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MRC Council Study

Cumulative impact assessment of water resource development scenarios

Design and methods

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Council Study Programme

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Document history

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1	0	Draft report prepared for internal discussion	15 Oct 2015	Scenario assessment team
	1	Draft report prepared for consideration of RTWG, based on internal comments and suggestions	16 November 2015	Scenario assessment team
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4	1	Revised report based on feedback received during consultation with member countries and stakeholders.	22 March 2017	Alex Smajgl
4	2	Revised report based on indicator design workshop with member countries	25 April 2017	Alex Smajgl

Executive summary

The purpose of this report is to provide guidance to the design and methods for the triple-bottom lined Cumulative Impact Assessment (CIA) of basin-wide water resource development scenarios in multiple sectors under the MRC Council Study (CS). The approach builds upon earlier basin-wide assessment work undertaken by the MRC.

Process

A Cumulative Impact Assessment is a complex, iterative, process with many components. In this Assessment water resources development scenarios drive a series of modelling and evaluation activities that endeavour to link projected changes in the hydrological regime to sediment dynamics, changes in biological resources, and ultimately changes in economic and social outcomes (Figure A). The Cumulative Impact Assessment will integrate and synthesize the findings from individual disciplinary and sector assessments. Stakeholder inputs are important to the legitimacy and credibility of this process, providing feedback leading, for instance, to adjustments in scenarios and choice of indicators.

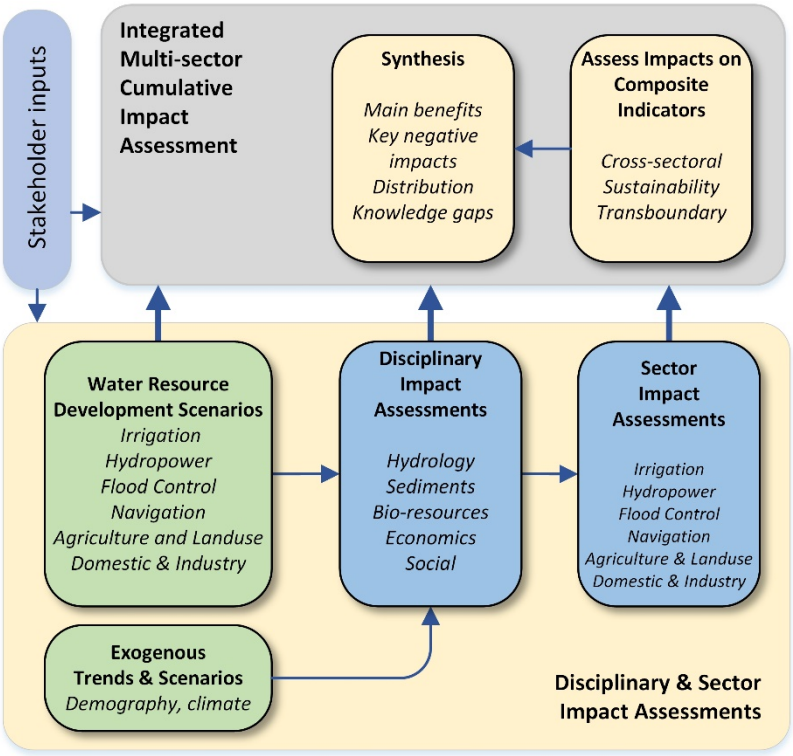

Figure A. Overview of key elements of the cumulative impact assessment approach.

While key stakeholders of the Council Study include the Regional Technical Working Group, the NMC Secretariats and ultimately the MRC Joint Committee for whom the Assessment reports are primarily written, stakeholder forums are also planned to give opportunities for inputs from a broader range of stakeholders, including from academics, NGOs and community representatives to be involved.

Scenarios

Scenarios are plausible stories or sets of assumptions about the future or past. The CIA is constructed around three main water resources development scenarios for the Mekong River Basin. The first scenario, *Early Development*, describes the status of water resources development in 2007. This scenario is often treated as the reference conditions against which to compare two other scenarios. The second scenario, *Definite Futures*, representing the likely status of water resource development in 2020, and the third scenario, *Planned Development*, a plausible vision of the status in 2040.

The scenarios are a product of consultation and negotiation that consider development in six water-related sectors and are based on plans and projections approved by the Member Countries. In addition to these main scenarios a set of additional sub-scenarios for 2040 have been constructed to investigate the impacts of climate change and alternative patterns of water resource development in individual sectors.

Indicators

Indicators will play an important role in taking outputs of one analysis as inputs into another as analyses move from the individual sector and disciplinary assessments to the multi-sector cumulative impact assessment (Figure A). The CIA has reviewed the MRC Indicator Framework to inform selection and classification of indicators for further development. To strengthen the logical coherence of the indicators and to meet the rigorous integration requirements of the CIA, new strategic indicators have been introduced whilst others have been re-classified or dropped. To better address the key objectives of the CS related to impacts of water resource development in particular sectors additional sub-scenarios have been introduced.

Reporting

The Cumulative Assessment Report will be equivalent to the Main Report. It will integrate the key findings of the individual thematic sector reports with those of the CIA to assess the overall impacts and benefits of the water resources development scenarios. In particular, the report will present the valuation of changes in composite assessment indicators arising from different scenario assumptions of how water resources are developed. Based on this information, the report will describe the evolution of regional distribution of benefits, costs, impacts (positive and negative) and risks of water resources development in the Mekong basin. Finally, the possible implications for planning and decision-making will be discussed. The report will set out recommendations covering potential mitigation, and where appropriate the need for further studies. The report will be supported by a wide range of technical documentation emanating from the Council Study.

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Abbreviations and acronyms

AIP	:	Agriculture and Irrigation Programme (of the MRC)
BDP	:	Basin Development Plan
BDP2	:	BDP Programme, phase 2 (2006 –10)
BDS	:	(IWRM-based) Basin Development Strategy
BioRA	:	Biological resource assessment team (under Council Study)
CIA	:	Cumulative Impact Assessment (under Council Study)
CCAI	:	Climate Change and Adaptation Initiative (of the MRC)
DMP	:	Drought Management Programme (of the MRC)
EP	:	Environment Programme (of the MRC)
FMMP	:	Flood Mitigation and Management Programme (of the MRC)
FP	:	Fisheries Programme (of the MRC)
IKMP	:	Information and Knowledge Management Programme (of the MRC)
IWRM	:	Integrated Water Resources Management
ISH	:	Initiative for Sustainable Hydropower (of the MRC)
JC	:	Joint Committee (of the MRC)
LMB	:	Lower Mekong Basin
LNMC	:	Lao National Mekong Committee
M&E	:	Monitoring and evaluation
MIWRMP	:	Mekong Integrated Water Resources Management Project (of the MRC)
MRC	:	Mekong River Commission
MRCS	:	Mekong River Commission Secretariat
MRC-SP	:	MRC Strategic Plan
MWRAS	:	Mekong regional water resources assistance strategy (of the World Bank)
NIP	:	National Indicative Plan (C-NIP: Cambodia, L-NIP: Lao PDR, T-NIP: Thailand, V-NIP Viet Nam)
NMC	:	National Mekong Committee
NMCS	:	National Mekong Committee Secretariat
NAP	:	Navigation Programme (of the MRC)
PMFM	:	Procedures for Maintenance of Flow on the Mainstream
PWUM	:	Procedures for Water Use Monitoring
RDA	:	Regional distribution analysis
TCU	:	Technical Coordination Unit (of the MRCS)
TNMC	:	Thai National Mekong Committee
TRG	:	Technical Review Group (of the MRC)
UMB	:	Upper Mekong Basin
VNMC	:	Viet Nam National Mekong Committee

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1 Introduction

1.1 Purpose of this report

The purpose of this report is to provide guidance to the approach and methodology for the integrated, multi-sector, cumulative impact assessment (CIA) of basin-wide development scenarios under the MRC Council Study. As the CIA is primarily a synthesis of the findings from the disciplinary and thematic sector assessments, this report also provides an overview of the main features of the approach and methods of the underlying assessments.

As this report is also intended to be a step towards developing a robust and replicable framework for integrated assessments to support MRC's work in the future, in particular the formulation and assessment of exploratory scenarios included in MRC's Strategic Plan for 2016-20 [1], some commentary is also provided on alternatives to the current design.

This report takes as its primary guidance the Inception Report of the Council Study [2] with updates based on the phase II implementation Plan [3] and progress reports of the contributing assessments [4, 5].

This version of the Approach & Methodology report is substantially shorter than the previous version as it has been re-organized to reduce redundant or no longer relevant material as well as to reduce overlap with other documents. This report contains a further five chapters as described below.

Chapter 2, describes how the Council Study (CS) is organised, its overall objectives, the responsibilities of other study components and the overall scope of the Cumulative Impact Assessment (CIA) called for under the CS.

Chapter 3, describes the design of the CIA, with the main emphasis being on the critical comparisons between scenarios and sub-scenarios. The framework of indicators to be used is also described.

Chapter 4, summarises the methods used for the environmental, social and economic assessments as well as sectoral assessments, and for overall integration and synthesis.

Chapter 5, describes the plan for the final, main, report of the CIA. It also lists the principal technical reports and other outputs such as databases, tools and model enhancements.

2 The Council Study

This chapter explains the purpose of the Council Study and briefly summarizes its foundations in past assessment work and implementation.

2.1 Objectives of the Council Study

The overall objective of the Council Study (CS) as set out in the Inception Report [2] is to:

> "*further enhance the ability of the MRC to advise Member Countries on the positive and negative impacts of water resources development on people, economies and the environment of the Mekong River Basin*".

The specific objectives are to:

1. Further develop/establish a reliable scientific evidence base on the environment, social and economic consequences (positive and negative) of development in the Mekong River Basin

2. Results of the study are integrated into the MRC knowledge base to enhance the BDP process providing support to the Member Countries in the sustainable management and development of the Mekong River Basin.

3. Promote capacity and ensure technology transfer to Member Countries in the process of designing and conducting of the study.

The Cumulative Impact Assessment (CIA) will primarily address the first objective, but also contribute to objectives 2 and 3 through the conduct of the assessment process.

By assessing consequences across six thematic areas as well as identifying hotspots and tipping points the CIA will help inform "*recommendations directly addressing potential uncertainties, risks and the information needs for development planning in the mainstream of the LMB*" [2].

The Council Study will provide insights on transboundary issues, including the regional distribution of benefits, costs, impacts and risks of basin developments. This will require the assessment of past, ongoing and planned water resource development, recognizing that in some countries most water resource development has already taken place, while in other countries much more is underway or planned.

The required outcome of the CIA is a main report that synthesizes what is known about the cumulative impacts and benefits of the selected water resources developments [2]. This will be supported by assessments of the cumulative impacts of water resource development in the six thematic areas.

With better information on the distribution of benefits, costs, impacts and risks of past, ongoing and planned development across the LMB countries, the Member Countries can discuss with more confidence whether this distribution is reasonable, equitable and fair, and whether the planned development leads towards more sustainable development. The results of these discussions can be used for the exploration of alternative development pathways to address Strategic Priority No. 5 of the Basin development Strategy 2016-20 [1].

2.2 Foundations of the Council Study

Cumulative impact assessment under the CS is intended to build on earlier work undertaken by MRC including on Integrated Basin Flow Management (IBFM) in 2004-6 and by BDP in 2008-10 to assess the basin-wide cumulative impact of national water resources development plans, including alternative configurations of proposed mainstream dams [6]. Since 2010, MRC has made progress on a number of fronts which have bearing on how best to address the objectives of the CS.

- Firstly, the MRC has addressed key information gaps identified in 2010 which limited the scope of the assessments;
- Secondly, the MRC has made progress in developing an Indicator Framework to support monitoring;
- Thirdly, the MRC has made progress in developing the concepts of regional benefit sharing in line with the central objectives of the 1995 Mekong Agreement; and,
- Fourthly, the MRC has prepared a Basin Development Strategy for 2016-20 which builds on these achievements and establishes the intent to explore alternative development pathways.

Accordingly, the approach in the CS to cumulative impact assessment has been formulated in the light of these achievements and the further work of the CS thematic and discipline teams in a manner that:

- Overcomes the limitations of earlier assessments, making best use of the new information and tools now available, principally relating to better understanding sediment and nutrient flows, and tools for environmental, economic and social assessment and social assessment;
- Promotes the concepts of regional benefit sharing by introducing a cumulative assessment approach that will demonstrate the overall positive and negative impacts each Member Country has and would experience in the future if different plans were taken up, expressed in relation to all historic water resources development, so that the principle of reasonable and equitable use can be evaluated;
- Introduces the concept of exogenous development, recognising that water resource development is not the only sector affecting environmental, social and economic conditions within the basin and that, as a consequence, not only will these conditions

continue to change irrespective of water resource developments, but also that the impacts of water resource developments need to be measured taking into account exogenous changes; and

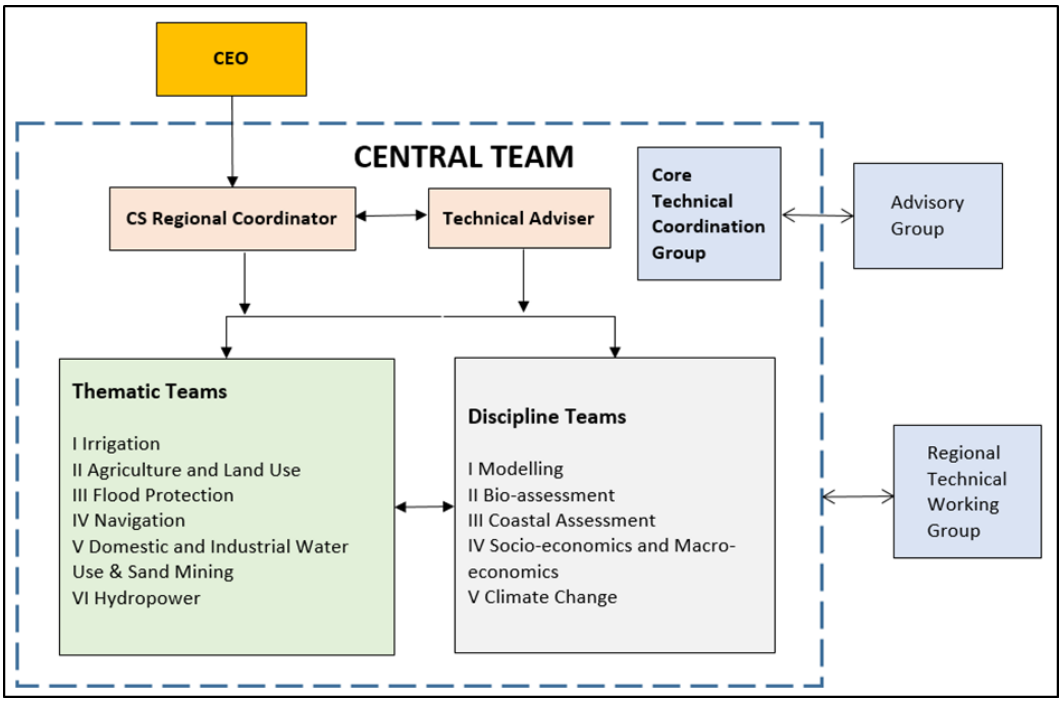
- Recognises that the CS provides the opportunity not only to better understand the complex relationships between development and environmental, social and economic conditions but also, through the insights gained, to provide a framework within which to explore future pathways towards more sustainable development within the LMB.

2.3 Organisation of the Council Study

The Council Study is managed and implemented by the office of the CEO with the support of the Technical Coordination Unit (Figure 1). A Technical Advisory group, comprising of senior MRCS technical personnel and representatives from the Development Partners advises the CEO and the formulation of principal policy recommendations. An MRCS Coordinating Group coordinates the work of the Council Study including input from MRCS programmes, external consultants and to liaise with National Line Agencies. This group consists of MRCS programme coordinators, the Technical Coordination Unit and external consultants as needed. A Technical Coordinator with experience in management and technical assessments supports the MRCS Coordinating Group.

In addition to a Cumulative Impact Assessment (CIA) Team, six **Thematic Teams** and five **Discipline Teams** have been established covering the important thematic IWRM sectors and sub sectors that contribute to development in the basin.

Figure 1 Implementation arrangement showing thematic and discipline teams [3]



The CIA Central or Core Team is one multi-disciplinary team that integrates the social, economic, and environmental assessments to produce an integrated, multi-sector, CIA. The Thematic Sector Teams undertake studies to define the proposed sectoral scenarios for 2007, 2020 and 2040 for consideration by RTWG for inclusion in the multi-sector scenarios. These scenarios drive the modelling and bio-resource assessments which in turn are inputs to the environmental, social and economic assessments that are ultimately synthesized using a triple-bottom line or sustainable development logic in the CIA.

3 Design of the Assessment

This chapter describes the key features of the design of the Cumulative Impact Assessment. It explains the origins and logic of the scenarios and sub-scenarios as well as the indicators that will be evaluated and reported. Chapter four describes the assessment methodology.

3.1 Origins

The approach and methodology for this cumulative impact assessment builds on earlier work undertaken by and with the MRC, in particular: by the World Bank under the Mekong Water Resources Assistance Strategy in 2004 [7]; a program on Integrated Basin Flow Management (IBFM) in 2004-06; a commissioned Strategic Environmental Assessment of mainstream dams in 2010 [8]; the cumulative impact assessment of basin-wide scenarios undertaken in 2008-10 by BDP [6]; and more recent and ongoing activities since 2010 including on indicators [1] and of the effects of mainstream hydropower on the delta [9].

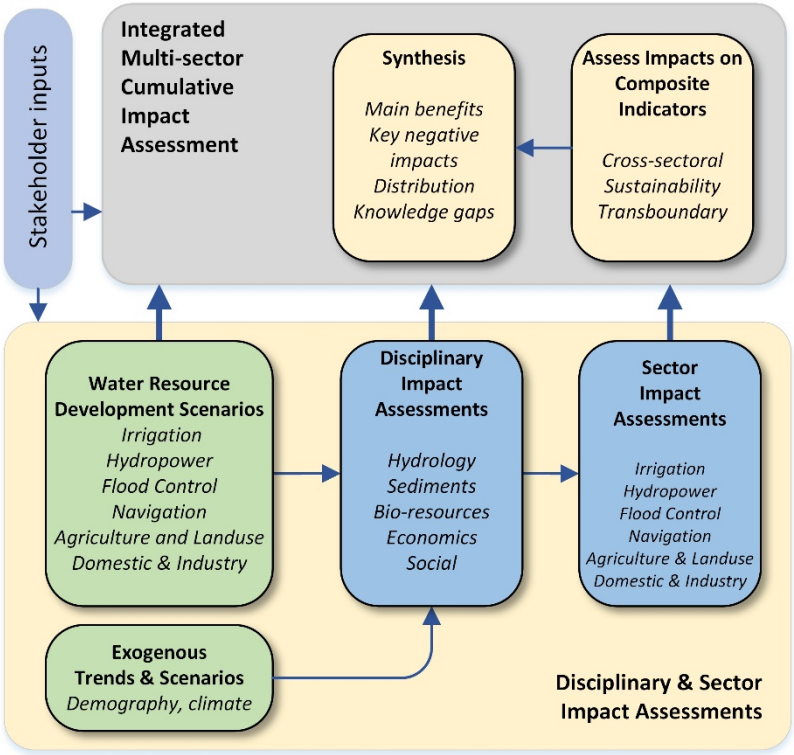
Together these advances create conditions in which the cumulative impact assessment under the Council Study can be carried out in a more comprehensive, integrated and structured approach than has been the case hitherto [10]. In particular, the assessment responds to the challenge to be: **cumulative** by considering water resource development plans in multiple sectors over several decades; **integrative** by evaluating across social, environmental and economic criteria, that is a 'triple-bottom-line'; **inclusive** through iterative engagement with stakeholders; and, **transparent** through explicit articulation of assumptions, communication of uncertainties, and comparisons with work done previously and by others.

3.2 Overview

The cumulative impact assessment is therefore designed to be both a technical and a consultative process with significant iterations between the Member Countries, the technical core team, and a broader pool of stakeholders.

The assessment has several inter-linked components (Figure 2). The scenarios and sub-scenarios are defined based on Member Country inputs in six thematic, or water-related, sectors. These scenarios are used to drive a set of models that integrate changes in land-use and water-related infrastructure to estimate the net impacts on the hydrological regime and sediment dynamics. Other models and tools are then used to assess how these physical changes may impact biological resources, and ultimately economic and social outcomes. The findings of these studies are documented in a set of 'disciplinary' impact assessments. The disciplinary assessments, in turn, inform a set of sector impact assessments which integrate across the social, environmental and economic insights to understand the impacts from and on that particular sector (Figure 2).

Figure 2 Overview of the cumulative impact assessment process and its relationship to disciplinary and thematic sector assessments



l component of the cumulative impact assessment is to integrate and synthesize the findings from the various disciplinary and sector assessments (Figure 2). This analysis includes the evaluation of a set of composite indicators that cut-across individual disciplines and sectors. Indicators play an important function in transferring understanding of impacts in one discipline to another as well as in communicating the findings of the assessment more broadly.

3.3 Main scenarios

The definition of scenarios and sub-scenarios in the CS is one of the most critical elements of the design of the CIA as it largely determines what can be rigorously assessed and thus to what extent the objectives of the CS can be met. The main analytical value of scenarios to an assessment, it should be underlined, comes from making logical comparisons among them.

3.3.1 Definition

The CIA will focus on the 3 agreed main water resource development scenarios (Table 1). The Early Development Scenario (M1) includes the infrastructure and the land cover in the 6 sectors as of 2007. The Definite Future Scenario (M2) includes all existing, under-construction, and firmly committed development in the six sectors which are expected to

be in place by 2020. The Planned Development Scenario (M3) includes in addition to contents of M2 water resource development that is planned in the six sectors in the Mekong Basin and that would be in place in 2040 if fully implemented. With the study design in Table 1 comparison between M2 and M1 measure the effects of water resource development between 2007-2020, while comparisons between M3 and M2 estimate the effects of planned development between 2020-2040 in the context of a climate expected to be warmer and wetter and with expansion of human settlements in the flood plains. Flood protection infrastructure development is not included in the main scenarios for M2 and M3 so that the impacts of changes in flood regimes can be evaluated in the context of other expected changes, in particular, the expansion of human settlements into floodplains.

Table 1 Main water resources development scenarios for CIA.

	Scenario	Level of Development for water-related sectors*						Climate	Flood-plain settlement
		ALU	DIW	FPF	HPP	IRR	NAV		
M1	Early Development Scenario 2007	2007	2007	2007	2007	2007	2007	1985-2008	2007
M2	Definite Future Scenario 2020	2020	2020	2020	2020	2020	2020	1985-2008	2020
M3	Planned Development Scenario 2040	2040	2040	2040	2040	2040	2040	1985-2008	2040
M3-CC	Planned Development Scenario 2040	2040	2040	2040	2040	2040	2040	Mean warmer & wetter	2040

*ALU = Agric/Landuse Change; DIW = Domestic and Industrial Water Use; FPF = flood protection infrastructure; HPP = hydropower; IRR = irrigation; and NAV = Navigation

3.3.2 *Elaboration*

The details of the main scenarios in particular, were elaborated through a process of consultation and negotiation. First, sector teams compiled information through surveys of official sources in Member Countries about existing (2007) and potential future development (2020 and 2040). Second, as this information was sometimes incomplete or too general experts in the Core Team had to do further analyses and make additional assumptions: for instance, if given a percentage increase in total irrigated area by 2040 they had to do to allocate this total change into plausible locations. Third, the RTWG then approved or requested modifications of the scenarios. As a result of these exchanges the 2040 scenario is intended to be a plausible pathway of development.

3.3.3 *Reference period*

The three main scenarios and most of the sub-scenarios will be modelled using the same 24-year time series from 1985 – 2008 of hydro-meteorological data (rainfall, evaporation, boundary water levels etc.) agreed to by the MC. As this reference period is held constant in the model runs it allows comparisons to be made between scenarios or sub-scenarios without confounding the results by changes in climate (Table 1). The only sub-scenarios

where the climate input is changed are those sub-scenarios specifically designed to investigate the impacts of climate change (Table 2).

It should be noted that this series is much shorter than ideal. In future assessments, it is recommended that this reference period be extended so as to better capture climate variability across the basin. With such a short time series, the climate for specific locations will be greatly influenced by individual extreme events that just happened to fall within the period, or conversely, in other locations situations where extreme events that could easily occur may not be represented in the short sample of years. This limitation needs to be taken into account when interpreting hot spots of high impact.

3.3.4 Exogenous influences

Exogenous influences are those which arise from activities not captured in the thematic sectors, but which have bearing on conditions within the basin that affect the magnitude of impacts caused by water resource development. Two have been incorporated into the main scenarios. First, a projected mean trend towards a warmer and wetter climate in 2040 has been included in M3 (Table 1). Second, a projected trend of increased human settlements in the floodplains in 2020 and 2040 has been included in M2 and M3 (Table 1).

The advantage of including mean changes in climate and floodplain settlement within the main scenarios is they allow evaluation of the impacts of water resources to be made in the context of likely future changes, and in this sense, more realistic conditions. The limitation of this design is that it is not possible to unambiguously attribute differences between scenarios. For example, when comparing M2 and M3 any differences found cannot be claimed to have been due to planned development in the water sector between 2020 and 2040, because it may have been caused by differences in assumed climate or changes in land-use in the floodplains. To help overcome this limitation when making interpretations additional sub-scenarios were defined to allow more rigorous comparisons and thus analyses of the effects of different factors on the level of impacts.

3.4 Sub-scenarios

In order to respond rigorously to key policy questions arising from the stated objectives and assessment requirements of the Inception Report additional sub-scenarios have been developed.

3.4.1 Impacts of climate change

Three sub-scenarios for 2040 are being prepared to explore the interactions between water resource development and changes in climate (Table 2). Comparisons between scenarios M3 and C2 for instance measure the effect of water resources development at the level of 2040 under a climate that is even wetter than mean projections. To help better understand the overall effects of climate change a fourth scenario (C1) is introduced with no climate change against which other scenarios may be compared. The sub-scenarios which assume climate changes (M3, C2, and C3) are derived from statistical downscaling the outputs of a set of global circulation models driven with assumptions of intermediate levels of

greenhouse gas emissions (RCP4.5) and using these estimates to adjust the reference 1985-2008 climate.

Table 2 Climate change sub-scenarios for analysis CIA.

	Sub-scenarios	Level of Development for water-related sectors						Climate	Flood-plain
		ALU	DIW	FPF	HPP	IRR	NAV		
M3	Planned Development Scenario 2040	2040	2040	2040	2040	2040	2040	1985-2008	2040
C2	Planned Development 2040 + Wetter Climate	2040	2040	2040	2040	2040	2040	Wetter	2040
C3	Planned Development 2040 + Drier Climate	2040	2040	2040	2040	2040	2040	Drier	2040

3.4.2 *Impacts of early development*

To take into account the substantial level of large-scale water resources development already completed by 2007 a sub-scenario for 1960 will be prepared.

Table 3 Sub-scenario to better understand impacts of early development.

	Scenario	Level of Development for water-related sectors[1]						Climate	Flood-plain
		ALU	DIW	FPF	HPP	IRR	NAV		
M1	Development Scenario 2007	2007	2007	2007	2007	2007	2007	1985-2008	2007
T0	Pre-Development Scenario 1960	1960	1960	1960	1960	1960	1960	1985-2008	1960

3.4.3 *Impacts of individual sectors*

To evaluate and report on the impacts and benefits of water resources development in each sector as requested in the Inception Report (see: Table 15) it is necessary to analyse the contributions made by each sector. The best study design for doing this is to compare the main scenario with all sectors developed with a sub-scenario having all the developments apart from those in the target sector. In the following sections these comparisons are tabled for each sector.

3.4.4 *Agricultural land-use sub-scenarios*

To address the key policy goal in the Inception of reporting on the impacts and benefits of agriculture and land-use development comparisons will be made between main scenario

M3 and sub-scenario A1 (Table 4). An alternative scenario with more land-use changes (A2) will also be compared with M3 or A1.

Table 4 Sub-scenario to better understand impacts of different assumptions about future agricultural land-use.

	Scenario	Level of Development for water-related sectors[1]						Climate	Flood-plain
		ALU	DIW	FPF	HPP	IRR	NAV		
M3-CC	Planned Development Scenario 2040	2040	2040	2040	2040	2040	2040	Mean warmer & wetter	2040
A1	Planned Development 2040 without ALU	**2007**	2040	2040	2040	2040	2040	Mean warmer & wetter	2040
A2	High level ALU implementation	**HIGH**	2040	2040	2040	2040	2040	Mean warmer & wetter	2040

3.4.5 Flood protection sub-scenarios

To assess the positive and negative impacts of flood protection infrastructure comparisons will be made between main scenario M3 and sub-scenario F1 (Table 5). Two other alternative flood protection strategies (F2 and F3) will also be compared with F1 or M3.

Table 5 Sub-scenarios to better understand impacts of different assumptions about future flood protection investments.

	Scenario and sub-scenarios	Level of Development for water-related sectors						Climate	Flood-plain
		ALU	DIW	FPF	HPP	IRR	NAV		
M3-CC	Planned Development Scenario 2040	2040	2040	2040	2040	2040	2040	Mean warmer & wetter	2040
F1	Planned Development 2040 without FPF	2040	2040	**2007**	2040	2040	2040	Mean warmer & wetter	2040
F2	Planned Development 2040 with FP2	2040	2040	FPF2	2040	2040	2040	Mean warmer & wetter	2040
F3	Planned Development 2040 with FPF3	2040	2040	FPF3	2040	2040	2040	Mean warmer & wetter	2040

3.4.6 *Irrigation sub-scenarios*

To assess the positive and negative impacts of irrigation infrastructure overall comparisons will be made between main scenario M3 and sub-scenario I1 (Table 6). Another sub-scenario with even more irrigation infrastructure (I2) will also be compared with I1 or M3.

Table 6 Sub-scenarios to test the effects of water resources development in the irrigation sector.

	Scenario and sub-scenarios	Level of Development for water-related sectors						Climate	Flood-plain
		ALU	DIW	FPF	HPP	IRR	NAV		
M3 - CC	Planned Development Scenario 2040	2040	2040	2040	2040	2040	2040	Mean warmer & wetter	2040
I1	Planned Development 2040 without IRR	2040	2040	2040	2040	**2007**	2040	Mean warmer & wetter	2040
I2	Planned Development 2040 with IRR HIGH	2040	2040	2040	2040	**HIGH**	2040	Mean warmer & wetter	2040

3.4.7 *Hydropower sub-scenarios*

To assess the positive and negative impacts of hydropower development will be made between main scenario M3 and sub-scenario H1 (Table 7). Two other alternative flood protection strategies (H2 and H3) will also be compared with H1 or M3.

Table 7 Sub-scenarios to test the effects of water resources development in the hydropower thematic sector.

	Scenario and sub-scenarios	Level of Development for water-related sectors						Climate	Flood-plain
		ALU	DIW	FPF	HPP	IRR	NAV		
M3 - CC	Planned Development Scenario 2040	2040	2040	2040	2040	2040	2040	Mean warmer & wetter	2040
H1	Planned Development 2040 without HPP	2040	2040	2040	**2007**	2040	2040	Mean warmer & wetter	2040
H2	Planned Development 2040 with HPS1	2040	2040	2040	**HPS1**	2040	2040	Mean warmer & wetter	2040
H3	Planned Development 2040 with HPS2	2040	2040	2040	**HPS2**	2040	2040	Mean warmer & wetter	2040

3.4.8 *Navigation sub-scenarios*

To assess the positive and negative impacts of navigation infrastructure comparisons will be made between main scenario M3 and a single sub-scenario N1 (Table 8).

Table 8 Sub-scenarios to test the effects of water resources development in navigation sectors.

	Scenario and sub-scenarios	Level of Development for water-related sectors						Climate	Flood-plain
		ALU	DIW	FPF	HPP	IRR	NAV		
M3-CC	Planned Development Scenario 2040	2040	2040	2040	2040	2040	2040	Mean warmer & wetter	2040
N1	Planned Development 2040 without NAV	2040	2040	2040	2040	2040	**2007**	Mean warmer & wetter	2040

3.4.9 *Domestic and industrial water use sub-scenarios*

To assess the positive and negative impacts of domestic and industrial water use comparisons will be made between main scenario M3 and a single sub-scenario D1 (Table 9).

Table 9 Sub-scenarios to test the effects of water resources development in in the domestics and industrial water use sectors

	Scenario and sub-scenarios	Level of Development for water-related sectors						Climate	Flood-plain
		ALU	DIW	FPF	HPP	IRR	NAV		
M3-CC	Planned Development Scenario 2040	2040	2040	2040	2040	2040	2040	Mean warmer & wetter	2040
D1	Planned Development 2040 without DIW	2040	**2007**	2040	2040	2040	2040	Mean warmer & wetter	2040

3.5 Indicators

Indicators play important functions in the assessment. First, indicators provide the metrics to convert (analytical) results into information that is meaningful to the audience. Second, indicators are needed to help transfer understanding and estimates of impacts in one discipline, tool or model to another. Third, indicators are useful for communicating the findings of the assessment more broadly.

3.5.1 Framework

The framework of indicators used by the CIA is informed by but not restricted to the MRC Strategic Indicator Framework (Table 10). At the core of this cumulative impact assessment are five classes of indicators. Three classes will involve a qualitative assessment approach and interpreting social, environmental, and economic indicators that emerge from the disciplinary assessments. This group of indicators will allow for a synthesis to develop a conjoined understanding of how the Lower Mekong basin is likely to evolve as a social-ecological system. The indicators involved during this first step are listed in Table 10 and mapped against the MRC Indicator Framework to explain the consistency of this approach within the broader MRC work.

In a next step, these disciplinary indicators and their conjoint understanding will be analysed in the context of resilience and vulnerability. This largely qualitative step will aim to identify thresholds and analyse how resilience and vulnerability of communities throughout the lower Mekong basin changes. The value-add provided form a cumulative assessment perspective will be the occurrence of changes across all three disciplines at the same time. Some combinations are likely to have non-linear co-relationships, which considers that a social-ecological system can cope with some changes but not with too many without experiencing a decline in resilience or an increase in vulnerability to some (environmental, social, or economic) drivers. This perspective will convert the combined effects of disciplinary outcomes as societal risks.

In a third step, another class of integrated indicators will be assessed quantitatively. This class includes (1) sustainability, (2) cross-sector synergies, and (3) transboundary effects. These three composite indicators are explained in more detail below.

The c*limate change* dimension will be considered in form of scenario variations, which will allow for covering some of these important MRC indicators throughout the council study, see Table 2.

The cooperation dimension from the MRC indicator framework will be partly address during the scenario comparison and partly by the quantitative assessment of transboundary impacts. Both will reveal potential for improved transboundary outcomes. However, indicators related to the organizational performance cannot be covered during this cumulative impact assessment. The modified CIA impact framework thus has 4 dimensions (social, environmental, economic, and integrated) consistent with triple-bottom line language in the Inception Report [2].

Table 10 Comparison of the strategic indicators used in the assessment and the emerging MRC indicator framework.

Assessment approach	Dimensions	Strategic Indicators	
		CIA Indicator Framework	MRC Indicator Framework
Qualitative & Quantitative synthesis	Social	Well-being Employment	Living conditions and well-being Employment in MRC sectors
	Environmental	Water flow conditions in mainstream Water quality and sediment conditions in mainstream Status of environmental assets	Water flow conditions in mainstream Water quality and sediment conditions in mainstream Status of environmental assets
	Economic	Economic value of MRC sectors Contribution to national economy	Economic performance of MRC sectors Contribution to national economy
	Integrated	Resilience; Vulnerability	
Quantitative analysis	Integrated	Resource sustainability Cross-sectoral synergies Transboundary balance	
Scenario comparison	Climate change		Greenhouse gas emissions Climate change trend and extreme Adaptation to climate change
	Cooperation		Equity of benefits derived from the Mekong River system Benefits derived from cooperation Self-finance of the MRC Level of information sharing and participation

3.5.2 Strategic indicators

The strategic indicators used in the CIA have been selected to inform the assessment of positive and negative impacts of the water resource development scenarios.

Table 11 lists the individual indicators this cumulative impact assessment will utilise from the disciplinary assessments to inform

- wellbeing and employment for the social dimension of change,
- water quantify, water quality, and other land use related indicators for the environmental dimension,

- and changes in MRC sectors and in the broader LMB economies for the economic dimension.

Table 11 Candidate composite strategic indicators for use in the Cumulative Impact Assessment based on selected indicators from the disciplinary assessments.

Dimension	Composite Strategic Indicators	Disciplinary assessment Indicators
Social	Wellbeing	Water security
		Food security
		Income security
		Health security
	Employment	Employment in MRC sectors
		Mean MRC sector income
Environmental	Water flow conditions in mainstream	Dry season flows – PMFM compliance
		Flood season peak flows – PMFM compliance
		Tonle Sap reverse flows – PMFM compliance
		Timing of onset of wet season flows
		Annual flooding
	Water quality and sediment conditions in mainstream	Mainstream water quality – PWQ compliance
		Sediment transport in the mainstream
		Salinity intrusion in the delta
	Status of environmental assets	Wetland area
		River channel conditions and habitats
		River bank erosion risk
		Aquatic biodiversity
		Ecologically significant areas
Economic	Net economic value of MRC sectors	Economic value of irrigated agriculture, recession agriculture, rainfed agriculture, hydropower production, flood damage, drought damage, capture fisheries, etc.
		Economic expenditure on tourism and recreation
	Contribution to national economy	Proportion of MRC sectors to overall GDP
	Natural resource intensity of growth	Natural resource input in production and consumption process of the LMB economies
Integrated (qualitative)	Resilience & Vulnerability	Combination of the above listed disciplinary results
Integrated (quantitative)	Sustainability	Selected indicators from disciplinary assessments that match SDGs
	Cross-sectoral synergies	Scenario impact on value differences between MRC sectors to quantify level of synergy or trade-off
	Transboundary balance	Quantification of proportion in sustainability effect and of cross-sector changes triggered by decisions in neighbouring countries and how much due to domestic investments.

These three dimensions will be jointly interpreted to inform an integrated perspective using resilience and vulnerability concepts. The assessment will be focused on understanding the relevance of synergetic effects of disciplinary outcomes as interpret them as changes in the resilience or vulnerability of the social-ecological system.

This qualitative assessment of the cross-disciplinary integration will be strengthened by a quantitative assessment of (1) sustainability, (2) cross-sector relationships, and (3) transboundary shifts. Sustainability will be defined through 34 indicators selected by the Member Countries during a participatory indicator design workshop. These 34 indicators were selected from the list of SDG assessment indicators. The Sustainability Development Goals (SDG) framework provides an internationally agreed definition of sustainability and comes with 241 indicators across 17 sustainable development goals. While it is outside the scope of the Council Study to comprehensively cover all 241 indicators, the selected 34 indicators cover a broad range of SDGs, see Table 12.

Table 12 Selection of disciplinary assessment indicators for SDG-based Sustainability definition

Economic loss due to disasters in percent of GDP	*High Priority – HP*	Economic
Average farming household income	*HP*	Economic
Change in water-use efficiency over time	*HP*	Environmental
Proportion of important sites for terrestrial and freshwater biodiversity that are protected	*HP*	Environmental
Proportion of population below national poverty line	*HP*	Social
Proportion of population with low food security	*HP*	Social
GDP per unit of primary energy input	*Medium Priority – MP*	Economic
Annual growth rate of real GDP per capita	*MP*	Economic
Level of water stress: freshwater withdrawal as a proportion of available freshwater resources	*MP*	Environmental
Change in the extent of water related ecosystems over time	*MP*	Environmental
Renewable energy share in the total final energy consumption	*MP*	Environmental
Proportion of fish stocks within biologically sustainable levels	*MP*	Environmental
Sustainable fisheries as a percentage of GDP	*MP*	Environmental
Proportion of land that is degraded over total land area	*MP*	Environmental
Loss of human life due to disasters	*MP*	Social
Proportion of population undernourished	*MP*	Social
Proportion of children under 5 with malnutrition	*MP*	Social
Under-five mortality rate	*MP*	Social
Proportion of population with access to electricity	*MP*	Social
Proportion of people living below 50 per cent of median income	*MP*	Social
Tourism as a proportion of total GDP	*Low Priority – LP*	Economic
Proportion of domestic budget funded by domestic taxes	*LP*	Economic
Foreign direct investments (FDI)	*LP*	Economic
Investments under an enforced disaster risk management strategy	*LP*	Environmental

Degree of integrated water resources management implementation (0-100)	*LP*	Environmental
Proportion of transboundary basin area with an operational arrangement for water cooperation	*LP*	Environmental
Coverage of protected areas in relation to marine areas	*LP*	Environmental
Forest area as a proportion of total land area	*LP*	Environmental
Proportion of Government spending on education	*LP*	Social
Mortality rate attributed to unsafe water	*LP*	Social
Proportion of population using safely managed drinking water services	*LP*	Social
Proportion of wastewater safely treated	*LP*	Social
Proportion of youth (aged 15-24 years) not in education, employment or training	*LP*	Social
Number of agencies with policies on mitigation, adaptation, and early warning	*LP*	Social

The workshop process involved selecting sustainability indicators relevant for the Mekong basin context through a scoring system. Member country representatives could vote which SDG indicators to delete from the proposed list. All indicators that received three or four votes were deleted. Table 12 lists those indicators that no Member Country suggested to delete as high priority indicators (HP). Indicators that received one vote to be deleted are listed as medium priority and those that received two votes are listed with a medium priority. In total six indicators ranked with high priority, 14 with medium, and 14 with low priority. This ranking does not imply that the topics are of low priority to the Governments of the lower Mekong basin. Instead it highlights the level of agreement on which indicators to include in the design of the sustainability index.

3.6 Assessment areas

The focus of the assessment is on areas in the LMB impacted by water resources development, in particular, those areas likely to be directly impacted positively or negatively by changes in mainstream hydrology and bio-resource conditions, being defined in the CS as:

- A corridor on both sides of the mainstream from Chinese border to Kratie
- The Cambodia Floodplains including the Tonle Sap River and Great Lake
- The Mekong Delta in Cambodia and Viet Nam
- The coastal areas directly influenced by the Mekong estuary

It is recognized that to properly understand these impacts, particular analyses may need to consider the full Mekong River Basin or consider information at the country level.

Many of the tools above are being developed as part of the CS. It is important that stakeholders in the CS have confidence in the results produced by these new tools and models. This requires that each new tool is calibrated and peer reviewed.

4 Methods

This chapter summarizes briefly the key methods behind the disciplinary and sectoral assessments and describes the strategies and methods for how these will be integrated and synthesized to complete the cumulative impact assessment.

4.1 Overall

In this report, **cumulative** impact assessment is understood to refer to the notion of examining impacts of many projects (accumulating across projects) which may not all be implemented at the same time and trigger responses which may be delayed (accumulating across time), and integrated (accumulating across development criteria or the triple bottom line). This synthesis and integration component builds directly on the results of the disciplinary and thematic sector assessments. Table 13 summarizes the key scenario and sub-scenario comparisons made to test for various effects and their use in the various disciplinary assessments.

Table 13 Scenario and sub-scenario comparisons used by the disciplinary and thematic assessments. Cells left empty are a lower priority and may be evaluated after others have been completed.

		Disciplinary Assessments				
Effects tested	**Key Scenario or sub-scenario Comparisons**	**Hydrological**	**Sediments**	**Bio-resources**	**Economic**	**Social**
Overall water resources development	M3/C1 vs M2	X	X	X	X	X
	M2 vs M1	X	X	X	X	X
Climate change	C1 vs C2	X	X	X	X	X
	C1 vs C3	X	X	X	X	X
	M3-CC vs C1	X	X	X	X	X
Irrigation development	M3-CC vs I1	X	X	X	X	X
	M3-CC vs I2	X				
Hydropower development	M3-CC vs H1	X	X	X	X	X
	M3-CC vs H2	X				
	M3-CC vs H3	X				
Navigation development	M3-CC vs N1	X	X	X	X	X
Domestic & Industry water use	M3-CC vs D1	X	X	X	X	X
Agriculture & land-use development	M3-CC vs A1	X	X	X	X	X
	M3-CC vs A2	X				

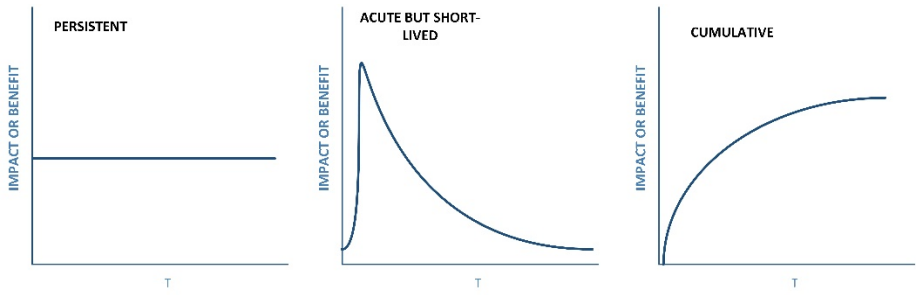
Effects tested	Key Scenario or sub-scenario Comparisons	Disciplinary Assessments				
		Hydrological	Sediments	Bio-resources	Economic	Social
Flood protection infrastructure development	M3-CC vs F1	X	X	X	X	X
	M3-CC vs F2	X				
	M3-CC vs F3	X				

Apart from comparison of scenarios and sub-scenarios listed above assessments will also draw on comparisons of impacts in:

- dry versus wet season in normal years;
- Very wet compared to normal years;
- Very dry compared to normal years.

Finally, one of the benefits of running models out for 23 years while holding the level of water infrastructure constant is that it allows consideration in the assessment of different possible patterns of response over time from ecosystems, social or economic systems (Figure 3).

Figure 3 Impacts and benefits from water resource development are not instantaneous or necessarily linear over time.



The details of the methods and indicators used in the environmental, social and economic assessment are documented fully elsewhere [4, 5, 11]. The following sections highlight some of the key methodological features.

4.2 Disciplinary synthesis

4.2.1 Environmental assessment

The objective of the environmental assessment is to determine the impacts on environmental conditions within the LMB of the water resource development scenarios and

sub-scenarios (Table 13). The general sequence will be from changes in the hydrological regime, water quality and sediment dynamics through to bio-physical and ecological changes.

Various scenario analysis models and tools are being developed, calibrated and validated to describe and link these impacts [11]. The DSF suite of approved modelling tools will be used to link infrastructure developments, land use changes and climate change with changes in mainstream flow conditions, flooding and saline intrusion. WUP-FIN and other models will be used to link infrastructure developments, sand mining, and other developments, with changes in mainstream sediment and nutrient flow conditions. The DRIFT expert system will be used to link changes in mainstream flow, sediment, nutrient and salinity conditions with indicators related to bio-physical conditions in the basin and the productivity of ecological assets.

4.2.2 Social assessment

The objective of the social assessment is to determine the impacts on social conditions within the LMB of the changes driven by scenarios and sub-scenarios of water resource development (Table 13). The social impact of the development scenarios will be assessed against the social assessment indicators (Table 10). For example, the living conditions and well-being indicator define communities as water secure if sufficient households (HHs) have access to safe water, have reliable primary domestic water sources run dry, do not experience either water shortages or floods that result in crop damage.

In some situations, focussing on direction and levels of change in the value of an indicator as a measure of impact may be much easier than trying to estimate the values under two conditions. Moreover, estimates of direction of change or difference may also be more robust than estimates of projected values.

All social assessment indicators are subject to impacts from both water resource developments as well as exogenous developments and thus the latter must be taken into account in the analysis or interpretation whenever possible. Causal-loop or influence diagrams can be used to make analytical reasoning and assumption transparent.

4.2.3 Economic assessment

The main objectives of the economic assessment are to: (i) estimate the economic benefits and costs of existing and planned water resource developments; (ii) evaluate the economic impacts of interventions (both positive and negative); (iii) determine the distribution of economic benefits and costs, as well as economic losses, between LMB countries; and (iv) estimate the impact on employment and livelihoods.

The economic assessment will be in two parts. The first part focuses on economic valuation of the impacts of the three development scenarios on the economic performance of MRC

sectors using conventional methods. The second part will examine the contribution of these impacts overall on the national economy, including, if possible structural changes.

4.3 Thematic sector assessments

Each of the thematic sector assessments has two main components.

First, description and projection of the level of development of the sector in 2007, 2020 and 2040 as inputs to the construction of the three main water resource development scenarios (Table 1).

Second, analysis and interpretation of the impacts and benefits of sector development based on the findings of the hydrological, environmental, economic and social assessments including specific scenario and sub-scenario comparisons (Table 13). Assessing the positive and negative impacts of a sector as a whole is the main task and will be investigated by comparing sub-scenarios which exclude developments in that sector with the corresponding main scenario.

4.4 Qualitative integration

The final component of the assessment is integration and synthesis. This activity might be described in full as the **cumulative, multi-sector, integrated assessment**. It builds on the results and insights of the disciplinary and thematic sector assessments.

4.4.1 Analytical strategies

The main analytical strategies will be to:

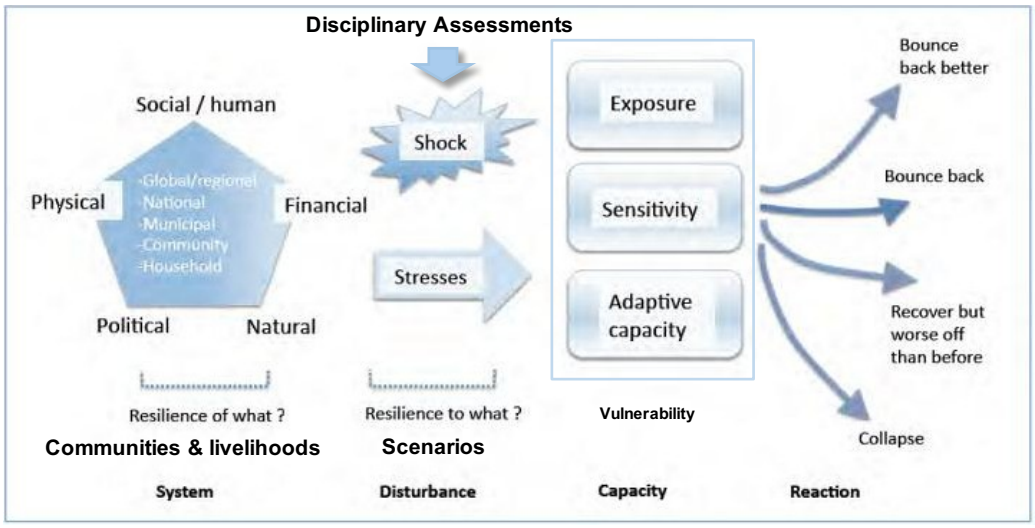
- Collate evidence of significant impacts from the comparisons made between scenarios in the individual assessments, and use these alongside key messages in the text;
- Compare changes in value of a specific strategic indicators across assessments, for example, across sectors, displaying important information in graphic form whenever possible;
- Analyse and interpret differences in the three integration indicators, retaining them in the synthesis if they add value to the individual strategic indicators;
- Select a handful of well understood causal chains from hydrological changes through to positive or negative social and economic impacts that can be used to illustrate the linked assessment process;

In a next step of the synthesis, these findings will be interpreted considering the resilience and the vulnerability concepts, see Figure 4. This step will be focused on communities and their livelihoods. However, this will consider the broader systems perspective of how communities and livelihoods depend and are being influenced by social, natural, financial,

physical and political factors. Shocks to this system are defined by the scenarios and the disciplinary assessments project the various facets of change households would have to face and to cope with in the various parts of the lower Mekong basin. This change will translate into different exposure, sensitivity and adaptive capacity, if one compares the scenarios. Consequentially, this qualitative interpretation will identify in which parts of the Mekong communities are likely to fall into which category:

- Communities bounce back and are better off than before, often a positive transformation of the social-ecological system;
- Communities will bounce back and recover from the shock to a situation with similar characteristics than before the shock;
- Communities will recover but they be worse off than before;
- Communities will collapse, which could involve substantial segments of the communities moving away and a loss of the majority of existing livelihoods.

Figure 4 Resilience framework and vulnerability concept with outcome categories



In addition to the categorisation of possible community outcomes, this part of the assessment will qualify how the resilience of the overall system changes and how vulnerabilities change.

Finally, the synthesis will aim to identify knowledge gaps and discuss strategies to improve the analytical base for an assessment that has a similar extent and scope to council study.

4.5 Quantitative integration based on composite indicators

Three composite, integrated, indicators are proposed (Table 11). The first, *sustainability*, is intended to quantify sustainability effects as defined by the UN-led SDG process all Mekong riparian countries committed to. The second, *cross-sectoral synergies*, is intended to measure the extent of synergies or trade-offs among sectors including capture fisheries.

The third, *transboundary influence*, is intended to measure the contribution on sustainability and cross-sector changes due to investments in any of the other LMB countries. It is anticipated that all three indicators will be derived from the basic assessment indicator

4.5.1 *Sustainability index*

Sustainability is a core concept of the council study and of the overall framework the MRC is implementing. This suggests that the development of a sustainability index is useful for understanding and interpreting the differences between scenario results from an integrated assessment perspective.

The sustainability index is based on the subset of SDG indicators, as listed in Table 12. Methodologically, this index is calculated by normalising each indicator. In a first step, the selection of SDG indicators will be completed with member countries. In a second step, the range of possible outcomes will be specified for each indicator. Also this step will be implemented with member countries. The starting values for the worst and the best situation of each indicator will be derived from global data. Once complete, disciplinary assessment results will be used to calculate the state of each indicator for each scenario and then normalised within the agreed value range of possible outcomes.

This approach will assign each indicator a sustainability value between zero (unsustainable) to one (highly sustainable). The sum over all sustainability indicators could then be compared across scenarios and this index would identify of scenarios lead to sustainability improvements or to sustainability losses.

4.5.2 *Cross-sector relationship*

Many MRC documents and negotiations point out that the aim is to guide investment decision to a balanced development. Balanced development is interpreted in two ways. First, there should be a balance between sectors, which implies that investments should not aim for the development of a single sector at the cost of other sectors. Second, the development process in the lower Mekong basin should consider transboundary effects, which emphasises the relevance of a balance between the outcomes for each country. This assessment defines one indicator for each perspective of balanced development: cross-sector, and transboundary.

Cross-sector relationships can be positive or negative. Typically, positive cross-sector relationships are referred to as synergies. This implies that investments in one sector achieve improvements in this target sector but triggers also improvements in one or more other sectors. Negative cross-sector relationships imply trade-offs. Investments in one sector lead to improvements in the target sector but trigger losses in other sectors.

Based on this understanding this indicator will calculate the value improvement or value loss for each MRC sector by comparing all (sub-)scenario. For instance, the comparison of hydropower output (in economic value) in scenario M1 (water infrastructure situation in 2007) and M2 (planned water infrastructure situation for 2020) results in what is gained for the hydropower sector through the additional investment defined by the 2020 scenario. This can be calculated for all MRC sectors based on the outputs of the macro-economic assessment approach. Dividing the sectoral value differences leads to an important insight:

$$\frac{\text{Fisheries sector [M2]} - \text{Fisheries sector [M1]}}{\text{Hydropower sector [M2]} - \text{Hydropower sector [M1]}}$$

This relationship defines how much is gained or lost in one sector (e.g. fisheries) for every dollar gained in another sector (e.g. hydropower). Example, if the macro-economic assessment shows that the hydropower sector output increases in the 2020 scenario by $100m and the fisheries output decreases in the same scenario comparison by $50m, then the result shows that for every dollar gained in hydropower about 50 cents are lost in fisheries. Comparing all sectors identifies not only synergies and trade-offs but also how synergies and trade-offs shift as investments gradually increase of shift between sectors. From a wider systems perspective, these results would guide management of cross-sector trade-offs and the realisation of conceivable synergies.

4.5.3 Transboundary impacts

The second perspective of balanced development requests the management of transboundary impact. Typically, transboundary impacts are calculated as sectoral gains or losses. This is already included in the macro-economic assessment and should not be repeated in this cumulative impact assessment. The development of a cumulative indicator that goes beyond the sectoral perspective needs to look again at the broader system. Consequently, this assessment approaches transboundary impacts as the ratio of the two previous composite indicators (sustainability & cross-sector relationship) that can be attributed to the change in any of the three other countries. In other words, this indicator calculates

(1) which percentage of the sustainability index change is due to transboundary impacts, and
(2) which percentage of cross-sector synergies/trade-offs are due to transboundary impacts.

Accordingly, two sub-indicators result from this approach and add to the macro-economic assessment perspective by identifying that overall (considering gains in one sector and losses in another sector) transboundary impacts will affect sustainability and cross-sector relationships in a particular way.

Methodologically this can be achieved in four steps. First the weight of each sector is calculated for each scenario. Second, the scenario investment is mapped to its location. Third, these two values will be multiplied with each other to gain sector-country

coefficients. Then, these coefficients will be multiplied with (1) the sustainability index change and with (2) the cross-sector effect. The result will show how much of the sustainability index change (comparing two scenarios) is due to transboundary effects. Correspondingly, the result will show how much of the cross-sector synergy or the cross-sector trade-off results from investment in other countries.

4.6 Consultation process

The council study combines a wide range of assessment approaches. Disaggregated results are provided by disciplinary assessments and analysed by themes for each MRC sector perspective (Figure 2). This cumulative impact assessment aims to provide value add by interpreting the wide variety of disciplinary and sectoral results. This introduces an additional level of abstraction that requires a strong engagement with all member countries and with stakeholder, to design and interpret synthesis approaches and composite indicators in a way that they are meaningful to the transboundary negotiation and the policy and planning processes of all member countries.

Additionally, the synthesis and integration task is complicated and some findings and evidence may be open to alternative interpretations. Inevitably, it will be extremely important for drafts of the findings to be deliberated upon, both with technical experts and a broader stakeholder group. The aim of these exercises will not necessarily be to achieve consensus, but to ensure that relevant knowledge is considered, and that the findings of the report and key assumptions behind them are transparent and understood.

5 Outputs and reporting

5.1 Cumulative Impact Assessment Report

The Cumulative Impact Assessment Report will be equivalent to the Main Report [3]. It will integrate the key findings of the individual thematic sector and disciplinary reports to assess the overall impacts and benefits of the water resources development scenarios.

5.1.1 Style and organization

The main report will play an important role in communicating the findings of the Cumulative Impact Assessment and Council Study. The report should therefore be concise, easy to read and be liberally illustrated with meaningful graphics. The proposal is to structure the report around a handful of key messages as outlined in Table 14.

Table 14 Proposed organization of the final Cumulative Impact Assessment report.

	Chapters
1.	Executive Summary
2.	Introduction
3.	Key Message 1: Most important benefits and opportunities
4.	Key Message 2: Most significant negative impacts and risks
5.	Key Message 3: Key trade-offs and synergies
6.	Key Message 4: Implications for planning and policy
7.	Key Message 5: Knowledge gaps
8.	Key Message 6: Main recommendations

To allow interested readers to investigate issues in greater-depth the main report will liberally cross-references the set of supporting technical reports (Table 15), and thus also act as an index into the more important analyses and results.

Chapter 2, the introduction, will describe the rationale, purpose and design of the assessment.

Chapters 3-5 will focus on key findings of the analysis. The report will describe the evolution of regional distribution of benefits, costs, impacts and risks of water resources development in the Mekong basin. Key graphics will highlight significant changes in strategic indicators for individual countries with water resources development in 2020 and 2040 compared to 2007. Other graphics will show the impacts of climate change and water resource development in particular sectors. Integrated indicators will be used as

appropriate to underline insights with respect to sustainability, synergies and transboundary distribution of benefits and negative impacts.

Chapters 6-8 will reflect on the key findings to highlight and discuss the main implications of the assessment for planning and policy as well as identify knowledge gaps, and offer recommendations. The analysis of implications will consider ways to ensure planned development is leading towards improved security within the LMB, and more equitable water use between the Member Countries. Key uncertainties and gaps in knowledge will be identified and their implications for interpretation and needs for further work clearly communicated. The main recommendations are expected to relate to options to avoid or reduce negative impacts while still meeting social development objectives.

The entire report will be 35-50 pages in length.

5.2 Supporting reports and documents

The final CIA report will be supported by the reports of the Thematic and Disciplinary teams (Table 15).

Table 15 Supporting reports for the CIA

Topic	Reports
Irrigation	A Thematic Report on the Impacts and Benefits of Irrigation Development in the Lower Mekong River Basin Including Recommendations for Impact Avoidance and Mitigation Measures.
Agriculture and Land-use Change	A comprehensive land-use/land cover map for the council study A Thematic Report on Impacts of Non-irrigated Agriculture Development and General Trends in Major Land-Use Categories in the Lower Mekong River Basin Including Recommendations for Impact Avoidance and Mitigation Measures.
Domestic and Industrial Water Use	A Thematic Report on Impacts and Benefits of Domestic and Industrial Water Use in the Lower Mekong River Basin including Recommendations for Impact Avoidance and Mitigation Measures.
Flood protection and flood plain infrastructure	A Thematic Report on Impacts and Benefits of Flood Protection Structures and Floodplain Infrastructure and Impact of other Developments on Flood Risk Including Recommendations for Impact Avoidance and Mitigation Measures.
Hydropower	A Thematic Report on Impacts and Benefits of Hydropower Development in the Lower Mekong River Basin Including Recommendations for Impact Avoidance and Mitigation Measures.
Navigation	A Thematic Report on the Impacts and Benefits of Navigation Infrastructure Development in the Lower Mekong River Basin Including Recommendations for Impact Avoidance and Mitigation Measures.
Hydrology and climate	A disciplinary technical report on hydrological modelling.

Sediment transport	A disciplinary technical report on sediment transport.
Biological Resources	Technical report outlining changes in selected ecological and environmental parameters
Social	A report documenting the social assessment including socio-economic or livelihood analyses
Economic	A report documenting the economic assessment including a resource economics and macro-economic perspectives.
Design & methods	A report summarizes main features of the Assessment Design and Methods

In addition to the above, peer review and associated technical reports will be prepared for the new analytical tools described below.

5.3 Databases and tools

The CS will also result in MRC being equipped with a range of important databases and analytical and assessment tools as summarised below.

The **analytical tools** will include:

- An enhanced DSF to model changes in mainstream flow and saline intrusion;
- Improved WUP-FIN and other models to model mainstream sediment and nutrient flow conditions;
- A calibrated DRIFT methodology to evaluate changes in bio-physical conditions and the productivity of ecological assets;
- A social impact spreadsheet tool to model impacts on social conditions arising from changes in environmental and hydrological conditions; and
- GIS applications to support the assessment process.

The **assessment tools** will include:

- An environmental assessment spreadsheet tool to evaluate assessment indicators;
- A social assessment spreadsheet tool to evaluate assessment indicators;
- An economic spreadsheet tool to evaluate to evaluate assessment indicators; and
- A cumulative assessment spreadsheet tool to calculate the three composite indicators (sustainability, cross-sector synergies, and transboundary impacts).

The **databases**, which generally will be geo-referenced, will include:

- An agriculture and land use database, including watershed management, deforestation, livestock and aquaculture, and fisheries;

- A water supply and sanitation database, including industrial development;
- An enhanced irrigation database;
- An enhanced hydropower database;
- An enhanced spatial database of flood protection structures and floodplain infrastructure;
- An enhanced spatial database of mainstream navigation facilities;
- A complete set of environmental, social and economic discipline specific indicators at data capture date and adjusted for a consistent set valued for 2007;
- A set of data and maps describing the pre-development situation;
- A set of trend functions for the discipline specific indicators describing the impacts of exogenous development; and
- Data sets describing the Council Study scenarios for 2007, 2020 and 2040.

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