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MEKONG RIVER COMMISSION SECRETARIAT

Information and Knowledge Management Programme

PROGRESS OF MODELLING TEAM

Support to the Council Study

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ROLE OF MODELLING TEAM IN THE COUNCIL STUDY

Carry out the hydrologic, hydraulic, sediment transport, and water quality modeling required to support the assessment of environmental and socio-economic impacts associated with water resources developments in six thematic areas

- Model setup, calibration, and validation for baseline conditions
- Support cumulative and thematic teams in formulation of development scenarios
- Prepare and update input data and model for the development scenarios
- Run model and analyze results
- Prepare technical modeling reports

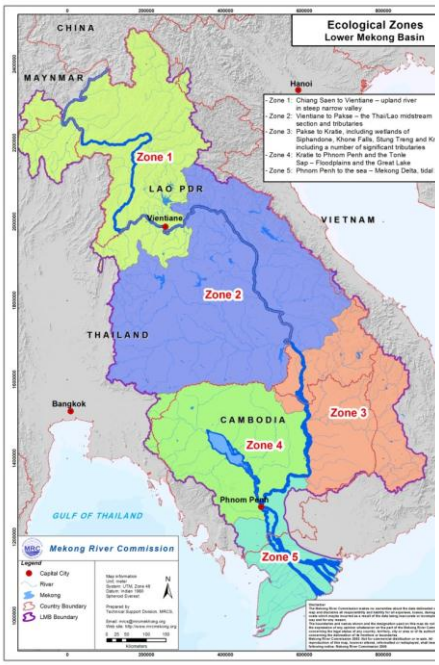
MODELING THE LMB

The Lower Mekong Basin (LMB) is comprised of five different zones.

- Zones 1,2,3: Mekong River
- Zone 4: Tonle Sap River and Lake
- Zone 5: Delta

Each of these zones requires a different set of models:

- 1D Model: Mekong River Mainstream and Lower Kratie
- 2D or 3D: Tonle Sap Great Lake and Delta



THE COUNCIL STUDY MODELING REQUIREMENT

In addition to "standard" hydrologic/hydraulic parameters such as runoff and water depth, the Council Study requires modeling results for nutrients, sediments and water quality for all zones.

Model Output Requirements for the Council Study

No.	Sector	Location required	Zone	Scenarios required	Data required	Output		Model Application		
						TS Data	Map	1D	2D	3D
1	Hydrology/Flow regime	River sites, and entrance to Tonle Sap and Delta	Zone 1, 2, 3	Historic (H), Observed (O), Baseline (B), Thematic (T) and Cumulative (C), plus two DRIFT calibration regimes (D)	Daily time series	X		x		
					Hourly time series for relevant EF sites, according to operating rules of infrastructure	X		x		
2	Hydraulics	River sites	Zone 1, 2, 3	OBTCD	Average velocity	X		x		
					Maximum velocity	X		x		
					Maximum depth	X		x		
					Average depth	X		x		
					Wetted perimeter	X		x		
					Lateral connectivity			x		
					Longitudinal connectivity			x		
					Riparian zone/floodplain - inundated area			x		
					Riparian zone/floodplain - average velocity			x		
					Riparian zone/floodplain - maximum velocity			x		
					Riparian zone/floodplain - maximum depth			x		
					Riparian zone/floodplain - average depth			x		
				Impacts of changes in channel morphology, e.g., for flood protection/navigation; sand mining	Knock on effects on flow, sediments and channel hydraulics (inundation of secondary channels, riparian areas and/or floodplains)	X		x		
		Delta	Zone 5	OBTCD	Channel average velocity	X		x		
					Channel maximum velocity	X		x		
					Channel maximum depth	X		x		
					Channel average depth	X		x		
					Extent and timing flooding and inundation in the delta	X	X	x		
				Impacts of changes in morphology/structures	Knock on effects on flow, sediments and water quality (salinity)	X	X	x		
		Tonle Sap	Zone 4	OBTCD	Maximum depth	X		x		
					Average depth	X		x		
					Wetted perimeter			x		

Model Output Requirements for the Council Study

No.	Sector	Location required	Zone	Scenarios required	Data required	Output		Model Application		
						TS Data	Map	1D	2D	3D
3	Sediment	River sites	Zone 1, 2, 3	HOBTCD	Sediment Load/Transport/Flux	X				
					Bed material/gain size	X		-		
					Bed elevation	X		x		
					Suspended Sediment Concentration	X		x		
					Suspended sediment grain size			x		
					Local sedimentation	X	X	x		
					Local erosion	X	X	x		
					Deposition rate on floodplains					
		Delta	Zone 5	HOBTCD	Sediment Load/Transport/Flux	X		x		
					Bed material/gain size	X		x		
					Suspended Sediment Concentration (in size fractions if possible)	X		x		
					Local sedimentation	X	X		x	
					Local erosion	X	X		x	
					Erosion/Deposition rate in the coastal areas				x	
		Tonle Sap	Zone 4	HOBTCD	Sediment load entering Tonle Sap - annual				x	
					Bed material grain size	X			x	
					Suspended Sediment Concentration (in size fractions if possible)	X			x	
					Local sedimentation	X	X		x	
					Local erosion	X	X		x	
4	Water quality	River sites	Zone 1, 2, 3	OBTCD	Water temperature	X		x		
					Conductivity	X		x		
					Nutrient concentrations	X		x		
		Delta	Zone 5	OBTCD	Salinity	X	X	x		
					Water temperature	X		x		
					Nutrient concentrations	X		x		
					Primary production	X	X	-		
					Water clarity	X		-		
					Dissolved inorganic nitrogen	X		x		
					Dissolved inorganic phosporus	X		x		
					Silicates	X		x		
		Tonle Sap	Zone 4	OBTCD	Water temperature	X			x	
					Conductivity	X			x	
					Nutrient concentrations	X			x	
					Primary production	X	X		x	
5	Hydropower	n/a			Energy Production	X		x		
					Operation rule curve (Normal, Optimize, Store, Dam break)			X		
					Flow release plan	X		X		
					Weirs and Sluices	X		X		

Remark : Model Name* Need Further recalbration
Model Name** Need Model Setup and Calibration in Riparian zone and flood plain with support information from member countries

Model Capacity and Gaps of Current DSF

Capacity of DSF Package to providing result for Hydrological and Sediment Assessment

Zone 1, 2, 3

		Model Capacity		
		Flow/WL	*Sediment*	*Water quality*
	SWAT/IQQM	√	√*	-
Mainstream Mekong	1D - iSIS (Upper Kratie)	√	√*	-

Model Output: Daily discharge, water level from 1985 -2008
**Monthly sediment from 1985 -2008 (Calibration Needed)*
Modelling Gap: lack 2D, 3D Sediment Modelling
lack Water Quality Modelling
Need Sediment simulation in Reservoir (2D, 3D)

Zone 4a, 4b

		Model Capacity		
		Flow/WL	*Sediment*	*Water quality*
Tonle Sap River and	SWAT/IQQM	√	-	-
Great Lake	1D - iSIS (Lower Kratie)	√	-	-

Model Output Daily discharge, water level from 1985 -2008
Inundated area of Floodplain in the Tonle Sap
Modelling Gap: lack 2D, 3D Sediment Modelling
lack Water Quality Modelling

Zone 5

		Model Capacity			
		Flow/WL	*Sediment*	*Water quality*	*Salinity*
The Cambodia and	IQQM	-	-	-	-
Vietnamese Delta	1D - iSIS (Lower Kratie)	√	-	-	√

Model Output Daily discharge, water level from 1985 -2008
Inundated area of Floodplain in the Mekong Delta
Salinity Impact in the Mekong Delta
Modelling Gap: lack 2D, 3D Sediment Modelling
lack Water Quality Modelling

Legend: ✓ Available
✓* Available, but recalibration is required
Yellow shaded cells mark model gaps

THE MODELLING APPROACH FOR THE COUNCIL STUDY

Due to the current modeling limitations of the DSF models, other models were identified and evaluated to address these limitations and augment the current modeling functionalities of the DSF models to support the Council Study

Three ***possible choices*** were presented to the TACT. The choices were evaluated based on the following factors:

1. Several selection criteria (Model Capacity, Model available and existing input data using for each Model) and
2. Time of implementation
3. Including required cost and

POSSIBLE CHOICES

The review of capacity and gap of model reveals a number of possible combinations/configurations of these two modeling packages that could be viable approaches to meet the modeling requirements of the Council Study.

These possible model configurations are:.

Possible choice 1	MRC DSF (Supplemented by WUP-FIN Models)
Possible choice 2	Balanced Configuration of MRC DSF and WUP-FIN Models to take Advantage of Respective Model Strengths
Possible choice 3	MRC DSF (Supplemented by DHI-Mike Models)

These three choices were presented to the TACT during the 10th IKMP TACT Meeting in Hanoi, 3-4 February 2015

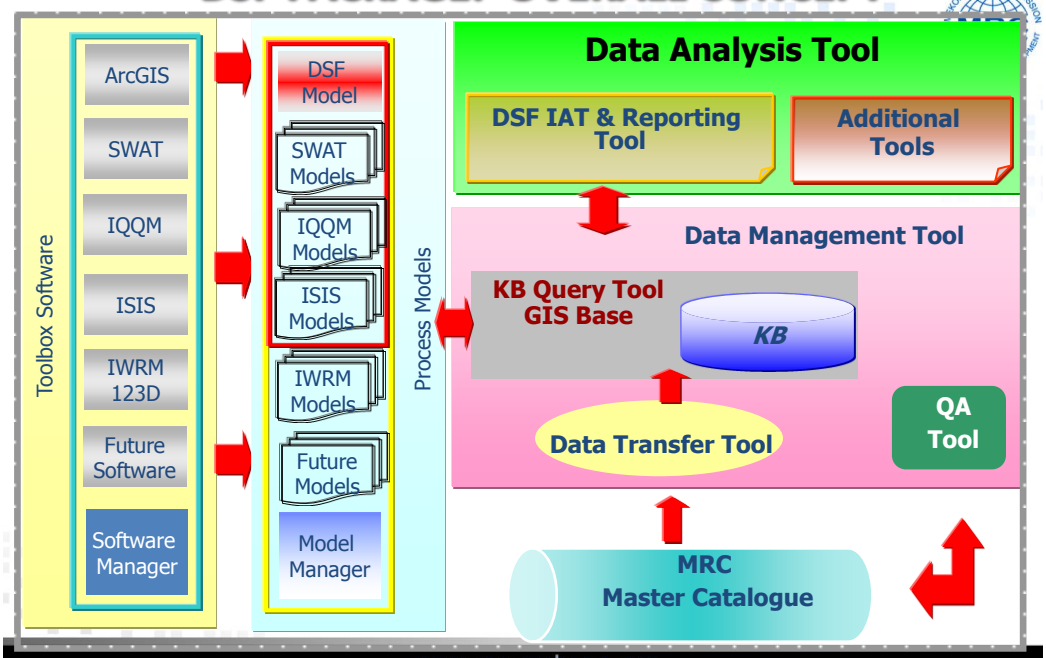
SELECTED MODELLING APPROACH

Possible choice 1: MRC DSF (Supplemented by WUP-FIN Models)
This is evaluated to be the most suitable choice and its was approved by the TACT to use for council study.

This will focus on using the core DSF as the main model. The WUP-FIN model will be used to fill the gap on water quality and if needed, 3D model.

- SWAT and IQQM will be used to simulate basin hydrology for all five zones (except zone 5 in Delta: IQQM will be used to calculate the water demand only) and water quality in zones 1 to 3.
- iSIS will be used to simulate hydrodynamics for zones 4 and 5, the ISIS for zone 1-3 only use for the MeKong mainstream, and sediment transport for zones 1 to 3.
- The results from iSIS in zones 3, and 4 area connected will be taken as boundary conditions and input for the 2/3D EIA model to model hydrodynamics, sediment, and water quality in zones 4 and 5 in more detail.
- Dam operation will be simulated using IQQM. The simulated runoff / reservoir storage and reservoir inflow will provide flow boundary conditions for the 3D EIA model to simulate sedimentation and water quality in the artificial reservoirs.

DSF PACKAGE: OVERALL CONCEPT



THE SCOPE AND CAPACITY OF THE DSF MODELS

Model		Model Scope					Model Capability		
		Model Area	Mekong Mainstream	Tributaries	Great Lake (Tonle Sap)	Mekong Delta	Flow	Sediment	Water Quality
MRC Decison Support Framework package									
Hydrologic Model	**SWAT**	UMB, LMB from China Border - Kratie, Great Lake (Tonle Sap)	x	x	x	NA	x	*x	NA
Water Balance Model	**IQQM**	UMB, LMB from China Border - Kratie, Great Lake (Tonle	x	x	x	x	x	NA	NA
Hydrodynamic Model	**ISIS**	Mekong Mainstream from Chiang Saen - Kratie, Cambodia Flood Plain - Mekong Delta	x	NA	x	x	x	NA	NA

Legend:
- x Available
- *x Available, but recalibration is required
- NA Not available (shaded in grey)

ISSUES WITH THE DSF MODEL PACKAGE

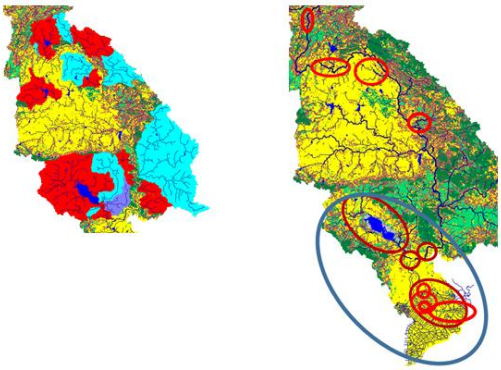
The main issues of the DSF within the context of the Council Study modeling requirements are as follows:

1. The current DSF models have not been applied to simulate sediment and water quality fate and transport including nutrients due to the limited on time and quality of sediment and water quality data is still need further investigation.
2. Despite complex flow conditions in floodplains and reservoirs including the Tonle Sap -Great Lake, they can only be simulated in iSIS using one-dimensional hydrodynamic flow model.
3. 1D-ISIS models for the Mekong Mainstream (from Chiang Saen – Kratie is still under the process of testing by Modelling Team and waiting for approval for official use by the Technical Assistance and Coordination Team)

WUP-FIN MODELING PACKAGE

The IWRM modeling system consists of the following two components:

1. VMOD (IWRM/HAE) distributed hydrological model with comprehensive water management, farming system, erosion, hydropower and climate change sub-components; simple flooding is included for crop impact modeling.
2. Combined 1D/2D hydrodynamic model for flooding, erosion, water quality, primary productivity and fisheries productivity.



THE SCOPE AND CAPACITY OF THE WUP-FIN MODELS

Model		Model Area	Model Scope				Model Capability		
			Mekong Mainstream	Tributaries	Great Lake (Tonle Sap)	Mekong Delta	Flow	Sediment	Water Quality
WUP-FIN model package									
Hydrologic model	**VMOD**	UMB, LMB from China Border - Kratie, Great Lake (Tonle Sap), Mekong Delta	x	x	x	x	x	NA	NA
Water Balance Model	**IWRM**	UMB, LMB from China Border - Kratie, Great Lake (Tonle Sap), Mekong Delta	x	x	x	x	x	*x	NA
Hydrodynamic Model	**EIA 3D Model**	Great Lake (Tonle Sap), Mekong Delta	NA	NA	x	x	x	*x	*x

Legend:
- x Available
- *x Available, but recalibration is required
- NA Not available (shaded in grey)

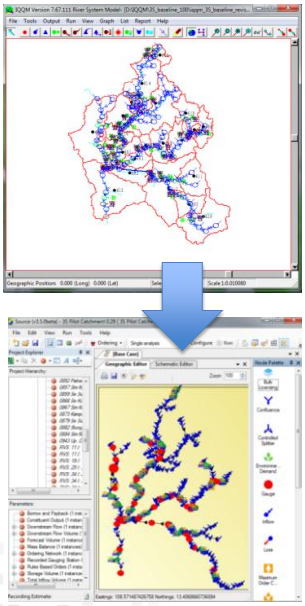
THE ISSUES WITH THE WUP-FIN MODELS

The main issues of the WUP-FIN models in the context of the Council Study modeling requirements are the following:

1. The WUP-FIN models need recalibration as they have not been updated with the most recent available data.
2. The WUP-FIN models do not cover the entire LMB.
3. The approval from NMCs.

Incorporating eWater Source

SOURCE Model



eWater Source is an adaptable framework which reproduces the functionality of IQQM to an accuracy well within modelling tolerances. A conversion program allows a Source model to be built directly from the IQQM input data files with the vast majority of IQQM parameters converted.

Source has also been demonstrated to offer advantages over SWAT particularly for climate change and low-flow analysis studies, and to be able to provide a simpler workflow and scenario management platform.

Targeted of using sources:

- Sediment and Nutrient link between SWAT –ISIS is still need IQQM and Sources for future Scenario (Dam on tributary)

	Model Scope					Model Capacity		
	Model Area	MK mainstream	Tributaries	Great Lake	Mekong Delta	Flow	Sediment	Water Quality
Hydologic + Water balance Model								
eWater-Source	UMB, LMB from China Border - Kratie, Great Lake	TBC				x	x	x

eWater Source Modelling to Support Council Study

- Source as the Water Quality and Water Volume Tool which routes information from SWAT to ISIS and from WUP-FIN to ISIS)
- Can augment IQQM capability by providing Multi-Reservoir Operation analysis
- Can Incorporate Environmental Flows (inform from DRIFT and Fisheries)
- Will be fully integrated with DSF in terms of data in/out under Council Study, full DSF Source file ingestion and reporting finalised in later phases.

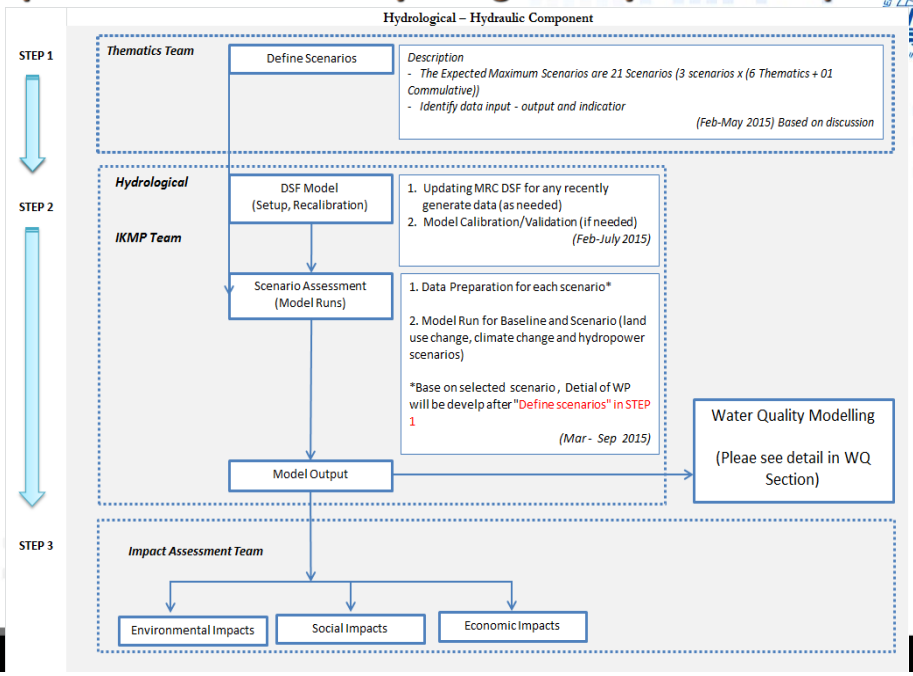
ACTION TO SUPPORT THE COUNCIL STUDY

1. Convert IQQM Baseline model to eWater Model then prepare a technical report on the comparison of flows. (*End of April 2015*)
2. eWater will develop a plugin which will read the SWAT setup and output files and load time series of flow, sediment and water quality into Source (*May – July 2015*).
3. IKMP and eWater will implement water quality and sediment routing decay functions to calibrate the Source model to observed water quality data. (*May – August 2015*).
4. eWater will create a plugin which will export Source results into DSF format or ISIS format so that the flows, sediment and water quality time series are loaded into ISIS for running (*July – August 2015*).
5. eWater will also work with the Finnish EIA to develop a plugin which will load flow, water quality and sediment from the VMOD model. This will be used also as a sensitivity check on the SWAT outputs (*July – August 2015*).

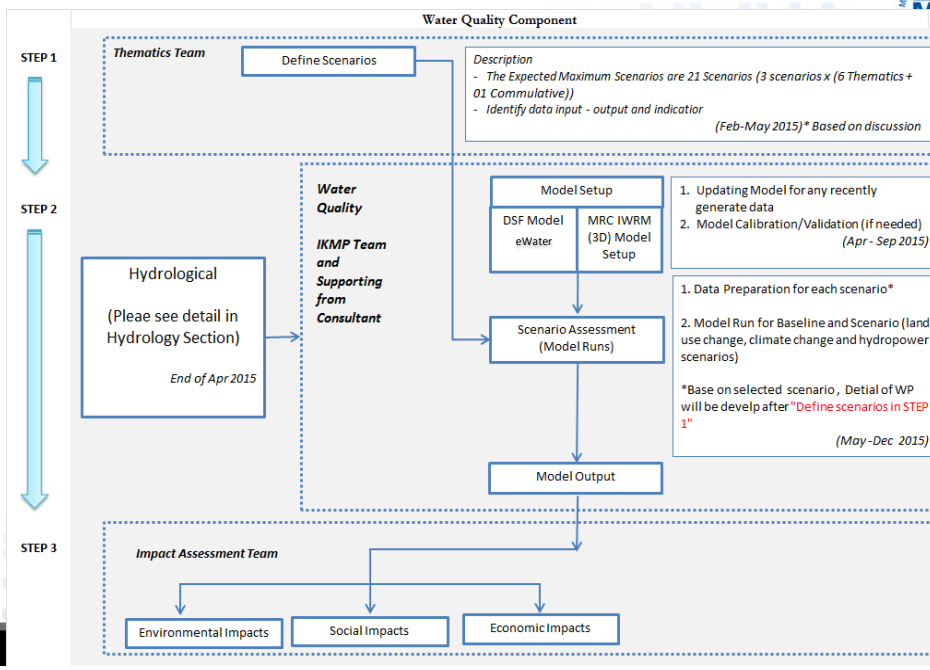
Using the eWater-Source as another source to provide Technical information for Council study: *Will seek the consideration from all after eWater Team provide the Proposal, Plan in April 2015*

Modelling Work Flow and Implementation Plan

Implementation Plan for Hydrological – Hydraulic Component



Implementation Plan for Water Quality Component



Implementation Plan For Hydrological – Hydraulic Component

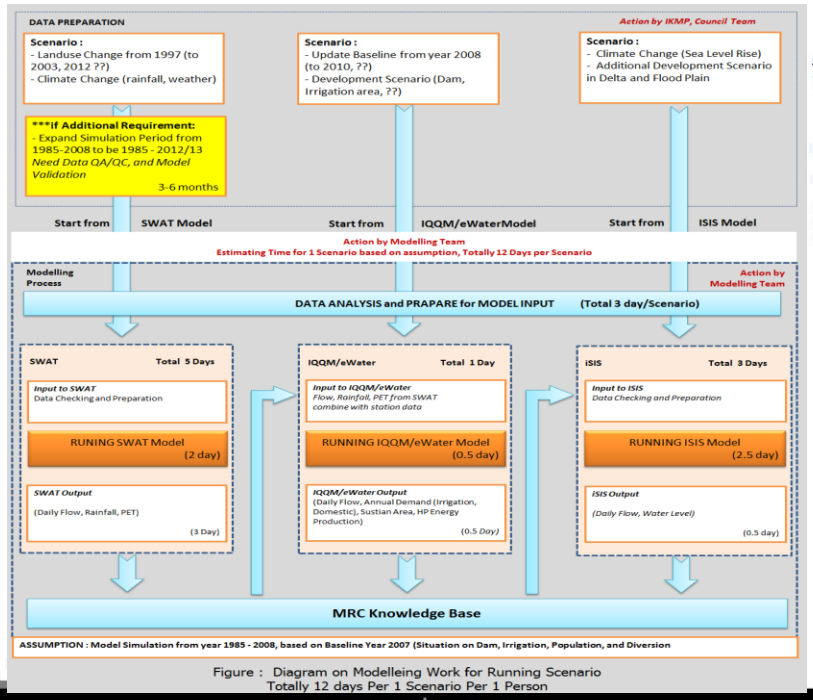


Figure : Diagram on Modelleing Work for Running Scenario
Totally 12 days Per 1 Scenario Per 1 Person

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Implementation Plan for eWater Source support for council study

Project Summary and Timing												
		Action	2015									
	IKMP	eWater	March	April	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Preparation and IT Integration												
Finalise SWAT Time Series Loader from SWAT or DSF		Programming	Finish by Mid-April									
Finalise and Check IQQM Convertor	Provide Finished IQQM model(s)	Programming	Finish by Mid-April									
Source Output Export to DSF for ISIS	DSF Formats and Data Mapping	Programming		2 weeks starting early April								
Time Series Loader from WUP-FIN/DSF	Specs from WUP-FIN	Programming		2 weeks effort depending on WUP-FIN Start Date								
Test and Validate Water Quality Routing	Water Quality SWAT Model	Engineer/Tester		Dependent on IKMP - est 3 weeks effort								
Regional Workshop and Training on SWAT/Source/DSF tools	Workshop Design and ICBP Support	Design and Deliver		3 day Workshop Late April								
Technical Support												
Ongoing Technical Support to IKMP during Council Study				Estimate 0.5 FTE over period of Engineer Estimate 0.5 FTE over period of Programmer								

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Progress of Hydrologic Assessment Team (IKMP) Support to Council Study

Final Decisions from the 10th TACT Meeting

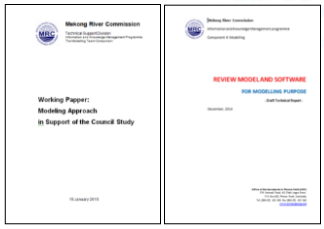
- **Modeling Approach and work plan for support the Council Study**
  - ✓ All Member Countries (TACT) agreed in principle to select option 1 for the council study.
- **eWater Source hydrological modeling platform to assist MRC Council Study and PWUM pilot project**

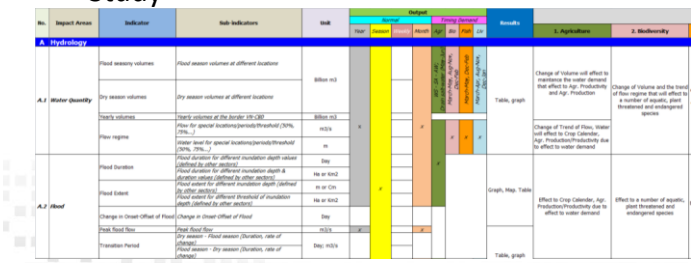
The TACT agreed with the following statements:

- ✓ Acknowledge eWater Source as successor to IQQM
- ✓ Agreement on the use of eWater as an additional tool for the PWUM pilot studies and Hydrology component.
- ✓ Acknowledge that eWater Source is recommended as a tool by TACT for the Council study.

MT SUPPORT THE COUNCIL STUDY

- Reviewed the data and model capacity and application within LMB.
- Prepared and Provided list of Priority Parameters.
- Provided Technical support via Working Paper on Modelling Approach for the Council Study





Progress of the implementation

- **Team formulation:**
- TORs for all required experts (international, regional and national) have been finalized and submitted to CCAI and CS for further processes.
- Potential experts as required under this study identified.
- Proposal for request additional financial support from Finland for WUP-Fin team finalized and submitted.
- Developing the detail work plan for DSF, WUP-Fin and E-water sources to support the council study (Apr 2015)
- **Modeling setup and updates:**
- Continue DSF modeling setup and calibration focusing on sediment and water quality parameters
- **Support for the scenarios development**
- Providing technical support and advices on the development of technical guideline for thematic team scenario development

Issues and Challenges

- Shortage of funding and resources for support Council Study will lead to the reprioritization of modeling work plan and outputs delivery.
- The progress of the hydrologic team is depending on input from thematic teams and data delivery from MCs and sufficient resources to support the team.

Next Steps

		2015										2016				
Rank	Tasks	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
1	Complete the team formulation															
2	Setup/calibrate/validate of the DSF models for 1985-2008															
3	Setup/calibrate/validate of the WUP-Fin and eWater models for 1985-2008															
4	Setup model for 2020 DFS and simulate conditions															
5	Setup model for 2040 Planned development plus 2 CC scenarios and simulate conditions															
6	Write up technical note about the modeling result phase 1															

The RTWG on Council Study may wish to:

1. Take note on the progresses made by IKMP since the 3th RTWG meeting.
2. Approve on the recommendations made by TACT to engage the eWater Source as one of DSF supplement tools in the council study.

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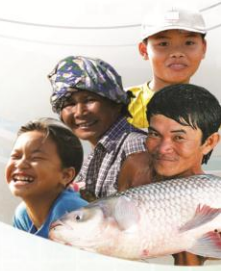
THANK YOU