Council Study

Progress Update Presentation
Hydrologic Assessment/Modeling Team

Contents

• Background
• Overview of the Modelling Progress
• Status of Modelling Progress of each Model Package
• Challenges
• Next steps
BACKGROUND

Role of Modeling Team

Conduct the hydrologic, hydraulic, sediment transport, and water quality modeling required to support impact assessment:

- Model setup, calibration, and validation for baseline conditions
- Prepare, update input data and model for the development scenarios
- Run model and analyze results of scenarios
- Prepare technical modeling reports
Modeling Approach

Zones 1 - 3

Hydrology and Hydraulics

\[ \text{SWAT} \rightarrow \text{IQQM} \rightarrow \text{ISIS} \]

Sediment

\[ \text{SWAT} \rightarrow \text{Source} \rightarrow \text{ISIS} \]

Nutrients

\[ \text{SWAT} \rightarrow \text{Source} \rightarrow \text{ISIS} \]

Modeling Approach

Zone 4 - Tonle Sap River

Hydrology and Hydraulics

\[ \text{SWAT} + \text{IQQM} \rightarrow \text{ISIS} \]

Sediment

\[ \text{SWAT} \]

Nutrients

\[ \text{SWAT} \]

Zone 4 - Tonle Sap Lake and Floodplain

Hydrology and Hydraulics

\[ \text{SWAT} \rightarrow \text{EIA-3D (WUP-FIN)} \]

Sediment

\[ \text{SWAT} \& \text{VMOD} \rightarrow \text{EIA-3D (WUP-FIN)} \]

Nutrients

\[ \text{SWAT} \& \text{VMOD} \rightarrow \text{EIA-3D (WUP-FIN)} \]
Modeling Approach

Zone 5 - Viet Nam/Cambodian Delta

Hydrology and Hydraulics
\textbf{SWAT + IQQM $\rightarrow$ ISIS}

Salinity
\textbf{ISIS}

Flooding
\textbf{ISIS}

Agriculture and aquaculture impacts
\textbf{ISIS (salinity and flooding) + WUP-FIN tools}
Activities

• Mr. Vannaphone (Lao National Modeling expert) works and guides team to work with SWAT-Sediment and Nutrient including mainstream and Tributary (Calibration and verification). In addition, summarized all team work to MT including (Sediment Landphase, Sediment yield mapping, Trapping efficiency, Literature on Nutrient, result of sediment and Nutrient)

• Mr. Thien (Vietnamese National Modeling expert) works with ewater source: Check and try to link SWAT with Source, test sediment routing in source

Activities

• Mr. Simmaron (Cambodian National Modeling expert) works with Sediment Loadest and Nutrient including QA/QC as well as calibrate the sediment and nutrient in A9. Support some data to WUP-FIN team

• Mr. Bounmy (Lao Assistant Modeler) Assist in calibrate Sediment-Nutrient A5, assist to solve the issue of Trapping efficiency and Landphase

• Mr. Pory (Cambodian Assistant Modeler) Assist in calibrate Sediment-Nutrient A6-A7, assist to solve the issue of Trapping efficiency and Landphase

• Mr. Direx (Thai Assistant Modeler) Assist in
Activities

• Mr. Direx (Thai Assistant Modeler) Assist in Calibrate Sediment (A3-A8) and Nutrient (A8), do mapping, assist to solve the issue of Trapping efficiency and Landphase
• Mr. Thanhdat (Vietnamese Assistant Modeler) Assist in Calibrate Sediment (A2) and Nutrient and also work with KB link with ewater source and ISIS

Completed and on-going tasks

• SWAT-Sediment Tributary and Mainstream (Completed)
• SWAT-Nutrient Tributary (Completed) and Mainstream (On going)
• Ewater-Sediment and Nutrient (test- ongoing)
• ISIS-Sediment and Nutrient (on going)
Issues

• As team member comes not the same time, so that the work might be delayed
• The understanding and knowledge of team member is different. We have to work and learn by the same time as it is initial to work with SWAT-Water Quality model (Sediment and Nutrient)
• The limited of Data and the efficiency of model
Modelling Team activity overview

- Model setup, calibration, and validation for baseline conditions
- Collect, process and analyse sediment and nutrient data
- Collaborate with the Thematic Teams, MRC projects and Delta Study
- Support SWAT, Source/eWater and WUP-FIN consultants
- Provide baseline and scenario data to the BioRA team
- Develop data and modelling tools
- Test and validate new tools (eWater/SOURCE)

Progress overview

- Sediment and nutrient monitoring data analysis has been finalized for the upstream, on-going for the Delta
- SWAT sediment calibration has been mostly finalised
- SWAT nutrient calibration on-going
- Upper Basin ISIS model has been extended to between Pakse and Stung Treng
- ISIS morphological, sediment and water quality model in preparation
Progress overview

- **Source** implementation more complex than originally thought but should be finalized before end of the year
- **WUP-FIN** model setup finalised, calibration and linking to DSF on-going
- Modelling for **BioRA** finalized for baseline and calibration scenarios for FA1 – FA6, Tonle Sap and Delta work on-going

ISIS Report

- Council Study Consultant Nguyenh Dinh Dat has prepared a comprehensive ISIS modelling Status Report
- The report details upper and lower Kratie model data, improvements and calibration
- The report includes also sediments and bank erosion
DSF STATUS FOR CS

PROGRESS on DSF

- short description of tasks accomplished and ongoing
- near-future work plan
- models and other tools used
- data analysis results
- model calibration results
- assessment of work as a whole: on time?, delays?, issues, required corrective measures, suggestions for future work.
STEP OF PROCESS FOR DSF - WQ

WQ Data Preparation
Load Estimation using Loades Program
QA/QC WQ data
SWAT Calibration for Sediment and Nutrient
(Testing) SOURCE Calibration for Sediment and Nutrient
ISIS Calibration for Sediment and Nutrient

BASELINE MODEL

WQ DATA AVAILABLE AND PREPARATION

SEDIMENT :

1. HYMOS database – IKMP :
   - Collected from 1962 (some station) : 2004 / 2005 (1-2 time / month)
   - Mostly on Laos and Thailand Tributary and MK mainstream
2. Water Quality Monitoring Network – EP :
   - 1985 – Present (1 time / month)
   - Collected together when collected water quality sample
   - Collect in tributary and MK Mainstream
3. DSMP – IKMP
   - 2009- 2012/2013
   - Including Regional Sediment Expert
   - Collecting on MK mainstream including Station Lower of Kratie

NUTRIENT :

1. Water Quality Monitoring Network – EP :
   - 1985 – Present (1 time / month)
   - Collected together when collected water quality sample
   - Collect in tributary and MK Mainstream
SEDIMENTS DATA AVAILABILITY

MRCS and MC

1. HYMOS database (IKMP)
   Use standard US-designed isokinetic samplers and involved depth-integrated sampling in several vertical profiles in order to derive and estimate of the mean suspended sediment concentration (SSC) in the cross section.

2. Water Quality Monitoring Network Programme (EP)
   Measurement of total suspended solids (TSS). The sample frequency in monthly and the samples are collected near the surface (0.3 m depth) of the river using a bottle rather than a true sampler.

3. The Discharge and Sediment Monitoring Project (DSMP-IKMP)
   Collected discharge measurements and depth integrated suspended sediment sampling at 15 monitoring location, including 12 on the Mekong mainstream, 2 on the Bassac and 1 in the Tonle Sap.

SEDIMENTS DATA AVAILABILITY

Data from 1985 - 2008

HM: Mainstream 6 stations, Tributary 21 stations
EP: Mainstream 8 stations, Tributary 15 stations (Estimation)

Data from 2009-2013

DSMP: Mainstream 12 stations, Tributary 3 stations in GL

www.mrcmekong.org
SEDIMENTS DATA AVAILABILITY

Refer to Walling (2005, 2008): Available Estimate of Sediment Load on Mekong Mainstream (from China & Hymos Database)

ESTIMATION OF SEDIMENTS LOAD

Deriving daily time-series for use to calibrating sediments is challenging because:

There are limited data for tributaries & mainstream
- 21 tributaries, 6 mainstream stations from Hymos database
- Not all sites have data over entire period
- Errors associated with sediment sampling

The data has inconsistencies
- Natural variability
- Conversion of suspended sediment to bedload
- Sampling errors
- Land use / water resource development change over time
ESTIMATION OF SEDIMENTS LOAD

- Measurement of the Sediment and nutrient concentrations in the stream is usually done on weekly, biweekly or monthly basis due to limited resources.
- Need to estimate concentration and loads during the period when no data is available.
- This study used the LOADEST program which includes several predefined regression models that specify the model form and complexity.

LOAD ESTimator (LOADEST from USGS) is a FORTRAN program for estimating constituent loads in streams and rivers.

Given a time series of stream flow, additional data variables, and constituent concentration, LOADEST assists the user in developing a regression model for the estimation of constituent load (calibration).

QA/QC WQ (SEDIMENT) DATA

**Approach**

1. Review of input data sets
2. Review of model (Loadest) Output and Evaluation for further use
3. Recheck quantity & timing of sediment input from different geomorphic regions
4. Use recent DSMP results to guide estimates of inputs between sites mainstream
GEOMORPHIC UNDERSTANDING

- Combine monitoring results with geomorphic understanding of LMB
- Differences in sediment input from different geomorphic settings
- Use DSMP monitoring results at mainstream to understand sediment inputs

Significance Potential Sediment Production in the Lower Mekong Basin: from Dr. Lois (Sediment Expert)

QA/QC WQ (SEDIMENT) DATA

Use Loadest results to better understand quantity & timing of sediment input from different geomorphic regions
**QA/QC WQ (SEDIMENT) DATA**

**DSMP results at Mainstream**

Use recent DSMP results to guide estimates of inputs between sites mainstream.

**Annual Water Flow (cu.km/Yr)**

**Annual Sediment Flux (MT/Yr)**

**Average Suspend Sediment (mg/L)**

**QA/QC WQ (SEDIMENT) DATA**

**DSMP results at Mainstream**

Estimated of sediment budget (Percent of Load Contribution from area) and Loadest results will be used to adjusted Sediment at Key Stations for period of DSF model calibration.

<table>
<thead>
<tr>
<th>Station</th>
<th>Sediment Load (Mg/Yr)</th>
<th>Cumulative Sediment Load (Mg/Yr)</th>
<th>Catchment Area (km2)</th>
<th>Sediment Yield (t/km2)</th>
<th>Percent of Total Load Area (%)</th>
<th>Cumulative Percent of Total Load from Area (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>STN</td>
<td>53,235,000</td>
<td>53,235,000</td>
<td>180,750</td>
<td>300</td>
<td>43%</td>
<td>43%</td>
</tr>
<tr>
<td>LPR</td>
<td>11,205,857</td>
<td>68,428,967</td>
<td>75,245</td>
<td>149</td>
<td>8%</td>
<td>51%</td>
</tr>
<tr>
<td>CYN</td>
<td>3,937,096</td>
<td>72,366,063</td>
<td>26,062</td>
<td>148</td>
<td>3%</td>
<td>54%</td>
</tr>
<tr>
<td>HCM</td>
<td>475,672</td>
<td>72,841,735</td>
<td>3,214</td>
<td>148</td>
<td>0%</td>
<td>58%</td>
</tr>
<tr>
<td>NKP</td>
<td>18,124,680</td>
<td>90,996,415</td>
<td>64,731</td>
<td>280</td>
<td>13%</td>
<td>67%</td>
</tr>
<tr>
<td>MTP</td>
<td>4,138,000</td>
<td>97,105,415</td>
<td>21,925</td>
<td>280</td>
<td>5%</td>
<td>73%</td>
</tr>
<tr>
<td>KTV</td>
<td>8,363,000</td>
<td>105,488,015</td>
<td>29,870</td>
<td>280</td>
<td>6%</td>
<td>78%</td>
</tr>
<tr>
<td>PNB</td>
<td>5,930,518</td>
<td>111,398,533</td>
<td>127,958</td>
<td>46</td>
<td>4%</td>
<td>82%</td>
</tr>
<tr>
<td>SIT</td>
<td>21,781,489</td>
<td>133,193,023</td>
<td>40,788</td>
<td>466</td>
<td>16%</td>
<td>98%</td>
</tr>
<tr>
<td>KTE</td>
<td>2,065,244</td>
<td>135,256,267</td>
<td>11,155</td>
<td>182</td>
<td>2%</td>
<td>100%</td>
</tr>
<tr>
<td>Total</td>
<td>139,256,267</td>
<td>598,410</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
QA/QC WQ (SEDIMENT) DATA

Summary of Sediment Load Estimation on Mekong Mainstream (CSN – KRE) for DSF calibration

<table>
<thead>
<tr>
<th>Station</th>
<th>Sediment Load from Area (T/yr)</th>
<th>Cumulative Sediment Load (T/yr)</th>
<th>Catchment Area (km²)</th>
<th>Sediment Yield (T/km²)</th>
<th>Percent of Total Load from Area (%)</th>
<th>Cumulative Percent of Total Load from Area (%)</th>
<th>Adjust by</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSN</td>
<td>80,298,642</td>
<td>80,298,642</td>
<td>189,000</td>
<td>425</td>
<td>54%</td>
<td>54%</td>
<td>-</td>
</tr>
<tr>
<td>LPB</td>
<td>19,078,132</td>
<td>19,078,132</td>
<td>79,000</td>
<td>241</td>
<td>13%</td>
<td>67%</td>
<td>-</td>
</tr>
<tr>
<td>CMK</td>
<td>(238,873)</td>
<td>99,376,774</td>
<td>24,000</td>
<td>(10)</td>
<td>0%</td>
<td>66%</td>
<td>Increase 9% ignore</td>
</tr>
<tr>
<td>KRE</td>
<td>3,512,443</td>
<td>102,720,244</td>
<td>10,000</td>
<td>105</td>
<td>1%</td>
<td>68%</td>
<td>Increase 71%</td>
</tr>
<tr>
<td>NKP</td>
<td>5,965,077</td>
<td>114,650,861</td>
<td>71,000</td>
<td>168</td>
<td>8%</td>
<td>76%</td>
<td>Reduce 30</td>
</tr>
<tr>
<td>MDR</td>
<td>4,299,654</td>
<td>118,965,515</td>
<td>18,000</td>
<td>239</td>
<td>3%</td>
<td>79%</td>
<td>Reduce 52%</td>
</tr>
<tr>
<td>KCM</td>
<td>5,096,157</td>
<td>122,471,213</td>
<td>26,000</td>
<td>125</td>
<td>2%</td>
<td>82%</td>
<td>Reduce 55%</td>
</tr>
<tr>
<td>PSZ</td>
<td>4,899,996</td>
<td>128,360,809</td>
<td>128,000</td>
<td>47</td>
<td>4%</td>
<td>86%</td>
<td>-</td>
</tr>
<tr>
<td>STT</td>
<td>19,768,864</td>
<td>148,121,013</td>
<td>90,000</td>
<td>220</td>
<td>13%</td>
<td>99%</td>
<td>Increase 2.5%</td>
</tr>
<tr>
<td>KRE</td>
<td>1,332,670</td>
<td>150,033,883</td>
<td>11,000</td>
<td>176</td>
<td>1%</td>
<td>100%</td>
<td>-</td>
</tr>
</tbody>
</table>

Total: 150,033,883

QA/QC WQ (SEDIMENT) DATA

Summary of Sediment Load Estimation on Mekong Lower Kratie for DSF/WUP-FIN calibration
# QA/QC WQ (NUTRIENT) DATA

Summary of Nutrient Load Estimation on Mekong Mainstream (CSN – KRE) for DSF calibration

<table>
<thead>
<tr>
<th>Station Name</th>
<th>Catchment Area (sq. km.)</th>
<th>Estimate TN Load (Ton / Year)</th>
<th>Estimate TP Load (Ton / Year)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Total Average</td>
<td>Inc In Load - Average</td>
</tr>
<tr>
<td>Chiang Saen</td>
<td>189,000</td>
<td>44,959</td>
<td>44,959</td>
</tr>
<tr>
<td>Luang Prabang</td>
<td>268,000</td>
<td>34,734</td>
<td>-</td>
</tr>
<tr>
<td>Vientiane</td>
<td>299,000</td>
<td>78,952</td>
<td>33,993</td>
</tr>
<tr>
<td>Nakhon Phanom</td>
<td>373,000</td>
<td>115,567</td>
<td>36,616</td>
</tr>
<tr>
<td>Khong Chiam</td>
<td>419,000</td>
<td>165,941</td>
<td>50,374</td>
</tr>
<tr>
<td>Pakse</td>
<td>545,000</td>
<td>170,751</td>
<td>4,810</td>
</tr>
<tr>
<td>Stung Treng</td>
<td>635,000</td>
<td>208,680</td>
<td>37,929</td>
</tr>
<tr>
<td>Kratie</td>
<td>646,000</td>
<td>202,202</td>
<td>6,478</td>
</tr>
</tbody>
</table>

## SWAT CALIBRATION FOR SEDIMENT AND NUTRIENT

[www.mrcmekong.org](http://www.mrcmekong.org)
CONCEPT FOR SWAT LMB CALIBRATION

1. Tributaries:
   - The Loadest estimation from HM data will be used for SWAT model, and Loadest estimation from EP (3S area and around Grate Lake) will be also consider* if no HM data.
   - Sub basin with no sediment monitoring station will considered sediment yield from nearby monitoring station and potential sediment production in LMB.

2. Mainstream
   - The data from DSMP (2009-2013) will used to Estimate Sediment Load for year 1985 – 2008 using Loadest Program, However some station in the middle reach will be consider to adjust based on inconsistent of data
   - Sediment Load will be used to Calibrated SWAT inside area between monitoring station. (can start at SWAT area 2; use sediment at CSN – input and LPB – output then move to downstream)
   - Sediment Load at ChiangSaen will be consider from EP dataset and downscale based on compare data from 2009-2013 between EP and DSMP dataset
<table>
<thead>
<tr>
<th>Variable name</th>
<th>Definition</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>sLUE</td>
<td>USLE soil erodibility (K) factor</td>
<td>0</td>
<td>0.65</td>
</tr>
<tr>
<td>sLUE P</td>
<td>USLE equation support practice</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>ADJ PRR</td>
<td>Peak rate adjustment factor for sediment routing in the subbasin (tributary channels)</td>
<td>0.5</td>
<td>0.5</td>
</tr>
<tr>
<td>SPEDR</td>
<td>Exponent parameter for calculating sediment reentrained in channel</td>
<td>1</td>
<td>1.5</td>
</tr>
<tr>
<td>SPEDR</td>
<td>Linear parameter for calculating the maximum amount of sediment that can be reentrained during channel sediment routing</td>
<td>0.001</td>
<td>0.01</td>
</tr>
<tr>
<td>NSED</td>
<td>Normal sediment concentration in the reservoir</td>
<td>1</td>
<td>5000</td>
</tr>
<tr>
<td>SED</td>
<td>Initial sediment concentration in the reservoir</td>
<td>1</td>
<td>5000</td>
</tr>
<tr>
<td>DoS</td>
<td>Median particle diameter of sediment (mm)</td>
<td>1</td>
<td>10000</td>
</tr>
<tr>
<td>CH BKN TC</td>
<td>Critical shear stress of channel bank (N/m²)</td>
<td>0</td>
<td>400</td>
</tr>
<tr>
<td>CH BKN TC</td>
<td>Critical shear stress of channel bed (N/m²)</td>
<td>0</td>
<td>400</td>
</tr>
<tr>
<td>CH BKN TD</td>
<td>Erodibility of channel bank sediment by jet test (cm²/N-m)</td>
<td>0.001</td>
<td>3.75</td>
</tr>
<tr>
<td>CH BKN TD</td>
<td>Erodibility of channel bed sediment by jet test (cm²/N-m)</td>
<td>0.001</td>
<td>3.75</td>
</tr>
<tr>
<td>CH BKN TD</td>
<td>Erodibility of channel bed sediment (cm²N-s/m²)</td>
<td>-0.001</td>
<td>1</td>
</tr>
<tr>
<td>CH BKN TD</td>
<td>Erodibility of channel bed sediment (cm²N-s/m²)</td>
<td>-0.001</td>
<td>1</td>
</tr>
<tr>
<td>CH COV1</td>
<td>Channel erodibility factor</td>
<td>-0.05</td>
<td>0.6</td>
</tr>
<tr>
<td>CH COV2</td>
<td>Channel cover factor</td>
<td>-0.001</td>
<td>1</td>
</tr>
<tr>
<td>CH EQR</td>
<td>Channel routing method</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>CH SIDE</td>
<td>Change in horizontal distance per unit vertical distance</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>CH S2</td>
<td>Average slope of main channel</td>
<td>-0.001</td>
<td>10</td>
</tr>
</tbody>
</table>

**SEDIMENT PARAMETERS**

**Land**

- **sLUE**: USLE soil erodibility (K) factor
- **sLUE P**: USLE equation support practice
- **ADJ PRR**: Peak rate adjustment factor for sediment routing in the subbasin (tributary channels)
- **SPEDR**: Exponent parameter for calculating sediment reentrained in channel
- **SPEDR**: Linear parameter for calculating the maximum amount of sediment that can be reentrained during channel sediment routing

**Reservoir**

- **NSED**: Normal sediment concentration in the reservoir
- **SED**: Initial sediment concentration in the reservoir
- **DoS**: Median particle diameter of sediment (mm)

**Channel**

- **CH BKN TC**: Critical shear stress of channel bank (N/m²)
- **CH BKN TC**: Critical shear stress of channel bed (N/m²)
- **CH BKN TD**: Erodibility of channel bank sediment by jet test (cm²/N-m)
- **CH BKN TD**: Erodibility of channel bed sediment by jet test (cm²/N-m)
- **CH BKN TD**: Erodibility of channel bed sediment (cm²N-s/m²)
- **CH BKN TD**: Erodibility of channel bed sediment (cm²N-s/m²)
- **CH COV1**: Channel erodibility factor
- **CH COV2**: Channel cover factor
- **CH EQR**: Channel routing method
- **CH SIDE**: Change in horizontal distance per unit vertical distance
- **CH S2**: Average slope of main channel

**Data Availability**

- SEDIMENT DATA from HYMOS/EP DATABASE
- Data available for Sediment calibration
- Water Quality DATA from EP DATABASE
- Data available for WQ calibration
## SWAT Calibration for Sediment and Nutrient

### Area 2: Chieng Sao to Long Phubong

<table>
<thead>
<tr>
<th>Station Code</th>
<th>Station Name</th>
<th>Sediment Calibration</th>
<th>Nutrient (DON) Calibration</th>
<th>Nutrient (TOTP) Calibration</th>
</tr>
</thead>
<tbody>
<tr>
<td>2021</td>
<td>Nam Chai at Mong Ngoy</td>
<td>2006-2006</td>
<td>0.52</td>
<td>102</td>
</tr>
<tr>
<td>2010</td>
<td>Nam Moe Keh at Ban Tai Ton</td>
<td>2006-2006</td>
<td>0.50</td>
<td>90</td>
</tr>
<tr>
<td>2044</td>
<td>Nam Moe Keh at Chiang Ra</td>
<td>2006-2006</td>
<td>0.52</td>
<td>107</td>
</tr>
<tr>
<td>2051</td>
<td>Nam Mee Lay at Ban Tai Tai</td>
<td>2006-2006</td>
<td>0.72</td>
<td>84</td>
</tr>
<tr>
<td>2060</td>
<td>Nam Moe Lay at Thaung</td>
<td>2006-2006</td>
<td>0.72</td>
<td>83</td>
</tr>
</tbody>
</table>

### Area 3: Long Phubong to Vientiane

<table>
<thead>
<tr>
<th>Station Code</th>
<th>Station Name</th>
<th>Sediment Calibration</th>
<th>Nutrient (DON) Calibration</th>
<th>Nutrient (TOTP) Calibration</th>
</tr>
</thead>
<tbody>
<tr>
<td>3016</td>
<td>Noi Lam at Ban Xai Chui</td>
<td>2005-2007</td>
<td>0.63</td>
<td>100</td>
</tr>
</tbody>
</table>

### Area 4: Vientiane to Mukdahan

<table>
<thead>
<tr>
<th>Station Code</th>
<th>Station Name</th>
<th>Sediment Calibration</th>
<th>Nutrient (DON) Calibration</th>
<th>Nutrient (TOTP) Calibration</th>
</tr>
</thead>
<tbody>
<tr>
<td>4028</td>
<td>Nam Leo at Ban Hia Hei</td>
<td>1997-2000</td>
<td>0.46</td>
<td>92</td>
</tr>
<tr>
<td>4032</td>
<td>Nam Ngam at Ban Phai Lom</td>
<td>1997-2000</td>
<td>0.46</td>
<td>92</td>
</tr>
<tr>
<td>4075</td>
<td>Nam Sangkham at Ban Tai Tha Dung</td>
<td>1990-2000</td>
<td>0.44</td>
<td>105</td>
</tr>
<tr>
<td>4095</td>
<td>Nam Tha at Ban Agio</td>
<td>1990-2000</td>
<td>0.42</td>
<td>105</td>
</tr>
<tr>
<td>4101</td>
<td>Se Bang Pi at Mekong</td>
<td>1990-2000</td>
<td>0.76</td>
<td>99</td>
</tr>
<tr>
<td>4115</td>
<td>Nam Kdo at Nam Koo</td>
<td>1987-1999</td>
<td>0.47</td>
<td>85</td>
</tr>
</tbody>
</table>

### Area 5: Mukdahan to Pakse

<table>
<thead>
<tr>
<th>Station Code</th>
<th>Station Name</th>
<th>Sediment Calibration</th>
<th>Nutrient (DON) Calibration</th>
<th>Nutrient (TOTP) Calibration</th>
</tr>
</thead>
<tbody>
<tr>
<td>5021</td>
<td>Se Bang Phai at Ban Hang Dao</td>
<td>1987-2000</td>
<td>0.62</td>
<td>93</td>
</tr>
<tr>
<td>5042</td>
<td>Se Dong at Nekwamakhi</td>
<td>1987-2000</td>
<td>0.47</td>
<td>89</td>
</tr>
<tr>
<td>5046</td>
<td>Nam Jom at Ubon</td>
<td>1987-2000</td>
<td>0.63</td>
<td>100</td>
</tr>
<tr>
<td>5054</td>
<td>Haa Khong at Sophakhon Keewong</td>
<td>1987-2000</td>
<td>0.56</td>
<td>89</td>
</tr>
<tr>
<td>5044</td>
<td>Nam Dong Pi at Ban Dong Tha</td>
<td>1987-1999</td>
<td>0.70</td>
<td>93</td>
</tr>
</tbody>
</table>

### Area 6: Pakse to Kison

<table>
<thead>
<tr>
<th>Station Code</th>
<th>Station Name</th>
<th>Sediment Calibration</th>
<th>Nutrient (DON) Calibration</th>
<th>Nutrient (TOTP) Calibration</th>
</tr>
</thead>
<tbody>
<tr>
<td>6040</td>
<td>Nam Ngam at Toong Niaq</td>
<td>1987-1997</td>
<td>0.41</td>
<td>83</td>
</tr>
<tr>
<td>6042</td>
<td>Se Ban Phai at Khonkham</td>
<td>1987-2000</td>
<td>0.50</td>
<td>82</td>
</tr>
<tr>
<td>6069</td>
<td>Sen Phai at Lom Phang</td>
<td>2005-2008</td>
<td>0.48</td>
<td>101</td>
</tr>
<tr>
<td>6120</td>
<td>Sen Phai at Ban Dong</td>
<td>1982-2008</td>
<td>0.60</td>
<td>89</td>
</tr>
</tbody>
</table>

### Area 7: Chao in Vientiane

<table>
<thead>
<tr>
<th>Station Code</th>
<th>Station Name</th>
<th>Sediment Calibration</th>
<th>Nutrient (DON) Calibration</th>
<th>Nutrient (TOTP) Calibration</th>
</tr>
</thead>
<tbody>
<tr>
<td>7042</td>
<td>Nam Bar at Ban Nai Laos</td>
<td>1987-2000</td>
<td>0.30</td>
<td>83</td>
</tr>
<tr>
<td>7046</td>
<td>Nam Yang at Ban Tai Nai Laos</td>
<td>1987-2000</td>
<td>0.40</td>
<td>83</td>
</tr>
<tr>
<td>7047</td>
<td>Nam Chai at Ban Chai Laos</td>
<td>1985-2008</td>
<td>0.55</td>
<td>86</td>
</tr>
<tr>
<td>7059</td>
<td>Nam Chai at Vientiane</td>
<td>1982-2008</td>
<td>0.73</td>
<td>83</td>
</tr>
</tbody>
</table>

### Area 8: Man in Roi Et

<table>
<thead>
<tr>
<th>Station Code</th>
<th>Station Name</th>
<th>Sediment Calibration</th>
<th>Nutrient (DON) Calibration</th>
<th>Nutrient (TOTP) Calibration</th>
</tr>
</thead>
<tbody>
<tr>
<td>8046</td>
<td>Noi Man at Ban Sai Laos</td>
<td>1982-2008</td>
<td>0.45</td>
<td>128</td>
</tr>
</tbody>
</table>

### Area 9: Ampeak Settha

<table>
<thead>
<tr>
<th>Station Code</th>
<th>Station Name</th>
<th>Sediment Calibration</th>
<th>Nutrient (DON) Calibration</th>
<th>Nutrient (TOTP) Calibration</th>
</tr>
</thead>
<tbody>
<tr>
<td>9045</td>
<td>Nam Pong at Koom</td>
<td>1982-2008</td>
<td>0.50</td>
<td>91</td>
</tr>
<tr>
<td>9042</td>
<td>Nam Pong at Koom</td>
<td>1982-2008</td>
<td>0.50</td>
<td>99</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Location</th>
<th>Sediment Calibration</th>
<th>Nutrient (DON) Calibration</th>
<th>Nutrient (TOTP) Calibration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total stations</td>
<td>28 stations</td>
<td>Total 14 stations</td>
<td>Total 14 stations</td>
</tr>
<tr>
<td>COE Higher than 0.45</td>
<td>23 stations</td>
<td>COE lower than 0.45</td>
<td>3 stations</td>
</tr>
<tr>
<td>COE Higher than 0.45</td>
<td>On-going</td>
<td>COE lower than 0.45</td>
<td>On-going</td>
</tr>
</tbody>
</table>
### SWAT Calibration for Sediment and Nutrient

<table>
<thead>
<tr>
<th>Sub</th>
<th>Gauge Name</th>
<th>Period</th>
<th>COE</th>
<th>Vol (%)</th>
<th>Sub</th>
<th>Gauge Name</th>
<th>Period</th>
<th>COE</th>
<th>Vol (%)</th>
<th>Sub</th>
<th>Gauge Name</th>
<th>Period</th>
<th>COE</th>
<th>Vol (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1031</td>
<td>Mekong at Chiang Saen</td>
<td>1985-2008</td>
<td>0.62</td>
<td>94</td>
<td>2049</td>
<td>Mekong at Luang Prabang</td>
<td>1985-2008</td>
<td>0.72</td>
<td>101</td>
<td>3026</td>
<td>Mekong at Chiang Khan</td>
<td>No Sediment Data</td>
<td>No Nitrogen Data</td>
<td>No Phosphorus Data</td>
</tr>
<tr>
<td>3024</td>
<td>Mekong at Vientiane</td>
<td>No Sediment Data</td>
<td>No Nitrogen Data</td>
<td>No Phosphorus Data</td>
<td>4075</td>
<td>Mekong at Nong Khai</td>
<td>1985-2008</td>
<td>0.71</td>
<td>97</td>
<td>4100</td>
<td>Mekong at Nakhon Phanom</td>
<td>1985-2008</td>
<td>0.80</td>
<td>100</td>
</tr>
<tr>
<td>4121</td>
<td>Mekong at Mukdahan</td>
<td>1985-2008</td>
<td>0.78</td>
<td>100</td>
<td>5032</td>
<td>Mekong at Pakse</td>
<td>1985-2008</td>
<td>0.78</td>
<td>100</td>
<td>on going</td>
<td>on going</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6087</td>
<td>Mekong at Stung Treng</td>
<td>1985-2008</td>
<td>0.77</td>
<td>97</td>
<td>6134</td>
<td>Mekong at Kratie</td>
<td>1985-2008</td>
<td>0.84</td>
<td>105</td>
<td>on going</td>
<td>on going</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**SEDIMENT RESULTS OF MAINSTREAM**

- **Observed (from Loadest)**: 80.30 M Ton/Year
- **Simulation (from SWAT)**: 75.64 M Ton/Year

Calibration Evaluation in Monthly:
- **COE**: 0.62
- **Vol Ratio**: 94%
SUMMARY OF SWAT CALIBRATION

- Sediment result from SWAT from Tributary and Mainstream was finalized and will be used for SOURCE and ISIS model
- Nutrient (TOTN, TOTP) from SWAT is on going and expect to finalized on mid of Nov and will be used for SOURCE and ISIS model
- In the future more emphasis on daily flow, sediment and nutrient calibration (now monthly)
Rationale for eWater Source Modeling to Support Council Study

- IQQM has limited capacity for sediment and water quality modelling
  
  - eWater Source will be used to complement IQQM for sediments and water quality

eWater Source Modeling to Support Council Study

- Customization of Source and integration with the DSF
- Technical Assistance in Modelling Sediment and Water Quality
- Capacity Building for MRCS and Member Countries
eWater Source Modeling to Support Council Study

- Customization of Source and integration with the DSF
  - Enhancing plug-in converter from IQQM to eWater Source
  - Developing Source adapter for Data Transfer Tool (DTT)
  - Testing, Validating and Reporting on Water Quality Routing
  - Incorporation of Reservoir Sediment Trapping

Status of EWATER Source

<table>
<thead>
<tr>
<th>Tasks</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flow model conversion from IQQM to Source</td>
<td>Completed for baseline</td>
</tr>
<tr>
<td>DTT configuration (flow) and KB Utility in term of E-Water</td>
<td>Completed</td>
</tr>
<tr>
<td>DTT confirmation for sediment gradation (% sand, silt, clay from SWAT)</td>
<td>On-going</td>
</tr>
<tr>
<td>DTT configuration (aggregate SWAT loads)</td>
<td>Completed</td>
</tr>
<tr>
<td>Plug-in: reservoir trapping and link routing of sediments algorithm</td>
<td>Completed</td>
</tr>
<tr>
<td>Plug-in: reservoir trapping and link routing of nutrient algorithm</td>
<td>On-going</td>
</tr>
<tr>
<td>Calibration of overall balance for both Sediment and Nutrients is done within SWAT – so Source calibration will mostly be around the reservoirs and in river.</td>
<td>Calibration pending</td>
</tr>
</tbody>
</table>
Status of EWATER Source

• Technical Assistance in Modelling Sediment and Water Quality
  - assist on other technical tasks

• Capacity Building
  1. In-house Training for Key Modeller, National Modeller/Assistant Modeller (at OSP), 17-19 August 2015
  2. Regional training course to finalise the integration work of eWater SOURCE into the DSF (OSP), October 2015
  3. eWater specialist Rachel at the OSP September – December 2015 working together with a National Modeller

WUP-FIN STATUS
National WUP-FIN Modellers

- Cambodia senior modeller (Vongsar) has been working longer time, junior modeller should arrive soon
- Thailand and Vietnam have received basic training
- Thailand implementing nutrient modelling in Tonle Sap
- Vietnam implementing Delta modelling
- Lao PDR identified and starting soon

Tonle Sap VMOD

- Objectives:
  - Provide data for the 3D Lake model
  - Utilise WUP-FIN monitoring database for hydrology, sediments and nutrients
  - Confirm SWAT results (very few data available)
- Status:
  - 2.4 km and 800 m resolution models have been set-up
  - KB 1985 – 2008 data imported
  - Initial hydrology, sediment and nutrient parameter values from upstream applications
  - Hydrological calibration finalized, sediments and nutrients ongoing
Tonle Sap VMOD

- Developments:
  - Define constituents (dissolved and particulate phosphorus and nitrogen)
  - Add in-stream mass storages (sedimentation/erosion)
  - Add channel erosion
  - Add geologically dependent erosion for mountain erosion

Model setup
Calibration

Chinit_Obs  Chinit_Sim

Kompong Thmar discharge

obs.  model

m³/s

0  50  100  150  200  250

01/07/2002  01/07/2003  01/07/2004  01/07/2005
Tonle Sap EIA-3D HD

• Objectives:
  – Model Tonle Sap 3D flooding, sediment, nutrient and productivity processes and development impacts

• Status:
  – Model parameters have been extensively re-tested resulting in modification of low water flow friction
  – Improved flooding algorithm for better account for large terrain gradients
  – Improved resolution from 1 km to 0.5 km
  – 2010 MRC land use

Tonle Sap EIA-3D WQ

• Objectives:
  – Model Tonle Sap 3D nutrient cycle
  – Provide basis for modelling reservoir water quality and nutrients

• Status:
  – Model has been setup
  – Under calibration
WUP-FIN 3D WQ Model

- WUP-FIN 3D WQ model utilised the 3D model computed flow fields
- Because no hydrodynamic modelling is needed the model is fast
- The model is comprehensive including all main water quality constituents

WQ model (one of the available)
Test model setup

Delta Impact Model
Delta Impact Model

- Objectives:
  - Model water quality, sediments and productivity on the floodplains based on ISIS

- Status:
  - Model has been setup
  - ISIS results extracted for discharge, water level and salinity
  - Mapping tuning
  - Impact assessment testing

Modelling approach
Indicator maps based on flooding

Av. depth  Duration  Probability

Definition of constituents

- Upstream point, distance weighing, settling and decay can be prescribed
Time series and GIS analysis of the model results

Floodplain sedimentation

- Model computes sedimentation distribution from mapped concentrations but the mass is corrected based on following formula:

\[ F D_{fs} (kg) = I_f \times \left( \frac{Q_f}{Q_L} \right) \times \left( 1 - e^{- \frac{A_f}{Q_f} v_p} \right) \]

Where
- \( Q_L \) = daily discharge (m\(^3\)/s)
- \( Q_{bf} \) = Bank Full Flow (determined during parameterisation) (m\(^3\)/s)
- \( Q_f = Q_L - Q_{bf} \) (m\(^3\)/s)
- \( I_f \) = daily fine sediment supply (kg)
NEXT STEPS

Next Steps

- Finalize SWAT nutrient calibration
- Finalize ISIS for sediments and nutrients
- Finalize IQQM-Source transition
- Finalize WUP-FIN modelling
- Draft Technical Report December 15
- Final Report December 31
Thank You