. Following consultation, outstanding concerns of Member Countries are contained in an agreed Statement and a Joint Action Plan for Pak Beng, Pak Lay, and Luang Prabang projects. Each Joint Action Plan has included the requirement for cascade operating rules and cooperative operations in some form to be developed. These cascade operating rules cover the key areas to be developed under this activity. Extracts from the agreed Statements are shown below. In each case, these rules are formulated in a manner that “respects the sovereign decision-making of the Government of Lao PDR and balance the financial viability of the upper Lao Cascade HPPs, while making every effort to minimize the risk of potential transboundary adverse impacts.”

**Extract from Luang Prabang’s Prior Consultation Statement**

The Joint Committee of the MRC:

V. Requests the Government of Lao PDR to work with the MRC in the development of cascade operating rules that respects the sovereign decision making of the Government of Lao PDR and balance the financial viability of the upper Lao Cascade HPPs while making every effort to minimize the risk of potential transboundary adverse impacts. This should aim to identify measures that address, inter alia:

- a. The regular flushing of coarse-grained sediments through the impoundments by adjusting the operating rules.
- b. The routing of sediments through the impoundments during natural flood events.
c. **The downstream drift of aquatic species larvae and eggs during critical migration periods.**

d. **The potential impacts of extreme flood and drought events in line with the provisions of the Procedures for the Maintenance of Flows on the Mainstream (PMFM).**

e. **The risks of multiple failure of infrastructure on the upper mainstream.**

f. **Early warning of rapid increases in inflows and large water releases to the downstream HPPs and affected communities, the MRC Secretariat and downstream countries.**

g. **The preservation of any remaining free-flowing habitats between the proposed Sanakham HPP and Chiang Saen of Thailand.**

h. **The provision for a River Information System to improve the safety of navigation and reduce the waiting times for shipping at the navigation facilities.”**

**Extract from the Pak Lay’s Prior Consultation Statement:**

1. **Addressing the impacts of the changed hydrology by:**
   - Introducing the operating rules curve to accommodate requirements of flow management as Article 6 of the 1995 Mekong Agreement, cascade optimization and no significant harm to the downstream, that is aligning with Xayaburi HPP, and other potential mainstream HPPs to improve sediment flushing and downstream larval drift; and
   - Ensuring environmental flows for the area immediately downstream of the dam site.

2. **Increasing the transport of sediment through the head pond by considering:**
   - Optimizing sediment-related design to improve the sediment delivery efficiency of the PLHPP, including effective flushing gates and mechanical delivery method;
   - Considering the measures to minimize and mitigate the potential impacts of sediment deposition in the headpond/in-channel storage;
   - Reviewing the sediment management strategy to pass sediment more frequently, such as on a seasonal or annual basis; and
   - Coordinating water management and sediment management operations at the PLHPP with other hydropower projects of the cascade to minimize adverse impacts of flood and drought downstream, and optimize power supply.

**Extract from the Pak Beng’s Prior Consultation Statement**

1. **Address potential effects to upstream and downstream hydraulics and hydrology:**
   - Undertaking, in cooperation with Thailand, further flood modelling to map areas and infrastructure in Thailand that may be inundated, under a range of operating rules, and a range of tributary inflows;
   - Indicating the frequency at which this inundation may occur;
c. Applying proper operation rules and coordination to minimize the impacts on flows both local and transboundary nature; and

d. Using the outcomes of these analyses to inform the Parties for development of monitoring activities and the design and operations of the PBHPP.

2. Improve the sediment transport through the headpond/in-channel storage and water management by:

   e. Optimising sediment-related design to improve the sediment delivery efficiency of the PBHPP, including effective flushing gates and mechanical delivery method;

   f. Considering the measures to minimize and mitigate the potential impacts of sediment deposition in the headpond/in-channel storage;

   g. Creating near pre-dam hydraulic conditions at the dam site during higher inflow conditions;

   h. Reviewing the sediment management strategy to pass sediment more frequently, such as on a seasonal or annual basis, and not only when flow levels exceed 5,961 m\(^3\)/s;

   i. Coordinating sediment management operations at the PBHPP with other hydropower projects in the region to minimize adverse impacts and optimize power supply; and

   j. Coordinating water management operations at the PBHPP with other hydropower projects in the region to minimize adverse impacts for flood and drought downstream.

3.4.3 The Procedures for Data and Information Exchange and Sharing

The objectives of the PDIES\(^3\) are as follows:

- Operationalize the data and information exchange among the four MRC Member Countries.

- Provide, upon request, basic data and information for public access as determined by the National Mekong Committees concerned.

- Promote understanding and cooperation among the MRC Member Countries in a constructive and mutually beneficial manner to ensure the sustainable development of the Mekong River Basin.

The principles and scope of the PDIES is appropriate for all information likely to be necessary for cooperation on water infrastructure operations. The PDIES has been used for numerous planning and flood management exercises, and lessons learned will be taken in consideration when deploying the PDIES in gathering the required information. If necessary, further guidelines for implementing the PDIES for sharing daily and weekly operational data will be

---

\(^3\) See the MRC Data Portal for more detail: https://portal.mrcmekong.org/procedure/pdies-overview
drafted to facilitate coordination. These operational data are not currently shared between Member Countries, although some countries have public web access to some relevant data.

3.4.4 Cascade operation in the Preliminary Design Guidance 2009

The Preliminary Design Guidance (PDG) 2009 highlights the importance of cascade operations for the Lower Mekong HPPs in several aspects, for example:

- Under section 1, “Purpose of the Guidance”, Clause 11: “Similarly, a consistent approach to the safety of individual dams and any cascade as a whole is of paramount importance.”

- Several places under section 4.1.3, “Management sediment in a cascade of dams”, e.g. PDG para. 116, “…The sediment management regime needs to be coordinated for any cascade of dams”.

- Several paragraphs under section 5, “Water Quality and Aquatic Ecology”:
  - PDG para. 158, “…the agreed upon flow regime is being provided, in this case recognizing the run-of river nature of the mainstream projects, the fact there may be peaking operation and taking into account the position of the dam in the potential cascade”.
  - PDG para. 162, “Developers should consider the impact of the dam and operating policies of any cascade on the 1995 Mekong Agreement as regard to water levels.”
  - PDG para. 168, “Developers should systematically assess the effect of combination of flow releases from the dam to address downstream impacts at different times of the year, also taking into account the position of the dam in the possible cascade series of dams.”

- Several paragraphs under topic 6, “Safety of Dams”:
  - PDG para. 176, “Dam safety is of paramount importance for the individual dams proposed on the mainstream of the Lower Mekong Basin, as well as the safety of any cascade as a whole.”
  - PDG para. 185, “A further consideration is dam break analysis of the proposed cascade of dams should be prepared and coordinated through concerned line agencies and the MRCS.”

3.4.5 Cascade operation in the updated Preliminary Design Guidance 2022

Based on lessons learned during past Prior Consultation processes and built on the PDG 2009 cascade operation concept, the draft updated PDG (updated between 2017 and 2022) highlights and strengthens the need for a common framework, expressed as Cascade Joint Operating Rules, to be developed by one or more Member Countries (and/or the MRC) hosting the projects in the cascade. This would be achieved in consultation with Member Countries and stakeholders that may be impacted by the operations of the cascade, as shown in Figure 2.2.
This implementation Plan for SP Output 4.2.1 aims to build the governance and technical framework to assist Member Country stakeholders in developing meaningful operational mechanisms, as promoted under the 2022.

3.4.6 The MRC and Lancang Mekong Water Resources Cooperation Centre

The broadening of transboundary coordination of these basin management operations will be explored for the Lower Mekong by the MRC and its Member Countries, as well as for the entire Mekong by the MRC and MLC Water, with technical support from the Mekong River Commission Secretariat (MRCS) and Lancang Mekong Water Resources Cooperation Centre (LMC Water Centre, under the recently agreed Memorandum of Understanding (MoU). Both organizations consider the management of flood and droughts, and information sharing as their core activities. They will build on ongoing activities between the MRC and China on data and information sharing, technical exchanges, and joint research on unusual and extreme flow conditions.

The broadening of transboundary coordination, research and technical collaboration for basin management and operations is being explored through a recently agreed MoU between the MRC and the LMC Water Centre. A Joint Working Group (JWG) was established “as a decision-making coordination body to advance pragmatic cooperation in the field of water resources.” The LMC Water Centre was set up in 2017 to “strengthen comprehensive cooperation in technical exchanges, capacity building, drought and flood management, data and information sharing and joint research.”

Under the Five-Year Plan of Action on Lancang-Mekong Cooperation (2018–2022), China is committed to continuing the Lancang-Mekong cooperation on sustainable water resources utilization, policy dialogue on water resources, joint research, and capacity building. Of particular interest of this cooperation is the focus on:

---

4 For details, see the MoU here: www.mrcmekong.org/assets/News/MRCS_LMC-Water-Center-MOU_2019.pdf
- developing and improving a water quality monitoring system, which is accessible to all Lancang-Mekong countries, and strengthening data and information sharing; and
- strengthening Lancang-Mekong River flood and drought disaster emergency management, carrying out joint assessments of flood control and drought relief in the Mekong Basin, and conducting a joint study on the early setting up of communication line/channel for sharing information during the Lancang-Mekong River flood and drought emergencies.

In September 2020, LMC member countries reached new joint agreements regarding the sharing of information on flows and water levels downstream of the Lancang (Jinhong) dams throughout the year. These data sharing arrangements are beneficial; however, they need to be expanded to include seasonal forecasts of significant changes to operational patterns due to plant maintenance, or sediment flushing operations to allow flow management in the LMB.

In addition, there is another ongoing effort proposed by the MLC Joint Working Group on LMC Information Sharing Platform (ISP) discussed during meeting of the MLC Joint Working Group (JWG) on Water Resources in May 2020. The MRC Member Countries expressed the need for the LMC Water Centre to work closely with the MRCS in developing this platform. This would aim to build synergy with the MRC Information System, thus avoiding duplication and saving costs. Importantly, the procedures and associated technical guidelines that govern the data and information sharing among the four MRC member countries, developed by the MRC, must be considered for any future development of the LMC Information Sharing Platform. MRCS will be working closely with the LMC Water Centre to revise and provide inputs to the draft concept note for the ISP of Lancang-Mekong Water Resources Cooperation.

Finally, there is also a recent study, “Transboundary cooperation mechanism on adaptation to climate change and hydropower development projects”, conducted by the Office of the National Water Resource (Thailand) and funded by Mekong-Lancang Cooperation special fund in late 2019. The study noted the very close linkages between climate change and flood and drought management, and the influence of hydropower operations in the upper Mekong. These linkages indicate how regional platforms in the Mekong-Lancang Basin could be enhanced to address technical solutions and improve communication and collaboration among the riparian countries. This investigation may be further expanded and discussed between stakeholders for implementation in the coming period regarding cascade operation and management issues.

---

6 See Global Times (29 September 2020) on the Lancang-Mekong countries reach new joint agreement on water resource info-sharing: www.globaltimes.cn/content/1202491.shtml
7 See Mekong Institute (n.d.) on Transboundary Cooperation Mechanism on Adaptation to Climate Change and Hydropower Development Projects Funded by Mekong-Lancang Cooperation Special Fund, at: https://mekonginstitute.org/uploads/tx_ffpublication/Project_snapshot_ADC.pdf
3.4.7 MRC data systems invigoration project (BDS 2021–2030, Outcome 4.1)

As shown in Table 1.1 SP Strategic Priority 4 contains outputs to strengthen the MRC’s information network and systems.

<table>
<thead>
<tr>
<th>Outcomes</th>
<th>Outputs</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.1 Better informed and prepared basin communities to respond to changing river conditions, and more frequent and severe floods and droughts</td>
<td>4.1.1 A core river monitoring network for the mainstream and remaining national river monitoring networks consolidated</td>
</tr>
<tr>
<td></td>
<td>4.1.2 Integrated data and information systems for more effective basin-wide data management and sharing</td>
</tr>
<tr>
<td></td>
<td>4.1.3 Compatible decision support systems building on reinvigorated data, modelling, forecasting, and the communication capabilities</td>
</tr>
<tr>
<td></td>
<td>4.1.4 Integrated basin-wide flood and drought forecasting and early warning</td>
</tr>
<tr>
<td></td>
<td>4.1.5 The joint State of the Basin Report</td>
</tr>
</tbody>
</table>

Throughout 2019, the MRC made efforts in strengthening data, modelling, and integration of flood and drought tools to the DSF, and processes to provide enhanced and useful information to the MRC Joint Committee. The aim is to support the MRC Member Countries, developers of large infrastructure, as well as the general public and academia in understanding status and trends in the Mekong basin.

This work is part of activities included in BDS 2021–2030 under Output 4.1.3, Compatible Decision Support Systems in line with reinvigorated data, modelling, forecasting, and communication capabilities.

The review and design concept activity covers the following areas of technology needs:

- integrated database and data management system;
- data quality control and assurance process
- document management system;
- modelling tools of the MRC to be expanded and enhanced;
- river monitoring and forecasting to be modernized;
- State of the Basin Report and the MRC Indicator Framework, to be presented in a simple dashboard and web-based reporting system; and
- capability for integrated implementation of the MRC Procedures and associated Technical Guidelines to be monitored and reported.

The scope of the concept design approved by the MRC Joint Committee includes:

- A technical review of the MRC’s current data management, modelling, forecasting and communication systems (Part 1 of the project); and
Development of a design concept of modern data management, modelling, forecasting and communication systems with a high-quality set of technology (Part 2 of the project). (an updated Decision Support Framework).

This strategic priority output will need to be synchronized and integrated with this project as it unfolds.

3.4.8 Initiative for Sustainable Hydropower Study: Improved Environmental and Socio-economic Baseline Information for Hydropower Planning (ISH11)

The Initiative on Sustainable Hydropower (ISH11) study as a part of MRC Initiative for Sustainable Hydropower study series aimed at providing a practical science and engineering-based set of studies and guidelines to promote sustainable hydropower practice in the Mekong. ISH’s full list of agreed studies and Guidelines is included in Annex 2.

ISH11, which commenced in November 2012 with a multi-disciplinary team of experts, aimed to review monitoring and information management systems at the MRC to assess how well they provide information to Member Countries for hydropower planning and management information needs. The ISH study undertook the following:

- reviewed information needs relevant to hydropower planning and management based on Mekong-specific issues and experiences elsewhere;
- established a Guiding Framework for hydropower information needs relevant to the MRC;
- completed a review of existing and presently collected information for the Mekong;
- identified gaps and opportunities with respect to the Guiding Framework; and
- proposed improvements to address key gaps.

The study focused on information that is most appropriately collected in a consistent and coordinated manner by the Member Countries and centralized and shared among them through the MRCS information management systems. The study focused on the whole-of-river and long-term information that can complement hydropower project- and site-specific information.

A number of the recommendations of this extensive work were taken up in the BDS and SP and ongoing Joint Environmental Monitoring (JEM) Programme.
3.4.9 The Joint Environmental Monitoring Programme

The JEM Programme aims to understand conditions on the river over time, so that MRC Member Countries and stakeholders will know how hydropower development is affecting the environment and people. Information will be collected on water flows, changes to the amount of sediment moving through the river, and how the shape of the river channel is changing. The JEM Programme will also measure water quality as well as the amount of living creatures in the river, including fish.

The JEM Programme builds on existing monitoring, and also collects new information (e.g. new water quality details) and information in new places (e.g. directly upstream and downstream of hydropower dam sites). The collected information will be shared among the Mekong countries to understand how hydropower-related changes are affecting the environment and people locally and regionally, both upstream and downstream of hydropower dam sites.

The Mekong River Commission (MRC) is testing, i.e. piloting, the JEM Programme at the Xayaburi and Don Sahong hydropower dams in Lao PDR. These are the first two operational dams on the LMB mainstream, so it is critical that MRC monitors their impacts. A major objective is to ensure that national monitoring teams use the same methods to collect data and report on river flows, changes in water chemistry, as well as on fisheries and river health. This will ensure that information collected in the four LMB countries (Cambodia, Lao PDR, Thailand and Viet Nam) can be easily analysed and compared. Piloting the JEM Programme requires that before applying JEM methods more widely, the MRC can ensure that:

- monitoring and reporting methods are robust;
- that they are not too costly; and
- they are suitable for the range of conditions that exist across the LMB countries.

The JEM Programme Pilots began in November 2019 and ended in December 2021. The MRC executed this project with support from the German development cooperation Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ).

3.4.10 The Core River Monitoring Network

To ensure that benefits of monitoring systems in place continue and meet new challenges of a rapidly changing Mekong River Basin, the MRC is willing to strengthen and further expand the hydro-meteorological monitoring network through the implementation of the Core River Monitoring Network (CRMN) for the LMB. As highlighted in the Basin Development Strategy 2021–2030, the Member Countries and the MRCS would like to re-design and establish an integrated system for a more effective Lower Mekong Basin Monitoring Network that can support the current and future basin environment.

---

The overall objective of the CRMN project is to provide a sustainable, standardized, harmonized, and integrated monitoring system for achieving four specific outcomes:

- assessment of river conditions: status and trends;
- monitoring of water infrastructure project operations;
- flood and drought forecasting;
- assessment of socio-economic conditions of vulnerable people whose livelihoods depend on the Mekong River.

The monitoring of water infrastructure project operations is also highlighted as one of specific objectives. This CRMN projects will build on existing monitoring systems and experience, in particular, HYCOS, JEM, and water quality monitoring.

This project started in Q2/2021 and is still in the inception phase. The project is expected to be completed by the end of 2022 in synergy with the team of experts from MRC, Compagnie Nationale du Rhône (CNR), French National Research Institute for Agriculture (INRAE), the International Office for Water (IOWater), as well as international and national consultants.

### 3.5 Important Regional Initiatives on Hydropower Cascade Optimization and Management

#### 3.5.1 The Cascade Optimisation Study

In 2009, the Government of Lao PDR commissioned a study of the optimization on the designs-related operations of the cascade of proposed dams within Lao PDR on the Mekong mainstream upstream of Vientiane (CNR, 2009).

The main purpose of this study was to determine the minimum and maximum operating water level of each of the five projects sites leading to an optimization of the cascade of dam design parameters (e.g. dam height, head, flow, tailwater levels). The objective was to balance overall hydro electricity production with social and environmental issues, without regard to dam construction costs. The study also includes a preliminary review of environmental and socio-economic impacts of the five sites. To this end, the study undertook the following:

- assessed and analysed the flow of the Mekong River as a consequence of dam operations in China, noting the positive and negative effects to the downstream projects;
- analysed and revised the operating water level of the listed projects based on the 1994 MRC study, “Mekong Mainstream Run-of-River Hydropower”;
- limited the maximum high water level of each project, taking into account the upstream dam projects;
optimized and suggested **manageable operation regimes for all five projects** by maximizing the power output of each of them including backwater studies at full reservoir level and seasonal flow maintenance, among others.

During the prior consultation process for the Luang Prabang HPP, the Government of Lao PDR indicated that they were carrying out the updated cascade optimization study of the upper Lao PDR cascade. However, the study report has not yet been shared with the MRC.

### 3.5.2 Lao PDR operations and information sharing

*Coordination and Monitoring Centre*

Lao PDR Ministry of Energy and Mines (MEM) has recognized the importance of coordination and monitoring of the hydropower cascades. With the support of the Agence Francaise de Development (AFD), MEM has completed an extensive feasibility study on the setting up of the Coordination and Monitoring Centre (CMC).

The work undertaken covers all aspects, from governance and information requirements to data management and staffing, as shown in Figure 2.3. The linkage between the CMC (proposed for implementation from 2021 and beyond) and the MRC will be vital. The CMC is proposed to be implemented incrementally, commencing with projects in the upper Mekong reach below China/Lancang.

The aide-mémoire of an identification mission of the CMC Project on 12–14 February 2020 submitted by the AFD to the MRCS concludes that:

> *the concept of the CMC is welcomed generally by the hydropower stakeholders in Lao PDR. Interest in this initiative may vary; coordination is key for governmental authorities and developers and in some cases (downstream HPPs on tributaries for instance) data sharing also. Internal discussions within AFD will pursue prior to an official decision to whether or not move forwards on the project financing.*
Figure 2.3. Scope of information flows and governance for the proposed Lao PDR CMC

Note: The CMC proposes a crisis Unit to manage emergencies.

Electricite du Lao - hydropower generation information
In addition, at present, Electricite du Lao – Generation Public Company (EDL-GEN) is sharing its HPPs operational information on their website⁹ to the public, for example, Nam Ngum 1 HPP, Nam Khan 2 HPP, and Xeset 2 HPP. There is an opportunity to draw on this experience for wider Mekong application.

⁹ See EDL website for more info: https://bit.ly/3l0NkfC
4 Opportunities for Coordinated Operating Mechanisms for Water Infrastructure Operations

Summary of this chapter

- In addressing the opportunities for coordinated operation of water infrastructure for wider benefits, the core purpose of this infrastructure (e.g. electricity generation), as well as the economic and legal constraints pertaining to these assets must be considered.
- Operations flexibility and the ability to adaptively manage environmental outcomes effectively should be built into the design of the project.
- Flood and drought management require specific allocated storage. The scale of storage available in the Mekong constrains the effectiveness of mitigation for large basin scale events.
- Dam and community safety emerges as a critical operational imperative.
- Water infrastructure operations is an important but are not the only element to be considered in IWRM based operations management.
- Hydropower, as a cross-cutting activity, links to many current and future SP activities; these links will need to be explicitly managed to ensure effective delivery and lack of duplication of effort.
- A broad range of opportunities and imperatives must be considered for effective operations management.

4.1 Conceptual framework for consideration of opportunities

4.1.1 Scope of integrated water resources management-based operations

Due to the range of requirements of integrated water resources management (IWRM), coordinated operation of infrastructure in the basin needs to deal with a wide range of sometimes competing objectives. Therefore, cooperating government agencies, hydropower operators, irrigation operators and emergency management agencies will need to understand the important consequences of operational decisions. Figure 3.1 shows the interconnected nature of these operational management decisions. The key point to note is that water infrastructure operations are only a part of the necessary IWRM. For example, flood protection management may include the construction of levees and/or urban planning regulations, which are not considered in this report. Broader fisheries management may include a range of strategies to manage demand and supply.
Therefore, this report will focus on the interconnection between water infrastructure operations in LMB and the key elements of IWRM (in a green circle in Figure 3.1).

**Water infrastructure:** For the purposes of this report and the associated pilot projects, water infrastructure includes:

- hydropower dams, irrigation dams and weirs, major water supply dams and pumps, navigation facilities, flood protection works and/or riverbank stability infrastructure.

![Figure 3.1. Roles of water infrastructure operations in IWRM](image)

**Figure 3.1. Roles of water infrastructure operations in IWRM**

**Notes:** The above figure indicates the overall context of IWRM within which the MRC operates. The mandate of the MRC may not cover all these areas of IWRM. Certain issues will need to be dealt with at a national level or by other basin actors (e.g. land use management, construction of flood levees, wetlands and forest management, urban pollution). The idea is to indicate that there are many related and interlinked matters that need to be dealt with in addition to water infrastructure when considering IWRM.

PDIES=, PMFM = Maintenance of flows; PWQ = Procedures for Water Quality

### 4.1.2 Purpose and elements of cooperation on water infrastructure operations in the Mekong Basin context

At the broadest scale, cooperation on water infrastructure operations may be aimed at the elements below:
Flow management for equitable socio-economic development

- Efficient resource use
- Maintenance of flows (PMFM)
- Water use monitoring (PWUM)
- Mitigation of floods and droughts
- Reasonable and equitable access to the resources – water, power
- Local benefit sharing (non-monetary) – operations to facilitate local development, industry, agriculture
- Community safety – sudden flow changes, communication.

Environmental management

- Sediment transmission
- Maintenance of water quality (PWQ) and quantity (PMFM)
- Aquatic ecosystems
- Fisheries management.

Management of emergencies

- Gender and vulnerability sensitive, regionally connected
- Water quality (PWQ) and quantity – chemical and wastewater spills, routine operations and floods,
- Forecasting and warning systems – data, models, communication platforms
- Emergency management (regional) – plans, procedures, protocols, governance and communication.

Planning, design and management of hydropower cascades

- Efficient production – efficient use of resource, sub-basins and mainstream
- Environmental and social sustainability – sediment trapping, coordinated sediment transmission, fish passage, environmental flows
- Adaptive management – monitoring mitigation efficacy, ramp rates, water quality, aquatic ecosystems
- Dam and community safety – consultation and communication – ongoing during the life of the project
- Flood and drought mitigation.
4.1.3 Specific considerations associated with operations in the Mekong

There are a number of specific considerations that need to be taken into account when cooperating on IWRM-based operations, as described below.

Core role of water infrastructure should be recognized

Water infrastructure projects (e.g. hydropower dams, irrigation weirs) are usually developed and operated for their core purpose of generating electricity or delivering irrigation water to farmers. Investment is made in this infrastructure on the understanding that environmental and social impacts must be mitigated according to agreed management plans. These constraints to operations are considered in the analysis of the economics of the projects and in negotiating on the power purchase and concession agreements. In these negotiations and decisions, developers and operators must also consider and make allowances for adaptive management of their operations as monitoring of the effectiveness of mitigation becomes clear through the life of the project. In addition, as noted in the case study for Columbia River Basin, community and government expectations may change throughout the life of the project, resulting in further negotiations on requirements for operational changes. Compensation for loss of revenue (or extension of concession period) may then be negotiated.

Multi-purpose projects may also be conceived, where a broader role for the scheme is considered at the design stage (e.g. flood/drought management with hydropower generation). Investigation of this type of infrastructure was included in the SHDS study (ECA, 2019) and is envisaged to be further considered in the BDP/MRC SP under the PRP initiative.

This report scopes opportunities for collaborative water infrastructure operations for both:

- existing infrastructure that has an already defined core purpose; taking into consideration existing power purchase agreements and related concession agreements; and
- planned or under investigation infrastructure that may have a dedicated or multi-purpose water resources management role.

Sediment management and environmental release coordination mechanisms

Design and operation of the HPP will include certain environmental constraints including:

- flows through fish passage;
- sediment management requirements (e.g. flushing);
- flow and water level ramping rates (i.e. restrictions on the rate of rise and fall of downstream water levels to avoid bank erosion and stranding of fish); and
- constraints on reservoir pond levels and rate of change.
In order to meet these requirements, information on inflows, upstream flushing operations are required as well as notification to upstream and downstream affected communities. As noted above, sediment management of mainstream dams in the LMB is one aspect of the MRC’s Preliminary Design Guidance and calls for coordinated management approaches including the establishment of Cascade Joint Operating Mechanisms governing sediment routing and flushing activities. There are implications for downstream water level fluctuations, ecosystem habitats, fisheries and water abstraction points for domestic and municipal use. These requirements are also included in the agreed statements arising from the PNPCA process for these dams (see Section 4.2.1).

Joint operations of cascades may also be needed to manage or mitigate a range of other environmental requirements such as retention of adequate reservoir velocities to maintain larval drift.

**Flood and drought risk management and mitigation**

Perhaps the most immediate need for coordinated infrastructure operations is for flood and drought management and mitigation. Communities living in towns and villages along the Mekong River mainstream and tributaries may need to adjust to a significantly altered flow and water level regimes due to climate change and regulation by water infrastructures. These altered flows affect the commercial/economic assets (e.g. boats, buildings, riverbank crops, fishing activities) and have community safety implications.

For a number of years the MRC managed the flood and drought forecasting centre for the LMB in data and information exchange and sharing under the Procedures for Data and Information Exchange and Sharing (PDIES), approved in 2001 to operationalize data and information exchange of vital water-related indicators among the four Mekong countries. This shared service has relied on the real-time sharing of hydrological data but not hydropower operational data (e.g. water level, inflow/outflow, spilled water). With the intensity of hydropower development, many of which are now in operation, this hydropower operations information is now vital to allow accurate forecasting and management of floods and droughts for community safety implications.

This activity seeks to scope opportunities to strengthen flood and drought monitoring and management mechanisms, taking into account hydropower dam operations and related emergency response planning. The enhancement of the MRC’s Regional Flood and Drought Management Centre capacities and the MRC’s data systems invigoration project (BDS 2021–2030, Outcome 4.1) will assist in this role of HPP cascade management.

**Reverse flows into Tonle Sap**

The reverse flows into the Tonle Sap start when the water levels in the Mekong mainstream at Phnom Penh increase to above the water levels in the Great Lake (MRC, 2020). Water then flows into the Lake from the Mekong, usually starting in mid-May. Return flows continue until water levels in the Great Lake and the Mekong mainstream are equal, usually in mid-September, as shown in Figure 3.2.
Figure 3.3.2. The accumulative reverse flows at Prek Kdam on the Tonle Sap River

Source: Article 6B for monitoring purposes of the MRC: https://pmfm.mrcmekong.org/monitoring/6b

As water levels in the Mekong mainstream decrease with the coming dry season, water flows out of the Lake to the Mekong (Adamson et al., 2009). The Tonle Sap Lake therefore also serves as an important and natural flow balancing storage for the Mekong Delta.

Both the timing and volume of water in this natural pulse of the Great Lake are important. The reverse flows increase the surface area of the lake from around 2,500 km² to around 13,000 km². The inundation of large areas around the lake triggers fish spawning and the MRC’s fisheries monitoring has noted a positive correlation between the flow in the Mekong and fish catch in the Tonle Sap Lake. While the timing and volume of the reverse flows has always varied from year to year, the systematic delaying of the reverse flows and reductions in the total reverse flow volume will have long-term impacts on the fisheries of the Lake and Mekong mainstream.

The development of hydropower and irrigation storage in the Mekong Basin will delay the timing and reduce the total volume of the reverse flows (MRC, 2018c). This is because the storage must first fill up at the start of the wet season, and some of the wet season flows are held back to provide for power generation or irrigation in the dry season.

**Dam and community safety**

Dam and Community safety is a major component of the Preliminary Design Guidance for Mainstream Dams 2009 (PDG 2009) and recently updated Preliminary Design Guidance for Mainstream Dams (PDG 2022). The guidance emphasizes the need for each project to have in place Emergency Action Plans (EAPs) related to flood and other operational requirements. It is necessary for these EAPs to include an understanding of how cascades of HPPs will be operated during floods and extreme events to prevent fatalities and injuries.
Recent dam safety incidents in the Mekong tributaries have highlighted that the wider availability of information on these dams, both their physical characteristics and their operational patterns and real time emergency management mechanisms, is vital necessary.

Under Article 10 of the 1995 Mekong Agreement, the Member Countries are required to notify each other through the Joint Committee in the event of ‘any special water quantity or quality problems constituting an emergency requiring immediate response’. This is currently separate to the routine data and information sharing activities under PDIES. As yet there is no agreed mechanism for operationalizing Article 10 (there is limited guidance provided under the Technical Guidance for Procedures for Water Quality (PWQ)). Had this been in place, and it was supported by a capability to predict the progression of flow peak downstream, then it could have been used to notify downstream riparians in the case of the dam break that occurred in July 2018 (MRC, 2018a). This incident caused transboundary impacts to downstream riparians and raised the urgent needs of transboundary Emergency Action Plans.

**Cascade operation of hydropower dams for energy security**

LMB mainstream hydropower projects are generally operated as “run-of-river” plant. That means that the power production is dependent on the daily flow in the river which may vary seasonally. Under the common Power Purchase Agreement of this “run-of-river” type, HPP operators must forecast the week ahead and day ahead production and make commitments to the purchaser, for example the Electricity Generating Authority of Thailand (EGAT). In addition, HPPs must meet commitments under their Concession Agreement (CA) to mitigate local and transboundary environmental and social impacts. Information sharing and coordination of the operations of upstream and downstream power stations within a cascade will be essential for efficient generation planning and resource use.

In addition, the increased development of storage in the Mekong Basin is to be studied as part of the SP 2021–2025 (Output 3.1.1). The improved use of storage and system-scale ‘optimization’ can significantly increase energy production from existing and planned HPPs.

The proposition to create a regional power pool and integrated grid across GMS and/or the Association of Southeast Asian Nations (ASEAN) has been under discussion for some time. A regional grid and power pool would allow greater flexibility to manage hydrological variability across the system, energy demand variability across the region and would promote a more efficient use of energy and water resource in meeting demand and avoiding risks that generation capacity runs ahead of demand.

While hydropower in generally deemed renewable and a low carbon energy solution, there are multiple ways in which hydropower may be able to support the broader regional grid in efforts to employ other forms of solar and wind energy. Pumped storage hydropower and altered operations of existing hydropower cascades with storage are able to firm up low cost, but intermittent, generation options such as solar and wind energy. These altered operating options will be further set out Stage 1 of this study.
4.2 Matrix of opportunities for water infrastructure cooperation

Operational cooperation may occur across different timeframes and across the “cooperation continuum” as discussed earlier in chapter 2. The matrix of opportunities in Table 3.1 seeks to lay out in point form the wide range of options that may arise. These are defined more completely in chapter 4.
<table>
<thead>
<tr>
<th>Scope</th>
<th>Coordination: Shared information to inform member states</th>
<th>Collaboration: Adapt operations and plans for regional benefit</th>
<th>Joint Action: Planning and investment for mutual benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flow management</td>
<td>Real time, daily, weekly Quality assured information on:  - Hydrology: rainfall, river flows  - Storage level and releases/ramping rates  - Spillway gate operations  - Abstractions  - Day/week forecasts of above</td>
<td>Adapt operation of existing water infrastructure to:  - assist management of floods and droughts where possible  - Manage storage to improve efficiency of water use at tributary/basin level through adapted operating rule curves  - Adapt operations to meet PMFM targets (including Tonle Sap Reverse flows)  - Multi-purpose use of storage: management of Irrigation, domestic and industrial abstraction</td>
<td>Joint investment in water infrastructure to manage  - enhance reliability of dry season flows, mitigate floods  - balance power generation with efficient water use  - implement PMFM for regional benefits</td>
</tr>
<tr>
<td></td>
<td>Seasonal forecasts  - Abstractions (irrigation, hydropower diversions)  - Hydro generation/releases  - Reservoir target levels/rules  - Environmental flow releases  - Drought forecast  - PMFM monitoring</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Planning, Development and Management:  - Plans for developments  - Water demand/supply projections  - Climate change assessments  - Hydrological data, analysis and research</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Scope</td>
<td>Coordination: Shared information to inform member states</td>
<td>Collaboration: Adapt operations and plans for regional benefit</td>
<td>Joint Action: Planning and investment for mutual benefits</td>
</tr>
<tr>
<td>-------</td>
<td>-------------------------------------------------------</td>
<td>---------------------------------------------------------------</td>
<td>----------------------------------------------------------</td>
</tr>
</tbody>
</table>
| Sediment and environmental management | Real time, daily, weekly  
- Notice of timing and quantity related to sediment flushing  
- Water quality (real time)  
- Changes to e-flow (daily)  
- Fish passage operations (during migration season) | Adaptive management of hydropower cascade operations to avoid minimize and mitigate harmful effects  
- Coordinated sediment flushing  
- Coordinated operation of fish passage  
- Consistent and coordinated environmental flow releases  
- Joint environment monitoring  
- Power station ramp rates (reservoir and downstream) to avoid bank erosion environmental impacts  
- Joint studies to facilitate improved environmental outcomes. | Energy water nexus resolved through water infrastructure jointly developed to maximise regional net benefits:  
- Storage designed to facilitate Tonle Sap reverse flows for productive fishery |
| Seasonal forecast | - Seasonal e-flow releases  
- Timing of sediment flushing  
- Ramp rates  
- Seasonal generation patterns (estimate) | | |
<p>| Planning, development and management: | - Shared studies on efficacy of mitigation | | |</p>
<table>
<thead>
<tr>
<th>Opportunities for Operational cooperation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Scope</strong></td>
</tr>
<tr>
<td><strong>Coordination:</strong> Shared information to inform member states</td>
</tr>
<tr>
<td><strong>Management of emergencies</strong></td>
</tr>
<tr>
<td><strong>water quality and quantity</strong></td>
</tr>
<tr>
<td><strong>Dam and community safety</strong></td>
</tr>
<tr>
<td><strong>Real time, daily, weekly</strong></td>
</tr>
<tr>
<td>- Real-time river flows and rainfall</td>
</tr>
<tr>
<td>- Daily/weekly water quality info</td>
</tr>
<tr>
<td>- Emergency action comms. – contact points</td>
</tr>
<tr>
<td>- Notification of spillway gate operations</td>
</tr>
<tr>
<td>- Notification of navigation lock operations</td>
</tr>
<tr>
<td><strong>Seasonal</strong></td>
</tr>
<tr>
<td>- Shared emergency response plans-contacts, processes</td>
</tr>
<tr>
<td>- Shared lessons from Emergency Action Plans</td>
</tr>
<tr>
<td>- Post-emergency review and lessons learned</td>
</tr>
<tr>
<td><strong>Joint Investment in satellite and terrestrial equipment to:</strong></td>
</tr>
<tr>
<td>- Predict/monitor floods and droughts</td>
</tr>
<tr>
<td>- Model and share forecasts and emergency warnings</td>
</tr>
<tr>
<td>- Joint systems and shared resources to manage emergencies (e.g. radio networks, aviation resources)</td>
</tr>
<tr>
<td><strong>Hydropower cascade operations</strong></td>
</tr>
<tr>
<td><strong>Real time, daily, weekly:</strong> In addition to the requirements for flow, sediment/environment and emergencies add:</td>
</tr>
<tr>
<td>- Details of “as-built” specifications of infrastructure (e.g. storage curves, spillway gate and power station capacities, etc)</td>
</tr>
<tr>
<td>- Power station operational warnings, spillway gates, navigation ops, ramp rates, day and week ahead forecast flows</td>
</tr>
<tr>
<td>- Navigation lock operations</td>
</tr>
<tr>
<td>- Major maintenance schedule</td>
</tr>
<tr>
<td><strong>Adapt operations to support all of the above as well as:</strong></td>
</tr>
<tr>
<td>- Operating rules coordinate upstream and downstream hydro generation for mutual maximum net benefit</td>
</tr>
<tr>
<td>- Hydro operation to support solar/wind and other renewables.</td>
</tr>
<tr>
<td><strong>Joint Planning and Investment to support all of the above plus:</strong></td>
</tr>
<tr>
<td>- ‘optimized’ regional hydropower design/operation through cascades for maximum output and minimum impact</td>
</tr>
<tr>
<td>- Hydro design and operation, including pumped storage to support other renewables, low carbon energy including floating solar generation on hydropower dams.</td>
</tr>
</tbody>
</table>
### Opportunities for Operational cooperation

<table>
<thead>
<tr>
<th>Scope</th>
<th><strong>Coordination:</strong> Shared information to inform member states</th>
<th><strong>Collaboration:</strong> Adapt operations and plans for regional benefit</th>
<th><strong>Joint Action:</strong> Planning and investment for mutual benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Seasonal add:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Operational storage rules curves</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Forecast releases, storage</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Seasonal flood capacity</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Notification of drought storage</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Planning, development and management add</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Shared plans for future developments (timeframe, specifications)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Supply and demand projections</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

10 ‘Optimization’ in this report refers to balancing the needs of the basin to maximise benefits and minimise costs and impacts. This “optimisation” will increase in complexity and rigour over time as the available tools are developed for this purpose. Refer also the BDS Output 3.1.1 on “Proactive Regional Planning” which is aimed at this balancing of basin needs.
4.2.1 Prioritization of opportunities

MRC Member Countries have discussed the range of opportunities mentioned in section 3.1 at a meeting held on 22 December 2020. Preliminary views of national priorities were proposed. These priorities varied based on the individual national circumstances. The output of the national discussions held at the meeting are provided in Annex 3.

In summary:

Scope: There was a wide variety of views on the priority scope. Generally, ‘flow management’ and ‘hydropower cascade operations’ were considered of importance, together with ‘management of emergencies’.

Time frame: Member countries considered ‘real-time’ and ‘seasonal’ cooperation on operations as important.

Nature of cooperation: Three countries confirmed the need to focus on ‘coordination’ and the sharing of information in relation to water infrastructure operations in the basin. There was similar support for the opportunities for ‘collaboration’ (i.e. adapting operations to maximize benefits and reduce impacts), particularly regarding emergency management and hydropower cascade operations.
5 Scoping the Opportunities

Summary of this chapter

- For coordination (information sharing):
  - A guiding framework for defining information needs is important.
  - An inventory and gap analysis on current and required information must include aspects of monitoring frequency and data quality to meet decision support requirements.
  - Clear governance arrangements will be needed to expedite the gathering of this information using PDIES.
  - Close links to related SP activities will be necessary on data and DSS scope.

- For Collaboration (adaptation of operations):
  - These aspects are already called for in the post-PNPCA Statements for Pak Beng, Pak Lay, Luang Prabang.
  - For projects already operational, adaptation should acknowledge commercial and legal requirements.
  - Flood and drought management opportunities may be limited by physical constraints of infrastructure.
  - Engagement with dialogue partners will be essential for effective operational coordination and efficient resource utilization.

- For joint action on operations:
  - Scoped opportunities will require assessment of costs and benefits through MRC SP output 3.1.1 on proactive regional planning.

5.1 Coordination opportunity – Information and decision support

SP Activity 4.2.1.2: 4.2.1.4

The matrix of opportunities indicates the breadth of information sharing that is needed to manage the operational aspects within the Mekong. Sharing of information is a current feature of the cooperation between the LMB Member Countries. Information sharing with UMB is increasingly improving in important areas of concern. Coordination of information sharing is a fundamental building block for all the further stages of cooperation, which builds trust and transparency in operations.

As noted in the matrix of opportunities (Table 3.1), data will be required within different timeframes. Hydropower data have been collected in an MRC hydropower database over the last 10 years to be used mainly in modelling of planning (e.g. the BDP Scenario Assessment) and assessment (e.g. the Council Study). This hydropower database therefore is a starting
point for further expansion to include additional operational parameters needed for cascade and basins-scale water infrastructure management.

5.1.1 Linked MRC Initiatives – SP Outcome 4.1: Better informed and prepared basin communities against changing river conditions, and more frequent and severe floods and droughts

As noted in Section 2.4.7, the MRC is currently upgrading data and DSSs. The organization, quality assurance, storage, and presentation of the current wealth of information housed within the MRC and within Member Countries is the subject of two activities under the SP 2021–2025. This work undertaken under Output 4.2.1 will link to and support this outcome.

As shown in Figure 4.1, the outputs to deliver this outcome include:

- 4.1.1 A core river monitoring network for the mainstream and remaining national river monitoring networks are consolidated;
- 4.1.2 Integrated data and information systems for more effective basin-wide data management and sharing;
- 4.1.3 Compatible DSS building on reinvigorated data, modelling, forecasting, and communication capabilities;
- 4.1.4 Integrated basin-wide flood and drought forecasting and early warning;
- 4.1.5 The Joint State of Basin Report prepared.
As noted in previous sections, BDS 2021–2030 under Output 4.2.1 will focus on:

- specifying the information that needs to be shared for operation of water infrastructure; and
- defining the cooperation mechanisms, governance and processes needed to share this information to achieve the objectives.

The current MRC systems and those under development will form the foundation for practically storing, analysing, and sharing this information in real time. This operational cooperation activity will be carried out together with the team developing these systems to ensure that the system capacity is supportive of the operational objectives.

5.1.2 Decision support systems

A preliminary design was completed for the MRC (eWater, 2019) covering the layout of an integrated data, information, and the DSS. This was approved by the Joint Committee in 2020. Figure 4.2 shows an example of how data systems associated with hydropower and other water infrastructure may be integrated with the proposed design to assist operational coordination.
Figure 4.2. Operational information integrated with (draft) design of invigorated MRC data systems


In addition, a draft Concept Note (see MRC, 2020) was prepared by the MRC for discussion at the Joint Platform in June 2021 on the scope and potential mode of use of such a DSS for flood and drought management. The Concept Note contains useful ideas on how this system could inform the Members Countries on operational cooperation needs and options using forecasts of potential operational scenarios analysed through the DSS. A potential framework of linkages to an updated DSS for drought management is proposed in the Concept Note and shown in Figure 4.3.
Characteristics of an operational decision support system

As an operational DSS is to be used to support operational information sharing and coordination, it will have certain characteristics that will differ from the DSS that has been used traditionally by the MRC for planning purposes. An operational DSS will need to respond to the daily, weekly, and seasonal operational needs of Member Countries, HP operators and stakeholders where decisions need to be made in these shorter timeframes. As noted in the draft CN above and in this report, forecasts a week in advance and seasonal river conditions will be important if operational decisions are to be made for either flood or drought mitigation. In addition, hydropower operators must commit to production targets a week in advance, which will depend on their projections of both their storage available, and clearly, inflows from upstream. The information shared and the outputs of any operational DSS will need to assist these decisions in a timely manner. It is suggested that an operational DSS therefore should:

- use readily available data sources and allow for data gaps and source malfunction;
- represent, at an appropriate level of detail, the operations of the major water infrastructure projects in mainstream and tributaries;
- be able to reliably analyse forecasts a week in advance, daily, or even several times a day;
- be able to analyse seasonal forecasts every month with probabilistic risk-based outputs to inform decisions (e.g. releases for flood mitigation, storage for droughts, assist Tonle Sap reverse flows);
provide outputs at selected relevant locations to assist national agencies and operators in their decisions.

Close collaboration will be needed between MRC initiatives involved in elements of this work to ensure that the DSS is specified so that it will perform for the operational context, because this will be a complex process in the Mekong system.

The Concept Note referenced above proposes a drought mitigation DSS with forecasts based on stochastic hydrological inputs together with the operational forecast input data on plant, storage, and river status. This provides an insight into the significant amount of input data from multiple sources needed to reliably forecast drought conditions and impacts.

As noted above, the existing DSF is unlikely to be appropriate to support operational information sharing.

Additional input to the enhanced design of the MRC DSF system will also derive from scoping Output 3.1.1 on PRP.

5.1.3 Current information sharing platforms

The current information sharing platforms include:

- **Near real-time water levels** at a range of stations relevant to water infrastructure operations
- **PMFM water level status**
- **Regional Flood Management and Mitigation Centre**
- **Drought Forecast**
- **The MRC Hydropower Database**.

The main information-sharing platforms are for river conditions. The status of water infrastructure storage and releases are not currently collected on a daily basis through the MRC processes.

In addition, there are **national data-sharing platforms** in Member Countries that may be able to be linked in real time to the MRC platforms.

In considering coordination (information sharing) for hydropower cascade operation, these platforms, based on the MRC Procedures (e.g., PDIES, PMFM) will provide a foundation. The proposed approach would be to enhance the content and link to these data sources/platforms.
5.1.4 Guiding framework defining information needs

Based on previous work by the MRC’s Initiative for Sustainable Hydropower (ISH), a proposed guiding framework has been developed to define and prioritize the operational information required for operational management of water infrastructure. Due to the nature of operational management, the number and location of collection points will be determined by the locations and operational characteristics of the water infrastructure and hydropower.

Given the remit of the MRC, the focus of this operational coordination will be to measure, forecast, and understand the impacts of operations on transboundary riparian communities and infrastructure.

Proposed guiding framework to define and prioritize information needed for operational management

1. **Data location:**
   - should facilitate understanding of effects of operations occurring across national boundaries;
   - covers upstream and downstream, and each major water infrastructure project (HP, irrigation, etc.), or cascades of projects;
   - enable sufficiently accurate modelling, forecasting and assessment of mainstream flows and water levels at critical points;
   - cover all Mekong River hydro ecological zones and environmental hot spots.

2. **Parameters monitored**
   - provide inputs to priority water infrastructure operations management (flow, environment, emergency, HP);
   - are able to be replicated across the basin (national and regional consistency);
   - are able to be measured and analysed at a low cost;
   - are able to help predict as well as explain cause and effect of changes.

3. **Timing of data collection**
   - frequency captures natural or operational system status and changes, and migratory cycles (real-time, daily and weekly information);
   - forecasts of patterns of operations a day ahead, a week ahead and seasonal.

4. **Information management**
   - quality management systems should in place to ensure consistency across countries;
   - systems should allow information to be centrally archived and shared;
   - information shared should be secured and commercial confidentiality should be ensured, as required.

---

1. This network of information sources will be built on the existing network and the enhancements proposed under BDS Output 4.1.1, *A core river monitoring network for the mainstream and remaining national river monitoring networks consolidated.*
5. **Information use**

- Information should be readily available for users such as Member Countries, developers, National Mekong Committees, and line agencies;
- Information should link to relevant models and analysis tools such as the DSS.

### 5.1.5 Monitoring locations

**Guiding considerations (ISH11)**

The ISH review of information needs suggested that the following considerations are important for the locations of data collection:

- Information should be sourced from sites with good long-term data;
- Data from different disciplines should be collected at the same monitoring locations as far as practicable to assist analysis; environmental data should be supported by hydrological data (water level, flow, and hydraulic data) at monitoring locations;
- Monitoring locations should take account of the location of hydropower projects, hydro-ecological zones, the location of sites or assets of importance to key stakeholders that may have concerns about hydropower effects, which may include national borders, vulnerable communities, etc;
- Information will be needed from tributaries. These are important to understand basin scale floods, droughts and environmental processes to assist operational dialogue and coordination.

These considerations apply for operational data for water infrastructure. In addition, the work being undertaken under JEM and *BDS Output 4.1.1, A core river monitoring network for the mainstream and remaining national river monitoring networks consolidated*, will be an important input.

During the next phase of this project, a detailed review of needs and availability will be undertaken in cooperation with these other MRC initiatives to confirm the priority data location requirements.

---

Figure 4.4. ISH11 Proposed baseline monitoring locations (excluding water infrastructure locations)
5.1.6 Parameters

Guiding considerations

For hydropower and water infrastructure operations the following considerations are important for monitoring parameters:

- The parameters that inform indicators should be assist and inform operational management, decision-making, and coordination of hydropower and other water infrastructure.

- Parameters important to water infrastructure operations include engineering, hydrological, environmental, emergency management and energy security considerations, and should support data requirements for DSS for forecasting flows resulting from operational forecasts.

- Parameters should support the understanding of the range of operational issues that might be anticipated to arise at different times through the hydropower operations.

MRC operational needs

Table 4.1 indicates a preliminary list of parameters that may be needed for managing operations of water infrastructure. These parameters will be used in concert with those already gathered on MRC and other platforms to form a comprehensive source for operational management.

<table>
<thead>
<tr>
<th>Information need</th>
<th>Coordination: Shared information to inform member states</th>
<th>Potential sources of data and information</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Flow management (Flood, drought, Procedures for the Maintenance of Flow on the Mainstream [PMFM])</strong></td>
<td>Real time, daily, weekly Quality assured information on: - Hydrology: rainfall, river flows - Storage level and releases - Spillway gate operations - Abstractions - Day/week forecasts of the above <strong>Seasonally forecast of:</strong> - Abstractions (irrigation, hydropower diversions) - Hydro generation/releases - Reservoir target levels/rules - Environmental flow releases - Drought forecast - PMFM monitoring</td>
<td>National agencies responsible for: Irrigation, mines and energy, water resources MRC network (Regional Flood Management and Mitigation Centre, drought, PMFM) Hydropower operators Irrigation operators Domestic water supply agencies Lancang-Mekong Cooperation/Association of Southeast Asian Nations/Greater Mekong Subregion</td>
</tr>
<tr>
<td>Information need</td>
<td>Coordination: Shared information to inform member states</td>
<td>Potential sources of data and information</td>
</tr>
<tr>
<td>---------------------------------------------------------------------------------</td>
<td>---------------------------------------------------------------------------------------------------------------------------------</td>
<td>--------------------------------------------------------------------------------------------------------</td>
</tr>
</tbody>
</table>
| Sediment and environmental management                                           | Planning, development and management:  
- Plans for developments  
- Water demand/supply projections  
- Climate change assessments  
- Hydrological data, analysis and research                                      | National agencies responsible for irrigation, mines and energy, water resources, environment  
MRC network (Water Quality, Sediment, Joint Environmental Monitoring)  
Hydropower operators (Joint Action Plan)  
Irrigation operators                                                                 |
| Management of emergencies                                                      | Management of emergencies  
water quality (PWQM) and quantity  
Dam and community safety                                                        | National agencies responsible for water resources, emergency management  
MRC network (RFMMC)  
Hydropower operators  
Regional agencies (Association of Southeast Asian Nations  
ASEAN Coordinating Centre for Humanitarian Assistance on Disaster Management, Asian Disaster Preparedness Centre, Greater Mekong Subregion) |
| Real time, daily, weekly                                                        | Real time, daily, weekly:  
- Notice of sediment flushing  
- Water quality (real time)  
- Changes to e-flow (daily)  
- Fish passage operations (during migration season)  
Seasonal forecast:  
- Seasonal e-flow releases  
- Timing of sediment flushing  
- Ramp rates  
- Seasonal generation patterns (estimate)  
Planning, development and management:  
- Shared studies on efficacy of mitigation |                                                                                                                      |
|                                                                                     Real time, daily, weekly:  
- Real-time river flows and rainfall  
- Real-time water quality info  
- Emergency action communication contact points  
- Notification of spillway gate operations  
Seasonally:  
- Dam safety procedures (national and regional)  
- Shared emergency response plans – contacts, processes  
- Shared lessons from Emergency Action Plans,  
- Post emergency review and lessons learned |                                                                                                                      |
<table>
<thead>
<tr>
<th>Information need</th>
<th>Coordination: Shared information to inform member states</th>
<th>Potential sources of data and information</th>
</tr>
</thead>
</table>
| Hydropower cascade operations | **Real time, daily, weekly:**  
In addition to the above add:  
- Details of ‘as-built’ specifications of infrastructure (e.g. storage curves, spillway gate and power station capacities, etc.)  
- Power station operational warnings, spillway gates, navigation ops, ramp rates, day and week ahead forecast flows  
- Navigation lock operations  
- Major maintenance schedule | National agencies (Mines and Energy, Water Resources, Electricity Generating Authority of Thailand, Electcite du Cambodge, Electricite du LAO, etc.)  
MRC network (HP database)  
Hydropower operators  
Irrigation operators |
| | **Seasonally** in addition to the above add:  
- Operational storage rules curves  
- Forecast releases, storage  
- Seasonal flood capacity  
- Notification of drought storage | |
| | **Planning, development and management:**  
- Shared plans for future developments (timeframe, specifications)  
- Supply and demand projections | |

### 5.1.7 Timing of data collection

Table 4.1 indicates the likely timing for relevant information needed. These requirements will need to be practical and economically delivered. Only priority information will be gathered to avoid costly, redundant data collection and storage.

### 5.1.8 Sources and information management

**Sources**

The entire range of sources of information will be needed to ensure informed operational management focused on transboundary considerations. Table 4.1 provides an initial list of potential sources, which will be refined in the next phase of the project.

**Information management**

SP Outcome 4.1 aims for *Better informed and prepared basin communities against changing river conditions, and more frequent and severe floods and droughts*. This is to be achieved through *integrated data and information systems for more effective basin-wide data management and sharing, and compatible DSSs, building on reinvigorated data, modelling, forecasting, and communication capabilities*. 

61
A preliminary design was completed for the MRC (MRC, 2019), covering the layout of an integrated data, information, and DSS. The operational information sharing will need to integrate with this system as it emerges.

**Information security**

The PDIES and the MRC’s Data Portal will form the basis of required cooperation mechanisms and systems by which information is shared across the MRC platforms. However, it is noted that certain information should remain for the use of MRC members only and may not be made public.

The information management systems should allow for these requirements where they are essential.

**5.1.9 Gap analysis of information needed**

A gap analysis is proposed to be undertaken as part of Pilot Project 1 (see Section 6.1) commencing Q4 2021, in order to gain an understanding of which information:

- is already available from MRC data platforms;
- must be accessed through national platforms;
- needs to be procured from HP and other water infrastructure operators;
- requires the establishment of additional equipment at particular locations.

An example of the type of analysis proposed is shown in Table 4.2. Gap analysis tables will be best set up in a suitable database and accessed through the MRC data portal.

**Table 4.2. Sample layout of gap analysis for information requirements**

<table>
<thead>
<tr>
<th>Required Information parameters</th>
<th>Available?</th>
<th>Source</th>
<th>Quality (1-5)</th>
<th>Frequency</th>
<th>Platform</th>
<th>New equipment needed?</th>
</tr>
</thead>
<tbody>
<tr>
<td>River Basin Location A</td>
<td>Quality assured information on:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- hydrology – rainfall, river flows</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- storage level and releases</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- spillway gate operations</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- abstractions</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- day/week forecasts of above.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Required Information parameters

<table>
<thead>
<tr>
<th>Forecast of:</th>
<th>Available?</th>
<th>Source</th>
<th>Quality (1-5)</th>
<th>Frequency</th>
<th>Platform</th>
<th>New equipment needed?</th>
</tr>
</thead>
<tbody>
<tr>
<td>- abstractions (irrigation, HP diversions)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- hydro generation/releases</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- reservoir target levels/rules</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- e-flow releases</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- drought forecast</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Procedures for the Maintenance of Flow on the Mainstream monitoring</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| Planning:                         |            |        |               |           |          |                      |
| - plans for developments          |            |        |               |           |          |                      |
| - water demand/supply projections |            |        |               |           |          |                      |
| - climate change assessments      |            |        |               |           |          |                      |
| - hydrological data, analysis and research |            |        |               |           |          |                      |

### 5.1.10 Information use

The most important aspect of coordination of operations may be the ability of stakeholders to access the available information in order to:

- notify the Joint Committee and national agencies of short- and medium-term risks emerging in the basin regarding floods, drought, environmental emergencies that may affect, or be affected by infrastructure operations;

- provide advice on the potential for water infrastructure to assist in the mitigation of these conditions (through the information provided by the data systems and DSS);

- inform individual water infrastructure operators to allow an operational response to changed conditions as required (e.g. hydropower operators);

- allow at-risk communities to have adequate warning of changed river conditions (e.g. spillway gate operations, sediment flushing operations).

These uses of the information require timely and readily available information on a range of platforms (e.g. web based, phone applications) that is well trusted by all stakeholders. These platforms are readily created, and the MRC already has good experience through the existing information-sharing platform for PMFM, RFMMC, etc.

In order to disseminate this information seamlessly, the platform and **communication protocols** must be clear and resilient to organizational changes within agencies and be well exercised by the Member Country involved. The institutional arrangement proposed are set out in Section 5.
5.1.11 Recommendations to promote coordination opportunities

**SP Deliverables: Cooperation mechanisms for data and information sharing for existing dams (2022/2023), and Information sharing and communication mechanisms for water-related emergencies (2022/2023)**

1. **Completion of the Scoping Stage** - Deliverable under SP Activities 4.2.1.1. The finalisation and endorsement of this report by the Joint Committee in November 2021 completes the Scoping Stage of this Activity 4.2.1.1 under the SP 2021–2025. This has been achieved through:
   a. National Consultations – September – October 2021,
   b. Regional Consultation – December 2021
   c. Joint Committee endorsement – November 2021.

As noted in this report, the following next steps are therefore endorsed:

2. **Pilot Project 1**, “Cooperation mechanisms for data and information sharing for existing dams (Integrated operational water infrastructure data available on MRC data portal)”: By Q4 2023 (i.e. SP Activity 4.2.1.2)

3. **Pilot Project 2**, “Information sharing and communication mechanisms for water-related emergencies (Operational coordination and Emergency response in the 3S Basin during the 2022/2023 flood season)”: By Q4 2023 (i.e. SP Activity 4.2.1.4).

5.2 **Collaboration Opportunities – Adapting operations for regional benefit**

**SP Activity 4.2.1.2: 4.2.1.2 Develop and implement cooperation mechanisms for data and information sharing for existing dam operations (linked to Joint Action Plans) to optimize regional benefits and minimize regional costs**

The achievement of this deeper stage of cooperation will have significant benefits for Member Countries. These benefits go beyond the benefits of shared information and enhanced communications during operations (e.g. emergencies).

A number of these collaboration opportunities are already noted in the Joint Statements issues after PNPCA for Pak Beng, Pak Lay and Luang Prabang mainstream dams. The coordination of the operations of the projects will be the task of the host member country, Lao PDR, with the transboundary elements dealt with by MRC under an institutional arrangement to be developed under this MRC SP Activity, as per the Joint Action Plan tracking matrix.

Some of these opportunities are more difficult to implement regionally, requiring the resolution of issues regarding the reasonable and equitable use of the resource. In addition, there may be limited scope in some water infrastructure due to: (i) the need to deal with existing CAs and Power Purchase Agreements and; (ii) there may be limited operational
flexibility due to limited existing storage capacity. Those opportunities that require more structural change to the capacity of storage or significant change to operation of storage, will be dealt with under Stage 2 MRC SP Activity 4.2.1.4 together with the PRP under MRC SP Output 3.1.1.

5.2.1 Operating Requirements within Existing PNPCA Statements and Joint Action Plans

The PNPCA process undertaken for mainstream dams over the last three to five years has, in each case, resulted in an agreed Joint Statement that sets out the approach on how to resolve the remaining key concerns of notified MRC Member Countries. These agreed actions are then included in a joint action plan, which would be followed to resolve these issues through the detailed design, construction, and operations stages of the project.

A number of these issues relate to operational coordination requirements between upstream and downstream hydropower projects but also include the consideration of environmental and socio-economic impacts of operations and emergency management. Examples are shown in the following sections.

Extract from the Luang Prabang’s Prior Consultation Statement

The Joint Committee of the MRC...

V Requests the Government of Lao PDR to work with the MRC in the development of cascade operating rules that respects the sovereign decision making of the Government of Lao PDR and balance the financial viability of the upper Lao Cascade HPPs, while making every effort to minimize the risk of potential transboundary adverse impacts. This should aim to identify measures that address, inter alia:

a. The regular flushing of coarse-grained sediments through the impoundments by adjusting the operating rules.
b. The routing of sediments through the impoundments during natural flood events.
c. The downstream drift of aquatic species larvae and eggs during critical migration periods.
d. The potential impacts of extreme flood and drought events in line with the provisions of the Procedures for the Maintenance of Flows on the Mainstream (PMFM).
e. The risks of multiple failure of infrastructure on the upper mainstream.
f. Early warning of rapid increases in inflows and large water releases to the downstream HPPs and affected communities, the MRC Secretariat and downstream countries.
g. The preservation of any remaining free-flowing habitats between the proposed Sanakham HPP and Chiang Saen of Thailand.
h. The provision for a River Information System to improve the safety of navigation and reduce the waiting times for shipping at the navigation facilities.
**Extract from the Pak Lay’s Prior Consultation Statement**

For the following extract is pertinent:

1. **Addressing the impacts of the changed hydrology by:**
   - Introducing the operating rules curve to accommodate requirements of flow management as Article 6 of the 1995 Mekong Agreement, cascade optimisation and no significant harm to the downstream, that is aligning with Xayaburi HPP, and other potential mainstream HPPs to improve sediment flushing and downstream larval drift; and
   - Ensuring environmental flows for the area immediately downstream of the dam site.

2. **Increasing the transport of sediment through the head pond by considering:**
   a. Optimising sediment-related design to improve the sediment delivery efficiency of the PLHPP, including effective flushing gates and mechanical delivery method;
   b. Considering the measures to minimize and mitigate the potential impacts of sediment deposition in the headpond/in-channel storage;
   c. Reviewing the sediment management strategy to pass sediment more frequently, such as on a seasonal or annual basis; and
   d. Coordinating water management and sediment management operations at the PLHPP with other hydropower projects of the cascade to minimise adverse impacts of flood and drought downstream and optimize power supply.

**Extract from the Pak Beng’s Prior Consultation Statement**

Similarly, the Pak Beng Statement states:

1. **Address potential effects to upstream and downstream hydraulics and hydrology:**
   a. Undertaking, in cooperation with Thailand, further flood modelling to map areas and infrastructure in Thailand that may be inundated, under a range of operating rules, and a range of tributary inflows;
   b. Indicating the frequency at which this inundation may occur;
   c. Apply proper operation rules and coordination to minimize the impacts on flows both local and transboundary nature; and
   d. Using the outcomes of these analyses to inform the Parties for development of monitoring activities and the design and operations of the PBHPP.

2. **Improve the sediment transport through the headpond/in-channel storage and water management by:**
   a. Optimizing sediment-related design to improve the sediment delivery efficiency of the PBHPP, including effective flushing gates and mechanical delivery method;
   b. Considering the measures to minimize and mitigate the potential impacts of sediment deposition in the headpond/in-channel storage;
   c. Creating near pre-dam hydraulic conditions at the dam site during higher inflow conditions;
d. Reviewing the sediment management strategy to pass sediment more frequently, such as on a seasonal or annual basis, and not only when flow levels exceed 5,961 m³/s;
e. Coordinating sediment management operations at the PBHPP with other hydropower projects in the region to minimize adverse impacts and optimize power supply; and
f. Coordinating water management operations at the PBHPP with other hydropower projects in the region to minimize adverse impacts for flood and drought downstream.

5.2.2 Flood and emergency management mechanisms

Further to the information sharing, operational mechanisms during floods could ensure that:

- the floods occur without a detrimental effect on downstream or upstream HPPs;
- sudden and extreme changes in water levels are avoided downstream;
- adequate warning and notification are provided to downstream communities and navigation;
- dam and other downstream infrastructure are not compromised;
- upstream and downstream plant are able to plan and estimate forward production (timeframe to be negotiated);
- opportunities to route sediments are maximized;
- opportunities to store flood waters to mitigate flooding are maximized.

Flood mitigation

The options to utilize water infrastructure in the Mekong Basin to mitigate floods has also been the subject of a number of studies over the years. The annual flood peak in some areas of the Mekong has already been reduced through the construction and operation of hydropower storages in the Lancang and Mekong Basins (Council Study, MRC, 2017). As more storages are constructed in the basin, this may further affect these seasonal pulses dependent on natural hydrological variability, climate change impacts, and operations.

The use of the Mekong basin’s infrastructure to mitigate floods will depend on the areas for which flood protection is required. Flood protection for local towns and villages on tributaries may be possible using existing hydropower, irrigation or water supply dams. Suitable mechanisms would need to be developed at a national and Mekong tributary level to assist with these floods. These may require the inclusion of flood storage capacity in these dams and associated operational rules.

However, mitigation of larger-scale flooding on the Mekong mainstream and of a transboundary nature (e.g. Cambodian flood plain or the Mekong Delta), requires more substantial storage. The ability to locate and develop this large-scale storage in the basin is to be considered as part of SP Output 3.1.1 on PRP.
Emergency management

Management of flood through existing infrastructure is aimed at reducing impacts of infrastructure operations and protecting lives of communities downstream, as well as facilitating safe navigation of vessels along the river.

Cooperation of the full cycle of emergency management will facilitate preparedness and rapid response for future incidents. Figure 4.5 is a typical emergency response cycle. Member Countries and stakeholders (e.g. HP operators) may cooperate in all phases of this cycle.


Cooperation will be required for power station and spillway gate operation rules and notifications, thresholds for flood notifications, shared community notification mechanisms, national and transboundary coordination of operations, shared Emergency preparedness plans and emergency action plans.
The development of these flood and emergency management mechanisms may include the following:

- Evaluation of the current national and regional water-related emergency management mechanisms in terms of completeness, effectiveness and reliability. This includes the identification of effective communication lines in order to communicate with communities as well as considerations regarding remoteness, language barriers, and differences in accessing information for vulnerable communities (women and men, girls and boys), and other factors to be determined.

- Information on evacuation needs to address mobility challenges of some affected groups, such as people with disabilities and the elderly. Subsequently, the options for improving the existing mechanisms will be identified, based on a review of relevant international systems, standards, testing (e.g. water quality), and communication mechanisms and response action plans that could be tailored to Mekong Basin conditions.

Improvement of the implementation of the MRC PWQ will also be considered. This may enable the timely identification and monitoring of a water quality emergency (see SP Activity 1.1.1.4) and the planned improvement of the technology and methodology for river monitoring and flood forecasting under SP Activities 4.1.1.1 and 4.1.4.1. The various options for improved emergency management will be clearly described, possibly in the form of alternative flow charts of communications, and actions at the regional and national levels. They will also consider cost-effectiveness, implementation capacity, and gender- and vulnerability-responsive approaches to ensure reliable dissemination of warning information to vulnerable river communities, and build their capacities for disaster response and recovery. All of this will be aligned with the national disaster management plans.

A gender- and vulnerability-responsive approach as envisioned by the ASEAN community needs to be central to all prevention, emergency and post-emergency measures.

### 5.2.3 Drought management mechanisms

Drought management mechanisms by their nature require strategic use of the basin storage facilities and cooperation on the energy/water nexus issues. Management of droughts will require PRP, as stated in the SP Output 3.1.1. Storages designed primarily for hydropower production may be used for drought mitigation; however, the effect on energy security/constraints of existing power purchase agreements will need to be taken into consideration. The scale of storage requirement may be substantial at a basin scale. Storage rules and releases would need to be compatible with energy generation obligations. There will be a trade-off between drought mitigation and hydropower production.

Due to the limited storage in the LMB, drought management opportunities may be limited to local tributary locations. Therefore, areas of cooperation regarding the use of existing water storage in drought management in the LMB will be limited to sharing information on seasonal storage capacity (real-time and forecast), forecast operations and on water releases.
The development of a DSS, as per Section 4.1.2, will facilitate forecasts of medium-term drought risks on PMFM thresholds and Tonle Sap reverse flows, and provide decision makers (the JC) with opportunity to consider contingency plans.

5.2.4 Tonle Sap reverse flows

The effect of operational water storage management of dams within the upper and lower Mekong Basins on the timing and scale of reverse flows into Tonle Sap has been demonstrated in a number of recent MRC studies (MRC, 2019). There may be the opportunity to utilize these basin storages to assist in the mitigation of these impacts. However, due to the relatively small scale of the storages in the basin overall (relative to mean annual runoff) and their ability to time reservoir releases in a coordinated manner to enhance these Tonle Sap reverse flows, this is a difficult proposition. A recent MRC paper (MRC, 2020) draws attention to the role that PMFM and related monitoring may have to assist in managing these impacts.

*PMFM monitoring tracks the mainstream flows and total reverse flow volumes allowing the MRC to provide timely warnings of the potential impacts, and allowing the Member Countries to implement their own mitigation measures. However, using the PMFM to trigger drought mitigation measures and to assist in improving Tonle Sap reverse flows depends on the risks faced by the hydropower operators and irrigators. This in turn rests on a continual assessment of the “available storage,”¹³ which requires regular reporting of reservoir levels.*

BDP/SP activities on PRP (Output 3.1.3) includes the investigation of locations for additional basin storage that may be jointly developed by MRC Member Countries to assist in flood, drought, and Tonle Sap reverse flow management.

5.2.5 Engagement with China and Myanmar

Existing major water storage in the UMB may have the capacity to assist in flood and drought management. However, these storages are primarily developed for hydropower production.

Essential to engagement with UMB operators will be the appreciation of mutual benefits that may arise from combined strengths in the UMB and LMB. The MRC will seek to focus on those areas of collaboration that will drive their strategic outcomes. The current cooperation in information sharing, joint research, and capacity building should be substantially enhanced in the coming SP.

 Particularly, additional cooperation for sharing hydropower operational information (planned and current) on flows, sediment, and forward seasonal plans for operations will allow practical support for downstream flood and drought management and notification.

¹³ ‘Available storage’ refers to water that could be released without an unacceptable risk of severely compromising the hydropower output or yields on irrigated crops.
Cooperation mechanisms may:

- enhance existing mechanisms for information sharing on operational coordination of hydropower (maintenance outages, flood management, drought management, etc.) between UMB and LMB hydropower, and communication to appropriate stakeholders;
- scope and implement joint studies on UMB/LMB operational interactions (including seasonal flow patterns and sediment transmission).

### 5.2.6 Summary of opportunities

**Flow Management – Adaptive management of existing water infrastructure**

<table>
<thead>
<tr>
<th>Opportunity</th>
<th>Collaboration proposed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assist flood and drought management where possible</td>
<td>Mitigation of floods though retention of ‘air-space’ for flood storage in reservoirs. Timing of gate operation, power station operation to reduce flood peak. Storage or retention of additional water seasonally to mitigate drought.</td>
</tr>
<tr>
<td>Adapt operations to meet PMFM targets (including Tonle Sap Reverse flows)</td>
<td>Coordinated release from water storage to seek to meet PMFM thresholds. This aims to mitigate effects of water infrastructure storage or operations normally in non-drought seasons.</td>
</tr>
<tr>
<td>Use multi-purpose storage for management of Irrigation, domestic and industrial abstraction</td>
<td>Water infrastructure operated to meet multiple uses for shared/regional benefits. This may include wider benefits such as tourism (e.g. Khone Falls) and/or provide resource access to project-affected communities (e.g. reservoir fish farming, domestic or agricultural water supply. Maximising benefits and minimizing impacts: economic, environmental, social.</td>
</tr>
</tbody>
</table>
**Sediment and Environmental Management – Adaptive management of the hydropower cascade to avoid, minimize, and mitigate harmful effects**

<table>
<thead>
<tr>
<th>Opportunity</th>
<th>Collaboration proposed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coordinate sediment flushing</td>
<td>Sediment flushing across a cascade coordinated and seasonally adjusted to facilitate maximum transmission.</td>
</tr>
<tr>
<td>Coordinate operation of fish passage</td>
<td>During the migration season, attraction flows and fish passage operation to facilitate maximum successful migration. Downstream migration and drift of larvae to be facilitated through the operation of cascades in order to increase reservoir velocities.</td>
</tr>
<tr>
<td>Coordinate consistent environmental flow releases</td>
<td>Agreed environmental flow releases passed through the cascade and across national boundaries to facilitate fish migration, maintenance of habitat in all seasons.</td>
</tr>
<tr>
<td>Use joint environment monitoring</td>
<td>Monitoring tests on the effectiveness of coordinated operations to allow adaptive changes to above operations based on agreed indicator targets.</td>
</tr>
<tr>
<td>Use power station ramp rates (reservoir and downstream) to avoid bank erosion environmental impacts</td>
<td>Avoidance of rapid changes in water level within the reservoir or downstream that causes bank erosion and loss of habitat for shore-based invertebrates and wildlife. Coordinated operation within cascade required.</td>
</tr>
<tr>
<td>Use joint studies (e.g. PRP) to facilitate improved environmental outcomes.</td>
<td>Basin-scale SOBR and joint monitoring to allow basin-scale and transboundary joint assessments. Improved environmental outcomes through lessons learned applied to future projects and plans.</td>
</tr>
</tbody>
</table>

**Emergency Management – Coordinated operations**

<table>
<thead>
<tr>
<th>Opportunity</th>
<th>Collaboration proposed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adapt operations to relieve flow/Water Quality (PWQM)</td>
<td>Agreed adapted operations to relieve emergencies.</td>
</tr>
<tr>
<td>Coordinate emergency planning and response</td>
<td>Preparation of consistent plans and regional sharing of resources for emergency response. Shared warning systems. Joint preparedness exercises ensure readiness and build regional cohesion.</td>
</tr>
<tr>
<td>Joint governance at basin/regional</td>
<td>Regional level permanent body to ensure communications and rapid decision making in times of emergency</td>
</tr>
<tr>
<td>Post-emergency review and lessons learned</td>
<td>Draw on joint lessons learned to reduce risks of future events.</td>
</tr>
</tbody>
</table>
Hydropower Cascade Design and Operations – In addition to the above

<table>
<thead>
<tr>
<th>Opportunity</th>
<th>Collaboration proposed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating rules coordinate upstream and downstream hydro generation for</td>
<td>Operate cascades of HPP in tributaries or basins for the mutual beneficial maximization of production from flows (e.g. the 3S Basin). Economic benefits</td>
</tr>
<tr>
<td>mutual maximum net benefit.</td>
<td>through ‘optimized’ cascade operation and shared benefits.</td>
</tr>
<tr>
<td>Hydro operation to support solar/wind and other renewables</td>
<td>HP storage operations adapted to economically to support solar and/or wind generation. Adaptation of commercial agreements to facilitate mutually beneficial outcomes and shared benefits.</td>
</tr>
</tbody>
</table>

5.2.7 Recommended steps to scope and analyse collaboration opportunities

SP Activity 4.2.1.2: Develop and implement cooperation mechanisms for data and information sharing for existing dam operations (linked to Joint Action Plans) to optimize regional benefits and minimize regional costs

In order to refine, prioritize, and develop these collaboration opportunities the following steps are proposed:

1. As part of Scoping Stage, these above collaboration opportunities (Section 4.2.6) will be further discussed with Member Countries and necessary stakeholders, and formulated into prioritized operational scenarios (e.g. for flood and drought mitigation). (Timeline to be confirmed)

2. These operational scenarios are to be shared with the team working on PRP (SP Output 3.1.1) to allow for their inclusion in the operational analysis using the enhanced operational DSS proposed under the first phase of the PRP. (Timeline to be confirmed)

3. The operational implications, benefits, and impacts on a range of economic, environmental, and social indicators will be analysed. They will be discussed with Member Countries and relevant stakeholders to understand the potential for altered and improved operational management outcomes. (Timeline to be confirmed)

4. Agreed collaboration proposals, where clear mutual net benefits for the basin and stakeholders are presented, may then be tested and the outcomes reviewed through agreed ongoing operations governance mechanisms.

5. The proposed institutional and governance arrangements documented in this report (Section 5) and documented and tested under the proposed pilot projects (Section 6) will be further enhanced and tested to facilitate cooperation towards the implementation of these revised operational collaboration proposals.
5.3 Joint Action Opportunities – Planning development, design, and operations for regional benefit

These opportunities seek to further advance and deepen the cooperation mechanisms surrounding the planning and future operations of dams and other water infrastructure in the Mekong.

Cooperation mechanisms highlighted for Coordination and Cooperation above mainly deliver the outputs from MRC SP Activities 4.2.1.2 and 4.1.2.4 on existing dams (Stage 1). These opportunities are focused on the immediate practical opportunities for information sharing, and adapted operations to increase benefits and reduce impacts while dealing with the important emergency management question.

The investigation of Joint Action is part of the Stage 2 (SP Activity 4.2.1.3) for new dams and other water infrastructure. This highlights opportunities for operational coordination among countries where the water infrastructure is specifically planned and designed with a view to optimizing regional benefits and minimizing regional costs.

PRP (SP Output 3.1.1) will consider the planning, development and management of this sort of infrastructure to deal with the challenges of floods, droughts, and climate change mitigation generally. Inevitably, to realize the mitigation benefits and reduce costs that may arise from that proactive planning, information sharing and cooperation on operational coordination will be required.

5.3.1 Recommended steps to scope and analyse joint action opportunities

Coordinated design and operation of cascading infrastructure through joint action as well as the associated data and information sharing on project plans and potential operations are complex throughout transboundary basins.

The further development of opportunities for joint action will draw on the lessons learned from the outcomes of the work undertaken on Coordination and Collaboration opportunities as described in the previous sections (i.e. SP Activities 4.2.1.2 and 4.2.1.4) considered as stage 2. Due to the complex and interlinked nature of these proactive planning activities, this activity will be explored further in the Mekong River Basin together with SP Output 3.2.2 in synergy with, or as part of, the SP Output 3.1.1 on PRP.
The following implementation steps are proposed:

1. **Hold consultations with the respective National Mekong Committees and Expert Group on Basin Planning on the scope of Stage 2 cooperation mechanisms and objectives**

   This step will be undertaken in close cooperation with the team that is assembled for the proactive planning exercise under SP Output 3.1.1. Specifically, the role that water storage infrastructure is proposed to play in managing basin resources, floods, drought, and climate change is defined.

2. **Based on lessons learned from Stage 1, define the scope of additional information sharing required for PRP exercise**

   Based on the need identified in the above step, the information gaps that may remain after Stage 1 will be specified, and a mechanism to close the gaps agreed.

3. **Identify conceptual options for information sharing and coordinated design and operations**

   Work with the proactive planning team to identify and describe conceptual options for data and information sharing, and coordinated design and operation suitable for the Mekong region to be discussed among key and broader stakeholders. This may include, for example:
   - the design and operation of new hydropower storage for flood and/or drought management;
   - the operational coordination needed between new proposed dams and existing hydropower dams for flood/drought management, the transmission of sediment, other environmental management purposes; and
   - dialogue and joint research with China and UMB operators to assist with the above imperatives.

4. **Conduct modelling and analysis on proposed conceptual options to test feasibility and economics**

   In order to maximize net benefits and preserve the economic integrity of existing water infrastructure assets, where possible, any proposed conceptual operational coordination will need to be carefully analysed and the economics tested. In these cases, the previous work under MRCs Initiative for Sustainable Hydropower (ISH) (MRC, 2017) and other relevant studies may be drawn upon to frame scenarios for assessment. This work will use the MRC’s improved DSS tools, which will also be used for the assessment of PRP scenarios. The operational scenarios will be tested alongside, or be included in, the PRP scenarios. Promising opportunities for joint action will be advanced through the MRC governance arrangements.
6 Governance and Communication Arrangements for Water Infrastructure Operations

Noting the lessons learned from the international experience (Section 2.2), the MRC under the 1995 Mekong Agreement and being associated with LMC and other regional bodies (e.g. ASEAN, GMS) is the appropriate structure in which institutional arrangements for transboundary operational cooperation may be created. These institutional arrangements should be fit for purpose and scaled to be responsive to the objectives set by the Member Countries.

The overall governance structure of the MRC should guide the operational cooperation. However, as operational decision-making will need to be timely, clear delegations will be needed to be provided to relevant national agency heads to allow the operations management in real-time. Clear lines of communication and specific contact points with relevant authority (with proxy as necessary) are necessary.

In the context of the Mekong, the definition of governance in the Economic and Social Commission for Asia and the Pacific (ESCAP)14 is appropriate:

- **Governance** is the process of decision-making and the process by which decisions are implemented (or not implemented).
  Since governance is the process of decision making and the process by which decisions are implemented, an analysis of governance focuses on the formal and informal actors involved in decision-making and implementing the decisions made and the formal and informal structures that have been set in place to arrive at and implement the decision....

- **Good governance** has eight major characteristics. It is participatory, consensus oriented, accountable, transparent, responsive, effective and efficient, equitable and inclusive and follows the rule of law.

The structures proposed below would be informed by the above principles.

**6.1.1 Mirrored national and regional processes for coordination of operations**

In order to facilitate timely and clear information sharing and notifications between regional and national coordination centres, it is proposed to, wherever possible, mirror coordination processes of national and regional operations. A proposal to illustrate this coordination is shown in Figure 5.1.

---

14 See ESCAP (n.d.) on “What is Good Governance”: [www.unescap.org/pdd](http://www.unescap.org/pdd)
Transboundary communications – routine

It is likely that national water and energy coordination of Member Country will take different forms and be influenced by a variety of requirements. For example, the key operator of a number of HPPs in Lao PDR is EGAT, Thailand, which will dispatch the HP plant according to its grid requirements. The availability of the plant capacity for the following week is set by the HP operator, accounting for inflows, reservoir level, and environmental constraints, etc.

Therefore, operations affecting downstream HP projects, communities, and the environment are either as a result of the power generation of a HP plant (power dispatch by EGAT) or through the operational decisions of the individual operator (e.g. for flood releases).

The HP plant operator will therefore be required to first forecast the above availability and likely dispatch, and second, communicate the effect of that on upstream downstream HP projects and communities prior to the event. Both the forecast and the communication to downstream may require transboundary negotiations and communication. The processes for these routine negotiations and communications can be set up through a regional Planning Expert Group (or future Operations Expert Group) under the umbrella of the MRC governance.

Transboundary emergency management

Emergency management will be set up differently in each Member Country to meet the national priorities. In addition, it will be important for transboundary emergency management planning to be set up well before any incidents occur. As noted in Section 4.2.2, there are valuable steps within the emergency management continuum that may be implemented under the auspices of the MRC Planning Expert Group well in advance of emergency incidents occurring. When an emergency incident occurs, rapid and clear transboundary communication and well-practised response processes may then be set in motion.
The work of the MRC Regional Flood and Drought Management Centre (RFDMC) is highly regarded among the MRC Member Countries. Real-time information links between the RFDMC and operational water infrastructure will be needed to allow flow forecasting and information dissemination. The above communications arrangements should leverage existing communication channels, both for routine and emergency (flood) situations.

Figure 5.1. National and regional operational coordination
6.1.2 Regional information-sharing platform and decision support systems

The Regional Information Sharing Platform and DSS have been described in Section 4.1.2, which will be implemented in collaboration with the SP Activity 4.1.3 Core River Basin Monitoring Network and in support of future work on SP Activity 3.1.1, Proactive Regional Planning.

6.1.3 The role of the MRC Expert Groups on Basin Planning and on Environmental Management

The 2018 dam break incident at Xe-Pian Xe-Namnoy has highlighted the need for real-time sharing of information to allow downstream nations to be fully informed about emergency situations and to be able to respond through their national agencies. The lessons learned from this incident will serve as an important input to the set-up of governance and communications arrangements within the MRC and National Mekong Committees.

The aim is for the existing MRC Expert Group on Basin Planning to oversee the initial pilot projects under this SP Activity.

It should be noted that operations will also be covered in the work of a number of other MRC expert groups, including the Expert Group on Environmental Management. Mechanisms to ensure cross-sector communication will need to be built into the governance processes.

6.1.4 Formal MRC operations coordination sub-body

As the workload associated with operations increases, consideration should be given to the formation of a formal MRC Operation Expert Group in the medium term to allow clear focus on these operational matters. This proposed Operations Coordination Expert Group (OCEG) should have clear terms of reference and oversee cross sector and transboundary communications and operational coordination mechanisms as a priority.

This MRCS operations role may later be formalized under a subsequent Mekong Agreement addendum that sets out the roles and responsibilities of MRCS sub-body in relation to operations coordination.

6.1.5 Coordination with the Mekong Lancang Cooperation Centre

In line with the national and regional coordination as shown above, an important link to the LMC will be needed. The existing dialogue on full seasonal information sharing sets a foundation for additional data to be sourced from the LMC needed to procure forecasts of flows into the LMB.

The additional information that would be needed for both weekly and seasonal forecasting of river conditions would include:
- notification of plant outages affecting flows at Chiang Saen (week ahead and seasonally);
- forecast discharges from the Jinhong Dam two weeks ahead (updated weekly) and seasonally (updated monthly).

There will be a number of routine and emergency preparedness issues that would require ongoing dialogue through the existing channels.

An initial proposal showing coordination interactions is shown in Figure 5.2.

![Figure 5.2. Outline of interactions between Lancang-Mekong Cooperation and Mekong operations](image)

**LMC shared data platform**

For operational coordination between the Lancang HPP and those in the LMB, additional information will need to be shared between the operators and riparian nations on current and forecast operations. This will require enhancements to LMC and MRC data platforms to accommodate this additional data to allow sharing within the appropriate timeframes.

At the 25 August 2020 meeting of the Lancang and Mekong riparian nations’ leaders in Vientiane, Lao PDR, the Chinese Prime Minister, Li Keqiang, pledged to share year-round hydrological data with the Mekong countries. This undertaking was welcomed by the Member
Countries. Previously, only flood season data had been shared. The details of the specific information to be shared and the mechanism for sharing it are yet to be finalized.

China, as an MRC dialogue partner, expressed its interest in working with the other five Mekong Countries to set up a new data-sharing platform under the LMC mechanism.

The LMB countries already have an operational data and information-sharing platform in place, which is governed by the 1995 Mekong Agreement and the PDIES.

The MRCS is supporting the work within Member Countries (with cooperation with China and Myanmar) to enhance the existing, long-established shared data platform, seeking to capitalize on the Commission’s culture of collaboration in this area. The current consideration is that these two information-sharing platforms (the LMC and the MRC) will be closely connected to allow wide access to these data in a timely manner.

**Note:** The MRC Procedures relevant to information sharing (PDIES, PMFM, PNPCA) have been mainly used in a planning context to date although they are also applicable to real-time operations and daily information sharing. It will be necessary to ensure that sharing of information in real time is reliably facilitated through the procedures and related technical guidelines. This work will need to be carried out in parallel with the Pilot Project 1 in coordination with SP Outcome 5.1.

### 6.1.6 Mekong Basin stakeholder engagement

A critical component of the operational coordination will be the engagement of key stakeholder groups in the process. Most importantly, water infrastructure operators (e.g. hydropower developers and operators, irrigation, operators) will need to be closely engaged in coordinated operation. Initially, this will be achieved through the sharing of information from their infrastructure on water levels and flows, and then more importantly on the forecasts of operations for coordinated management.

Similarly, key stakeholders in related government agencies will need to be engaged: emergency management bodies, power grid operators (e.g. EGAT, EDL, EDC) and national water management authorities (e.g. Royal Irrigation Department of Thailand).

Communities along the river directly affected by the water infrastructure operations will need to be involved in operational communications and design of warning and notification mechanisms. Attention will need to be paid to the involvement of women, minorities and other vulnerable groups to be sure that their needs are properly addressed.
7 Proposed Pilot Testing of Preliminary Operating and Communication Protocols

Member Countries have noted the urgent need to enhance operational information sharing and coordination. Four potential pilot projects are set out below with a brief description of their scope, which contribute to the deliverables as per the SP Output 4.2.1. Other suggestions from Member Countries may be provided through the consultations in June and November 2021.

The pilot projects are aimed at achieving two of the four deliverables that are proposed under the SP Output 4.2.1.

7.1 Pilot Project 1: Cooperation mechanisms for data and information sharing for existing dams (integrated operational water infrastructure data available on MRC data portal)

SP Deliverable: Cooperation mechanisms for data and information sharing for existing dams (SP Activity 4.2.1.2 by 2022/2023)

As noted in the previous sections of this report, there is a large amount of information that may be necessary for fully fledged operational management. However, the information that is already on publicly available data platforms can be made available through the MRC data portal integrated with information on existing MRC data sharing platforms:

- Near real-time water levels at a range of station relevant to water infrastructure operations
- PMFM water level status
- Regional Flood Management and Mitigation Centre
- Drought forecast
- MRC Hydropower Database.

There are hydropower and irrigation project status data that are currently shared on a number of national websites; an example from Thailand is shown in Figure 6.1 below.
Information gap analysis: This Pilot Project 1 will focus primarily on that operational water infrastructure information, specifically on flow conditions, that is currently not available on MRC data systems highlighted through a detailed gap analysis. The nature of this water infrastructure operational information is set out in the “Coordination- related Flow Aspect” column in the matrix of opportunities in Annex 1. The criteria to be considered in the gap analysis are also elaborated on in the Operational Opportunities Report including the location, parameters, timing, and quality of the information needed. The gap analysis is required to obtain an understanding of which information:

- is already available from MRC data platforms;
- must be accessed through national platforms;
- needs to be procured from HP and other water infrastructure operators;
- requires the establishment of additional equipment or IT linkages at particular locations, etc.
An example of the type of analysis that is proposed is shown below. These tables will be best set up in a suitable database and accessed through the MRC data portal.

**Note:** No additional monitoring equipment is proposed to be installed under this activity. If additional monitoring sites are needed and agreed between Member Countries, then these may be delivered under SP Output 4.1.1 *A core river monitoring network for the mainstream and remaining national river monitoring networks consolidated.*

### Example of a layout of gap analysis for “FLOW” information requirements

<table>
<thead>
<tr>
<th>Required Information parameters</th>
<th>Available?</th>
<th>Source</th>
<th>Quality (1-5)</th>
<th>Frequency</th>
<th>IT Platform</th>
<th>New equipment needed?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quality assured information on:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Hydrology – rainfall, river flows</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Storage level and releases</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Spillway gate operations</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Abstractions</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Day/week forecasts of above</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>River Basin Location A</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Forecast of:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Abstractions (irrigation, HP diversions)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Hydro generation/releases</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Reservoir target levels/rules</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- E-flow releases</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Drought forecast</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Procedures for the Maintenance of Flows on the Mainstream (PMFM) monitoring</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Plans for developments</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Water demand/supply projections</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Climate change assessments</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Hydrological data, analysis, and research</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Cooperation mechanisms for collection and dissemination:** Pilot Project 1 will cover the processes by which the information is collected and disseminated, both through MRC platforms and through Member Country line agencies, hydropower stakeholders (e.g. HP developers/operators) and civil society channels, as well as the operationalization of these processes. This step of the pilot project will be carried out in collaboration with the team working on the MRC’s Data Invigoration Project, which will provide updated information systems to support the MRC’s DSS. In addition, the MRC procedures (e.g. PDIES) will form a foundation for the sharing of this operational information. The MRC has an activity under the SP 2021–2025 that is aimed at investigating suitability of these procedures and relevant technical guidelines for near real-time information exchange between Member Countries. The cooperation mechanisms will be documented based on existing procedures and protocols and then trialled during the Pilot Project.
Dashboard: The aim is to bring this new information together with that currently available on the MRC and other platforms in a meaningful operational dashboard. This dashboard will start in a simple form and be developed over time with the additional of week ahead and seasonal forecasts provided by an upgraded DSS. The dashboard will be a synthesis of information gathered from MRC Platform, Member Countries, stakeholders, and other relevant sources formulated in a manner that supports understanding of the current and forecast conditions in the Mekong at the selected pilot testing sites. This information should be disseminated to and clearly understood by a range of stakeholders including vulnerable communities upstream and downstream of the cascades. Initially, the dashboard will be focused on flow and water levels only and will source information from currently available locations. The information should be provided in a form that addresses the needs of stakeholders. For example, the dashboard may indicate forecast river level rises and falls in the next 12–48 hours at locations important to upstream and downstream infrastructure, and villages affected by hydropower operations. A prototype of the dashboard design will be discussed with Member Countries and stakeholders to ensure that it respond to relevant needs.

Stakeholder engagement: It will be important to engage asset owners, line agencies, relevant dispatch centres, and affected communities. This will allow an understanding of their needs and also the most appropriate communication protocols. Discussions will be held with Member Countries to ascertain the most effective way to obtain this engagement in the current COVID-19 environment.

Link to relevant BDS activities: Pilot Project 1 will need to link closely to the other MRC initiatives that are currently underway to ensure that the information that is arriving through those initiatives meet the needs (location, parameters, frequency, availability) of operational management of water infrastructure and feed into enhanced DSS analysis. Those linkages were set out in the preceding sections and included in Figure 1.5. In particular, the necessary information technology platforms, databases, and links to national data systems will be implemented under SP Output 4.1.2, Integrated data and information systems for more effective basin-wide data management and sharing.

Prioritize: To achieve progress on the practical implementation of this work, the Pilot Project 1 will prioritize the key information that will meet the requirements raised by Member Countries. At the Regional Consultation in June 2021, the Member Country clearly stated that emergency management (flood and drought) was to be the immediate focus.

Pilot implementation: Processes collection and dissemination of information will be proposed and piloted under this activity.

Governance arrangements: The governance and institutional arrangements that have been proposed in this report will be documented and consulted with Member Countries so that they may be trialled as part of these pilot projects. This will be achieved through a learning by doing process so that operational discussion can commence on the basis of sharing information as soon as possible.
7.1.2 The regional focus of Pilot Project 1

While the ultimate aim of the Pilot Project 1 is to obtain operational information for the whole basin, it is proposed to direct its attention to areas that will be of most interest to Member Country line agencies responsible for IWRM within the basin.

The MRC Member Countries will direct the focus of Pilot Project 1 on Mekong mainstream reaches, which are the subject of current study (e.g. JEM and existing MRC data monitoring). There is already a reasonable amount of operational data on these reaches gathered through the operators, MRCS, and national systems. In addition, the operations of these dams have transboundary impacts.

Therefore, in order to test concepts and build trust and cooperation on operational coordination under this pilot project, it should focus on the mainstream Xayaburi and Don Sahong HPPs. While these are clearly not currently operating in a cascade, the dashboards developed will provide valuable opportunity to test the concepts and cooperation mechanisms.

7.1.3 Proposed output

The following outputs of this pilot project are proposed:

- preparation of a combined inception report for Pilot Projects 1 and 2;
- completion of a gap analysis of information needs versus available information, including indicating sources of relevant hydropower operational information;
- documentation and trial of the cooperation mechanism to facilitate the sharing and the sourcing of required hydropower static and operational data;
- a simple clear operational dashboard set up for integrating these available data in a form useful for operators, government agencies, and wider stakeholders;
- consultation with stakeholders of processes, dashboard and dissemination plan;
- solutions for relevant IT connections needed to collect the information based on relevant MRC and national systems;
- documentation of preliminary governance arrangements tested and lessons learned.
- pilot of the implementation of processes, dashboard and cooperation mechanisms;
- final report covering description of the implementation of the above steps and lessons learned from the trials together with actions to improve processes.

Note: It should be made clear that, although the Pilot Project 1 will provide a synthesized data platform to facilitate dialogue on water infrastructure operations, the MRC will not be providing warnings or any guidance on operations for this infrastructure. The operations of this infrastructure will be the sole responsibility of the Member Country and/or asset owner.
### 7.1.4 Timeline for Pilot Project 1

<table>
<thead>
<tr>
<th>No.</th>
<th>Item</th>
<th>Collaborations and additional resources</th>
<th>Start/completion date</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Combined inception report on Pilot Projects 1 and 2</td>
<td>MRC</td>
<td>Q2 2022</td>
</tr>
<tr>
<td>2</td>
<td>Gap analysis</td>
<td>Consultant team, the MRC (Technical Support Division, Environmental Management Division, Planning Division), national consultants, Joint Environment Monitoring team, PNPCA team, flood and drought team</td>
<td>Q2 2022 to Q3 2022</td>
</tr>
<tr>
<td>3</td>
<td>Cooperation mechanisms, process, collect information</td>
<td>Consultant team, MRC, Australian Water Partnership hydropower advisor, flood and drought team, data invigoration team, proactive regional planning team</td>
<td>Q3 2022 to Q4 2022</td>
</tr>
<tr>
<td>4</td>
<td>Dashboard (including consultation)</td>
<td>As above</td>
<td>Q4 2022 to Q2 2023</td>
</tr>
<tr>
<td>5</td>
<td>Preliminary governance arrangements</td>
<td>MRCS, Member Countries’ line agencies</td>
<td>Q3 2022 to Q1 2023</td>
</tr>
<tr>
<td>6</td>
<td>Pilot implementation</td>
<td>As above plus IT consultant, decision support systems team</td>
<td>Q3 2022 to Q3 2023</td>
</tr>
<tr>
<td>7</td>
<td>Report on lessons learned and actions needed to improve process for application across the Mekong Basin.</td>
<td>Consultant team</td>
<td>Q4 2023</td>
</tr>
</tbody>
</table>

### 7.2 Pilot Project 2: Information sharing and communication mechanisms for water-related emergencies (operational coordination and emergency response in the 3S Basin during the 2022/2023 flood season)

**SP Deliverable: Information sharing and communication mechanisms for water-related emergencies (SP Activity 4.2.1.3 by 2022/2023)**

The 3S Basin contains many hydropower and irrigation projects. The Xe Kong River has been the subject of a recent CIA study and was also the sub-basin that suffered consequences of the dam break in 2018 on the Xe Piang-Xe Namnoy HPP. The lessons learned from these studies and events indicate that there are a number of vulnerable communities within the 3S Basin affected by flooding in Lao PDR and Cambodia. The operation of projects in the Viet Nam part of the Basin has been the subject of dialogue and cooperation with Cambodia. Transboundary Rapid Basin-wide Hydropower Sustainability Assessment Tool (RSAT) dialogue has also taken place for the Se San Basin.
7.2.1 Scope

Building on the cooperation already undertaken in the 3S Basin, this pilot project aims to further strengthen the needed information sharing and communication from the 2021 flood season to ensure adequate warning and emergency response for vulnerable communities and commercial interests (e.g. HP operators) within the Basin. This will be achieved as follows:

- **Document processes:** In each of the three Member Countries, relevant flood and emergency agencies are already present. In addition, there are regional emergency management agencies (e.g. ASEAN, GMS) that cover both water and many other emergency-related matters. These processes should be documented to define the role that the MRC may play to assist these national processes particularly focused on water infrastructure in emergency management.

- **Review and document the existing MRC emergency management process** (e.g. hazardous waste guideline for shipping, PWQ Technical Guidelines).

- **Link to regional agencies:** Contact will be made with relevant wider regional emergency response initiatives (e.g. ASEAN Coordinating Centre for Humanitarian Assistance on Disaster Management, Asian Disaster Preparedness Centre, GMS) to familiarize the group with the role that the MRC may play in the overall emergency management process.

- **Cooperation mechanisms for emergency management:** The MRC Planning Expert Group (or equivalent) convenes a virtual meeting held between these three Member Country key agencies and contact points, including perhaps the regional bodies, to: (i) review past experiences with flood and emergency management, and specifically the role of water infrastructure operations; and (ii) document required actions to
close any gaps in information requirements; and to (iii) improve communication channels.

- **Information dashboard:** As for Pilot Project 1, a specific dashboard will be created for Pilot Project 2 based on the platform designed and consulted in Pilot Project 1.

- **Vulnerable communities and stakeholder engagement:** Particular attention will be paid to the locations of vulnerable communities within the Basin and how flood conditions are communicated to their representatives in order to take local actions to reduce risk. This may include defining the roles and responsibilities of water infrastructure operators in cooperation with national and regional bodies. Every effort should be made to engage these communities in the Pilot Project 2 to ensure that their needs are well represented in the dashboard and resulting communication protocols.

- **Test the MRC and water infrastructure operators’ roles in emergency management governance:** Using available information sources, the above Planning Expert Group will convene in an ad hoc manner through the flood season (say for only one to two hours) to discuss basin river conditions, water infrastructure status and flood storage, spillway gate releases, etc. and to liaise with relevant national and regional emergency bodies on these river conditions.

- **Test procedures:** Consideration would be given to the potential for a ‘dry run’ to test emergency procedures and communication channels between these relevant agencies contact points and the affected communities.

- **Capture lessons learned:** Finally, after the 2022 flood season, the group will convene to capture any lessons learned and document these for future action.

### 7.2.2 Regional Focus – Pilot Project 2

At the consultation meeting on 10 June 2021 and after further discussions held at the regional consultation on 13 December 2021 and the Joint Platform on 5 January 2022, Member Countries agreed that the 3S Basin would be a suitable test site for the Pilot#2. Three Member Countries (Lao PDR, Viet Nam and Cambodia) have significant vested interest in this Basin for hydropower, irrigation, and fisheries resources management. In addition, flood and sediment management have been historical areas of concern.

In order to ensure that the outputs for Pilot Project 2 are achievable, focus will be specifically on the Se San Sub-Basin, which has a number of projects operating in a cascade.

All Member Countries will participate and be observers in this pilot to gather lessons learned.

### 7.2.3 Proposed outputs

- Preparation of the combined inception report for Pilot Project 1 and 2.

- Documentation of existing 3S Basin emergency management processes at a high level, including the role of national and regional agencies.
Definition of the role of the MRC and of water infrastructure in emergency management and actions to close gaps and make any improvements.

Document and map vulnerable communities and the proposed role of MRC water infrastructure operations in assisting in national and regional emergency management.

Design and implement a trial of processes to implement the MRC’s role in emergency management in a sub-basin of the 3S Basin focused on the role of water infrastructure operations, and to note actions to close gaps and improve processes.

Report on the above process and lessons learned from Pilot #2 (combined with PP#1), including the mapping of vulnerable communities in the selected sub-basin.

7.2.4 Timeline for Pilot Project 2

<table>
<thead>
<tr>
<th>No.</th>
<th>Item</th>
<th>Collaborations and additional resources</th>
<th>Start/closing date</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Document existing emergency management procedures and agencies, gaps, and improvements.</td>
<td>MRC, national agencies in Lao PDR, Cambodia, Viet Nam, MRC Flood Centre Team</td>
<td>Q2 2022 to Q3 2022</td>
</tr>
<tr>
<td>2</td>
<td>Mapping of vulnerable communities and emergency management process</td>
<td>As above</td>
<td>Q3 2022 to Q4 2022</td>
</tr>
<tr>
<td>3</td>
<td>Pilot test process improvements</td>
<td>As above</td>
<td>Q3 2022 to Q3 2023</td>
</tr>
<tr>
<td>4</td>
<td>Report on above process and lessons learned from Pilot Project 2</td>
<td>As above</td>
<td>Q4 2023</td>
</tr>
<tr>
<td></td>
<td>(combined with Pilot Project 1) including the mapping of vulnerable communities in the selected sub-basins.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

7.3 Implementation approach to the pilot projects

7.3.1 Expert resources

The implementation of the pilot projects shall be facilitated by the MRCS with support from a firm/consortium of international consultants, who will be assisted by national consultants. Terms of reference will be drafted for the procurement of a small, suitably qualified team of international consultants consisting of:
a team leader and hydropower cascade operations specialist; and

support consultants with expertise in the management of the social and environmental impacts associated with water infrastructure operations in large river basins.

In addition, the **national consultants** should have knowledge and experience in hydropower and water infrastructure operations, including on social and environmental aspects.

### 7.3.2 Reporting

The team of consultants will cover both pilot projects and will work through the MRCS structure, as shown in Figure 6.2.

![Figure 6.2. Reporting arrangements for the management of the pilot projects](image)
8 Conclusions, Recommendations and Next Steps

8.1 Conclusions

The ongoing development of water infrastructure in the Mekong Basin requires a reorientation of MRC cooperation towards operational imperatives has been emphasized in the Siem Reap Declaration. The benefits arising from cooperation on water infrastructure operations can lead to reduced impact on the river and increased value from the resource. As cooperation deepens, further benefits arise through reduced geo-political risk and improved regional energy and food security. Existing MRC and regional initiatives supporting operational management can provide a valuable starting point as the MRC moves towards operational management.

Water infrastructure operations is an important element to be considered in IWRM-based operations management. River flow management, sediment and environmental management, management of emergencies, and design and management of hydropower cascades are key focus areas for MRC operational coordination.

Cooperation on operational IWRM provides opportunities across the cooperation continuum:

- Coordination: information sharing between Member Countries and water infrastructure operators. There are opportunities to expand the existing cooperation and provide platforms to share information to increase efficient resource use and reduce impacts;
- Collaboration: adaptation of the operations and operating rules of existing water infrastructure to gain greater benefits and reduce risks (e.g. as recommended under the Statements arising from the PNPCA for certain mainstream dams);
- Joint action: requirement of regional considerations of the design and operation of infrastructure that may be focused on mutual multi-sector benefits for Member Countries. This deeper level of cooperation is proposed to be explored under PRP.

8.2 Recommendations to advance coordination opportunities

SP Deliverables: Cooperation mechanisms for data and information sharing for existing dams (2022/2023) and Information sharing and communication mechanisms for water-related emergencies (2022/2023)

1. Completion of the Scoping Stage - Deliverable under SP Activities 4.2.1.1. The finalisation and endorsement of this report by the Joint Committee in November 2021 completes the Scoping Stage of this Activity 4.2.1.1 under the SP 2021–2025. This has been achieved through:
   a. National Consultations – September – October 2021;
   b. Regional Consultation – December 2021;
As noted in this report, the following next steps are therefore endorsed:

2. **Pilot Project 1**, “Cooperation mechanisms for data and information sharing for existing dams (Integrated operational water infrastructure data available on MRC data portal)”: **By Q4 2023** (i.e. SP Activity 4.2.1.2);

3. **Pilot Project 2**, “Information sharing and communication mechanisms for water-related emergencies (Operational coordination and Emergency response in the 3S Basin during the 2022/2023 flood season)”: By Q4 2023 (i.e. SP Activity 4.2.1.4).

### 8.3 Recommended next steps to scope and analyse collaboration opportunities

**SP Activity 4.2.1.2: Develop and implement cooperation mechanisms for data and information sharing for existing dam operations (linked to Joint Action Plans) to optimize regional benefits and minimize regional costs**

In order to refine, prioritize, and progress these collaboration opportunities, the following steps are proposed:

1. As part of the Scoping Stage, these above collaboration opportunities (Section 4.2.6) will be further discussed with Member Countries, and necessary stakeholders and formulated into prioritized operational scenarios (e.g. for flood and drought mitigation). (Timeline to be confirmed);

2. These operational **scenarios** will be shared with the team working on PRP (SP Output 3.1.1) to allow for their inclusion into the operational analysis using the enhanced operational DSS proposed under the first phase of the PRP. (Timeline to be confirmed);

3. The operational implications, benefits, and impacts on a range of economic, environmental and social indicators will be **analysed**. They will be discussed with Member Countries and relevant stakeholders to understand the potential for altered and improved operational management outcomes. (Timeline to be confirmed);

4. Agreed collaboration proposals, where clear mutual net benefits for the basin and stakeholders are illustrated, may then be tested and the outcomes reviewed through agreed ongoing operations governance mechanisms.

The proposed institutional and governance arrangements documented in this report (Section 5) and documented and tested under the proposed pilot projects (Section 6) will be further enhanced and tested to facilitate cooperation towards the implementation of these revised operational collaboration proposals.
8.4 Recommended steps to scope and analyse joint action opportunities (Stage 2)

**SP Deliverable: Cooperation mechanisms for data and information sharing for existing and newly identified dams and other water infrastructure (2024)**

The following implementation steps are proposed:


2. Based on lessons learned from Collaboration Stage 1 activities, define the scope of additional information sharing required for PRP exercise.

3. Identify conceptual options for information sharing and coordinated design and operations. This may include, for example:
   a. the design and operation of new hydropower storage to combine with flood and/or drought management;
   b. the operational coordination needed between new proposed dams and existing hydropower dams for flood/drought management, transmission of sediment, other environmental management purposes; and
   c. dialogue and joint research with China and UMB operators to assist with the above imperatives.

4. Modelling and analysis on proposed conceptual options to test feasibility and economics
   a. The operational scenarios will be tested alongside, or be included in, the PRP scenarios.

5. Promising opportunities for joint Action will be progressed through the MRC governance arrangements.
References


ESCAP. (n.d.). What is good governance? www.unescap.org/pdd

GIZ. (2012). Mechanisms for sustainable hydropower development and management. GIZ


MRC. (n.d.). *Joint Environmental Monitoring (JEM) programme pilots project (Factsheet)*
www.mrcmekong.org/assets/Publications/leaflet/Jem-factsheet.pdf

Annex 1: Definitions of the Collaboration Continuum\textsuperscript{15}

**Unilateral Action**

Unilateral action in a basin would mean no cooperation, not even communication or information exchange, over the management and development of the shared river. Not only do such arrangements forgo the opportunity to secure cooperative gains, but they can lead to situations where riparian countries’ development and investment schemes undermine one another. The cumulative impact of these uncoordinated developments may diminish flows or degrade water quality to the point that all activities may be compromised.

**Coordination**

Coordination is achieved through the exchange, or the cooperative gathering, of information in a basin. The exchange of hydrologic information could generate a range of benefits, such as enabling improved flow forecasting and greater preparedness for floods and droughts. The exchange of information on development plans will help basin planners in different countries avoid conflicting projects, particularly where planners assess their national projects for impacts, costs, and benefits, if any, extending beyond their borders. (This raises an important point regarding the direction of the effects of development. While upstream extraction generates externalities downstream by diminishing or deteriorating flows physically, downstream extraction generates externalities upstream by diminishing future flows available for abstraction upstream, by virtue of perceptions of acquired rights to that water downstream.) Coordination on international rivers may enable nations to secure some Type 1 and 2 benefits (Figure 2.1) and, to some extent, Type 3 benefits, because tensions will reduce as trust grows. At this level of cooperation, regional assessments undertaken in a cooperative manner can provide a platform of information symmetry, which may facilitate more intensive cooperation.

**Cooperation**

Collaboration results when national plans are adapted either to secure gains or to mitigate harm in another riparian country. Collaboration could generate benefits of all four types and could be achieved simply through ad hoc adaptations of ongoing plans or through agreed portfolios of national projects developed from a basin perspective. As with coordination, collaboration on international rivers may enable nations to secure direct Type 1 and 2 benefits. Benefit-sharing mechanisms may be needed to effect a redistribution of benefits that is perceived to be fair; this may further bind countries together and build trust, leveraging Type 3 benefits or even Type 4 benefits if the chosen benefit-sharing mechanism secures or redistributes broader bundles of benefits ‘beyond the river’.

\textsuperscript{15} See an article by Sadoff and Gray (2002) on “Beyond the river: The benefits of cooperation on international rivers”.

97
Joint Action

Joint action occurs when riparians act as partners in the design, investment, and implementation of international rivers development. This level of cooperation will need to be formalized by treaties. Benefit-sharing arrangements such as joint ownership and management of assets represent the greatest cooperative effort. Situations that lend themselves to this type of cooperation would include basins in which there is strong cooperation, capacity, and institutions. Joint action might include private sector engagement among co-riparian states and state-of-the-art management and investment scenarios that could optimize direct Type 1 and 2 benefits, as well as indirect Type 3 and 4 benefits. Less obviously, joint action might even be the right type of cooperation for basins in which there is little or uneven capacity, and high levels of mistrust, providing transparency, comfort, and security to affected riparians. Here, in addition to capturing the direct benefits of Types 1 and 2, joint action could be a powerful vehicle to deliver indirect Types 3 and 4 benefits.

The following Mekong River Commission (MRC) documents related to sustainable hydropower are all publicly available on the MRC website:

Project-specific guidance

- **The Study on the Sustainable Management and Development of the Mekong River Basin including Impacts of Mainstream Hydropower Projects (Council Study, 2018).** The Study on Sustainable Management and Development of the Mekong River including the Impacts of Mainstream Hydropower Projects, known as the Council Study, assesses current and potential future development plans of the Mekong countries in six water-related sectors (i.e. hydropower, land use, irrigation, navigation, flood protection and industry) and predicts both positive and negative impacts across economic, social and environment spheres.

- **Sustainable Hydropower Development Strategy (SHDS) Technical Reference Paper (Draft 2018).** This assessment of a range of 2040 hydropower development scenarios was completed to inform the development of the SHDS (not yet agreed on and published).

- **Preliminary Design Guidance 2009 (PDG, currently being updated).** This provides an initial design guidance for proposed mainstream dams in the Lower Mekong Basin in the form of performance targets and design. It also provides operating principles for mitigation measures, as well as compliance monitoring and adaptive management for reducing the environmental and social risks posed by hydropower schemes.

- **Guidelines for hydropower environmental impact mitigation and risk management in the Lower Mekong mainstream and tributaries (2018).** These guidelines provide consideration of planning, feasibility and design stages of hydropower projects, and their mitigation and adaptation as well as coordination options against risks.

- **Guidelines for Transboundary Environmental Impact Assessment in the Lower Mekong Basin (2018).** This guideline may be applied in line with the different national EIA legislation systems in Member Countries. In recognition of already agreed MRC mechanisms, these Transboundary Environmental Impact Assessment Guidelines build on and supplement the PNPCA, and draws on other MRC Procedures in addressing potential transboundary environmental impacts of development projects.

- **Joint Environment Monitoring of Mekong Mainstream Hydropower Projects (2019).** This activity served as a framework to standardize monitoring in the Mekong to support the assessment of hydropower development and also to determine the status and trends in resources.

- **Guidelines for the evaluation of hydropower and multipurpose project portfolios (2015).** These guidelines aim to provide a fuller picture of the social, economic, and environmental implications in hydropower project portfolio planning, with a view to maximizing overall net benefits. It also takes into consideration the integration of all risks and benefits into the national strategic planning approach.
Guidance on national-to-local benefit- and cost-sharing options for hydropower on Mekong tributaries (2013). This guidance examines different benefit sharing mechanisms to plan and implement hydropower projects such that project-affected communities benefit from the hydropower development to spread benefits both nationally, and transboundary.

Rapid Basin-wide Hydropower Sustainability Assessment Tool (RSAT). The RSAT is a multi-stakeholder dialogue and assessment tool designed to consider hydropower sustainability issues in a river basin context, such as major tributary basins of the Mekong (e.g. Se Kong). It has the potential to help identify development strategies, institutional responses and management measures that can be deployed to realize the benefits of hydropower development and reduce risks.

Other relevant technical reference papers include:

- Scoping of Regional Benefit Sharing in the Mekong Basin (2015): BDP’s extensive review of international and Mekong experiences on transboundary benefit sharing through joint projects.

- Review of international practices on fish passage: This focuses on existing research on fish passage through large dams and its applicability to Mekong mainstream dams.

- Review of fish compatible turbine design: This focuses on existing knowledge on the effectiveness and economics of fish compatible turbines.

- Identification of ecologically sensitive sub-basins for sustainable development of hydropower on tributaries: While enabling sustainable hydropower development, the guidance also ensures the identification and risk assessment for identified Ecologically Sensitive Areas (ESAs).
Annex 3: International Case Studies on Operational Management of Water Infrastructure

Columbia River Treaty (United States/Canada) – flood mitigation and hydropower generation

The coordinated development and management of dams in the Columbia River Basin under the Columbia River Basin Treaty (CRT) has enabled both Canada and the United States to benefit. Canada profits from the generated energy, flood control, and the compensations paid by the United States while the United States benefits from flood control, the increased reliable capacity of power plants, greater operational flexibility, and increased energy generation. Cooperation on the Columbia Basin has resulted in the following outcomes:

- **Reliable transboundary cooperation mechanisms and flexible operation plans** facilitate transparent and efficient operation of dams. The mechanisms for joint planning and coordinated operation of dams under the CRT include six year Assured Operation Plans, yearly Detailed Operation Plans, and Supplemental Operating Agreements that can be adopted from time to time. This framework provides for operational planning reliability with regard to power generation and flood control on the one hand, and flexibility to generate additional benefits, including environmental and recreational, on the other. The two national entities responsible for implementing the Agreement conduct joint studies to decide on operating plans and hold weekly conference calls to discuss the upcoming week’s CRT storage discharge. These coordination mechanisms have helped establish trust-based and transparent cooperation. This becomes evident, for example, in the fact that mitigation measures and changes to operating rules may be implemented without arduous negotiations. In several cases, these changes allowed riparian countries to comply with their national policies, e.g. for fish protection.

- **Continuous compensation payments** provide a suitable mechanism for reimbursing each participating party according to costs borne. The CRT sets out that downstream benefits, and through these, the cost for the construction and operation of the upstream Canadian dams, are explicitly shared between riparians. This not only refers to the Canadian Entitlement to downstream power benefits, but also to compensation payments for power losses resulting from agreed changes to dam operations for new environmental constraints, as well as from dam operations to meet any flood control requests.

- **Local benefit-sharing mechanisms and participatory programmes** support the mitigation of social and environmental effects. At the time of CRT negotiation, there was relatively little concern about environmental and social issues. However, increasing public awareness and pressure has required both countries to react. While agreed operational changes provide a framework for coordinated implementation of mitigation measures, national programmes play an important role in monitoring and mitigating social and environmental effects in the Columbia basin.
Murray Darling Basin (Australia) – Information sharing platforms

While not a classic transboundary river basin, the Murray Darling basin covers four Australian states with different priorities and a large number of irrigation and industrial enterprises with high water demand. A high percentage (>50%) of Australia’s irrigated agricultural production comes from within the basin valued at over AU$24 billion. The Basin has a much drier climate than the Mekong, with a Mean Annual Runoff of 0.024 Mm³/km² versus the Mekong, at 0.63 Mm³/km². There are competing water needs seasonally with the government buying back water rights from irrigators to allow water for the environment. Wetlands at the downstream end of the catchment are seldom flooded, with a significant impact on biodiversity.

The Murray Darling Basin provides a good example of basin-scale monitoring and information shared through common quality assured data systems. Decision support systems, including models, are used to provide daily updates on water releases at key points in the Basin to allow management of allocations and decisions on releases from storages. This management is critical in such a dry basin (Figure A1).

Figure A1. An example of an information sharing platform from the River Murray System
National examples

**Figure A2.** Lao PDR national sharing information platform for hydropower plants

**Thailand data sharing for hydropower and irrigation dams**

Thailand has in place data and information sharing\textsuperscript{16} for irrigation and hydropower dams to ensure that stakeholders will have relevant information on a daily basis for operational coordination within tributary basins. There is an opportunity to leverage this experience for wider Mekong application.

\textsuperscript{16} See its website for more detail: https://tiwrm.hii.or.th/DATA/REPORT/php/chart/2014/chi_mun
Figure A3. Thailand sharing information for basin management
ANNEX 4: Member Country’s Preliminary Prioritization of Opportunities

**Cambodia Priority Opportunities**
(Just a preliminary idea *It is not considered as official recognition by Cambodia*)

<table>
<thead>
<tr>
<th>Scope</th>
<th>Time Frame</th>
<th>Coordination</th>
<th>Collaboration</th>
<th>Joint Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flow Management 2</td>
<td>Real Time Seasonal 1 Planning (Long term)</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Sediment and Environmental Management 3</td>
<td>Real Time Seasonal 1 Planning (Long term)</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Management of Emergencies 1</td>
<td>Real Time Seasonal 1 Planning (Long term)</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Hydropower Cascade Operations 1</td>
<td>Real Time 1 Seasonal Planning (Long term)</td>
<td>X</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Priority Opportunities (Thailand)**

<table>
<thead>
<tr>
<th>Scope</th>
<th>Time Frame</th>
<th>Coordination</th>
<th>Collaboration</th>
<th>Joint Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flow Management 1</td>
<td>Real Time 1 Seasonal 1 Planning (Long term) 2</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Sediment and Environmental Management 2</td>
<td>Real Time 3 Seasonal 1 Planning (Long term) 2</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Management of Emergencies 1</td>
<td>Real Time 1 Seasonal 1 Planning (Long term) 2</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Hydropower Cascade Operations 2</td>
<td>Real Time 1 Seasonal Planning (Long term) 2</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
</tbody>
</table>
## Priority Opportunities (Lao PDR)

<table>
<thead>
<tr>
<th>Scope</th>
<th>Time Frame</th>
<th>Coordination Shared information to inform member states</th>
<th>Collaboration Adapt operations and plans for regional benefit</th>
<th>Joint Action Planning and investment for mutual benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flow Management</td>
<td>Real Time (1)</td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Seasonal (3)</td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Planning (Long term) (3)</td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Sediment and Environmental Management</td>
<td>Real Time (3)</td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Seasonal (3)</td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Planning (Long term) (3)</td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Management of Emergencies</td>
<td>Real Time (1)</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Seasonal (1)</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Planning (Long term) (2)</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hydropower Cascade Operations</td>
<td>Real Time (3)</td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Seasonal (2)</td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Planning (Long term) (1)</td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>

## Viet Nam Priorities for collaboration

<table>
<thead>
<tr>
<th>Scope</th>
<th>Time Frame</th>
<th>Coordination</th>
<th>Collaboration</th>
<th>Joint Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flow Management (1)</td>
<td>Real Time (1)</td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Seasonal (1)</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Planning (Long term) (1)</td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Sediment and Environmental Management (1)</td>
<td>Real Time (1) - (Env (2) - Sed)</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Seasonal (1) - (Env, Sed)</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Planning (Long term) (1) - (Env, Sed)</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Management of Emergencies (1)</td>
<td>Real Time (1)</td>
<td></td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Seasonal (2)</td>
<td></td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Planning (Long term) (2)</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Hydropower Cascade Operations (1)</td>
<td>Real Time (1)</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Seasonal (1)</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Planning (Long term) (1)</td>
<td></td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>
Annex 5. The Mekong River Commission’s Procedures and Guidelines

MRC Governance

An overview of the MRC’s institutional framework can be seen in Figure 4.

The following MRC agreements, procedures and guidelines contribute to the MRC governance framework agreed to by the four Member Countries:

**Agreements**

- **1995 Mekong Agreement and Procedures.** The 1995 Mekong Agreement and Procedures contain a number of mutually accepted objectives and principles of cooperation for sustainable development and utilization of the water and other natural resources in the Mekong River Basin between the four riparian nations of the LMB.

- **Agreement Between the Government of the Socialistic Republic of Viet Nam and the Royal Government of Cambodia on Waterway Transportation, 1998**

**Procedures**

- **Procedures for Data and Information Exchange and Sharing, 2001 (PDIES).** It is acknowledged that the operationalization of an effective, reliable and accessible data sharing and information system for the MRC is necessary for the implementation of the 1995 Mekong Agreement. The PDIES provides procedures for data sharing and information management.
Procedures for Notification, Prior Consultation and Agreement, 2003 (PNPCA). An MRC function is to promote better understanding and cooperation between the Member Countries in the development and utilization of the Mekong River Basin. The PNPCA provides steps to support this objective, as well as supports the establishment of water utilization and inter-basin diversion rules.

Procedures for Water Use Monitoring, 2003 (PWUM). It is recognized that equitable and reasonable use of water resources is only possible if water uses are monitored in the Mekong River Basin. The PWUM provides a framework and processes to support the implementation of intra-basin water use and inter-basin diversions monitoring.

Procedures for the Maintenance of Flows on the Mainstream, 2006 (PMFM). It is recognized that the sustainable use and development of the water and other natural resources in the Mekong River Basin are, apart from other relevant factors, not possible, if flows of the Mekong River are not appropriately maintained. The PMFM provides procedures for the maintenance of flows in the Mekong mainstream.

Procedures for Water Quality, 2011 (PWQ). It is acknowledged that the sustainable use and development of water and other natural resources in the Mekong River Basin are not possible if the water quality is not maintained. The PWQ provides for procedures for the management of water quality in the Mekong River mainstream.

Guidelines

MRC Guidelines on Custodianship and Management of the Mekong River Commission Information System, 2002. This document provides technical guidelines on the key operating principles and activities of data custodianship and management within the MRC to support the PDIES.

Guidelines on Implementation of the Procedures for Notification, Prior Consultation and Agreement, 2005 (PNPCA). These Guidelines facilitate the implementation of the PNPCA and address those issues of the latter that require clarification and elaboration.

Guidelines for Management of the Mekong River Commission Hydrometeorological Network, 2005. These Guidelines are part of a series of technical guidelines and standards to support the PDIES. They apply to the management of the MRC Hydrometeorological Network for the collection of hydrometeorological data, specified as physical data.

Guidelines on Implementation of the Procedures for Water Use Monitoring, 2006. These Guidelines support the implementation of the PWUM in addressing the management of the Water Use Management System (WUMS) and the strengthening of existing monitoring of intra-basin water uses and inter-basin water diversions.

Preliminary Design Guidance for Proposed Mainstream Dams in the Lower Mekong Basin, 2009 (PDG). The Preliminary Design Guidance for Proposed Mainstream Dams in the Lower Mekong Basin provides the developers of proposed dams in the Lower Mekong mainstream with an overview of the issues considered by the MRC during prior consultation, such as navigation, fish passages, sediment transport or the safety of dams.

MRC Communication Strategy and Disclosure Policy, 2009. This Communications Strategy seeks to promote the MRC as a world class river basin organization that serves...
the peoples of its Member States in their need to sustainably develop the water resources of the Mekong River Basin, so as to reduce poverty while maintaining essential environmental services.


- **Technical Guidelines for the Implementation of the Procedures for Water Quality (PWQ)**. These technical guidelines consist of four chapters:
  1. *Water Quality Technical Guidelines for the Protection of Human Health*, 2009. These guidelines have been agreed and are being implemented.
  2. *Water Quality Technical Guidelines for Protection of Aquatic Life*, 2010. These guidelines have been agreed and are being implemented.
  3. *Water Quality Technical Guidelines on Cooperative Framework for Implementation of the PWQ with regard to Human Health and Aquatic Life*. These guidelines have been agreed and are being implemented.
  4. *Water Quality Technical Guidelines on Water Quality Emergency Response and Management*. These guidelines have been agreed on and are being implemented.

### The MRC Institutional Framework and Linkages with ISH11 Identified Needs for Hydropower-relevant Information

**Location**

Relevant procedures and guidelines in the MRC institutional framework that focus on locations include the following:

- The PWUM requires the monitoring of water use in the Mekong Basin and of inter- and intra-basin water diversion from the Mekong mainstream or a tributary of the Mekong River system into another basin that may cause significant impact on the Mekong mainstream.

- The Guidelines for Implementation of the PWUM require that the relevant line agencies in each Member Country shall designate water use monitoring stations and provide a table and map of their locations. The locations should be periodically updated, as required.

- The Guidelines for the Management of the MRC Hydrometeorological Network as technical guidelines to the PDIES provide that a MoU executed between the MRCS, each National Mekong Committee, and the relevant nominated line agencies shall contain the identification and location details of all hydrometeorological facilities and sites, defined in latitude and longitude details and a map.

- The PMFM recommends the establishment of hydrological stations to monitor the Mekong flow level against minimum and maximum requirements. The criteria for the selection and a list of selected monitoring sites are to be set out in the accompanying Technical Guidelines.

- The Technical Guidelines to the PMFM list 11 locations for monitoring of river discharge and water level, which were agreed by the Member Countries in 2007.
The PWQ recommends the establishment of new (water quality) monitoring stations if identified, as needed.

**Parameters**

Relevant procedures and guidelines in the MRC institutional framework which focus on parameters include the following:

- The PDIES defines 12 groups/types of data and information that are required for the implementation of MRC Programmes/Activities and the Mekong Agreement, namely: (i) Water Resources; (ii) Topography; (iii) Natural Resources; (iv) Agriculture; (v) Navigation and Transport; (vi) Flood Management and Mitigation; (vii) Infrastructure; (viii) Urbanization/Industrialization; (ix) Environment/Ecology; (x) Administrative Boundaries; (xi) Socio-Economic; and (xii) Tourism. Moreover, they state that data and information contained in the MRC-IS should be relevant, timely, and accurate.

- The Guidelines for Management of the MRC Hydrometeorological Network state that the acquisition of data and information is necessary for planning, development and management purposes as well as to implement the Mekong Agreement. It provides that data shall be obtained from the measurement of water level, discharge, flow velocity, and related hydrological and meteorological parameters.

- The Guidelines for Implementation of the PWUM state that indicators should be practical and adequate.

- The Technical Guidelines to the PWQ provide lists of quality parameters to be monitored selected from the parameters from the Member Countries’ Water Quality Standards for domestic use of water and the protection of aquatic life.

- The Technical Guidelines to the PMFM define thresholds for flows to be maintained during dry and wet season respectively and differentiate between monitoring the flows for planning purposes and monitoring purposes. The former should serve as a framework against which proposed development projects and future basin-wide development scenarios shall be assessed; the latter should serve as a framework to enable appropriate policies to be developed and activated during critical periods of flow deficiency and excess.

**Timing**

Relevant procedures and guidelines in the MRC institutional framework which focus on timing include the following:

- The Guidelines for Management of the MRC Hydrometeorological Network state that long-term sustainable management and operation of the network should be ensured and that information and data needs to be obtained on a regular basis.

- The Guidelines for Implementation of the PWUM state that monitoring of inter-basin water diversion should be conducted in a systematic and timely manner that is daily during the diversion period in the dry season and not less than weekly in the wet season.

- The Technical Guidelines to the PWQ state that the water quality monitoring programme should monitor the long-term trends in water quality. They provide for
a minimum frequency of sampling and a list of factors that need to be taken into account when deciding upon the sampling frequency.

- The Technical Guidelines to the PMFM provide for the daily measurement of flows to raise awareness of real-time daily flow conditions that are not within the agreed flows framework, so that Member Countries can discuss whether coordinated action is needed.

**Information management**

Relevant procedures and associated technical guidelines in the MRC institutional framework which focus on information management include the following:

- The PDIES deals with data and information management and emphasizes the importance of standards, classifications and an acceptable level of data quality.

- MRC Guidelines on Custodianship and Management of the Mekong River Commission Information System state that the MRC-IS should support monitoring activities as a structured communication and management system for data and information.

- The PWUM states that the MRCS is to prepare reports relevant to water use monitoring and an annual report that documents the water use monitoring results, appropriateness and effectiveness of the PWUM, and the status of the monitoring system.

- The Guidelines for Management of the MRC Hydrometeorological Network state that all data collected and exchanged in accordance with the Guidelines shall be integrated into the MRC-IS.

- The PMFM states that the MRCS shall maintain the MRC-IS and update the DSF as a key tool supporting the flow assessments. Furthermore, they assign the responsibility for monitoring, data gathering, and reporting as well as establishment, maintenance and operation of the sites to the National Mekong Committees.

- The Technical Guidelines to the PWQ state that water sampling and analysis shall be performed in compliance with international standard methods or nationally accepted methods and that the analytical results should be recorded for traceability. Furthermore, they provide that the laboratories engaged should establish, implement and maintain a QA/QC system and apply appropriate standard methods. It is also stated that each Member Country is responsible for producing an Annual National Water Quality Report. Review mechanisms of the Technical Guidelines are incorporated in the document.

- The Technical Guidelines to the PMFM clearly define roles and responsibilities with regard to planning and monitoring of the flows monitoring as well as for the annual reporting.
Information use
Relevant procedures and associated technical guidelines in the MRC institutional framework which focus on information use include the following:

- The PDIES affirm the importance of operationalizing an effective, reliable, and accessible data and information system for the MRC and its Member Countries to implement the Mekong Agreement from 1995. They provide various principles of data and information sharing and define ways in which each National Mekong Committee and the MRCS shall cooperate in this regard.

- MRC Guidelines on Custodianship and Management of the Mekong River Commission Information System define the different classes of data and information custodians and users.

- The PNPCA emphasize the importance of data availability and provide that the Notification shall include all available data to serve as a basis to the Member Countries for evaluation and the Consultation process.

- The PWUM state that the water use monitoring results shall be reported annually.

- The Guidelines for Management of the MRC Hydrometeorological Network state that all parties to the collection of data in accordance with the Guidelines will have rights to access and utilize the data through the MRC-IS.

- The Technical Guidelines to the PMFM emphasize the importance of data and information exchange with China and state that an ongoing dialogue process is to strengthen cooperation between the LMB Countries and China.

- The PWQ provide that the MRCS shall prepare necessary reports, including an annual report to the MRC JC on the quality of the water in the mainstream as well as providing appropriate documentation as a basis for discussions.