Council Study
Model Set Up and Results of Hydrologic Assessment/Modeling Team

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**

SWAT → IQQM → ISIS

**Sediment**

SWAT → Source → ISIS

**Nutrients**

SWAT → Source → ISIS

www.mrcmekong.org
Zone 4 - Tonle Sap River Watershed

Hydrology and Hydraulics

**SWAT + IQQM → ISIS**

Sediment

**SWAT**

Nutrients

**SWAT**

Zone 4 - Tonle Sap Lake and Floodplain

Hydrology and Hydraulics

**SWAT → EIA-3D (WUP-FIN)**

Sediment

**SWAT & VMOD → EIA-3D (WUP-FIN)**

Nutrients

**SWAT & VMOD → EIA-3D(WUP-FIN)**

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Zone 5 - Viet Nam/Cambodian Delta

Hydrology and Hydraulics

**IQQM → ISIS**

Flooding and Salinity

**ISIS**

Sediment and Nutrient

**ISIS + WUP-FIN**

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Agriculture and aquaculture impacts

**WUP-FIN tools**
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

MODEL SET UP
**SWAT Sediment and Nutrient Workflow**

- **Concentration (mg/L)**: Sediment, Nitrogen, Phosphorus
- **Load**: Sediment (Ton), Nitrogen (kg), Phosphorus (kg)
- **SWAT Model**: Sediment, Nitrogen, Phosphorus
- **Comparison**: Acceptable, Unacceptable
- **Final Outputs**: Water Yield, Sediment Yield, Nitrogen, Phosphorus

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**Source Sediment and Nutrient Workflow**

- **Modeling Tool**: IQQM, SOURCE
- **IQQM Outputs**: Flow, Dam Rule, Irrigation, Release
- **SOURCE Outputs**: Dam Rule, Irrigation, Release
- **Modelling Tool**: SWAT, Source Outputs, LR & Obs
- **LR & Obs Outputs**: TE, Downstream
- **Final Outputs**: Trapping Efficiency, TSS, TOTN, TOTP remaining, TSS, TOTN, TOTP release
Source
Chiang Sean-Kratie (Load and Discharge)

ISIS Model
Calibration

Unacceptable

Observed
Comparison

Acceptable

Final Outputs
- Sedimentation
- Nitro & Phosphorus
- Erosion

ISIS Sediment and Nutrient

DSF Outputs
- Stage
- Sediment
- Nitrogen
- Phosphorus

WUP-FIN Sediment and Nutrient

Final Outputs
- Aquaculture
- Agriculture
- Sediment
- Nitrogen & Phosphorus

WUP-FIN Monitoring

Unacceptable

Calibration

Comparison

Unacceptable

Tonle Sap 3D
3D Outputs

WUP-FIN Monitoring

VMOD/Mapping

Delta Mapper outputs

Unacceptable
UPSTREAM
SEDIMENT AND NUTRIENT (SWAT)

Calibration data

- Sediments: mainstream 8 stations, tributaries 28 stations
- Nutrients: mainstream 7 stations, tributaries 14 stations
- Data quality varies depending on dataset and location – need to be used with deliberation
Calibration using LOADEST

• The observed loads have been correlated with observed flow using USGS LOADEST software
• SWAT and Source has been calibrated against LOADEST monthly loads
• To consider:
  – In some tributaries there is poor correlation between flow and sediment load
  – Nutrients are often poorly correlated to flow
  – Reservoirs break correlations
  – Correlations don’t describe actual processes
### Tributary SWAT monthly loads compared with LOADEST

**Area 2: Chiang Saen to Luang Prabang**

<table>
<thead>
<tr>
<th>Sub Gauge Name</th>
<th>Period 1</th>
<th>COE</th>
<th>Vol (%)</th>
<th>Period 2</th>
<th>COE</th>
<th>Vol (%)</th>
<th>Period 3</th>
<th>COE</th>
<th>Vol (%)</th>
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### Mainstream SWAT monthly loads compared with LOADEST

**Area 3: Luang Prabang to Vientiane**

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**Area 4: Vientiane to Nakorn Phanom**

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**Area 5: Vientiane to Nong Khai**

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**Area 6: Vientiane to Nakorn Phanom**

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</table>

**Total Phosphorus Calibration**

[www.mrcmekong.org](http://www.mrcmekong.org)

**Total Nitrogen Calibration**

[www.mrcmekong.org](http://www.mrcmekong.org)

**Flow Calibration**

[www.mrcmekong.org](http://www.mrcmekong.org)

**Sediment Calibration**

[www.mrcmekong.org](http://www.mrcmekong.org)

**Sediment Calibration**

[www.mrcmekong.org](http://www.mrcmekong.org)
SWAT MONTHLY LOADS IN CHIANG SAEN COMPARED WITH LOADEST

Calibration Evaluation in Monthly:
COE: 0.87  Vol Ratio: 94%

Before Manwan

Annual sediment (Million Ton)
- Observed (from Loadest): 80.30 M Ton/Year
- Simulation (from SWAT): 75.64 M Ton/Year

SWAT WATER AND SEDIMENT YIELDS
SWAT NITROGEN AND PHOSPHORUS YIELDS

SEDIMENT AND NUTRIENT TRAPPING (SOURCE)
Source model for the upper Mekong  
Source model for the LMB
Validation of Source sediment trapping

<table>
<thead>
<tr>
<th>Source</th>
<th>Fu et al. (2008) Brune TE (%)</th>
<th>Siyam TE (%)</th>
<th>Kummu et al. (2010) Brune TE (%)</th>
<th>eWater Source Brune TE (%)</th>
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<td>Manwan</td>
<td>60.03</td>
<td>60.03</td>
<td>47</td>
<td>67.2</td>
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<tr>
<td>Dachaoshan</td>
<td>63.97</td>
<td>66.05</td>
<td>50</td>
<td>63.5</td>
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</table>

TE = Trapping Efficiency

Source nutrient trapping
- in Source nutrients are trapped with sediments

<table>
<thead>
<tr>
<th>Dam</th>
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<th>Particulate %</th>
<th>Nutrient TE %</th>
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<tr>
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<td>TOTP</td>
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<td>TOTP</td>
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MAINSTREAM FLOW, SEDIMENT AND NUTRIENT (ISIS)

ISIS for the upstream part

ISIS for the Delta
The Calibrated results: Water level

CHIENGSEAN

LUANGPRABANG

CHIANGKHAN

VIENTIANE

www.mrcmekong.org
Preliminary Isis Results for Sediments

CHIANG SAEN

NONG KHAI

PAKSE

CAMBODIAN AND DELTA SEDIMENT AND NUTRIENT (WUP-FIN)
Model calibration

- The Tonle Sap models including SWAT and WUP-FIN have been calibrated against MRC datasets (EP, HM and WUP-FIN)
- Both LOADEST and primary data have been used
- Both monthly and daily calibration have been conducted
- Calibration has been conducted for flow, sediments and nutrients in the tributaries and for sediments, nutrient cycle and dissolved oxygen in the lake

Sediment calibration

[Graphs showing sediment TSS calibration over time with model and observation data.]
Phosphorus calibration

Nitrogen calibration
Lake sediment calibration

Lake Sedimentation and dissolved oxygen

Sedimentation

Dissolved Oxygen
Primary and fisheries production

- Cambodian Floodplain and Delta Impact Model Results
Results will be compared with the DeltaMapper

WUP-FIN Results for Sediment and Nutrient
Summary

- 3 model packages are in good progress
- SWAT is almost finalized but some stations need further attention
- Source has been tested some functions and it provides reliable outputs
- ISIS has recently taken the sediment and nutrient from Source and is expected to complete soon
- WUP-FIN Tonle Sap models are nearly finalized but work in progress for nutrient cycle
- Delta Impact Mapping is in well progress but waiting for the latest output from other models

6th RTWG MEETING may wish to:

- Take Note the Progress of Modeling work to support council study
  - Provide advice, guidance as well as feedback on primary result of calibration
  - Provide other comments and guidance
Thank You so Much