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The Council Study

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

Technical Working Paper: Thematic Data and Map Specifications Document - Irrigation

November 2016

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1 Introduction

This working paper 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 cumulative development scenarios).
- Assessments for each thematic area summarizing 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.

Within Council Study, Agriculture and Land use change thematic Study focuses on agriculture development and land use change. The main objective of the Study is to further enhance the understanding of the negative and positive impacts of water resources development in the agriculture and land use sector on water resources, people, economies, and the environment of the Lower Mekong River Basin. This study will fill knowledge gaps and reduce the uncertainty in estimating these impacts, providing the Member Countries with higher confidence information towards informed decision-making.

2 Baseline and Development Scenarios

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 cumulative development scenarios and thematic sub-scenarios.

The cumulative scenarios are based on historic (2007) and planned (2020 and 2040) basin-wide developments in the six thematic areas. These cumulative 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 cumulative 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 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.

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 Irrigation

3.1 Approach and process of data collection/compilation

This paragraph describes the approach followed to collect the necessary information to develop the different scenarios. Under the supervision and coordination of the Agriculture and Irrigation program, the members of national teams (National coordinators, National Consultants, etc) have participated to various workshops and formal and informal meetings. Out of the coordination meetings a straight coordination and communication process was continuously held by emails and regular exchange.

The different steps are described in the next paragraphs.

3.1.1 Preparation of scenario formulation methodology

Based on the terms of reference and the guidelines highlighted in the inception report, the international consultant for the Irrigation thematic area has drafted a first methodology for the scenario formulation (see Annex: *Thematic Work Plan for the Formulation of Development Scenarios*)

The work plan describes the roadmap and the approach for formulating the development scenarios for the Irrigation 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

3.1.2 Presentation and discussion of the methodology and data to be collected

The document was shared with the national consultants and the national coordinators prior to the *Meeting on the scenario development* held in Phnom Penh on June 25th. This allowed each participant to take note of the methodology proposed and prepare the discussions during the meeting.

A full day meeting was organized where the International consultant has presented the methodology proposed. The presentations were focusing on:

- A shared vision of the process of the development of the Irrigation thematic area
- Which drivers are to be considered for the development of the scenarios?
- Which data should be collected to develop the scenarios?
- Explanation of the timelines to be considered for the purpose of the Council Study
- Explanation of the concept of sub scenario

The methodology proposed for the formulation of the development scenario is organized around the following activities that are to be conducted by the national consultants:

- ***Access data on existing & planned irrigation schemes***

At the country level, the national consultant must collect the necessary data that illustrates the current status and the future strategy for the irrigation development. Based on the organization of the sector for each of the four member countries, the national consultant should access:

- The reports and / or databases that describe the current irrigation development. This activity will lead to the description of the Early Development scenario that has led to the situation in 2007.
- The documents that describe the development strategies at the national, regional, provincial or (sub)basin level for the future time horizons. The purpose of the activity is to highlight the trends and objectives of the sector development at the country level, with a particular emphasis on the LMB. This activity will lead to the description of the Definite Future Scenario (2020) and the Planned Development Scenario (2040)

- ***Map planed and existing irrigation projects***

In addition to the collection of reports and databases that describe the current and future development of the sector, the national consultants are required to collect and to organize the related geographic datasets.

A set of thematic maps has to be collected or prepared on purpose to illustrate the current development of the sector within the basin. The set of maps will present:

- The overall development at the country level within the LMB,
- The maps for some selected irrigation schemes,

- ***Describe selected irrigation development projects.***

A specific activity has been assigned to the national consultants. Out of the description of the general national objectives at a country level, it is requested to prepare a report that will describe some selected irrigation development projects. The description will be compiled in a specific report describing the general parameters of the project: extent of development, crops, impact on land conversion, infrastructure required, engineering parameters driving the scheme development etc. To each project selected will be prepared a specific map and a dataset.

- ***Estimate area increase, water intake & return flows***

The key parameters to be collected to describe the sector development will be mainly focusing on the irrigated area increase, the water intake from the basin and the return flows emitted. These three parameters are the minimum requested to describe the scenario and the potential impacts. The national consultant is required to describe as precisely as possible in time and space these parameters. The data collection sheets have been developed on purpose (see 3.1.3)

- [Groundwater use for irrigation](#)

The terms of reference of the council study mention the need to describe the groundwater use for the irrigation purpose for each country. The methodology has identified a specific activity to be conducted by the national consultants that will aim to collect information on the baseline, trends and potential of the groundwater use in Irrigation. The further objective will be to evaluate its impact on the downstream hydrology

- [Estimate fertilizer & pesticide use and soil moisture and erosion process](#)

The collection of the data will also focus on two additional aspects that have been linked to the Irrigation thematic area. Two distinct consultants will collect information and will document the situation of their country regarding the following topics:

- The current and future use of fertilizer and pesticides and their impacts
- The situation of the soil moisture and the erosion process and the impacts at the basin level

The activities of the consultants will lead to the preparation of a specific report on the topic and to provide data inputs for the modelling and discipline team.

3.1.3 Preparation of the data collection sheets

The presentation of the methodological approach for the development of the scenario has highlighted the contents to be inquired and the procedure to be followed. To ease the collection process and provide a shared basis to each of the four member countries, some specific data collection sheets have been prepared.

The data collection sheets were organized according to the topics that characterize the irrigation development.

The information collected shall be made available temporally for each of the proposed time frames featured for the Council Study (i.e. 2007 / 2020 / 2040), and spatially allowing the geographic location of the information.

It is hence proposed to separate the data collection for the selected large schemes and for the rest of the development at the district / province level.

A set of blank spreadsheets has been prepared and was transmitted to each national consultant for compilation. These are presented in annex. The data collection sheets were further discussed and presented in detail during the meeting and a guideline note was written by the international consultant to describe the process of the sheets compilation.

The topics covered by the data collections are presented on Table 1 below.

Table 1: Topics to be covered by the data collection

DEVELOPMENT
· Areas equipped for irrigation (ha)
· Wet, dry and 3 rd season irrigated areas (ha)
· Non-rice crop area (ha)
WATER
· Cropping calendars
· Evapotranspiration data (mm) by project and timestep
· Gross irrigation water Requirement (Rice and Non rice) (m ³ /ha)
· Return Flow and location (m ³ /ha) by project and timestep
INFRASTRUCTURE
· Existing Infrastructures and Reservoirs
· Conveyance, On Farm and Overall Efficiency (%)
· Cost for Conveyance Infrastructure (USD/Ha)
· Cost for On Farm Infrastructure (USD/Ha)
· O&M Cost per Year (USD/Ha/Year)
· Energy Cost per Year (USD/kWh/Year)
CROP
· Crop Production (t)
· Production Value (USD)
· Crop Production Cost (USD/ ha)
· Crop Intensity (%) by project
· Mechanization level (units to be determined)
ENVIRONMENT
· Erosion load (t/Ha) by project and timestep
· Return flow water quality (units to be determined)

3.1.4 Collection and Review of the existing data within the MRC (Including GIS)

In parallel with the activities carried out by the national consultants on the Irrigation development, a review of the existing data within the MRC database was conducted.

The review concerned the following sources:

- The consolidated GIS dataset
- The datasets and reports prepared for the Basin Development Phase Two (BDP2)
- The datasets and the modelling tools available in the IKMP

This review of dataset will allow the consultants to evaluate the status of the existing data and to develop a strategy for data gap filling.

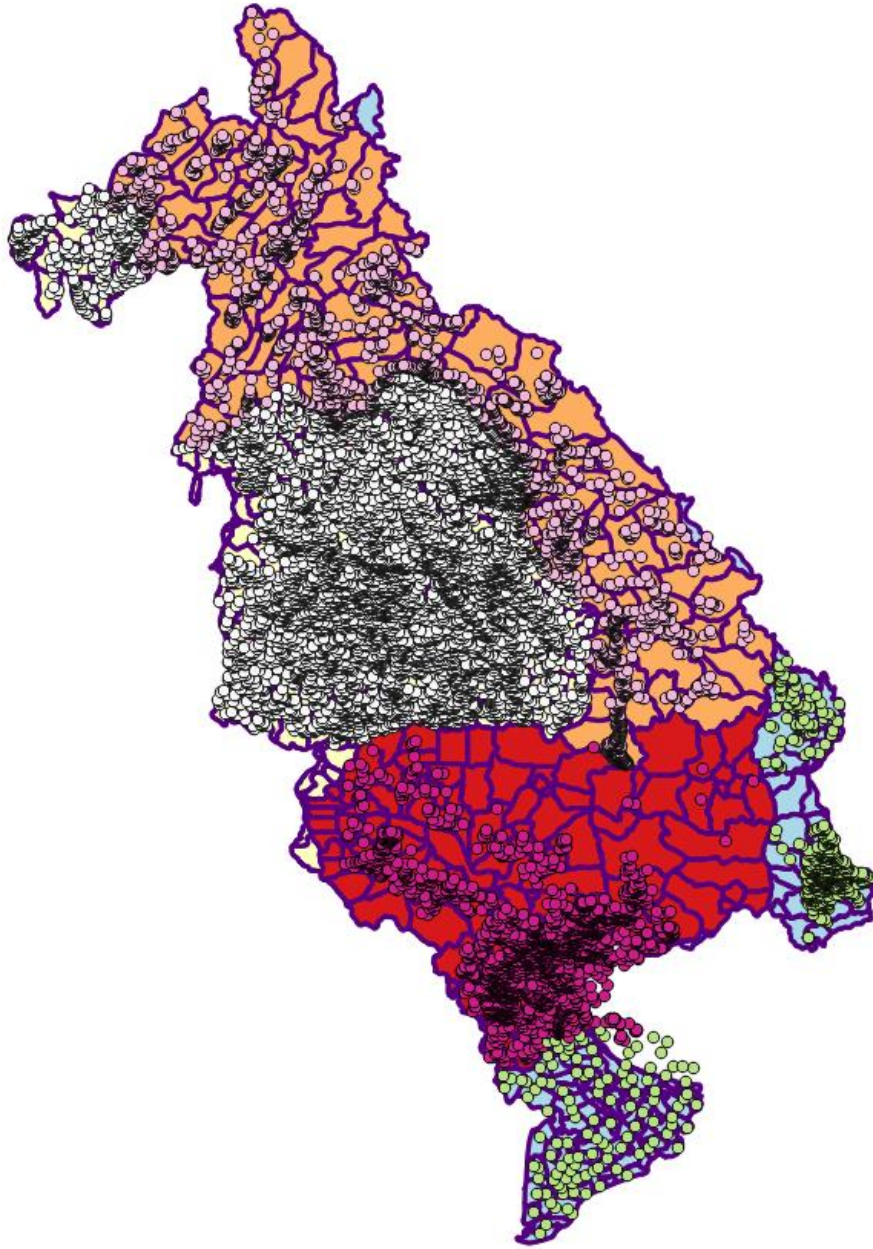
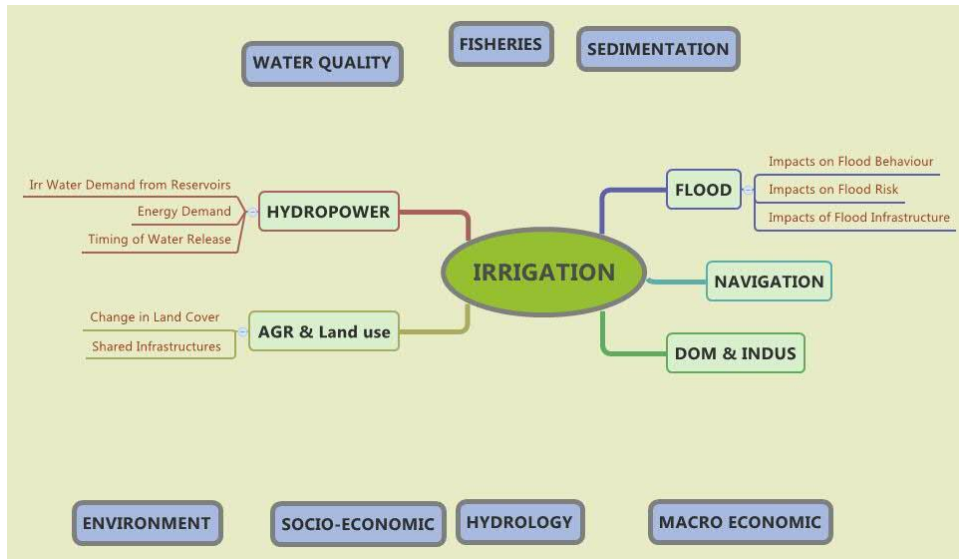


Figure 1: Overview of the Irrigation dataset related to the Irrigation projects of the BDP2

3.1.5 Coordination with the modelling team for the format of the datasets

Within the framework of the council study, Irrigation is one of the six thematic areas that are assessed for the potential impacts its development will generate on the lower Mekong basin.



The modelling teams of the MRC will be in charge to assess either the single impact of the specific thematic area development on the LMB but also the cumulated impact of the six thematic areas. Two major modeling teams will be involved:

- The modeling team in charge of the impact assessment on the hydrology of the basin
- The modeling team in charge of the social and economic impact

A strong coordination between the teams is required to ensure a successful understanding of each parties needs and objectives. AIP has conducted several informal meetings with the experts of those discipline teams all along the development of the activities. The major steps are presented below:

- a) Presentation of the Irrigation thematic area needs and objectives and the scenarios to be developed to each one of the discipline team
- b) Discussions on the scenarios /simulations to be developed within the council study
- c) Presentation of the modeling suite that will be used within the council study according to the areas of interest: SWAT/IQQM – SOURCE – ISIS – 3D-EIA. A special focus was given on the way the irrigation sector is conceptualized and the potential outputs that can be made available
- d) Analysis of selected reports on previous modelling activities developed for the BDP2 program describing the procedures for data exchange and model outputs.
- e) Discussions on the possibility to model the Water quality (nutrient load) and the erosion process
- f) Thematic meeting on the data exchange procedures between AIP and IKMP in order to define the data input, the models used, the area of interests and the data in output.

Table 2: Data exchange framework for the Irrigation thematic area

No	Scenario Name	Objective		Zone	Input Data for Model	Output from Model	Model Use	Optional	
Main Scenario 1	EDS 2007	Prepare the reference conditions of the impacts of the future development conditions	Water Quantity	Zone 1-5	Irrigated areas at a district level or associated with the 8.3 node	Daily Time series of Flow regime at the key stations Daily Time series of Water Demand Calculated for the Nodes / districts Daily Time series of Water use for the Nodes / districts (Water available)	IQQM		
				Zone 4 (from Tonle Sap Lake)	Nitrogen, Potassium and Phosphorus average load in kg/Ha	Zone 1-3	Monthly Time Series of Sediment Load at the key stations Monthly Time Series of Total Nitrogen Laod at the key stations Monthly Time Series of Total Phosporus Laod at the key stations	IQQM / Source	
						Zone 5	Daily Time Series of Salinity at the key stations (including Map) Monthly Time Series of Sediment at the key stations (optional) Monthly Time Series of Total Nitrogen at the key stations (optional) Monthly Time Series of Total Phosporus at the key stations (optional)	ISIS	
							Monthly Time Series of Sediment Load from Tonle Sap Monthly Time Series of Total Nitrogen Laod from Tonle Sap Monthly Time Series of Total Phosporus Laod from Tonle Sap	3D-EIA	

No	Scenario Name	Objective	Zone	Input Data for Model	Output from Model	Model Use	Optional
					Monthly Time Series of Sediment Laod at the key stations Monthly Time Series of Total Nitrogen Laod at the key stations Monthly Time Series of Total Phosporus Laod at the key stations	VMOD Assessment	Crop Productivity (Zone 5)
2	Dev 2020	Assess the impacts of the Irrigation development for 2020 respect to the reference conditions		Same as SCN "1"			
3	Dev 2040	Assess the impacts of the Irrigation development for 2040 respect to the reference conditions		Same as SCN "1"			

3.1.6 Compilation of draft datasets

The national consultants have started the compilation of the datasets after the technical meeting on the scenario development. Different kinds of difficulties were met by the consultants to compile the datasheets due to several reasons:

- Access to the datasets at the national level describing the current and future development of the sector
- Homogeneity of the information between projects according to their size and their age
- Organization of the datasheet templates not adapted to local particularities
- Absence of planning documents for the time horizons targeted by the council study

Generally, the topics related to the irrigation development and the water needs were covered (Irrigated areas, rice and non-rice crops, water requirements ...) but only poor data was made available to describe the infrastructure development, the social and economic sections and the agronomic parts.

3.1.7 Review and Quality Control

Preliminary versions of the datasets were sent to the international consultant that made a first quality control. The datasets were commented and sent back to the national consultants for revision.

The latest draft datasets by country are attached to the document in annex.

3.1.8 Finalization of datasets

At the time of the submission of the draft version of the interim report in December 2016, the datasets for each country had not yet been finalized. Some additional work has been conducted by the national consultants in the first months of 2016 to present a finalized version of their datasets.

These final datasets were reviewed allowing the formulation of the final scenarios.

A strategy was proposed during the 6th RTWG for the finalization of the datasets that will allow the council study to proceed without expecting the national consultants to fill completely the requested datasheets. This is discussed in the Gap Filling section of the report - 3.2.3.

The table below presents the activities that still need to be performed by the national consultants.

In the meanwhile, for the purpose of the interim, a data gap filling strategy was developed to obtain a preliminary homogenous dataset covering each country and time horizon.

Dataset	Cambodia	Lao PDR	Thailand	Viet Nam
Dataset for Scenario Formulation	A dataset was provided in February 2016 describing the irrigated areas for the two seasons at a province level for the three scenarios and for the three sub scenarios. The information for some provinces is missing but was filled based on a strategy	A dataset was provided in February 2016. It provides the information at a province level for each timeline.	A decision must still be made on the geographic coverage of the dataset: corridor or whole basin. This is needed to organize the activities with the modelling team. The dataset for each of the three scenarios at a global level were inserted. They correspond to the “proposed strategy 3” discussed by the TNMC	Dataset provided for the two areas (Delta and Central Highlands) for the three scenarios. A final quality control could be done. The dataset of the PDS and DFS are the same for the central Highland area. An improvement can be made
Dataset for Selected Projects	A first version and not homogenous of the datasets for 3 projects only was compiled – The primary figures must be controlled and 7 additional projects have to be prepared to meet the 10 requested	Datasets of 10 projects compiled. One final quality control and final approval is required	Datasets of 10 projects compiled. One final quality control and final approval is required	Three reports for the selected projects in the delta area were prepared. The 3 for the central highlands area are missing
Report on Scenario Formulation	A report on the scenario formulation was prepared in February 2016. A review is needed.	The final report was submitted in February 2016.	The final report was submitted in January 2016.	The draft version was prepared and reviewed. The final version that integrates the quality control on the dataset was submitted in February 2016.

	Incomplete		Finalized
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3.2 Data gaps

3.2.1 Methodology for the identification of Gaps

- *Discussions with the NC of the data requested*

Discussions started during the working sessions with the national consultants to set up a comprehensive list of the available data within the MCs and the MRC's databases as a result of the past activities. Based on the list of data requested, and the agreed scenarios to be studied, each national consultant will draw up a list of the data available, for each time-frame.

- *Continuous monitoring of the data collection*

The data listing activity was strongly interfaced with the GIS to allow a direct and rapid evaluation of the spatial location of the information.

- *National Consultation meeting*

The national consultation meetings that were held within each country have given the opportunity of a global review of the process of data compilation and report formulation for each thematic area of the council study. These national consultation meetings should have validated the contents of the draft datasets prior to the communication to the international consultant.

3.2.2 Gaps Identified

This paragraph presents a summary of the gaps that were identified in the datasets. It includes the submissions that were received after the 6th RTWG.

Cambodia

The data communicated in February 2016 have been analyzed and organized in the general tables that allow conducting a gap analysis. Among the figures communicated at the province level, some are questionable. A quality control on those figures was operated referring them to the national consultant on irrigation. Globally the gaps identified are the following:

1- The dataset do not cover every Cambodian province of the LMB. No data were made available for Kandal and Phnom Penh.

2- The figures proposed in the datasets for the 2040 horizon are much lower than for 2020. Nothing is explained in the report to justify this. The issue was raised to the national consultant.

3- The report mentions that the figures used to describe the ED-2007 scenario are the ones of the BDP2 dataset. In fact, after checking, the values are very similar although slightly different. This let the consultant to use the data of BDP2 to complete the missing values for Kandal and Phnom Penh provinces.

Laos

The figures for the scenario development were detailed and revised for each period with a distinction of the dry and wet season irrigated areas for the 2007-2014-2020-2040 timelines. Another file presents the development for the period 2015-2040, based on the national plans with a detail by province of the irrigable areas. For the PDS, there are some discrepancies between the two sources by 30% on the wet season and by 20% on the dry season, the figures of the formulated scenarios being higher in both cases. The figures proposed for the scenario formulation are conserved.

Thailand

The datasets prepared by the Thai national consultant only describes partly the information required to formulate the scenarios. From a spatial point of view, the dataset is only concentrating on the corridor of the Mekong River and does not allow having a clear picture of what might happen in terms of irrigation infrastructure development in the Thai's part of the Mekong basin.

This issue was discussed during the 6th RTWG and subsequently during the Thailand National Consultation Meeting on 5 January 2016. The conclusions of the meeting managed to propose a strategy to present figures describing each development scenario with global figures for the Thai part of the LMB.

Vietnam

After various exchanges with the international consultant, the Vietnamese experts have compiled a dataset with global figures that give a picture of the planned development for the two distinctive areas of the Central Highlands and the Mekong Delta. The dataset covers the three time horizons 2007 -2020 and 2040.

The table below presents the summary of the contribution by country.

Table 3: Summary of the data collection by country

Activity	Cambodia	Laos	Thailand	Vietnam
Development Scenarios				
ED 2007	+++	+++	+++	+++
DFS - 2020	++	+++	+	+++
PDS - 2040	++	+++	Not available	++
Report on Development Scenario and National Strategy	++	+++	+++	+++

+++	Finalized, reviewed and completed at the province level
++	To be reviewed
+	Draft document
Not available	Dataset not available for the study
Work in progress	Dataset under construction, not communicated yet

A first comparison between the datasets made available by each country and the data available within the MRC database is presented in the table below. The comparison is based on the data presented during the BDP2 project. It is important to mention that this comparison is only indicative since the objectives and the timelines of the Council Study and the BDP2 are different. However, this first comparison allows having first indicative results on the contribution received.

The comparison is only done at a national level for the Irrigation areas declared, the incompleteness of the datasets does not allow to go at a lower level (i.e. province or district) and for another parameter (water needs, yields, etc)

Table 4: Comparison of the council study present datasets and the BDP2 dataset

Irrigation Area in Ha	Council Study			BDP2			
	Country	ED - 2007	DFS - 2020	PDS - 2040	2008	2015	2030
Cambodia		488 433	756 008	343 552	504 225	778 403	1 155 815
Laos		209 116	309 068	597 893	165 985	450 730	716 516
Thailand		809 671	1 582 554	1 854 763	1 412 298	2 358 918	2 397 680
Vietnam		3 162 346	3 145 432	3 084 459	1 919 643	2 044 884	2 062 830

Table 4 above illustrates the gaps between the data obtained and the data available in the MRC database for the irrigation area, in ha. The following observations can be stated from the comparison of the figures above:

- The Cambodian dataset present similar values for the CS and BDP2 up to the 2020 horizon. The values presented to formulate the 2040 scenario of the council study are very low and should be reviewed by the national consultant. A correction is needed.
- The dataset of Laos is different from the BDP2 dataset, with higher figures characterizing the 2007 time horizon and lower expectations for the future. Since the dataset is based on a recently approved plan, we propose to adopt those values without corrections.
- For Thailand, although the figures presented in the council study were discussed on purpose to allow a comparison with the other member countries, the comparison of the Thai datasets shows large differences. This might be linked with different accounting methods over the Mekong corridor or the tributary basins. The data of the council study is retained valid and will not be corrected.
- The dataset prepared by the Vietnamese consultants was almost complete. There are some differences between the two datasets that were discussed with the consultant, but that were finally confirmed. The council study dataset was updated with additional information on the Mekong Delta and Central Highlands areas development plans.

3.2.3 Need for a Gap Filling Strategy

When the draft interim report was presented in December 2015, the data comparison at the national level had identified some gaps for each country and for each type of data.

Some improvements were made by each team of national consultants in the first months of 2016 to communicate revised datasets.

In the present state, the datasets declared as final by the member countries do not allow to have the necessary information to formulate the scenarios and to further proceed with the impact assessment with the modelling teams. They however allow having a global idea of what might occur at the global level in terms of irrigation infrastructure development.

After the contributions of the national consultants will have been declared completed, a comprehensive dataset that would allow the modelling teams to proceed with the impact assessment will be needed. The final data gap analysis would then be conducted. Considering the completeness of the contributions received, the time and efforts needed to achieve satisfactory results with this option are questionable.

Therefore, to avoid blockage of the council study implementation process, a strategy must be adopted. This strategy will have to work with the following constraints and documents.

- The datasets presented in the national consultants reports and the corresponding data collection sheets with a strong quality control and validation from the national committees;
- The values available from the BDP2 database taking care of the differences of approach and timelines between the two projects. These values being detailed at a province / district / sub basin level allowing a connection with the models retained for the hydrologic modelling.
- Some scientific assumptions based on the best professional judgement and additional scientific sources available in literature
- The guidance of the national consultants

The strategy to be adopted will be discussed during the 7th RTWG. Further, a methodological approach will need to be prepared in phase 2.

Strategy for the Draft Interim report

For the preparation of the Draft interim report, a first gap filling strategy was proposed to allow the creation of a dataset that would at least illustrate the prospects at a national level and to have at least global figures for discussion. The databases¹ available at the MRC were used to build a homogenous dataset covering at least the primary parameter related to the irrigation area developed. The analysis was only conducted to a national level.

This strategy led to corrections for the Cambodian, Lao and Thai datasets.

After communication of the revised datasets in the first month of 2016, and for the final version of the Interim report, the following corrections were done:

Cambodia

The figures of the BDP2 database were retained to illustrate the 2040 planned development scenario.

Laos

No adjustments were made to the Lao dataset, considered complete and valid by the national consultant.

Thailand

The figures calculated following the “Proposed strategy 3” by the national consultant were retained as valid and representative of the Thai part of the Mekong watershed. They are only available at a national level and used to have a general figure for the LMB. The dataset proposed at the province level is only concentrating on the corridor and cannot be used as this with the other national dataset.

Vietnam

No adjustments were made to the Vietnamese dataset, considered complete and valid by the national consultant.

The table below summarizes the source and assumptions retained to present a global dataset.

Table 5: Source and assumptions retained to present a global dataset

	Cambodia	Laos	Thailand	Vietnam
2007 - ED	<i>As per the dataset communicated, with</i>	<i>As per the dataset communicated</i>	<i>As per the dataset communicated for</i>	<i>As per the dataset communicated</i>

¹ BDP2 and GIS databases

	<i>minor corrections on Kandal and Phnom Penh provinces</i>		<i>the national level</i>	
2020 - DFS	<i>As per the dataset communicated, with minor corrections on Kandal and Phnom Penh provinces</i>	<i>As per the dataset communicated</i>	<i>As per the dataset communicated for the national level</i>	<i>As per the dataset communicated</i>
2040 - PDS	Value extracted from BDP2	<i>As per the dataset communicated</i>	<i>As per the dataset communicated for the national level</i>	<i>As per the dataset communicated</i>

3.3 Data for the baseline and development Scenario

In the following paragraphs, the original datasets compiled by the member countries prior to the 6th RTWG are presented. Further, the revised version proposed by the consultant after implementation of the gap filling strategy is presented in section 3.4.

Country	Scenarios			Sub-Scenarios		
	2007	2020	2040	2040 Low	2040 mid	2040 high
Cambodia						
Banteay Meanchey	13702	35595	14619	6239	8380	14619
Battambang	47571	100184	12438	6609	5829	12438
Kampong Cham	68497	80934	62533	9797	52736	62533
Kampong Chhnang	37943	54242	18023	1240	16783	18023
Kampong Speu	36456	41389	29128	19898	9217	29128
Kampong Thom	18658	65962	22950	13715	9235	22950
Kampot	0	2995	1220	1079	1079	1220
Kandal *	75134	78359	83197	no data	no data	no data
Kratie	1360	17318	3508	2505	1003	3508
Mondul Kiri	0	2422	2422	2422	2422	2422
Otdar Meanchey	2175	2290	2290	2140	150	2290
Phnom Penh *	1250	1480	1825	no data	no data	no data
Prey Veng	25551	82484	8113	4325	3788	8113
Pursat	54127	83540	19299	2100	17199	19299
Ratanak Kiri	0	1778	1778	1568	210	1778
Siem Reap	49271	11092	27205	1665	25550	27205
Stung Treng	0	1362	1362	150	1212	1362
Svey Rieng	3683	30216	14301	2860	11441	14301
Takeo	53055	62366	17341	3706	13480	17341
Total Council Study	488433	756008	343552	82018	179714	258530

Table 6: Summary of the dataset for the three Scenarios - Laos

No.	Provinces	Irrigated Area (Early Development to 2007)		Irrigated Area (Early Development to 2020)		Irrigated Area (Early Development to Future Planned 2040)	
		Wet Season (Ha)	Dry Season (Ha)	Wet Season (Ha)	Dry Season (Ha)	Wet Season (Ha)	Dry Season (Ha)
Northern Region		51 091	13 726	83 881	32 396	83 881	32 396
1	Bokeo	5 392	2 748	14192	10048	14192	10048
2	Luangnamtha	7 852	2 250	11392	4450	11392	4450
3	Phongsaly	2 385	550	5469	3572	5469	3572
4	Oudomxay	8 886	1 519	12254	3050	12254	3050
5	Xayabury	9 980	3 499	12200	5199	12200	5199
6	Luangphabang	5 260	2 810	11935	3627	11935	3627
7	Xiengkhouang	11 336	350	16440	2450	16440	2450
Central Region		83 408	45 589	121 834	78344	226984	163493
8	Vientiane Province	30 746	11 009	41496	20379	49496	28379
9	Vientiane Capital	25 090	18 200	31990	25100	33490	26600
10	Bolikhamxay	10 957	4 130	16069	4951	60269	39300
11	Khammouane	16 615	12 250	32279	27914	83729	69214
Southern Region		74 618	66 649	103 353	86035	287028	206625
12	Savannakhet	42 501	33 000	49451	39250	96451	70750
13	Saravane	12 817	14 900	21117	20200	92717	60800
14	Champasak	12 441	16 129	22641	22829	65741	55519
15	Sekong	3 756	1 520	6771	2156	10871	5156
16	Attapue	3 103	1 100	3373	1600	21248	14400
Total Area (Ha)		209 116	125 964	309 068	196775	597893	402514

Table 7: Key Features of the formulated scenarios - Summary Figures of the 10 Provinces in Khong River Basin of Thailand²³

Irrigation Development Status	Current	2020
Total Developed Area (Ha)	271,938	571,993
Number of Large Projects	7	7
Total Area of Large Projects	141,592	141,592
Area of Remaining Projects	130,346	430,401
Proposed main water sources	Current	2020
River Water (share%)	100%	100%
Groundwater (share%)	0%	0%
Total Reservoir Storage Capacity (MCM)	4,396.2	6,073.6
Storage Capacity of Large Projects (MCM)	3,202.5	3,297.1
Storage Capacity of remaining projects (MCM)	1,193.7	2,776.6
Irrigated Areas (Cropping Areas in 2014)	Current	2020
Wet Season Irrigated area (Ha)	248,520.5	
Dry Season Irrigated area (Ha)	89,824.5	
Perennial Crops irrigation area (Ha)	3,368.8	
CROP PRODUCTION	Current	2020
Wet Season Rice Crop Productivity (t/ha) (data in 2013)	2.566	
Dry Season Rice Crop Productivity (t/ha) (data in 2013)	3.190	
Non Rice Crops Productivity (USD/Ha) (average values of Maize, Cassava, Soybean, and Pineapple, based on year 2014) US\$1 = 33 Baht	1,646.4	

Table 8: Summary of the dataset for the ED Scenario, the DFS Scenario and the PDS Scenario - Vietnam

Country	Vietnam					
Scenario	Early Development		Definite Future Scenario		Planned Development Scenario	
	Year	2007	Year	2020	Year	2040
Irrigation Development						
Total Developed Area	3 162 346	Ha	3 145 432	Ha	3 084 459	Ha
Total Area of Large Projects	2 600 406	Ha	2 621 793	Ha	2 731 124	Ha
Water Resources						
Total Water Need		MCM		MCM		MCM
Total Reservoir Capacity		MCM		MCM		MCM
Share of GW use		%		%		%
Irrigated Areas						
Rice Irr. Area Wet season	1 719 130	Ha	1 701 148	Ha	1 674 915	Ha
Rice Irr. Area Dry season	1 988 241	Ha	1 971 755	Ha	1 928 850	Ha
Crop Production						
Wet Season Rice production	8 078 488	M-tons	8 941 270	M-tons	10 411 359	M-tons
Dry Season Rice production	10 101 587	M-tons	10 734 546	M-tons	11 193 105	M-tons

² Data not used to calculate a global basin dataset

³ Remark: 10 provinces include Chaing Rai, Phayao, Loei, Sakon Nakhon, Udon Thani, Nong Khai, Bung Kan, Nakhon Phanom, Mukdahan, and Ubon Ratchathani

3.4 Revised overall dataset for the Interim report

The table below presents the national dataset after implementation of the gap filling strategy. The red figures are the figures obtained from the application of a data gap filling strategy.

Table 9: Proposed corrected dataset illustrating the global developments in the LMB after implementation of the data gap filling strategy

<i>Irrigation Area in Ha</i>	Proposed Data		
Country	<i>ED - 2007</i>	<i>DFS - 2020</i>	<i>PDS - 2040</i>
Cambodia	488 433	756 008	1 155 815
Laos	209 116	309 068	597 893
Thailand	809 671	1 582 554	1 854 763
Vietnam	3 162 346	3 145 432	3 084 459
Total	4 669 566	5 793 062	6 692 930

Based on the above mentioned figures, the total irrigation area nearly covering 4.7 million hectares in the ED 2007 situation would reach 5.8 million hectares by 2020 and would totalize 6.7 million hectares by 2040. Basin wide, the development rate between 2007 and 2020 would be 24% whereas it would decrease to 16% between 2020 and 2040.

The considerations above are to be retained as indicative since they are issued from a data gap analysis. They however bring interesting figures on the growth rate the sector might observe.

These rates will necessarily be different within the countries and within the different provinces and basin. These differences in the local dynamics of the evolution are to be analyzed through a detailed dataset that will be provided by the data collection of the national consultants or by the gap filling strategy accordingly.

3.5 Thematic Sub-Scenarios

For 2040 PDS, only one sub-scenario will be assessed based on the discussion of 7th RTWG meeting. The reasons are as follows:

- Only data of 2040 PDS scenario has been collected
- Insufficient data on proposed 2040 PDS sub-scenarios (Low, Medium, High) collected
- Newly proposed 2040 sub-scenarios is required

The newly proposed sub-scenarios is as follows:

- Focus on one sub-scenarios of high level
- Sub-scenario: highest level of the irrigated area expansion in each country in 2040.

(except Vietnamese Mekong Delta: keep the same with PDS 2040).

The detail of the proposed sub-scenario will be discussed with the modelling team.