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The Council Study

**Study on the sustainable management and development of the Mekong River,
including impacts of mainstream hydropower projects**

Work Plan: Formulation of Development Scenarios for the Flood Protection and Floodplain Infrastructure Thematic Area

This work plan describes the roadmap and the approach for formulating the development scenarios for the **Flood Protection and Floodplain Infrastructure** thematic area. It includes the following:

- Approved Cumulative Scenarios (2007 Early Development, 2020 DFS, 2040 Planned Development) and Proposed Thematic Sub-scenarios
- Detailed schedule of data collection and analysis including coordination with Member Countries through consultation with appropriate experts of line agencies, national consultations, and regional technical working group
- Detailed data needs including current status, source agencies, and known issues for each proposed development scenario
- Proposed methodology and assumptions to fill data gaps in particular where data are known to be not available
- Personnel roles and responsibilities

Prepared by:

FMMP

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1 Introduction

This work plan describes the roadmap and the approach for the formulation of the development scenarios that are going to be assessed under the Council Study. The results of these development scenario assessments will be used as the primary basis to address the overall objective of the Council Study which is to further enhance the ability of the Mekong River Commission (MRC) to advise Member Countries (MCs) on the positive and negative impacts of water resources development on people, economies and the environment of the Mekong River Basin. This enhanced ability is expected as a result of meeting the following specific objectives of the Council Study:

Objective 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.

Objective 2: Results of the study are integrated into the MRC knowledge base to enhance the Basin Development Planning (BDP) process providing support to the MCs in the sustainable management and development of the Mekong River Basin.

Objective 3: Promote capacity and ensure technology transfer to MCs in the process of designing and conducting of the study.

As such, the formulation of development scenarios is most critical since it defines the extent to which these three objectives can be met. The formulated development scenarios will set the boundary for what new knowledge will be generated, what knowledge gaps will be closed, and what uncertainties in the assessments will be minimized (i.e., Objective 1). The assessment methodology and the associated tools (both existing and new) along with the expanded MRC knowledge base will determine the extent of how the current BDP process can be enhanced (i.e., Objective 2). The participatory process adopted in formulating the development scenarios will govern how effective the learning-by-doing approach is with respect to building internal capacity and successfully transferring technology (i.e., Objective 3).

As per the Council Study Concept Note, Terms of Reference (ToR) and Inception Report, the assessments will include the following types:

- An assessment of the cumulative positive and negative impacts of water resource developments in all six selected thematic areas on the triple-bottom-line including clear indications of hotspots when/if relevant, and the thresholds of rapid transition—tipping points—in complex systems such as the Tonle Sap Lake in Cambodia and the Mekong Delta in Cambodia and Viet Nam (i.e., referred hereinafter as the assessment of **development scenarios**).
- Assessments for each thematic area summarising the transboundary impacts of developments in the selected thematic areas including cross-cutting impacts on the triple-bottom-line: the environmental, social and economic parameters of interest in the Mekong River Basin (i.e., referred hereinafter as the assessment of **thematic development sub-scenarios**)

In the end, the Council Study will produce a set of clear, strategic, pragmatic and actionable recommendations directly addressing potential uncertainties, risks and the information needs for

development planning in the mainstream of the Lower Mekong Basin (LMB) including recommendations for impact avoidance and mitigation measures.

2. Role of FMMP in the Council Studies

FMMP has a number of roles in implementing the Council Study (CS):

1. To formulate three 'development scenarios' for the 'flood protection works and floodplain infrastructure' thematic area;
2. To formulate up to three 'thematic sub-scenarios' for the 'flood protection works and floodplain infrastructure' thematic area;
3. To assess the need to protect future developments (other thematic areas) from flooding;
4. To assess the impact of thematic development scenarios and sub-scenarios on flooding behaviour; and
5. To assess the impact of thematic development scenarios and sub-scenarios on flood risk.

Roles 1, 2 and 3 are discussed in Section 3 of the Workplan. Roles 4 and 5 are discussed in Section 4 of the Workplan.

3 Formulation of Development Scenarios

3.1 General

The development scenarios will be formulated by defining levels of developments in six thematic areas for each scenario. The six thematic areas are:

- Irrigation; including water use, return flows, water quality, proposed diversions, etc.
- Agriculture and Land use; including watershed management, deforestation, livestock and aquaculture, fisheries etc.
- Domestic and Industrial use; including mining, sediment extraction, waste water disposal, urban development, water quality etc.
- Flood protection structures and floodplain infrastructure, including roads on major floodplains
- Hydropower, including potential of alternative energy options.
- Navigation, specifically on infrastructure to aid navigation

The development scenarios will be of two types namely (main) development thematic scenarios and sub-scenarios.

3.2 Development Scenarios

The development scenarios are based on historic (2007) and planned (2020 and 2040) basin-wide developments in the six thematic areas. These development scenarios will allow the assessment of cumulative positive and negative environmental and socio-economic impacts associated with planned developments by the MCs. The assessment will show the predicted changes in the environmental and socio-economic conditions in the LMB in space and time and potentially reveal clear indications of geographic hotspots and rapid transitions in time as a result of combined developments in the six thematic areas. Along with the results of the assessment of selected thematic sub-scenarios under which impacts of specific-thematic developments can be better understood, realistic, reasonable, and thus actionable development options and management measures can be identified to enhance positive impacts and minimize negative impacts of the planned developments. Strategic measures for long-term negative impact avoidance and risk mitigation can also be identified for development planning considerations by the MCs.

During the 4th RTWG Meeting, the following development scenarios were approved for the Council Study.

Early Development Scenario/Situation (2007): This scenario covers the period from the beginning of large-scale water resources development until the year 2007 when the flow regime of the Mekong mainstream was considered to be still in its natural state. This scenario includes the water infrastructure and the land use/cover changes in the six thematic areas by 2007.

Definite Future Scenario (2020): This scenario includes all existing (before and after 2007), undergoing construction, and firmly committed development infrastructure in the six thematic areas which are expected to be in place by 2020.

Planned Development Scenario (2040): This scenario includes all water resources development that is planned in the six thematic areas in the Mekong Basin and are expected to be in place by 2040 assuming these plans are fully implemented.

3.3 Thematic Sub-Scenarios

The Thematic Sub-Scenarios represent plausible thematic-specific deviations from the 2040 Planned Development Scenario. These thematic-specific deviations reflect level of uncertainties in the full implementation of the planned development level for the thematic area of interest as per the 2040 Planned Scenarios. These deviations can be due to several factors such as changes in national development policies and priorities, technology, demography, socio-economic conditions, global context, etc. The deviations are formulated around the 2040 Planned Scenario to keep these thematic sub-scenarios plausible. It should be noted that while a different level of development is used for the thematic area of interest, the levels of development for the other thematic areas are held equal to the planned 2040 levels.

The assessment of these thematic sub-scenarios will provide the following understanding:

- Sensitivity of impacts to deviations from planned development levels
- Better understanding of impacts of specific development stressors (i.e., closing knowledge gaps)

- In-depth analysis of the plans and plausible deviations in the plans (i.e., understand uncertainty in the plans and identify measure to minimize deviations)
- Increase understanding and capability to explore options and measures to enhance positive impacts and mitigate/reduce negative impacts

As per the Inception Report, a maximum of three thematic sub-scenarios per thematic area will be assessed. However, the Thematic Team may identify more than three potential thematic sub-scenarios. These thematic sub-scenarios will be presented to the MCs to get their input and final concurrence on what thematic sub-scenarios to assess.

3.4 Formulation of FMMP's Contribution to Development Scenarios

FMMP will seek details of existing (EDS-2007) and planned future (DFS-2020 and PFD-2040) *significant* flood protection works, together with floodplain infrastructure likely to *significantly* affect flooding behaviour (eg major road and irrigation embankments across floodplains), from the four Member Countries (MCs).

- FMMP has good information on EDS-2007 flood protection works and floodplain infrastructure across the Lower Cambodian Floodplains and the Mekong Delta of Viet Nam. FMMP will seek information on significant flood protection works and floodplain infrastructure along the mainstream reach of the Mekong River from the Chinese border to Kratie.
- Regarding planned developments in 2020 and 2040, FMMP can only seek and use information on proposed flood protection works and floodplain infrastructure provided by the four MCs.
- Information on flood protection works and floodplain infrastructure relevant to the 2007, 2020 and 2040 scenarios will be provided to IKMP for incorporation in the various hydrologic and hydraulic models used to simulate daily flow behaviour across the Lower Mekong Basin (LMB).

3.5 Formulation of FMMP's Contribution to Thematic Sub-Scenarios

The purpose of the thematic sub-scenarios is to assess the sensitivity of the socio-economic and environmental impacts of the PFS-2040 development scenario to uncertainties in the 2040 developments identified by each thematic area. As each thematic area will have the results for 2040 developments ready by October 2015 only, this activity will be implemented in stage 2 (see section 6 Project Implementation). FMMP will select two or three Sub-Scenarios from other thematic areas to assess flood behaviour, flood damage and flood damage risk of future developments.

3.6 Assessment of the Need for Flood Reduction Measures

In addition to formulating the flood protection works and floodplain development component of the development scenarios and thematic sub-scenarios, as outlined above, FMMP will also assess the need for flood risk reduction measures in the development scenarios (other thematic areas) and thematic sub-scenarios (other thematic areas). Also this activity will start only in stage 2 as these data will become available by October 2015.

Should such flood risk reduction measures be required, FMMP will incorporate them in FMMP's component of the development scenarios and thematic sub-scenarios.

4 Assessment of the Impacts of Development on Flood Behaviour and Flood Risk

4.1 Impact Assessment Locations

In assessing the socio-economic and environmental impacts of future basin development, the CS will adopt a 'basin-wide' outlook. FMMP will evaluate the impact of development on flood behaviour and flood risk and a limited number of 'impact assessment locations' (IALs) situated at key points of interest across the LMB.

- FMMP proposes that the IALs include all major monitoring stations along the Mekong, Bassac and Tonle Sap rivers, together with a limited number of other sites of flooding relevance to other thematic areas. (Yet to be discussed and decided with other thematic areas).

4.2 Impacts on Flood Behaviour

Flood behaviour can be characterized in a number of ways:

- Peak annual flood flow;
- Peak annual flood level;
- Annual flood volume;
- Onset and end dates of flooding; and
- Stage-duration curves of annual flooding.

FMMP has the ability to examine changes caused by basin development in all of the above flood characteristics.

- Before finalizing flood characteristics for assessment under the CS, FMMP will discuss with other thematic areas the relevance of the various characteristics to flooding issues in their specific areas.

FMMP proposes to assess changes to flood characteristics in terms of changes to the *frequency distribution of that characteristic*. Baseline distributions will be developed for:

- The EDS-2007 development situation, which will be used to assess future changes under the DFS-2020 and PFS-2040 situations; and
- The PFS-2040 development situation, which will be used to assess changes under the various thematic sub-scenario development situations.

4.3 Impacts on Flood Risk

FMMP takes 'flood risk' to mean average annual damage (AAD). FMMP will assess changes to flood risk in terms of changes to AAD between the baseline and future periods (development scenarios) and between the PFS-2040 development scenario and perturbed variations of that scenario (thematic sub-scenarios).

The assessment of flood risk, especially on a basin-wide basis is a big task. There are some 40 provinces affected by mainstream flooding in the LMB (see Tables 5.1 and 5.2). Most of the annual flood damage

and flood risk is generated in the nine provinces of the Lower Cambodian Floodplains and the nine provinces of Viet Nam's Mekong Delta.

- To assess flood damage and AAD under the CS, FMMP proposes to undertake a 'scoping study' to determine (i) those provinces with the greatest levels of flood damage, and (ii) the minimum number and identity of provinces to be included in the assessment, whilst providing a satisfactory overview of impacts on flood risk.
- FMMP will seek annual flood damage data for the selected provinces from water resource and disaster management agencies in the four MCs.

Table 4.1 Number of Provinces Affected by Mainstream Flooding

Country	Lao PDR	Thailand	Cambodia	Viet Nam	Total
Mekong Mainstream Provinces	8	7	1	-	16
Cambodian Floodplain Provinces	-	-	7	-	7
Mekong Delta Provinces	-	-	5	8	13
Total Provinces	8	7	13	8	36

Table 4.2 Provinces Affected by Mainstream Flooding

Country	Province		Council Study Assessment Zone
	West Bank	East Bank	
Lao PDR		Phongsaly	Mekong Mainstream Zone 1
		Luang Naptha	
		Bokeo	
	Xayabury	Luang Prabang	
		Vientiane	Mekong Mainstream Zone 2
		Vientiane Capital	
		Borikhamxay	
		Khammuane	
		Savannakhet	
		Saravane	
	Champasak	Champasak	Mekong Mainstream Zone 1
	Chiang Rai		
	Loei		
	Nong Khai		
	Nakhon Phanom		
Thailand		Mukdahan	Mekong Mainstream Zone 2
		Amnat Charoen	
		Ubon Ratchathani	
Cambodia	Stung Treng	Stung Treng	Mekong Mainstream Zone 3
	Kratie	Kratie	
		Tbong Khmum	Zone 4
	Kampong Cham	Kampong Cham	

	Kampong Chhang		Zone 4a
	Pursat		
	Battambang		Zone 4b
	Banteay Meanchey		
	Siem Reap		
	Kampong Thom		
	Kandal	Prey Veng	Mekong Delta Zone 5
	Takeo	Svay Rieng	
	An Giang	Dong Thap	
	Kien Giang	Tien Giang	
Viet Nam	Can Tho	Ben Tre	Mekong Delta Zone 5
	Vinh Long		
	Long An		

Note: Provinces Phongsaly, Luang Naptha, Bokeo, Xayabury and Stung Treng are deleted after a preliminary survey with Google revealed that flood damage will be minimal.

5 Data Requirements

5.1 Flood protection Works and Floodplain Infrastructure

To formulate the three development scenarios (ED-2007, DFD-2020 and PFD-2040), FMMP requires the following data from the four MCs:

Table 5.1 Data Requirements for Formulation of Development Scenarios

Thematic Element	Data Required	Scenarios	MC Line Agencies	Type of projects
Flood protection works and floodplain infrastructure	<input type="checkbox"/> Transport (road, railway) and flood embankments.	2007: Roads, dikes, canals, gates update (for period 1985 – 2008).	National FMMP Programme Coordinators	Planned flood protection projects.
	<input type="checkbox"/> River dikes.			Planned road construction projects.
	<input type="checkbox"/> River connections to floodplain (incl. to colmatage channels).	2020: From MCs regarding new intended projects.		Planned road construction projects.
	<input type="checkbox"/> Flood/salinity control structures in the VN delta.			Major irrigation infrastructure projects.
	<input type="checkbox"/> Urban areas (with year round flood control).			2040: As for 2020
<input type="checkbox"/> Agricultural areas with year round flood control.				

5.2 Thematic Sub-Scenarios

As each thematic area will have the results for 2040 development scenarios and also the Sub-Scenarios ready by October 2015 only, this activity will be implemented in stage 2 (see section 6 Project

Implementation). Based on the provided information, a total of two or three Sub-Scenarios from other thematic areas will be selected for assessment and FMMP will provide the data and information to IKMP for adjusting the schematization of the MRC Toolbox models which are required for the flood simulation runs. FMMP will assess and report on the impacts of the two or three Sub-Scenarios for 2040 on future flood behaviour, flood damage and flood damage risk.

5.3 Provincial Annual Flood Damage Data

Once the provinces to be included in the assessment of changes to flood risk have been finalized, FMMP will seek from MCs annual flood damage data from these provinces, possibly on a district basis. It is important that a scoping study be made as quickly as possible to ascertain the availability and format of provincial flood damage data in the four MCs.

- It is suggested that examples of annual flood damage data for the period 2007-2014 be requested for four key provinces in each MC.

6. Project Implementation

FMMP proposes to implement the CS in two stages:

Stage 1: Formulation of development scenarios; and

Stage 2: Analysis of impacts of development scenarios, formulation and analysis of impacts of thematic sub-scenarios.

6.1 Stage 1 Activities: Formulation of Development Scenarios

- FMMP will liaise with MCs to oversee the collection of the required 2020 and 2040 planned flood protection works and floodplain infrastructure data. These data will be reviewed and presented to IKMP for incorporation in the daily flow simulation models.
- FMMP will liaise with the other thematic areas to finalize the 'impact assessment locations' (IALs) where changes to flood behaviour will be assessed.
- FMMP will liaise with other thematic areas to finalize the flood characteristics to be reported.
- FMMP will formulate the development scenarios for 2020 and 2040 based on the provided data by the MCs.
- FMMP, in conjunction the MCs, will run a scoping study to collect annual provincial flood damage data from four provinces in each MC (for the period 2007-2014) to ascertain the availability and format of the data.
- FMMP will finalize the methodology to be used to assess future flood damages in 2020 and 2040 at selected Provinces.
- Time period for Stage 1 is July – October 2015

6.2 Stage 2 Activities: Assessment of Development Scenarios and Formulation and Assessment of Thematic Sub-Scenarios

- FMMP will review proposed 2040 basin developments from other thematic areas to assess whether flood reduction measures are needed. If so, FMMP will incorporate the flood reduction measures in its PFS-2040 scenario.
- Once the development scenarios have been finalized, FMMP will assess and report on the impacts of the 2020 and 2040 scenarios on flood behaviour at the IALs.
- FMMP will finalize the number of selected provinces to be included in the analysis of changes to annual flood behaviour, flood damage and flood damage risk. FMMP will then request annual flood damage data for the period 2007-2014 from the MCs for those 'new' provinces in the assessment.
- FMMP will assess and report on the impacts of the 2020 and 2040 development scenarios on future flood damage risk in the selected Provinces.
- FMMP will analyse and report on the impacts of two or three thematic sub-scenarios (still to be selected) for 2040 on future flood behaviour, flood damage and flood damage risk.
- Time period for Stage 2 is November 2015 – June 2016

6.3 Workplan

A provisional workplan for FMMP to implement Stage 1 of the CS is shown below.

Table 6.1 Provisional Workplan, FMMP Inputs to the CS

TASK	START	END	Resources
Work Plan Preparation	01/07/2015	25/07/2015	
Draft /review/final	01/07/2015	25/07/2015	SIPME/CS coordinator
Scenario Development	17/07/2015	30/09/2015	
Data collection Thailand	17/07/2015	14/09/2015	MC
Data collection Lao DPR	17/07/2015	14/09/2015	MC
Data collection Cambodia	17/07/2015	14/09/2015	MC
Data collection Vietnam	17/07/2015	14/09/2015	MC
Inventarisation at MRC	17/07/2015	01/09/2015	FMMP component 2 study TA 6456 REG study
Data processing	15/09/2015	30/09/2015	SIPME
Draft Formulated Development Scenarios for 2020 and 2040 (Data and Technical	15/09/2015	2/10/2015	SIPME

TASK	START	END	Resources
Document describing Scenarios)			
Final Formulated Development Scenarios for 2020 and 2040 (Data and Technical Document describing Scenarios)	2/10/2015	19/10/2015	to be presented for approval by RTWG during the 6th RTWG meeting

7. Handling of Data Gaps

The strategy proposed for handling of data gaps is as follows:

1. The data gaps will be identified for each country and for each type of data. Therefore, assumptions will be proposed by the MCs in collaboration with FMMP to find the best way to approach the data gaps.
2. Based on the approach for filling the data gap, the data set will be finalized to allow the scenario development and further assessment.

8. Personnel Roles and Responsibilities

8.1 FMMP's Inputs

The following management and reporting arrangements are proposed to oversee FMMP's inputs to the CS.

8.1.1 Programme Management Lead

FMMP's inputs to the CS will be lead by the FMMP Programme Coordinator, assisted by International Technical Advisor of FMMP.

8.1.2 Technical Lead

Technical aspects of FMMP's inputs to the CS will be lead by FMMP's Programme Manager, on behalf of the FMMP Programme Coordinator.

8.1.3 National Consultants

National consultants are responsible for the implementation, performance and reporting of tasks in compliance with the contractual arrangements and under the guidance of the Technical Lead, in close cooperation with Programme Management Lead. The National FMMP Coordinator, assisted by the National Flood Expert, is responsible for effective liaison and coordination with the FMMP Programme Coordinator on any issues related to the overall CS requirements.

8.1.4 International Consultants

International consultants are responsible for the design and implementation of the methodology, and for performance and reporting in compliance with the contract arrangements, and under the guidance of the Technical Lead, in close cooperation with Programme Management Lead. The National FMMP

Coordinator, assisted by the National Flood Expert, is responsible for effective liaison and coordination with the FMMP Programme Coordinator on any issues related to the overall CS requirements.

8.2 Inter-Programme Responsibilities

With regard to the CS, it is FMMP's understanding that roles and responsibilities regarding the formulation of development scenarios/sub-scenarios and the assessment of their impacts on flood behaviour and risk are as follows:

1. FMMP will provide the Council Study Hydrologic Team (led by IKMP) with details of flood protection works provided by the MCs for the three development scenarios, namely ED-2007 (baseline), DFD-2020 (Definite Future Development) and PFD-2040 (Planned Future Development) Scenarios.
2. Other thematic areas will provide IKMP with details of two or three future thematic sub-scenarios (still to be selected) for the 2040 situation. IKMP will simulate daily flows for these sub-scenarios; FMMP will assess the impacts of two sub-scenarios on the flood behaviour and flood risk for the 2040 situation.
3. The impact of three climate change scenarios on flood behaviour for the 2040 development scenario will be assessed.
4. IKMP will adjust the SWAT, IQQM and ISIS models to make the models representative of the selected basin development scenarios/sub-scenarios.
5. IKMP will 'run' all the model simulations and write daily outputs to a FMMP KB.
6. FMMP will analyse the daily outputs in the FMMP KB to assess changes to flood behaviour, flood damage and flood damage risk for the selected scenarios.
7. In addition, it is anticipated that FMMP will have to review the proposed 2040 basin developments by other thematic areas and to assess whether flood reduction measures are needed.