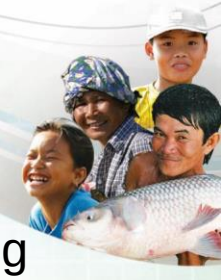
Cambodia • Lao PDR • Thailand • Viet Nam
For sustainable development

Council Study



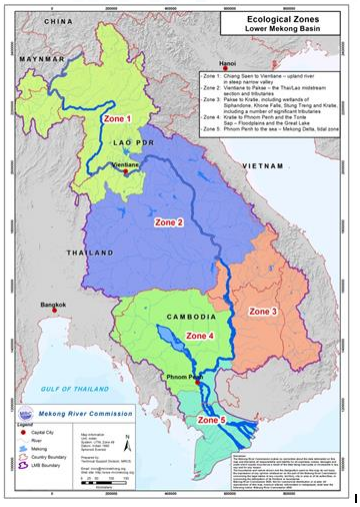
Model Set Up and Results of Hydrologic Assessment/Modeling Team

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

Modeling Approach

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)

Modeling Approach

Zone 5 - Viet Nam/Cambodian Delta

Hydrology and Hydraulics

IQQM → ISIS

Flooding and Salinity

ISIS

Sediment and Nutrient

ISIS + WUP-FIN

Agriculture and aquaculture impacts

WUP-FIN tools

WQ DATA AVAILABLE AND PREPARATION

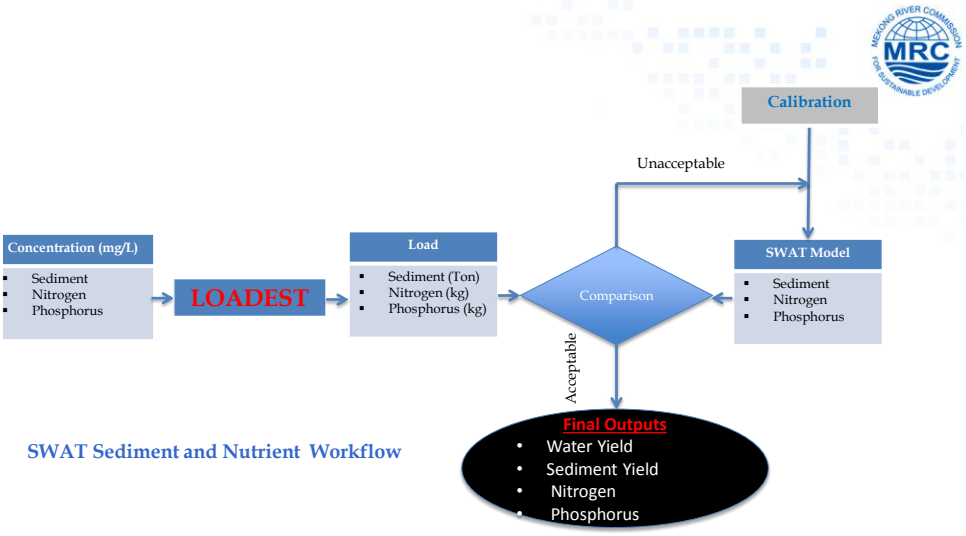
SEDIMENT :

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

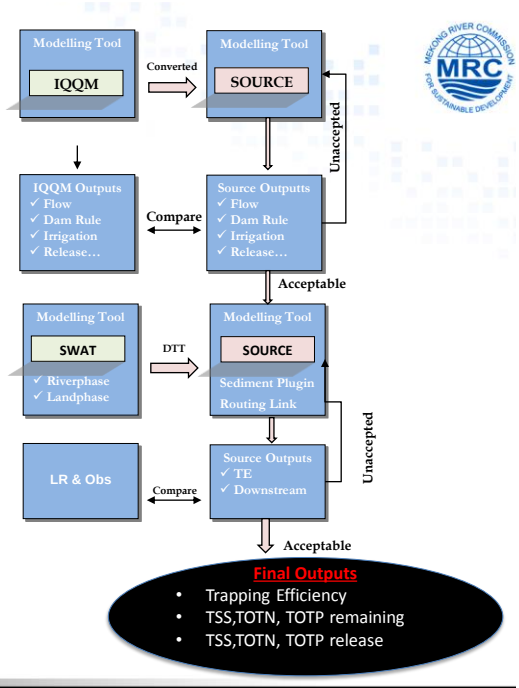
NUTRIENT :

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

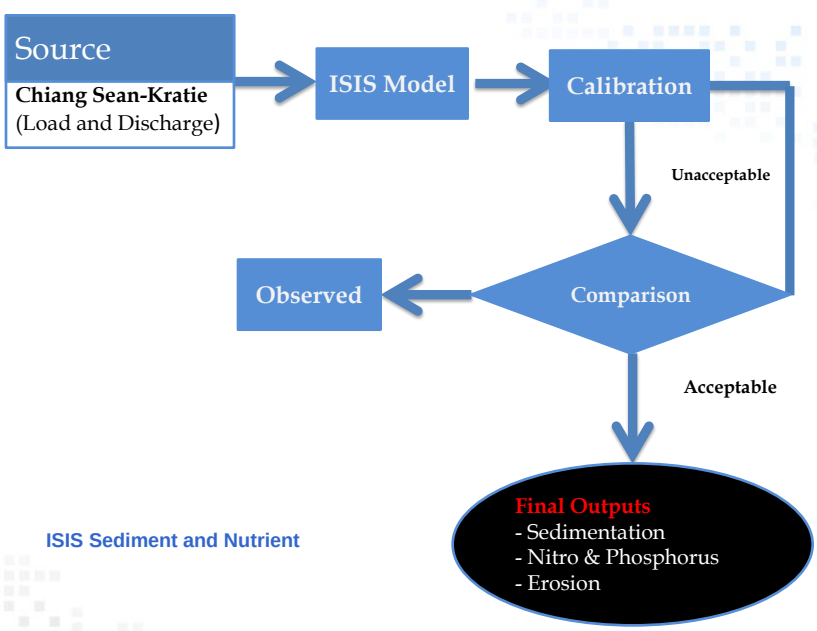
MODEL SET UP



SWAT Sediment and Nutrient Workflow



Source Sediment and Nutrient Workflow



ISIS Sediment and Nutrient

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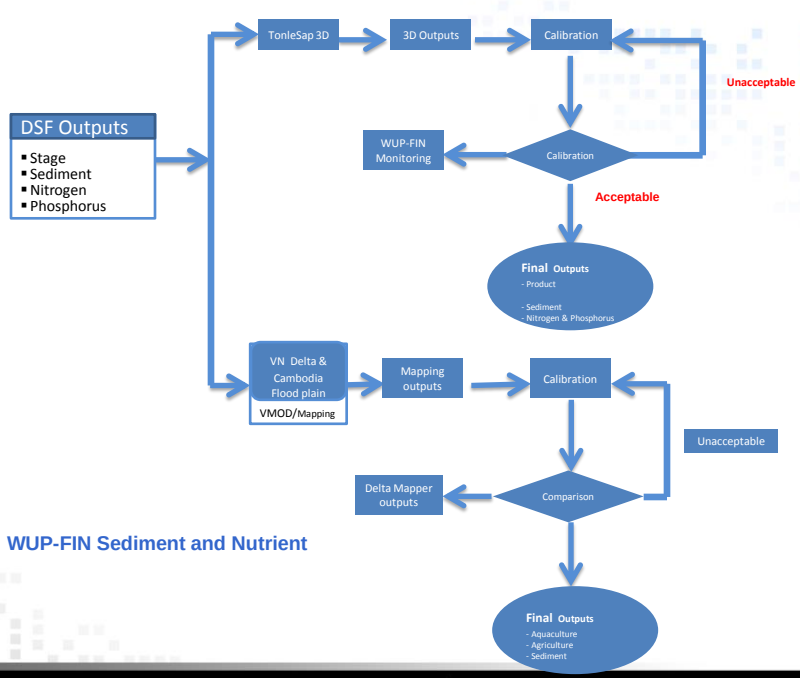

WUP-FIN Sediment and Nutrient

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UPSTREAM
SEDIMENT AND NUTRIENT (SWAT)

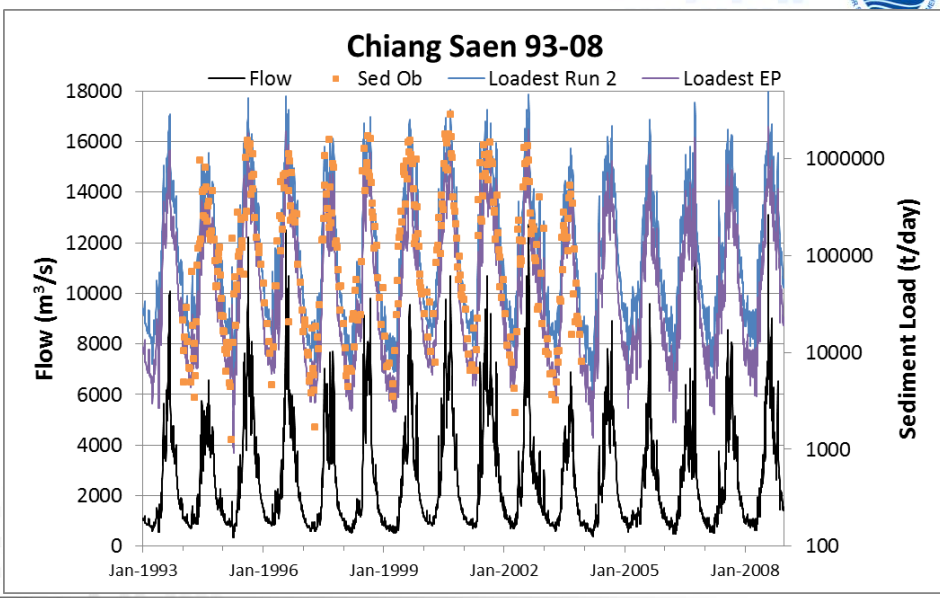
Calibration data

- 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

LOADEST in Chiang Saen



Tributary SWAT monthly loads compared with LOADEST

Area 2 : Chiang Saen to Luang Prabang

Sub	Gauge Name	Sediment Calibration			Nutrient (TOTN) Calibration			Nutrient (TOTP) Calibration		
		Period	COE	Vol	Period	COE	Vol	Period	COE	Vol
2021	Nam Ou at Muong Ngoy	1986-2008	0.52	102	No Nitrogen Data			No Phosphorus Data		
2036	Nam Mae Kok at Ban Tha Ton	1985-2005	0.60	91	No Nitrogen Data			No Phosphorus Data		
2044	Nam Mae Kok at Chiang Rai	1985-2005	0.32	87	1985-2005	0.65	92	1985-2005	0.39	66
2046	Nam Suong at Ban Sibounhom	No Sediment Data			No Nitrogen Data			No Phosphorus Data		
2051	Nam Mae Lao at Ban Tha Sai	1985-2003	0.72	84	No Nitrogen Data			No Phosphorus Data		
2058	Nam Khan at Ban Mout	No Sediment Data			No Nitrogen Data			No Phosphorus Data		
2060	Nam Mae Ing at Thoeng	1985-2008	0.73	88	No Nitrogen Data			No Phosphorus Data		
2069	Nam Mae Ing at Khao Ing Rod	No Sediment Data			No Nitrogen Data			No Phosphorus Data		

Area 3 : Luang Prabang to Vientiane

Sub	Gauge Name	Sediment Calibration			Nutrient (TOTN) Calibration			Nutrient (TOTP) Calibration		
		Period	COE	Vol	Period	COE	Vol	Period	COE	Vol
3029	Nam Heuang at Ban Pak Huai	No Sediment Data			No Nitrogen Data			No Phosphorus Data		
3038	Nam Loei at Ban Wang Saphung	1985-2007	0.58	115	No Nitrogen Data			No Phosphorus Data		

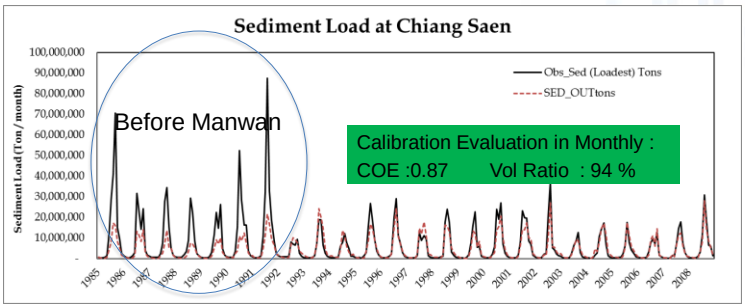
Area 4: Vientiane to Mukdahan

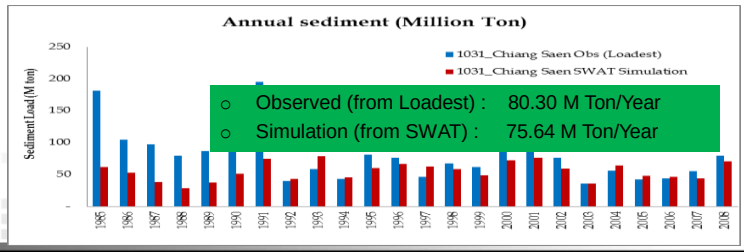
Sub	Gauge Name	Sediment Calibration			Nutrient (TOTN) Calibration			Nutrient (TOTP) Calibration		
		Period	COE	Vol	Period	COE	Vol	Period	COE	Vol
4028	Nam Leak at Ban Hin Heup	1985-2008	0.39	102	No Nitrogen Data			No Phosphorus Data		
4034	Nam Sane at Muong Borikhan	No Sediment Data			No Nitrogen Data			No Phosphorus Data		
4038	Nam Nhiep at Muong Mai	No Sediment Data			No Nitrogen Data			No Phosphorus Data		
4042	Nam Ngum at Ban Pak Khanoung	1997-2006	0.41	112	No Nitrogen Data			No Phosphorus Data		
4078	Nam Songkhram at Ban Tha kok Da	1990-2008	0.84	105	1990-2008	0.33	106	1990-2008	0.74	100
4080	Nam Theun at Ban Signo	1986-2005	0.41	114	No Nitrogen Data			No Phosphorus Data		
4083	Huai Mong at Ban Kruat	No Sediment Data			No Nitrogen Data			No Phosphorus Data		
4101	Se Bang Fai at Mahaxai	1990-2008	0.71	110	1985-2007	0.79	100	1985-2007	0.73	104
4103	Nam Don at Ban Phok Yai	No Sediment Data			No Nitrogen Data			No Phosphorus Data		
4115	Nam Kam at Na Kae	1985-1999	0.50	91	1985-1999	0.67	95	1985-1999	0.76	105

Mainstream SWAT monthly loads compared with LOADEST

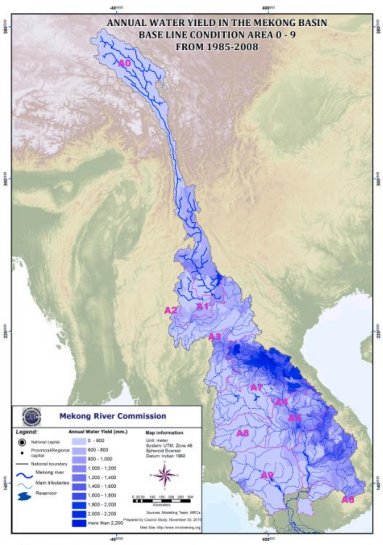
Sub	Gauge Name	Flow Calibration			Sediment Calibration*			Total Nitrogen Calibration			Total Phosphorus Calibration		
		Period	COE	Vol.	Period	COE	Vol (%)	Period	COE	Vol (%)	Period	COE	Vol (%
1031	Mekong at Chiang Saen	1985-2008	0.80	103	1993 - 2008	0.87	94	1985 - 2008	0.81	77	1985 - 2008	0.78	99
2049	Mekong at Luang Prabang	1985-2008	0.84	107	1993 - 2008	0.84	90	1985 - 2008	0.79	101	1985 - 2008	0.59	102
3026	Mekong at Chiang Khan	1985-2008	0.84	105	No Observed Data			No Observed Data			No Observed Data		
3024	Mekong at Vientiane	1985-2008	0.83	105	No Observed Data			No Observed Data			No Observed Data		
4075	Mekong at Nong Khai	1985-2008	0.83	102	1993 - 2008	0.87	100	1985 - 2008	0.71	116	1985 - 2008	0.70	89
4100	Mekong at Nakhon Phanom	1985-2008	0.88	102	1993 - 2008	0.89	95	1985 - 2007	0.71	117	1985 - 2008	0.80	97
4121	Mekong at Mukdahan	1985-2008	0.90	105	1993 - 2008	0.89	99	No Observed Data			No Observed Data		
5043	Mekong at Khong Chiam	1985-2007	0.86	116	1993 - 2007	0.83	101	1985 - 2007	0.87	106	1985 - 2007	0.71	119
5052	Mekong at Pakse	1985-2008	0.90	107	1993 - 2008	0.94	103	1985 - 2008	0.87	107	1985 - 2008	0.81	102
6087	Mekong at Stung Treng	1985-2008	0.90	105	1993 - 2008	0.86	96	1985 - 2008	0.86	114	No Observed Data		
6134	Mekong at Kratie	1985-2008	0.91	103	1993 - 2008	0.92	104	1985 - 2008	0.84	122	1985 - 2008	0.86	105

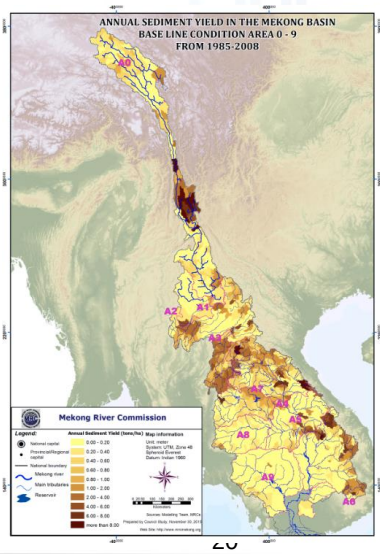
SWAT MONTHLY LOADS IN CHIANG SAEN COMPARED WITH LOADEST



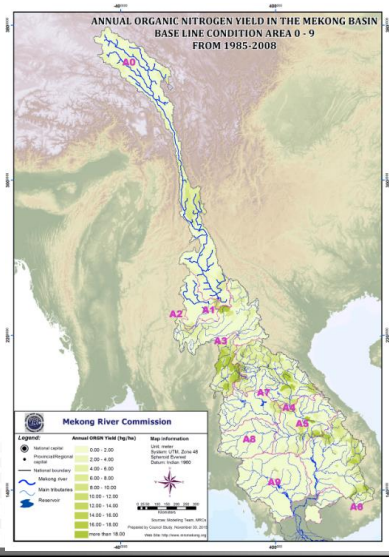


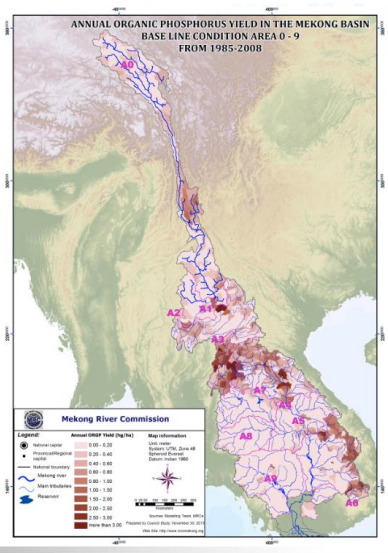
SWAT WATER AND SEDIMENT YIELDS



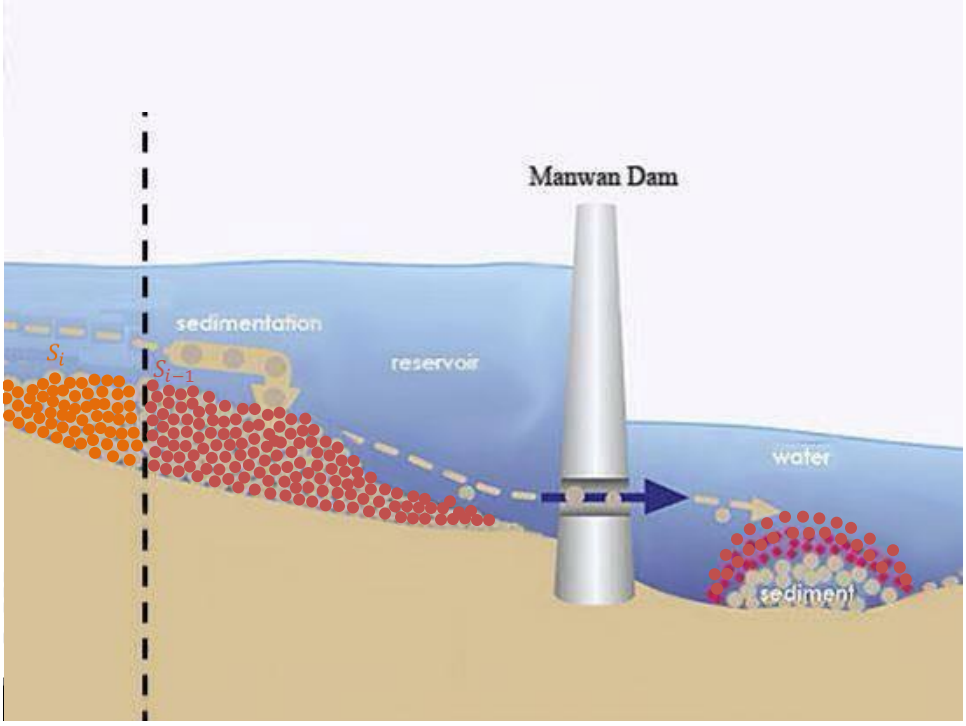


SWAT NITROGEN AND PHOSPHORUS YIELDS

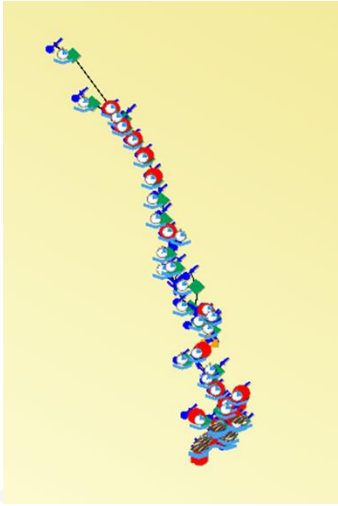




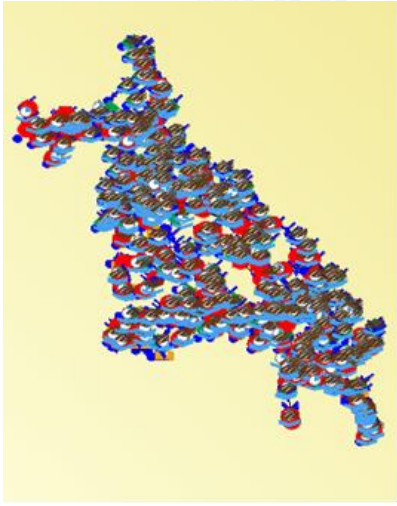
SEDIMENT AND NUTRIENT TRAPPING (SOURCE)



Source model for the upper Mekong



Source model for the LMB



Validation of Source sediment trapping

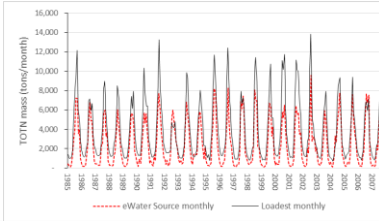
	Fu *et al.* (2008)		Kummu *et al.* (2010)	eWater Source
	Brune TE (%)	Siyam TE (%)	Brune TE (%)	Brune TE (%)
Manwan	60.03	60.03	47	67.2
Dachaoshan	63.97	66.05	50	63.5

TE = Trapping Effieciency

Source nutrient trapping

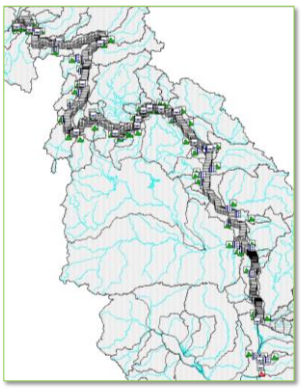
- in Source nutrients are trapped with sediments

Dam	Nutrient	Particulate %	Nutrient TE %
Manwan	TOTN	50	33.6
	TOTP	30	20.2
Dachaoshan	TOTN	50	31.7
	TOTP	30	19.0

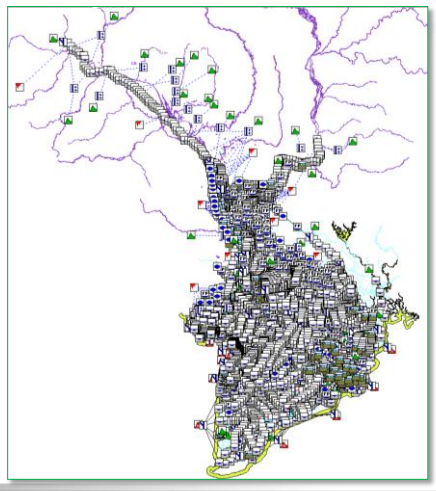


MAINSTREAM FLOW, SEDIMENT AND NUTRIENT (ISIS)

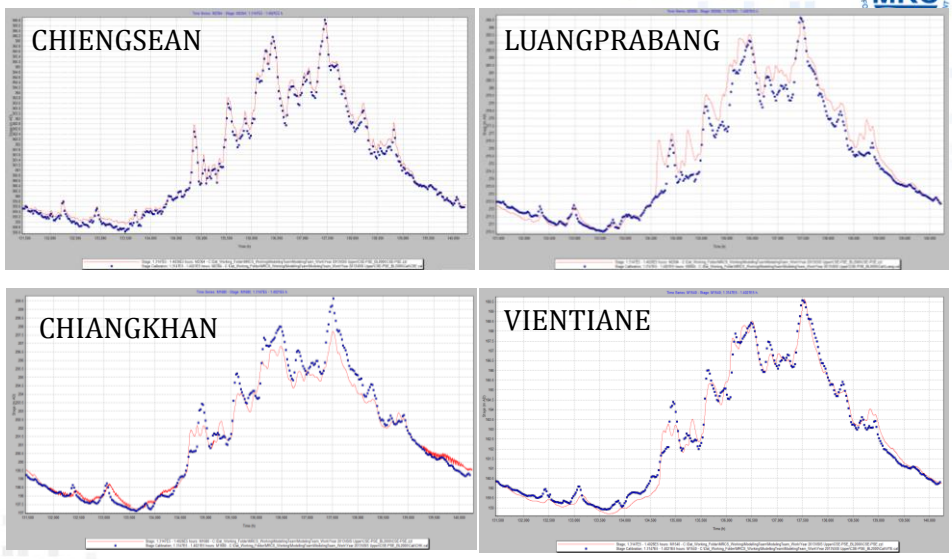
ISIS for the upstream part



ISIS for the Delta



The Calibrated results: Water level



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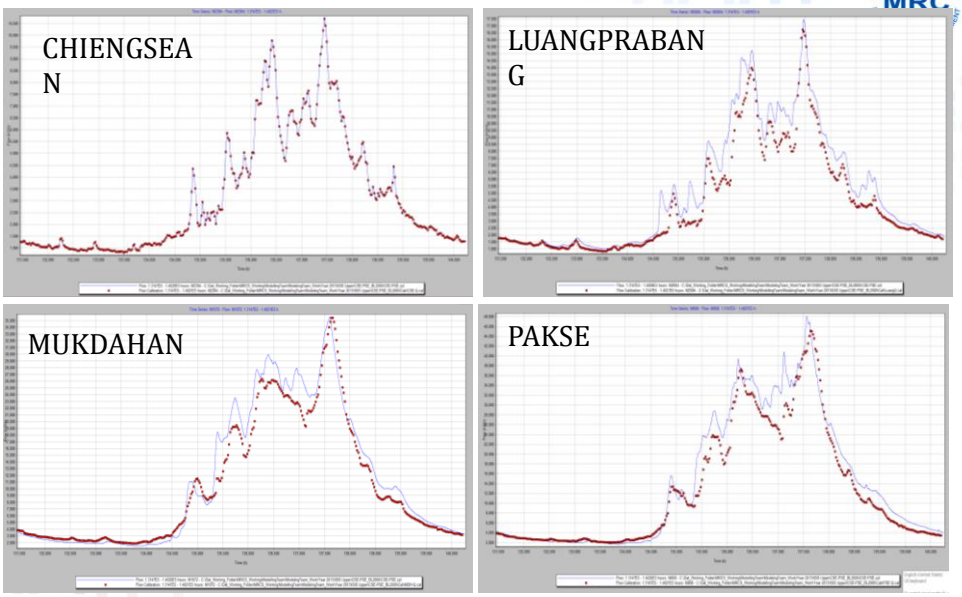
The Calibrated results: Water level



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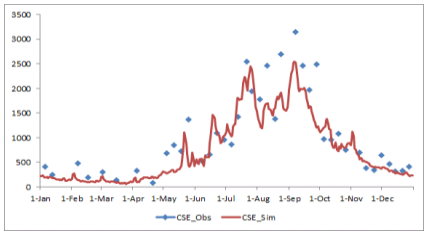
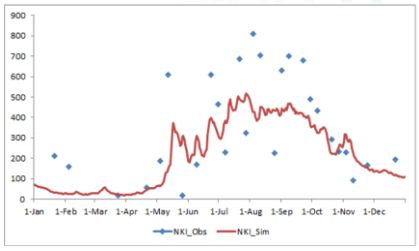
Preliminary Isis Results for Sediments

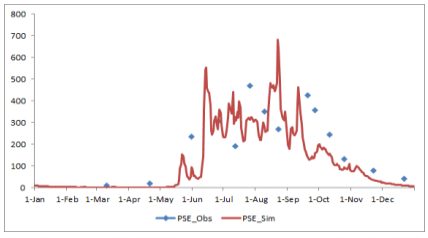
CHIANG SAEN



NONG KHAI



PAKSE

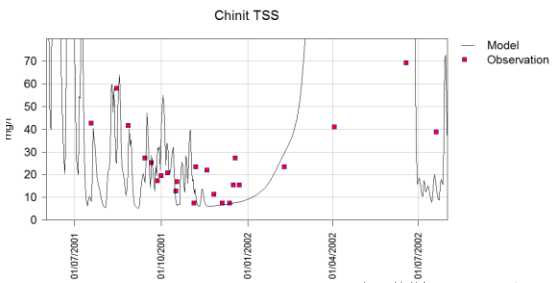


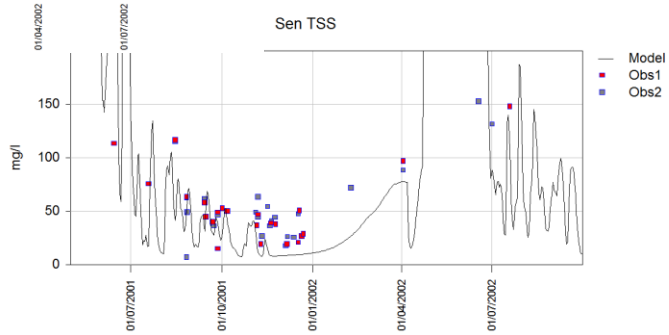
CAMBODIAN AND DELTA SEDIMENT AND NUTRIENT (WUP-FIN)

Model calibration

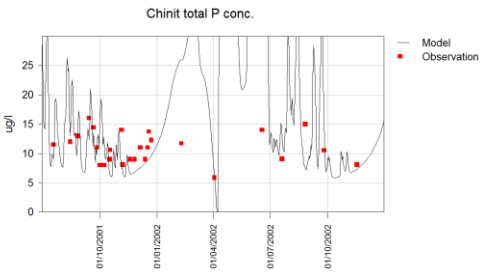
- The Tonle Sap models including SWAT and WUP-FIN have been calibrated against MRC datasets (EP, HM and WUP-FIN)
- Both LOADEST and primary data have been used
- Both monthly and daily calibration have been conducted
- Calibration has been conducted for flow, sediments and nutrients in the tributaries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

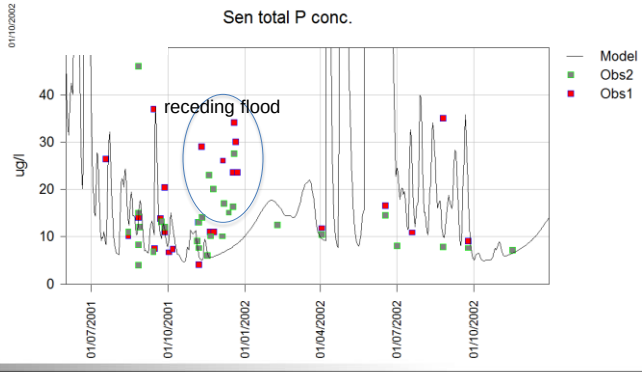
Sediment calibration



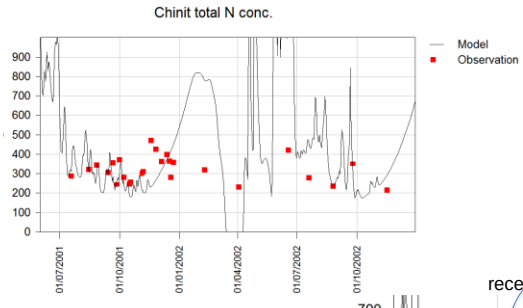


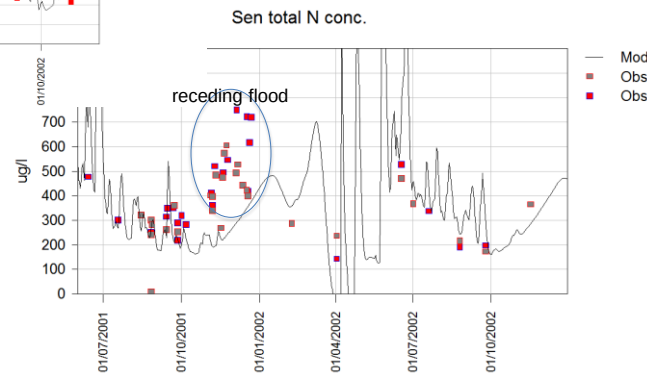
Phosphorus calibration



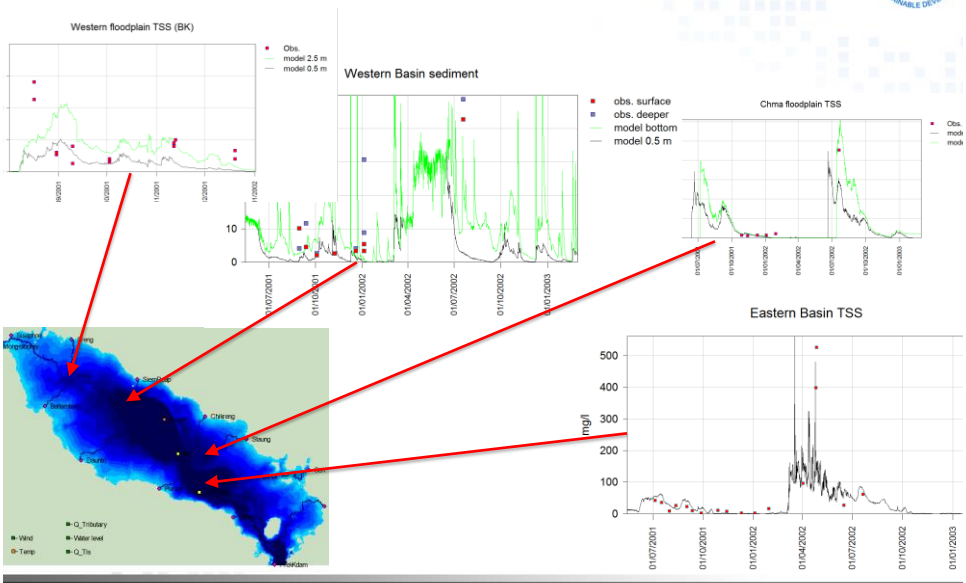


Nitrogen calibration



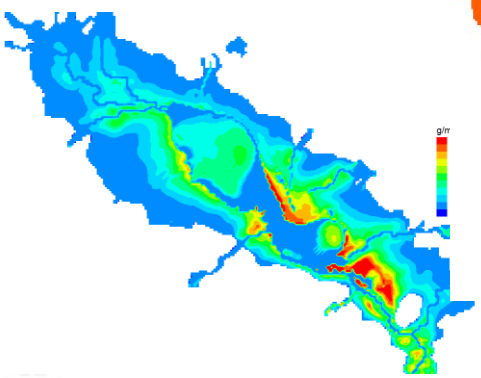


Lake sediment calibration

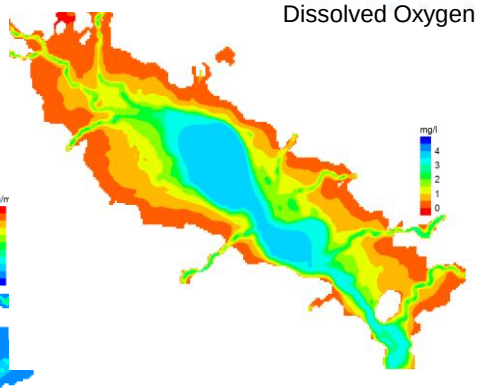


Lake Sedimentation and dissolved oxygen

Sedimentation

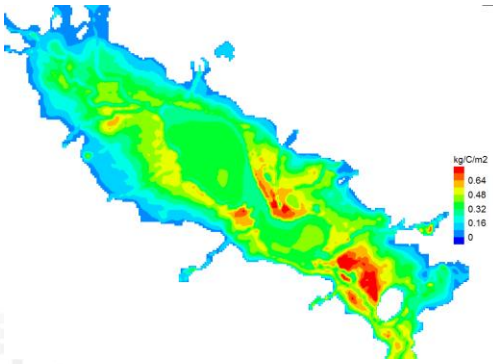


Dissolved Oxygen

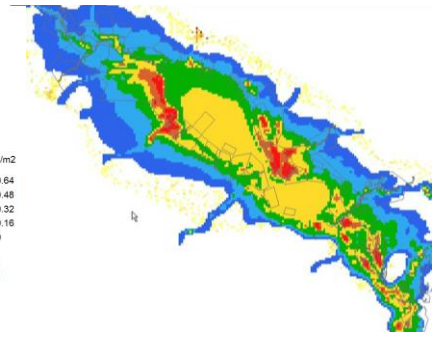


Primary and fisheries production

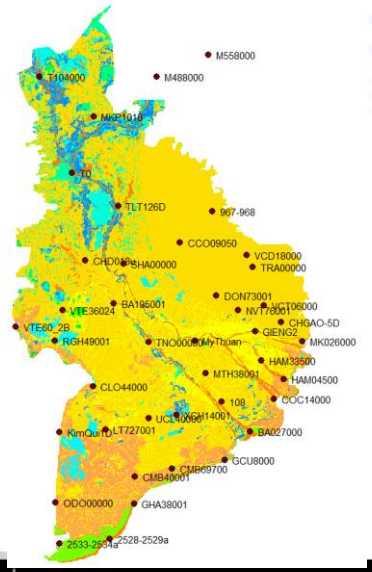
Primary Production



Fishery Productivity

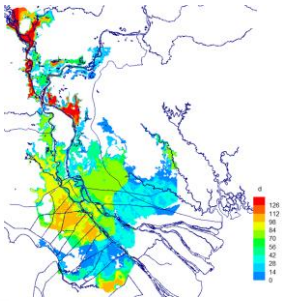


- Cambodian Floodplain and Delta Impact Model Results

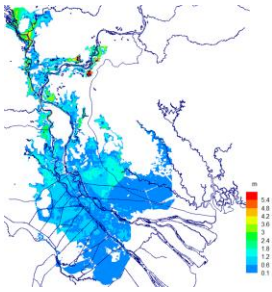


Results will be compared with the DeltaMapper

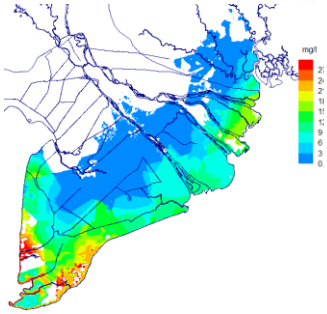
Flood duration



Flood depth

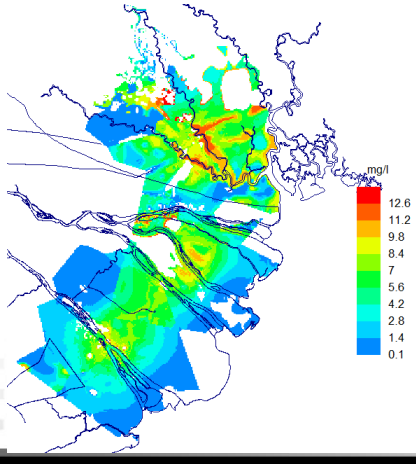


Salinity

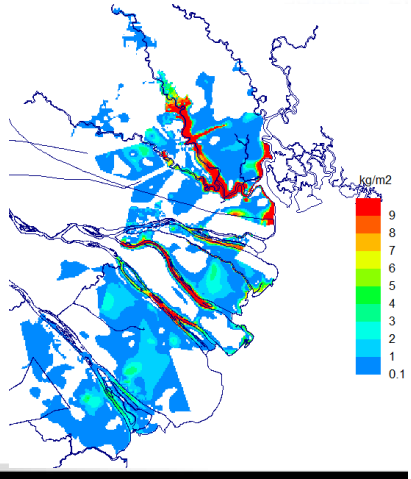


WUP-FIN Results for Sediment and Nutrient

Sediment concentration



Sedimentation



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

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Thank You so Much

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