Mekong River Commission

Technical Support Division
Information and Knowledge Management Program

Component 4: Modelling

Draft Working Paper:

The Sediment and Nutrient Data Available and Analysis for the DSF model Simulation in the Lower Mekong Basin

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CONTENTS AMENDMENT RECORD

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1. Introduction

This working paper have main proposed to record the process of checking available water quality data (Sediment and Nutrient) including list of station in the Lower Mekong Basin and process of data assurance and data control. The measurement data within MRC from 3 sources was check and convert to be Load using Sediment / nutrient rating curve that can use for model calibration and provide guidance for check sediment and nutrient budget that occurred within the Mekong River Basin

The QA/QC of Load data will be used for calibration process of the DSF model and IWRM model to support a number of MRCS studies including the Council Study, FMMP Climate sensitive flood management, CCAI/FMMP Basin wide Studies on Flood Management including the Cambodian Floodplain and Vietnam delta, future BDP work etc.

2. Water Quality data availability in the Mekong Lower Basin

Sediment data availability

Refer to DSMP project that summary on the sediment available data (as of 2013) come from three different programmes within MRCS.

1) **The mean suspended sediment concentration (SSC) from Hymos Database (IKMP-MRCS)**
   The first programme is started in 1960 within the framework of the Lower Mekong Project under the US Agency for International Development fund (ref). This measurement programme used 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. The availability of sediment data is on the middle and lower Mekong mainstream at Chiang Saen (Thailand), Luang Prabang (Lao PDR), Nong Kai (Thailand), Mukdahan (Thailand) and Pakse (Lao PDR). However, the recording data are discontinuous and limited numbers of samples (Walling DE. 2005). Nevertheless, these data could provide a useful baseline to compare with the present data. All the measurement data are stored in HYMOS database of the MRC

2) **The total suspended solids (TSS) from EP Database (EP-MRCS)**
   The second source of data is the Water Quality Monitoring Network Programme under the MRC which include 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. They are likely to underestimate the true mean suspended sediment concentration in the cross section due to suspended sediment concentration are known to increase with depth (Walling DE. 2008). Although SSC have been widely shown to be a more certain and accurate representation of suspended sediment loads in rivers carrying sands, the relationship between TSS and SSC is not as biased when silts and finer particles make the most of the suspended sediment load (Gray et al., 2000)

The data are recorded from 1985 to present or, in some cases were recorded from 2000 to present. 55 are designated 'primary stations' as they have basin wide, or transboundary, significance. 17 stations are located on the Mekong, 6 on the Bassac, 23 on tributaries, and 9 on the Delta (MRC 2008). There are six of the primary stations which recorded from end of 2004 are located in the 3S Basin including Siem Pang (Sekong), Angdoung Meas (Sesan), Phum Pi (Sesan), Pleicu (Sesan), Lamphat (Srepok), and Ban Don (Srepok).

3) **The mean suspended sediment concentration (SSC) under Discharge and Sediment Monitoring Project (DSMP from IKMP-MRCS)**

The recently third monitoring programme is in 2011 under the Discharge and Sediment Monitoring Project (DSMP) of the MRC. The programme 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. Three mainstream stations are located near the 3S outlet, including Pakse (upstream), Stung Treng and Kratie (downstream). The sediment rating curves were developed for 12 stations on the mainstream. The grain size analysis at six sites (Luang Prabang, Pakse, Kratie, Pre Kdam, Tan Chau and Chau Doc) were completed and provided an indication of the material moving through the basin. The bedload samples were collected at Chiang Sean, Nong Khai and Kratie (MRC 2012).

This assessment found that 90 % of the 116.2 million tons of annual suspended sediment load at Kratie are fine particles are fine silts (97.6 MT) and clays (7.5 MT) with particle sizes smaller than 0.063mm.

Nutrient data availability

The data are recorded from 1985 to present or, in some cases were recorded from 2000 to present. 55 are designated 'primary stations' as they have basin wide, or transboundary, significance. 17 stations are located on the Mekong, 6 on the Bassac, 23 on tributaries, and 9 on the Delta (MRC 2008). There are six of the primary stations which recorded from end of 2004 are located in the 3S Basin including Siem Pang (Sekong), Angdoung Meas (Sesan), Phum Pi (Sesan), Pleicu (Sesan), Lamphat (Srepok), and Ban Don (Srepok).

Parameter that was collected are Cond (mS/m), Ca (meq/L), K(meq/L), ALK(meq/L), NO2 (mg/L; in some station), NO3 (mg/L), NH4N (mg/L), TOTN(mg/L), TOTP (mg/L), DO (mg/L) and CODMN (mg/L)

Table 2-1: Available Sediment data from Hymos Database

Data Source Legend O Sediment
Frequency of Data 1 times / month

No.	Country	Station Name	Code	Coordinates		Year																																												
			MRCS	*Latitude*	*Longitude*	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
1	Laos	Luang Prabang	011201	19.89	102.14	o																							o	o	o	o	o	o	o	o					o	o	o	o	o	o						
2	Laos	Vientiane	011901	17.93	102.62	o						o																																								
3	Laos	Thakhek	013102	17.39	104.81	o	o	o	o	o	o	o	o	o	o																																					
4	Laos	Savannakhet	013401	16.56	104.75																																				o											
5	Laos	Pakse	013901	15.12	105.80	o																												o							o	o	o	o	o	o						
6	Laos	Ban Mouang	014101	14.94	105.91																													o																		
7	Laos	Muong Ngoy	100102	20.70	102.76																													o						o	o	o	o	o	o	o						
8	Laos	Ban Sibounhom	110101	19.97	102.27																														o																	
9	Laos	Ban Kok Van	110201	19.95	102.30																														o																	
10	Laos	Ban Mixay (Ban Mout)	120101	19.79	102.18	o																																														
11	Laos	Ban Pak Bak (downstream)	120102	19.74	102.28																													o						o	o	o	o	o	o	o						
12	Laos	Ban Pak Kanhoung	230101	18.42	102.55																																o				o	o	o	o	o	o			o			
13	Laos	Tha Ngon	230102	18.14	102.62					o	o																							o	o	o																
14	Laos	Ban Pak Ngum	230103	18.15	103.10																													o																		
15	Laos	Ban Na Luang	230110	18.91	102.78																													o	o					o	o	o	o	o	o	o			o			
16	Laos	Ban Hin Heup	230201	18.66	102.36						o																							o	o	o	o				o	o	o	o	o	o			o			
17	Laos	Muong Kasi	230205	19.23	102.26																														o																	
18	Laos	Ban Signo	270903	17.85	105.05																																			o	o	o	o	o	o	o			o			
19	Laos	Mahaxai	320107	17.41	105.20																													o	o	o				o		o	o	o	o	o			o			
20	Laos	Ban Keng Done	350101	16.19	105.32	o																													o	o					o	o	o	o								
21	Laos	Kengkok	350601	16.45	105.20																																				o	o	o	o								
22	Laos	Souvanna Khili	390104	15.40	105.83																																o			o	o	o	o	o	o	o			o			
23	Thailand	Chiang Saen	010501	20.27	100.08	o						o	o	o	o	o	o	o	o																			o	o	o	o	o	o	o	o	o	o					
24	Thailand	Sop Kok	010601	20.24	100.13											o	o	o	o																																	
25	Thailand	Chiang Khan	011903	17.90	101.67						o	o	o	o	o	o	o	o	o	o																																
26	Thailand	Pa Mong Dam Site	011904	17.99	102.43							o				o	o	o	o																																	
27	Thailand	Nong Khai	012001	17.88	102.72											o	o	o	o	o	o	o			o	o	o	o	o	o	o	o	o	o	o	o		o	o	o	o	o	o	o	o	o	o	o				
28	Thailand	Nakhon Phanom	013101	17.40	104.80											o	o	o	o																																	
29	Thailand	Mukdahan	013402	16.54	104.74	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o		o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o				
30	Thailand	Khong Chiam	013801	15.32	105.50					o	o	o	o			o	o	o	o	o	o	o	o	o		o	o	o	o	o																						
31	Thailand	Ban Pa Yang	040101	20.23	99.81																			o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o					
32	Thailand	Ban Huai Yano Mai	040201	20.11	99.79														o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o					
33	Thailand	Chiang Rai	050104	19.92	99.85																o	o	o	o	o				o	o	o	o	o	o	o	o	o	o														
34	Thailand	Ban Tha Ton	050105	20.06	99.36									o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o					
35	Thailand	Ban Tha Mai Liam	050201	20.02	99.36								o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o					
36	Thailand	Ban Tha Sai	050301	19.85	99.84											o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o					
37	Thailand	Nam Mae Suai Dam Site	051001	19.70	99.52														o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o								
38	Thailand	Nam Mae Pun Luang Dam Site	051101	19.43	99.46															o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o					
39	Thailand	Thoeng	070103	19.69	100.19								o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o					
40	Thailand	Ban Pak Huai	140101	17.70	101.42							o	o	o	o	o	o	o	o	o																																

Table 2-1: Available of Sediment data from Hymos Database (Cont'd)

		Data Source Legend	O	Sediment																																																
		Frequency of Data	1 times / month																																																	
No.	**Country**	**Station Name**	**Code**	**Coordinates**		**Year**																																														
			MRCS	*Latitude*	*Longitude*	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
41	Thailand	Dan Sai	140201	17.29	101.15							O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O		O		O	O	O	O	O	O	O	O	O	O	O	O					
42	Thailand	Wang Saphung	150101	17.30	101.78							O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O		O	O	O	O	O	O	O	O	O	O	O	O	O	O	O					
43	Thailand	Ban Wang Sai	150102	17.05	101.52															O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O					
44	Thailand	Ban Tha Kok Daeng	290102	17.86	103.78					O	O	O	O	O	O	O	O	O	O																																	
45	Thailand	Nam Kae	310102	16.96	104.51														O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O								
46	Thailand	Ban Tham Hai Bridge	310201	17.08	104.26			O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O					
47	Thailand	Ban Na Kham Noi	330103	16.72	104.63																								O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O					
48	Thailand	Yasothon	370104	15.78	104.14	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O					
49	Thailand	Ban Chot	370122	16.10	102.58														O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O					
50	Thailand	Ban Kae (Si Chomphu)	370210	16.87	102.19																		O	O		O	O	O	O	O	O	O																				
51	Thailand	Ban Tha Dua	370805	16.49	102.13																		O	O	O	O	O	O	O	O	O	O	O	O	O	O		O	O	O	O	O	O	O	O	O	O					
52	Thailand	Ban Nong Kiang	371101	16.13	101.67														O	O	O	O			O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O					
53	Thailand	Ban Tad Ton	371203	15.94	102.03																O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O					
54	Thailand	Ban Na Thom	371509	16.06	104.04																		O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O					
55	Thailand	Ubon	380103	15.22	104.86	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O					
56	Thailand	Pak Mun	380111	15.31	105.50											O	O	O	O	O	O	O	O	O	O																											
57	Thailand	Kaeng Saphu Tai	380127	15.24	105.25																		O	O	O	O	O	O	O	O	O	O																				
58	Thailand	Rasi Salai	380134	15.34	104.16																		O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O					
59	Thailand	Ban Huai Khayuong	381206	15.01	104.64																		O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O					
60	Thailand	Ban Fang Phe	381503	14.69	105.16								O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O								

Table 2-2: Available Water Quality data from EP Database

		Data Source Legand		o	WQ																																				
		Frequency of Data		1 times / month																																							
No	Country	Station_Name	StatID	Coordinate		Year																																				
				Latitude	Longitude	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
1	Lao PDR	Houa Khong	H010500	21.55	101.16																				o	o	o	o	o	o	o	o			
2	Thailand	Chiang Sean	H010501	20.28	100.09	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o			
3	Thailand	Chiang Rai	H050104	19.92	99.85	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o			
4	Lao PDR	Luang Prabang	H011200	19.94	101.30	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o			
5	Lao PDR	Luang Prabang	H011201	19.89	102.14																															
6	Lao PDR	Ban Hat Kham	H100101	20.09	102.26	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o			
7	Lao PDR	Nong Nieng	H910104	18.00	102.62																															
8	Lao PDR	Vientiane	H011901	17.93	102.62	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o			
9	Lao PDR	Donedang	H910107	18.00	102.61																	o	o	o	o	o	o	o	o							
10	Lao PDR	Hoa Khoa	H910103	17.96	102.62		o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o						
11	Lao PDR	Hong Ke	H910101	17.95	102.60																															
12	Lao PDR	Hong Xeng	H910102	17.99	102.64																															
13	Lao PDR	Thaleth (Keokou)	H230206	18.54	102.51				o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o						
14	Lao PDR	Nam Ngum at Damsite	H230199	18.53	102.55	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o						
15	Lao PDR	Nam Houm	H231090	18.25	102.47											o	o	o	o	o	o	o	o	o	o	o	o	o	o						
16	Lao PDR	Nam Houm Dam	H231901	18.18	102.47																															
17	Lao PDR	Nam Souang	H231801	18.25	102.47																	o	o	o	o	o	o	o	o							
18	Lao PDR	Ban Hai	H230103	18.18	103.06																				o	o	o	o	o	o	o	o			
19	Lao PDR	Tha Ngon	H230102	18.14	102.62	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o										
20	Lao PDR	Houay Mak Hiao	H910108	18.00	102.91																				o	o	o	o	o	o	o	o			
21	Lao PDR	Ban Sok	H910106	18.01	102.68											o	o	o	o	o	o	o	o	o	o	o	o	o	o						
22	Lao PDR	Salakham	H910105	17.88	102.95																															
23	Thailand	Ban Tha Kok Daenh	H290102	17.87	103.78	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o										
24	Thailand	Ban Chai Buri	H290103	17.64	104.46																				o	o	o	o	o	o	o	o			
25	Thailand	Nakhon Phanom	H013101	17.40	104.80	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o			
26	Lao PDR	Se Bang Fai	H320101	17.07	104.99	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o			
27	Thailand	Nam Kae	H310102	16.96	104.51	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o			
28	Lao PDR	Savannakhet	H013401	16.56	104.75																	o	o	o	o	o	o	o	o	o	o	o			
29	Lao PDR	Ban Keng Done	H350101	16.19	105.32	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o			
30	Thailand	Khong Chiam	H013801	15.32	105.50	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o			
31	Thailand	Mun (Kong Chiam)	H380128	15.32	105.51																				o	o	o	o	o	o	o	o			
32	Thailand	Ubon	H380103	15.22	104.86																															
33	Thailand	Ubon	H380104	15.25	104.96	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o			
34	Thailand	Kaeng Saphu	H380127	15.24	105.25	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o									
35	Lao PDR	Souvanna Khili	H390104	15.39	105.82					o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o							

Table 2-2: Available of Water Quality data from EP Database (Cont'd)

Data Source Legand O WQ
Frequency of Data 1 times / month

No	Country	Station_Name	StatID	Coordinate		Year																													
				Latitude	Longitude	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
36	Lao PDR	Se Done Dam	H390199	15.36	105.84	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o										
37	Lao PDR	Sedone Bridge	H390105	15.13	105.81																				o	o	o	o	o	o	o	o			
38	Lao PDR	Pakse	H013900	15.12	105.78	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o			
39	Lao PDR	Pakse	H013901	15.12	105.80																														
40	Thailand	Lam Dom Noi	H381699	15.21	105.43	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o									
41	Vietnam	Trung Nghia	H440601	14.37	107.87								o	o	o	o																			
42	Vietnam	Kon Tum	H440201	14.35	108.01								o	o	o	o																			
43	Cambodia	Siempang	H430102	14.12	106.39																				o	o	o	o	o	o	o	o			
44	Cambodia	Andaung Meas	H440103	14.05	107.11																				o	o	o	o	o	o	o	o			
45	Vietnam	Pleicu	H440402	13.94	107.47																				o	o	o	o	o	o	o	o			
46	Cambodia	Phum Pi	H440102	13.79	107.45																				o	o	o	o	o	o	o	o			
47	Cambodia	Stung Treng	H014501	13.55	106.02																				o	o	o	o	o	o	o	o			
48	Cambodia	Lumphat	H450101	13.55	106.53																				o	o	o	o	o	o	o	o			
49	Vietnam	la Hleo	H450501	13.07	108.08																														
50	Vietnam	Ban Don	H451303	12.91	107.74																				o	o	o	o	o	o	o	o			
51	Vietnam	Cau 14	H450302	12.61	107.93																														
52	Vietnam	Giang Son	H450502	12.50	108.20									o	o	o																			
53	Cambodia	Kratie	H014901	12.48	106.02											o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o			
54	Vietnam	Duc Xuyen	H450701	12.36	107.83								o	o	o	o																			
55	Thailand	Nam Pong Dam	H370299	16.77	102.62	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o										
56	Thailand	Lam Pao Dam Site	H371499	16.58	103.44	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o										
57	Thailand	Ban Kok	H370115	16.35	102.96	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o										
58	Thailand	Ban Chot	H370122	16.10	102.58	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o										
59	Thailand	Ban Tad Ton	H371203	15.96	102.03						o	o	o	o	o	o	o	o	o	o	o	o	o	o	o										
60	Thailand	Yasothon	H370104	15.78	104.14	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o									
61	Thailand	Ban Ku Phra Kona	H380903	15.57	103.82	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o										
62	Thailand	Ban Som	H380133	15.02	102.29						o	o	o	o	o	o	o	o	o	o	o	o	o	o	o										
63	Thailand	Rasi Salai	H380134	15.34	104.16	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o									
64	Cambodia	Phnom Krom	H020108	13.30	103.82																				o	o	o	o	o	o	o	o			
65	Cambodia	Kampong Chnang	H020103	12.25	104.67											o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o			
66	Cambodia	Kampong Thom	H610101	12.69	104.90																				o	o	o	o	o						
67	Cambodia	Kompong Thmar	H620101	12.50	105.13																				o	o	o	o	o						
68	Cambodia	Kampong Luong	H020106	12.58	104.21											o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o			
69	Cambodia	Kampon Toul	H640110	11.43	104.81											o	o	o	o	o	o	o	o	o											
70	Cambodia	Backprea	H020107	13.31	103.40																				o	o	o	o	o	o	o	o			

Table 2-2: Available of Water Quality data from EP Database (Cont'd)

		Data Source Legand		o WQ																																		
		Frequency of Data		1 times / month																																			
No	Country	Station_Name	StatID	Coordinate		Year																																	
				Latitude	Longitude	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
71	Vietnam	Hung Thanh	H988106	10.66	105.76		o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o							
72	Cambodia	Kampong Cham	H019802	12.00	105.47									o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o					
73	Cambodia	Khos Thom	H033403	11.11	105.07																				o	o	o	o	o	o	o	o					
74	Vietnam	Kien Binh	H988107	10.61	106.04		o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o							
75	Cambodia	Koh Khel	H033402	11.45	105.03									o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o					
76	Cambodia	Krom Samnor	H019807	11.07	105.21																				o	o	o	o	o	o	o	o					
77	Vietnam	Lo Gach	H988310	10.42	104.91							o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o							
78	Vietnam	Long Dinh	H988113	10.40	106.26		o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o							
79	Vietnam	My An	H988110	10.52	105.84		o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o							
80	Vietnam	My Lam	H988315	10.05	105.09							o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o							
81	Vietnam	My Phuoc Tay	H988111	10.50	106.09		o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o							
82	Vietnam	My Thanh	H988202	9.43	106.00				o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o												
83	Vietnam	My Tho	H019805	10.34	106.35	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o			
84	Vietnam	My Thuan	H019804	10.28	105.91	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o			
85	Vietnam	My Xuyen	H988201	9.56	106.00				o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o												
86	Vietnam	Mytho	H039805	10.36	106.37																																	
87	Cambodia	Neak Luong	H019806	11.60	105.29									o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o					
88	Vietnam	Nga Nam	H988212	9.56	105.61				o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o												
89	Vietnam	Ngan Dua	H988210	9.58	105.43				o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o							
90	Vietnam	Nha Bang	H988304	10.65	105.00							o	o	o	o	o	o	o	o	o	o	o	o	o												
91	Vietnam	Nhu Gia	H988203	9.52	105.84				o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o										
92	Vietnam	Ninh Quoi	H988211	9.47	105.52				o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o							
93	Vietnam	Nui Sap	H988301	10.26	105.26							o	o	o	o	o	o	o	o	o	o	o	o	o												
94	Cambodia	Phnom Penh Port	H020101	11.57	104.93											o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o					
95	Vietnam	Phong My	H988109	10.52	105.56		o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o												
96	Vietnam	Phung Hiep	H988213	9.79	105.82				o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o												
97	Vietnam	Phuoc Sinh	H988214	9.38	105.38						o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o							
98	Cambodia	Prek Kdam	H020102	11.81	104.80									o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o					
99	Vietnam	Rach Chanh	H988112	10.55	106.36		o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o							
100	Vietnam	Soc Xoai	H988314	10.13	105.03							o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o							
101	Cambodia	Takhmao	H033401	11.56	104.93											o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o					
102	Vietnam	Tam Ngan	H988312	10.28	104.82							o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o							
103	Vietnam	Tan Chau	H019803	10.79	105.23	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o			
104	Vietnam	Tan Thanh	H988102	10.82	105.59		o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o							

Table 2-2: Available of Water Quality data from EP Database (Cont'd)

		Data Source Legand		o WQ																																					
		Frequency of Data		1 times / month																																						
No	Country	Station_Name	StatID	Coordinate		Year																																				
				Latitude	Longitude	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
105	Vietnam	Thoi Binh	H988208	9.40	105.16				o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o										
106	Vietnam	Thong Binh	H988115	10.91	105.52																				o	o	o	o	o	o	o	o									
107	Vietnam	Tinh Bien	H988316	10.61	104.94																				o	o	o	o	o	o	o	o									
108	Vietnam	Tram Chim	H988105	10.67	105.55		o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o										
109	Vietnam	Tri Dien	H988313	10.20	104.93							o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o										
110	Vietnam	Tri Ton	H988303	10.60	105.20							o	o	o	o	o	o	o	o	o	o	o	o	o	o																
111	Vietnam	Tu Thuong	H988114	10.83	105.34																				o	o	o	o	o	o	o	o									
112	Vietnam	Tuyen Nhon	H988108	10.65	106.18		o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o																	
113	Vietnam	Vinh Dieu	H988311	10.44	104.73							o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o										
114	Vietnam	Vinh Thuan	H988209	9.50	105.27				o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o										
115	Vietnam	Vong Dong	H988307	10.26	105.20							o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o										
116	Vietnam	Vong The	H988308	10.26	105.13							o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o										
117	Vietnam	An Long	H988104	10.69	105.39		o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o																	
118	Vietnam	Bathe	H988302	10.54	105.26							o	o	o	o	o	o	o	o	o	o	o	o	o																	
119	Vietnam	Ca Mau	H988206	9.19	105.16				o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o										
120	Vietnam	Cai Mon	H988103	10.82	105.75		o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o																	
121	Vietnam	Can Tho	H039803	10.06	105.81	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o								
122	Vietnam	Cau Sap	H988204	9.31	105.68				o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o										
123	Vietnam	Cau So 13	H988305	10.42	105.05							o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o										
124	Vietnam	Cau So 5	H988306	10.44	105.17																o	o	o	o	o	o	o	o	o	o										
125	Vietnam	Cau Tri Ton	H988309	10.33	105.03							o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o										
126	Vietnam	Chau Doc	H039801	10.70	105.11	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o								
127	Cambodia	Chroy Chang Var	H019801	11.59	104.94									o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o							
128	Vietnam	Chu Chi	H988207	9.31	105.31				o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o										
129	Vietnam	Dai Ngai	H029812	9.73	106.08																				o	o	o	o	o	o										
130	Vietnam	Ho Phong	H988205	9.24	105.41				o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o										
131	Vietnam	Hong Ngu	H988101	10.81	105.36		o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o																	

Table 2-3: Available of Water Quality parameter from EP Database

No	StatID	Station_Name	SWAT Model		Parameter																																										
			SWAT SubArea	SWAT subbasin	TEMP_°C	pH	TSS_mg/L	COND_mS/m	Ca_meq/L	Mg_meq/L	Na_meq/L	K_meq/L	ALK_meq/L	Cl_meq/L	SO4_meq/L	NO2_mg/L	NO32_mg/L	NH4N_mg/L	TOTN_mg/L	PO4P_mg/L	TOTP_mg/L	DO_mg/L	CODMN_mg/L	FC_MPN/100m	Al_mg/L	ACID_meq/L	SUM_CAT	SUM_ANI	%IONB	EC_CAT	EC_CAT/EC	EC_AN	EC_AN/EC	Ca_EC	Mg_EC	Na_EC	K_EC	ALK_EC	Cl_EC	SO4_EC	NO32_EC	EC_EST	EC_DIFF	Ca/Mg	Na/Cl	Na/K	Ca/SO4
1	H010500	Houa Khong	SA1	15			Y	Y	Y			Y	Y			N	Y	Y	Y		Y	Y	Y																								
2	H010501	Chiang Sean	SA1	31			Y	Y	Y			Y	Y			N	Y	Y	Y		Y	Y	Y																								
3	H050104	Chiang Rai	SA2	44			Y	Y	Y			Y	Y			N	Y	Y	Y		Y	Y	Y																								
4	H011200	Luang Prabang	SA2	45			Y	Y	Y			Y	Y			N	Y	Y	Y		Y	Y	Y																								
5	H011201	Luang Prabang	SA2	49																																											
6	H100101	Ban Hat Kham	SA2	49			Y	Y	Y			Y	Y			N	Y	Y	Y		Y	Y	Y																								
7	H910104	Nong Nieng	SA3	24																																											
8	H011901	Vientiane	SA3	24			Y	Y	Y			Y	Y			N	Y	Y	Y		Y	Y	Y																								
9	H910107	Donedang	SA3	24			Y	Y	Y			Y	Y			N	Y	Y	Y		Y	Y	Y																								
10	H910103	Hoa Khoa	SA3	24			Y	Y	Y			Y	Y			N	Y	Y	Y		Y	Y	Y																								
11	H910101	Hong Ke	SA3	24																																											
12	H910102	Hong Xeng	SA3	24																																											
13	H230206	Thaleth (Keokou)	SA4	35			Y	Y	Y			Y	Y			N	Y	Y	Y		Y	Y	Y																								
14	H230199	Nam Ngum at Damsite	SA4	36			Y	Y	Y			Y	Y			N	Y	Y	Y		Y	Y	Y																								
15	H231090	Nam Houm	SA4	61			Y	Y	Y			Y	Y			N	Y	Y	Y		Y	Y	Y																								
16	H231901	Nam Houm Dam	SA4	61																																											
17	H231801	Nam Souang	SA4	61			Y	Y	Y			Y	Y			N	Y	Y	Y		Y	Y	Y																								
18	H230103	Ban Hai	SA4	62			Y	Y	Y			Y	Y			N	Y	Y	Y		Y	Y	Y																								
19	H230102	Tha Ngon	SA4	64			Y	Y	Y			Y	Y			N	Y	Y	N		Y	Y	Y																								
20	H910108	Houay Mak Hiao	SA4	72			Y	Y	Y			Y	Y			N	Y	Y	Y		Y	Y	Y																								
21	H910106	Ban Sok	SA4	72			Y	Y	Y			Y	Y			N	Y	Y	Y		Y	Y	Y																								
22	H910105	Salakham	SA4	72																																											
23	H290102	Ban Tha Kok Daenh	SA4	88			Y	Y	Y			Y	Y			N	Y	Y	Y		Y	Y	Y																								
24	H290103	Ban Chai Buri	SA4	91			Y	Y	Y			Y	Y			N	Y	Y	Y		Y	Y	Y																								
25	H013101	Nakhon Phanom	SA4	107			Y	Y	Y			Y	Y			N	Y	Y	Y		Y	Y	Y																								
26	H320101	Se Bang Fai	SA4	112			Y	Y	Y			Y	Y			N	Y	Y	Y		Y	Y	Y																								
27	H310102	Nam Kae	SA4	115			Y	Y	Y			Y	Y			N	Y	Y	Y		Y	Y	Y																								
28	H013401	Savannakhet	SA5	8			Y	Y	Y			Y	Y			N	Y	Y	Y		Y	Y	Y																								
29	H350101	Ban Keng Done	SA5	25			Y	Y	Y			Y	Y			N	Y	Y	Y		Y	Y	Y																								
30	H013801	Khong Chiam	SA5	43			Y	Y	Y			Y	Y			N	Y	Y	Y		Y	Y	Y																								
31	H380128	Mun (Kong Chiam)	SA5	43			Y	Y	Y			Y	Y			N	Y	Y	Y		Y	Y	Y																								
32	H380103	Ubon	SA5	44																																											
33	H380104	Ubon	SA5	44			Y	Y	Y			Y	Y			N	Y	Y	Y		Y	Y	Y																								
34	H380127	Kaeng Saphu	SA5	45			Y	Y	Y			Y	Y			N	Y	Y	Y		Y	Y	Y																								
35	H390104	Souvanna Khili	SA5	51			Y	Y	Y			Y	Y			N	Y	Y	Y		Y	Y	Y																								

Table 2-3: Available of Water Quality parameter from EP Database (Cont'd)

No	StatID	Station_Name	SWAT Model		Parameter																																										
			SWAT SubArea	SWAT subbasin	TEMP_°C	pH	TSS_mg/L	COND_mS/m	Ca_meq/L	Mg_meq/L	Na_meq/L	K_meq/L	ALK_meq/L	Cl_meq/L	SO4_meq/L	NO2_mg/L	NO32_mg/L	NH4N_mg/L	TOTN_mg/L	PO4P_mg/L	TOTP_mg/L	DO_mg/L	CODMN_mg/L	FC_MPN/100ml	Al_mg/L	ACID_meq/L	SUM_CAT	SUM_ANI	%IONB	EC_CAT	EC_CAT/EC	EC_AN	EC_AN/EC	Ca_EC	Mg_EC	Na_EC	K_EC	ALK_EC	Cl_EC	SO4_EC	NO32_EC	EC_EST	EC_DIFF	Ca/Mg	Na/Cl	Na/K	Ca/SO4
36	H390199	Se Done Dam	SA5	51			Y	Y	Y			Y	Y			N	Y	Y	N		Y	Y	Y																								
37	H390105	Sedone Bridge	SA5	51			Y	Y	Y			Y	Y			N	Y	Y	Y		Y	Y	Y																								
38	H013900	Pakse	SA5	52			Y	Y	Y			Y	Y			N	Y	Y	Y		Y	Y	Y																								
39	H013901	Pakse	SA5	52																																											
40	H381699	Lam Dom Noi	SA5	57			Y	Y	Y			Y	Y			N	Y	Y	Y		Y	Y	Y																								
41	H440601	Trung Nghia	SA6	49			Y	Y	Y			Y	Y			N	Y	Y	Y		Y	N	Y																								
42	H440201	Kon Tum	SA6	51			Y	Y	Y			Y	Y			N	Y	Y	Y		Y	N	Y																								
43	H430102	Siempang	SA6	62			Y	Y	Y			Y	Y			Y	Y	Y	Y		Y	Y	Y																								
44	H440103	Andaung Meas	SA6	65			Y	Y	Y			Y	Y			Y	Y	Y	Y		Y	Y	Y																								
45	H440402	Pleicu	SA6	74			Y	Y	Y			Y	Y			N	Y	Y	Y		Y	Y	Y																								
46	H440102	Phum Pi	SA6	81			Y	Y	Y			Y	Y			Y	Y	Y	Y		Y	Y	Y																								
47	H014501	Stung Treng	SA6	86			Y	Y	Y			Y	Y			Y	Y	Y	Y		Y	Y	Y																								
48	H450101	Lumphat	SA6	88			Y	Y	Y			Y	Y			Y	Y	Y	Y		Y	Y	Y																								
49	H450501	Ia Hleo	SA6	99																																											
50	H451303	Ban Don	SA6	116			Y	Y	Y			Y	Y			N	Y	Y	Y		Y	Y	Y																								
51	H450302	Cau 14	SA6	127																																											
52	H450502	Giang Son	SA6	133			Y	Y	Y			Y	Y			N	Y	Y	Y		Y	N	Y																								
53	H014901	Kratie	SA6	134			Y	Y	Y			Y	Y			Y	Y	Y	Y		Y	Y	Y																								
54	H450701	Duc Xuyen	SA6	135			Y	Y	Y			Y	Y			N	Y	Y	Y		Y	N	Y																								
55	H370299	Nam Pong Dam	SA7	21			Y	Y	Y			Y	Y			N	Y	Y	Y		Y	Y	Y																								
56	H371499	Lam Pao Dam Site	SA7	30			Y	Y	Y			Y	Y			N	Y	Y	Y		Y	Y	Y																								
57	H370115	Ban Kok	SA7	34			Y	Y	Y			Y	Y			N	Y	Y	Y		Y	Y	Y																								
58	H370122	Ban Chot	SA7	37			Y	Y	Y			Y	Y			N	Y	Y	Y		Y	Y	Y																								
59	H371203	Ban Tad Ton	SA7	51			Y	Y	Y			Y	Y			N	Y	Y	Y		Y	Y	Y																								
60	H370104	Yasothon	SA7	58			Y	Y	Y			Y	Y			N	Y	Y	Y		Y	Y	Y																								
61	H380903	Ban Ku Phra Kona	SA8	12			Y	Y	Y			Y	Y			N	Y	Y	Y		Y	Y	Y																								
62	H380133	Ban Som	SA8	15			Y	Y	Y			Y	Y			N	Y	Y	Y		Y	Y	Y																								
63	H380134	Rasi Salai	SA8	16			Y	Y	Y			Y	Y			N	Y	Y	Y		Y	Y	Y																								
64	H020108	Phnom Krom	SA9	16			Y	Y	Y			Y	Y			N	Y	Y	Y		Y	Y	Y																								
65	H020103	Kampong Chnang	SA9	17			Y	Y	Y			Y	Y			Y	Y	Y	Y		Y	Y	Y																								
66	H610101	Kampong Thom	SA9	42			Y	Y	Y			Y	Y			N	Y	Y	Y		Y	Y	Y																								
67	H620101	Kompong Thmar	SA9	49			Y	Y	Y			Y	Y			N	Y	Y	Y		Y	Y	Y																								
68	H020106	Kampong Luong	SA9	61			Y	Y	Y			Y	Y			Y	Y	Y	Y		Y	Y	Y																								
69	H640110	Kampon Toul	SA9	71			Y	Y	Y			Y	Y			N	Y	Y	N		Y	Y	Y																								
70	H020107	Backprea	SA9	81			Y	Y	Y			Y	Y			Y	Y	Y	Y		Y	Y	Y																								

Table 2-3: Available of Water Quality parameter from EP Database (Cont'd)

No	StatID	Station_Name	SWAT Model		Parameter																																										
			SWAT SubArea	SWAT subbasin	TEMP_°C	pH	TSS_mg/L	COND_mS/m	Ca_meq/L	Mg_meq/L	Na_meq/L	K_meq/L	ALK_meq/L	Cl_meq/L	SO4_meq/L	NO2_mg/L	NO32_mg/L	NH4N_mg/L	TOTN_mg/L	PO4P_mg/L	TOTP_mg/L	DO_mg/L	CODMN_mg/L	FC _MPN/100ml	Al_mg/L	ACID_meq/L	SUM_CAT	SUM_ANI	%IONB	EC_CAT	EC_CAT/EC	EC_AN	EC_AN/EC	Ca_EC	Mg_EC	Na_EC	K_EC	ALK_EC	Cl_EC	SO4_EC	NO32_EC	EC_EST	EC_DIFF	Ca/Mg	Na/Cl	Na/K	Ca/SO4
71	H988106	Hung Thanh	SA10				Y	Y	Y			Y	Y			N	Y	Y	Y		Y	Y	Y																								
72	H019802	Kampong Cham	SA10				Y	Y	Y			Y	Y			Y	Y	Y	Y		Y	Y	Y																								
73	H033403	Khos Thom	SA10				Y	Y	Y			Y	Y			Y	Y	Y	Y		Y	Y	Y																								
74	H988107	Kien Binh	SA10				Y	Y	Y			Y	Y			N	Y	Y	Y		Y	Y	Y																								
75	H033402	Koh Khel	SA10				Y	Y	Y			Y	Y			Y	Y	Y	Y		Y	Y	Y																								
76	H019807	Krom Samnor	SA10				Y	Y	Y			Y	Y			Y	Y	Y	Y		Y	Y	Y																								
77	H988310	Lo Gach	SA10				Y	Y	Y			Y	Y			N	Y	Y	Y		Y	Y	Y																								
78	H988113	Long Dinh	SA10				Y	Y	Y			Y	Y			N	Y	Y	Y		Y	Y	Y																								
79	H988110	My An	SA10				Y	Y	Y			Y	Y			N	Y	Y	Y		Y	Y	Y																								
80	H988315	My Lam	SA10				Y	Y	Y			Y	Y			N	Y	Y	Y		Y	Y	Y																								
81	H988111	My Phuoc Tay	SA10				Y	Y	Y			Y	Y			N	Y	Y	Y		Y	Y	Y																								
82	H988202	My Thanh	SA10				Y	Y	Y			Y	Y			N	Y	Y	Y		Y	Y	Y																								
83	H019805	My Tho	SA10				Y	Y	Y			Y	Y			N	Y	Y	Y		Y	Y	Y																								
84	H019804	My Thuan	SA10				Y	Y	Y			Y	Y			N	Y	Y	Y		Y	Y	Y																								
85	H988201	My Xuyen	SA10				Y	Y	Y			Y	Y			N	Y	Y	Y		Y	Y	Y																								
86	H039805	Mytho	SA10																																												
87	H019806	Neak Luong	SA10				Y	Y	Y			Y	Y			Y	Y	Y	Y		Y	Y	Y																								
88	H988212	Nga Nam	SA10				Y	Y	Y			Y	Y			N	Y	Y	Y		Y	Y	Y																								
89	H988210	Ngan Dua	SA10				Y	Y	Y			Y	Y			N	Y	Y	Y		Y	Y	Y																								
90	H988304	Nha Bang	SA10				Y	Y	Y			Y	Y			N	Y	Y	Y		Y	Y	Y																								
91	H988203	Nhu Gia	SA10				Y	Y	Y			Y	Y			N	Y	Y	Y		Y	Y	Y																								
92	H988211	Ninh Quoi	SA10				Y	Y	Y			Y	Y			N	Y	Y	Y		Y	Y	Y																								
93	H988301	Nui Sap	SA10				Y	Y	Y			Y	Y			N	Y	Y	Y		Y	Y	Y																								
94	H020101	Phnom Penh Port	SA10				Y	Y	Y			Y	Y			Y	Y	Y	Y		Y	Y	Y																								
95	H988109	Phong My	SA10				Y	Y	Y			Y	Y			N	Y	Y	Y		Y	Y	Y																								
96	H988213	Phung Hiep	SA10				Y	Y	Y			Y	Y			N	Y	Y	Y		Y	Y	Y																								
97	H988214	Phuoc Sinh	SA10				Y	Y	Y			Y	Y			N	Y	Y	Y		Y	Y	Y																								
98	H020102	Prek Kdam	SA10				Y	Y	Y			Y	Y			Y	Y	Y	Y		Y	Y	Y																								
99	H988112	Rach Chanh	SA10				Y	Y	Y			Y	Y			N	Y	Y	Y		Y	Y	Y																								
100	H988314	Soc Xoai	SA10				Y	Y	Y			Y	Y			N	Y	Y	Y		Y	Y	Y																								
101	H033401	Takhmao	SA10				Y	Y	Y			Y	Y			Y	Y	Y	Y		Y	Y	Y																								
102	H988312	Tam Ngan	SA10				Y	Y	Y			Y	Y			N	Y	Y	Y		Y	Y	Y																								
103	H019803	Tan Chau	SA10				Y	Y	Y			Y	Y			N	Y	Y	Y		Y	Y	Y																								
104	H988102	Tan Thanh	SA10				Y	Y	Y			Y	Y			N	Y	Y	Y		Y	Y	Y																								

Table 2-3: Available of Water Quality parameter from EP Database (Cont'd)

No	StatID	Station_Name	SWAT Model		Parameter																																										
			SWAT SubArea	SWAT subbasin	TEMP_°C	pH	TSS_mg/L	COND_mS/m	Ca_meq/L	Mg_meq/L	Na_meq/L	K_meq/L	ALK_meq/L	Cl_meq/L	SO4_meq/L	NO2_mg/L	NO32_mg/L	NH4N_mg/L	TOTN_mg/L	PO4P_mg/L	TOTP_mg/L	DO_mg/L	CODMN_mg/L	FC _MPN/100ml	Al_mg/L	ACID_meq/L	SUM_CAT	SUM_ANI	**_%IONB_**	EC_CAT	EC_CAT/EC	EC_AN	EC_AN/EC	Ca_EC	Mg_EC	Na_EC	K_EC	ALK_EC	Cl_EC	SO4_EC	NO32_EC	EC_EST	EC_DIFF	Ca/Mg	Na/Cl	Na/K	Ca/SO4
105	H988208	Thoi Binh	SA10				Y	Y	Y			Y	Y			N	Y	Y	Y		Y	Y	Y																								
106	H988115	Thong Binh	SA10				Y	Y	Y			Y	Y			N	Y	Y	Y		Y	Y	Y																								
107	H988316	Tinh Bien	SA10				Y	Y	Y			Y	Y			N	Y	Y	Y		Y	Y	Y																								
108	H988105	Tram Chim	SA10				Y	Y	Y			Y	Y			N	Y	Y	Y		Y	Y	Y																								
109	H988313	Tri Dien	SA10				Y	Y	Y			Y	Y			N	Y	Y	Y		Y	Y	Y																								
110	H988303	Tri Ton	SA10				Y	Y	Y			Y	Y			N	Y	Y	Y		Y	Y	Y																								
111	H988114	Tu Thuong	SA10				Y	Y	Y			Y	Y			N	Y	Y	Y		Y	Y	Y																								
112	H988108	Tuyen Nhon	SA10				Y	Y	Y			Y	Y			N	Y	Y	Y		Y	Y	Y																								
113	H988311	Vinh Dieu	SA10				Y	Y	Y			Y	Y			N	Y	Y	Y		Y	Y	Y																								
114	H988209	Vinh Thuan	SA10				Y	Y	Y			Y	Y			N	Y	Y	Y		Y	Y	Y																								
115	H988307	Vong Dong	SA10				Y	Y	Y			Y	Y			N	Y	Y	Y		Y	Y	Y																								
116	H988308	Vong The	SA10				Y	Y	Y			Y	Y			N	Y	Y	Y		Y	Y	Y																								
117	H988104	An Long	SA10				Y	Y	Y			Y	Y			N	Y	Y	Y		Y	Y	Y																								
118	H988302	Bathe	SA10				Y	Y	Y			Y	Y			N	Y	Y	Y		Y	Y	Y																								
119	H988206	Ca Mau	SA10				Y	Y	Y			Y	Y			N	Y	Y	Y		Y	Y	Y																								
120	H988103	Cai Mon	SA10				Y	Y	Y			Y	Y			N	Y	Y	Y		Y	Y	Y																								
121	H039803	Can Tho	SA10				Y	Y	Y			Y	Y			N	Y	Y	Y		Y	Y	Y																								
122	H988204	Cau Sap	SA10				Y	Y	Y			Y	Y			N	Y	Y	Y		Y	Y	Y																								
123	H988305	Cau So 13	SA10				Y	Y	Y			Y	Y			N	Y	Y	Y		Y	Y	Y																								
124	H988306	Cau So 5	SA10				Y	Y	Y			Y	Y			N	Y	Y	Y		Y	Y	Y																								
125	H988309	Cau Tri Ton	SA10				Y	Y	Y			Y	Y			N	Y	Y	Y		Y	Y	Y																								
126	H039801	Chau Doc	SA10				Y	Y	Y			Y	Y			N	Y	Y	Y		Y	Y	Y																								
127	H019801	Chroy Chang Var	SA10				Y	Y	Y			Y	Y			Y	Y	Y	Y		Y	Y	Y																								
128	H988207	Chu Chi	SA10				Y	Y	Y			Y	Y			N	Y	Y	Y		Y	Y	Y																								
129	H029812	Dai Ngai	SA10				Y	Y	Y			Y	Y			N	Y	Y	Y		Y	Y	Y																								
130	H988205	Ho Phong	SA10				Y	Y	Y			Y	Y			N	Y	Y	Y		Y	Y	Y																								
131	H988101	Hong Ngu	SA10				Y	Y	Y			Y	Y			N	Y	Y	Y		Y	Y	Y																								

Table 2-4: Available of Sediment data from DSMP Database

	Data Source Legend	0 Sediment																																				
	Frequency of Data	monthly																																				
No.	Station Name	Code	Coordinates																																			Remark
		MRCS	*Latitude*	*Longitude*	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	
Mekong Mainstream																																						
1	Chiang Sean	010501	20.273	100.083																									O	O	O	O	O	
2	Luang Prabang	011201	19.892	102.137																											O	O	O	
3	Chiang Khan	011903	17.897	101.668																									O	O	O	O	O	
4	Nong Khai	012001	17.877	102.720																									O	O	O	O	O	
5	Nakhon Phanom	013101	17.401	104.803																												O	O	
6	Mukdahan	013402	16.540	104.737																									O	O	O	O	O	
7	Khong Chiam	013801	15.318	105.500																									O	O	O	O	O	
8	Pakse	013901	15.117	105.800																											O	O	O	
9	Stung Treng	014501	13.547	106.016																											O	O	O	
10	Kratie	014901	12.478	106.015																											O	O	O	
Lower Kratie																																						
11	Sekong Bridge																															O	O	
12	Chroy Chanvar	019801																													O	O	O	
13	Koh Norea																														O	O	O	Use flow at Neak Leung
14	Bassac @ OSP																														O	O	O	Use flow at Bassac Chaktomuk
15	Prek Kdam	020102																													O	O	O	
16	Tan Chau																												O	O	O	O	O	
17	Chau Doc																												O	O	O	O	O	

3. Selected Station for the DSF model calibration

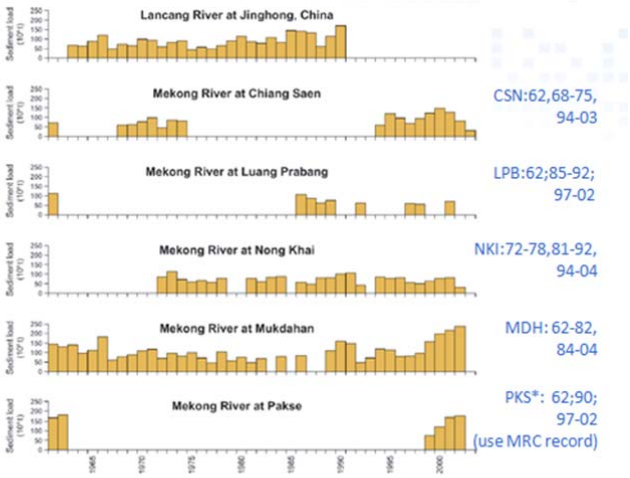
3.1 Sediment Station

The Sediment station was selected from all available data to check quality assurance and quality control (QA/QC) of dataset before use for DSF model Calibration

Mainstream : 11 stations was selected from Hymos (start – 2003/4), EP (1985 -2008) and DSMP (2009 – 2013) database for QA/QC process.

No	*Station*	*Hymos*	*EP*	*DSMP*
1	*Chiang Saen*	*x*	*x*	*x*
2	*Luang Prabang*	*x*	*x*	*x*
3	*Chiang Khan*	*x*	*-*	*x*
4	*Vientiane*	*x*	*x*	*-*
5	*Nong Khai*	*x*	*-*	*x*
6	*Nakhon Phanom*	*-*	*x*	*x*
7	*Mukdahan*	*x*	*-*	*x*
8	*KhongChiam*	*x*	*-*	*x*
9	*Pakse*	*x*	*x*	*x*
10	*Stung Treng*	*-*	*x*	*x*
11	*Kratie*	*-*	*x*	*x*
	Total	*8*	*7*	*10*

However, based on limitation of data (Hymos), methodology for measurement (EP) on the Mekong mainstram the futher analysis to estimated sediment budget will be consider.



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

Tributary; Totally 28 stations from Hymos and EP data selected as list:

SWAT sub-basin	No	Gauge Name
SA2	1	Nam Ou at Muong Ngoy
	2	Nam Mae Kok at Ban Tha Ton
	3	Nam Mae Kok at Chiang Rai
	4	Nam Mae Lao at Ban Tha Sai
	5	Nam Mae Ing at Thoeng
SA3	6	Nam Loei at Ban Wang Saphung
SA4	7	Nam Leak at Ban Hin Heup
	8	Nam Ngum at Ban Pak Ka nhoung
	9	Nam Theun at Ban Signo
	10	Se Bang Fai at Mahaxai
	11	Nam SongKram at Ban Thakok Deang
	12	Nam Kam at Na Kae
SA5	13	Se Bang Hieng at Ban Keng Done
	14	Se Done at Souvannakhili
	15	Nam Mun at Ubon
	16	Huai Khayung at SaphanHuai Khayung
	17	Lam Dom Yai at Ban Fang Phe
SA6	18	Krong Ko Po at Trung Nghai
	19	Se San at Kon Tum
	20	Srepok at Ban Don
	21	Srepok at Lomphat
SA7	22	Huai Rai at Ban Non Kiang
	23	Nam Yang at Ban Na Thom
	24	Nam Chi at Ban Chot
	25	Nam Chi at Yasothon
SA8	26	Nam Mun at Rasi Salai
SA9	27	Kampong Thom
	28	Kampong Thmar

3.2 Nutrient Station

The water Quality data was collected from EP database, Parameter selected for are TOTN and TOTP

Mainstream : 8 stations was selected from EP database for QA/QC process

No	*Station*	*TOTN*	*TOTP*
1	*Chiang Saen*	*x*	*x*
2	*Luang Prabang*	*x*	*x*
3	*Chiang Khan*	-	-
4	*Vientiane*	*x*	*x*
5	*Nong Khai*	-	-
6	*Nakhon Phanom*	*x*	*x*
7	*Mukdahan*	-	-
8	*KhongChiam*	*x*	*x*
9	*Pakse*	*x*	*x*
10	*Stung Treng*	*x*	*x*
11	*Kratie*	*x*	*x*
	Total	*8*	*8*

Tributary : 13 stations were selected from EP database for Total Nitrogen estimation and 16 stations were selected for Total Phosphorus.

Total Nitrogen

Swat Subbasin	No	Gauge Name
SA2	1	Nam Mae Kok at Chiang Rai
SA4	2	Nam Songkhram at Ban Tha Kok Daeng
	3	Se Bang Fai at Mahaxai
	4	Nam Kam at Ban Na Kae
SA5	5	Se Bang Hieng at Ban Keng Done
	6	Nam Mun at Ubon
	7	Se Done at Souvannakhili
SA6	8	Krong ko po at Trung Nghia
	9	Sesan at Kon Tum
	10	Seprok at Ban Don
	11	Nam Chi at Ban Chot
	12	Nam Chi at Yasothon
SA8	13	Nam Mun at Rasi Salai

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Total Phosphorus

Swat Subbasin	No	Gauge Name
SA2	1	Nam Mae Kok at Chiang Rai
SA4	2	Nam Songkhram at Ban Tha Kok Daeng
	3	Se Bang Fai at Mahaxai
	4	Nam Kam at Ban Na Kae
SA5	5	Se Bang Hieng at Ban Keng Done
	6	Nam Mun at Ubon
	7	Se Done at Souvannakhili
SA6	8	Krong ko po at Trung Nghia
	9	Sesan at Kon Tum
	10	Seprok at Lumphat
	11	Seprok at Ban Don
	12	Nam Chi at Ban Chot
	13	Nam Chi at Yasothon
SA8	14	Nam Mun at Rasi Salai
SA9	15	Kampong Thom
	16	Kompong Thmar

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Table 3-1: Selected Sediment Station from HYMOS database using for LOADEST estimation

	Data Source Legend	O Sediment																											
	Frequency of Data	1 times / month																											
No.	**Station Name**	**Code**	**Coordinates**		**Year**																								
		MRCS	*Latitude*	*Longitude*	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Mekong Mainstream																													
1	Chiang Saen	010501	20.273	100.083										O	O	O	O	O	O	O	O	O	O						
2	Luang Prabang	011201	19.892	102.137	O	O	O	O	O	O	O	O					O	O	O	O	O	O							
3	Nong Khai	012001	17.877	102.720	O	O	O	O	O	O	O	O		O	O	O	O	O	O	O	O	O	O	O					
4	Mukdahan	013402	16.540	104.737	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O					
5	Khong Chiam	013801	15.318	105.500	O	O																							
6	Pakse	013901	15.117	105.800						O							O	O	O	O	O	O							
Tributary																													
1	Muong Ngoy	100102	20.702	102.758						O						O	O	O	O	O	O	O							
2	Ban Pak Ka-nhoung	230101	18.418	102.550									O				O	O	O	O	O	O			O				
3	Ban Hin Heup	230201	18.660	102.355						O	O	O	O				O	O	O	O	O	O			O				
4	Ban Signo	270903	17.845	105.052												O	O	O	O	O	O	O			O				
5	Mahaxai	320107	17.413	105.202						O	O	O				O		O	O	O	O	O			O				
6	Ban Keng Done	350101	16.185	105.317							O	O					O	O	O	O									
7	Souvanna Khili	390104	15.397	105.825									O			O	O	O	O	O	O	O			O				
8	Chiang Rai	050104	19.918	99.850	O	O	O	O	O	O	O	O	O	O															
9	Ban Tha Ton	050105	20.060	99.363	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O					
10	Ban Tha Sai	050301	19.853	99.843	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O						
11	Thoeng	070103	19.687	100.192	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O						
12	Wang Saphung	150101	17.298	101.780	O	O	O		O	O	O	O	O	O	O	O	O	O	O	O	O	O	O						
13	Nam Kae	310102	16.955	104.508	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O									
14	Yasothon	370104	15.782	104.142	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O						
15	Ban Chot	370122	16.100	102.577	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O						
16	Ban Nong Kiang	371101	16.133	101.667	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O						
17	Ban Na Thom	371509	16.058	104.038	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O						
18	Ubon	380103	15.222	104.862	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O						
19	Rasi Salai	380134	15.335	104.162	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O						
20	Ban Huai Khayuong	381206	15.005	104.638	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O						
21	Ban Fang Phe	381503	14.690	105.160	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O										

Table 3-2: Selected Sediment/Nutrient Station from EP database using for LOADEST estimation

	Data Source Legand		O	WQ																																			
	Frequency of Data		1 times / month																																						
No	**Station_Name**	StatID	Coordinate		Year																																			
			Latitude	Longitude	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Mekong Mainstream																																							
1	Chiang Sean	H010501	20.276	100.092	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O
2	Luang Prabang	H011200	19.941	101.304	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O
3	Vientiane	H011901	17.930	102.62	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O
4	Nakhon Phanom	H013101	17.401	104.803	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O
5	Khong Chiam	H013801	15.320	105.5	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O
6	Pakse	H013900	15.123	105.784	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O
7	Stung Treng	H014501	13.547	106.016																				O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O
8	Kratie	H014901	12.478	106.015											O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O
Tributary																																								
1	Chiang Rai	H050104	19.921	99.85	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O
2	Nam Ngum at Damsite	H230199	18.532	102.553	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O										
3	Tha Ngon	H230102	18.137	102.622	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O															
4	Ban Tha Kok Daeng	H290102	17.869	103.783	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O															
5	Se Bang Fai	H320101	17.074	104.985	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O
6	Nam Kae	H310102	16.957	104.508	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O
7	Ban Keng Done	H350101	16.187	105.317	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O
8	Ubon	H380104	15.249	104.957	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O
9	Souvanna Khili	H390104	15.388	105.818					O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O										
10	Trung Nghia	H440601	14.369	107.8667								O	O	O	O																								
11	Kon Tum	H440201	14.345	108.007								O	O	O	O																								
12	Lumphat	H450101	13.551	106.5283																				O	O	O	O	O	O	O	O								
13	Ban Don	H451303	12.911	107.7406																				O	O	O	O	O	O	O	O								
14	Ban Chot	H370122	16.102	102.577	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O															
15	Ban Tad Ton	H371203	15.960	102.03						O	O	O	O	O	O	O	O	O	O	O	O	O	O	O															
16	Yasothon	H370104	15.784	104.142	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O														
17	Rasi Salai	H380134	15.337	104.162	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O														
18	Kampong Thom	H610101	12.688	104.9																				O	O	O	O	O										
19	Kompong Thmar	H620101	12.502	105.1308																				O	O	O	O	O										
20	Neak Luong	H019806	11.595	105.287									O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O
21	Phnom Penh Port	H020101	11.573	104.932											O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O
22	Prek Kdam	H020102	11.813	104.8									O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O
23	Tan Chau	H019803	10.788	105.234	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O
24	Chau Doc	H039801	10.701	105.114	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O
25	Chroy Chang Var	H019801	11.585	104.943									O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O

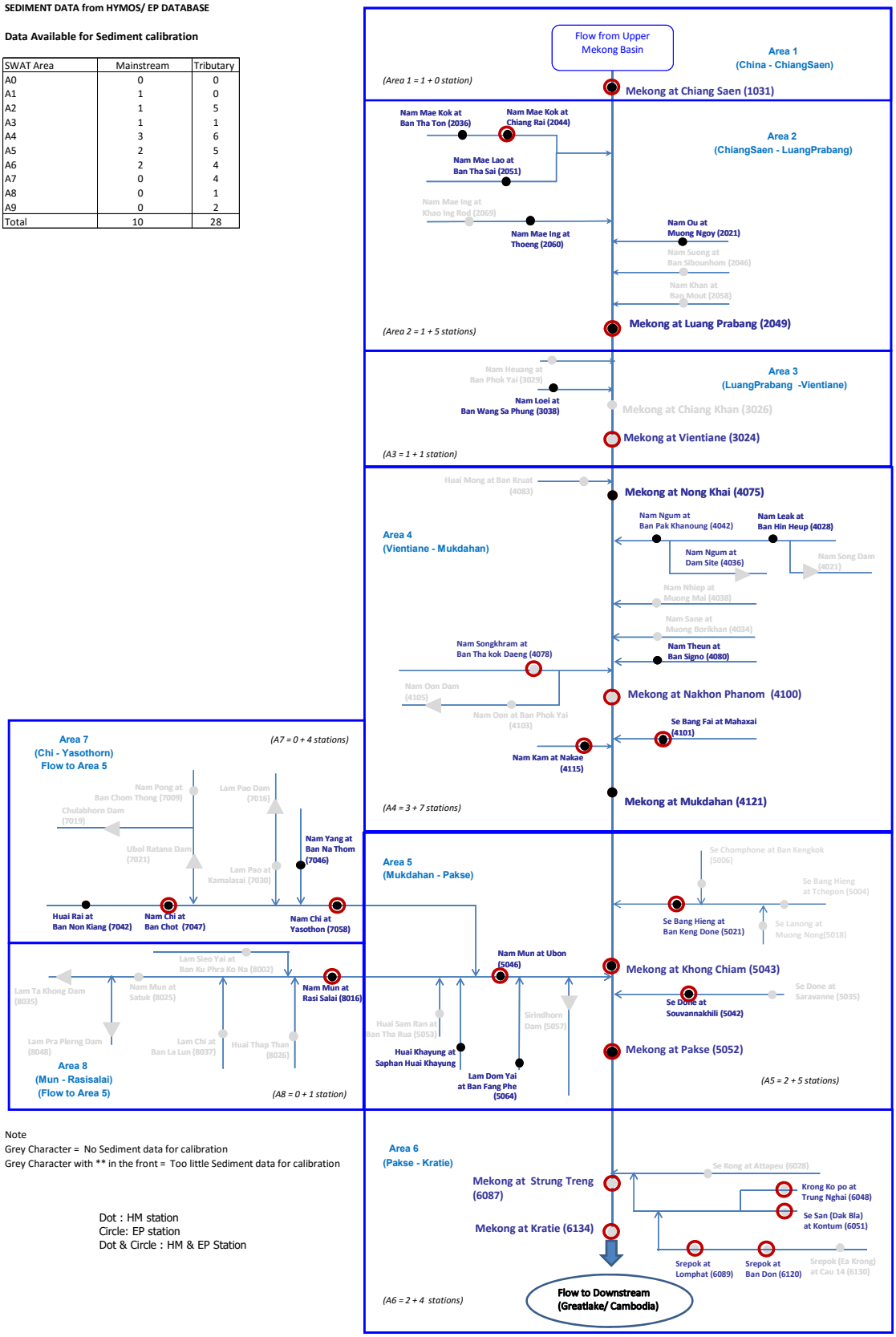
Table 3-3: Selected Sediment Station from DSMP database using for LOADEST estimation

	Data Source Legend	0 Sediment																																				
	Frequency of Data	monthly																																						
No.	**Station Name**	**Code**	**Coordinates**																																				
		MRCS	*Latitude*	*Longitude*	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Mekong Mainstream																																						
1	Chiang Sean	010501	20.273	100.083																									O	O	O	O	O
2	Luang Prabang	011201	19.892	102.137																											O	O	O
3	Chiang Khan	011903	17.897	101.668																									O	O	O	O	O
4	Nong Khai	012001	17.877	102.720																									O	O	O	O	O
5	Nakhon Phanom	013101	17.401	104.803																												O	O
6	Mukdahan	013402	16.540	104.737																									O	O	O	O	O
7	Khong Chiam	013801	15.318	105.500																									O	O	O	O	O
8	Pakse	013901	15.117	105.800																											O	O	O
9	Stung Treng	014501	13.547	106.016																											O	O	O
10	Kratie	014901	12.478	106.015																											O	O	O

SEDIMENT DATA from HYMOS/ EP DATABASE

Data Available for Sediment calibration

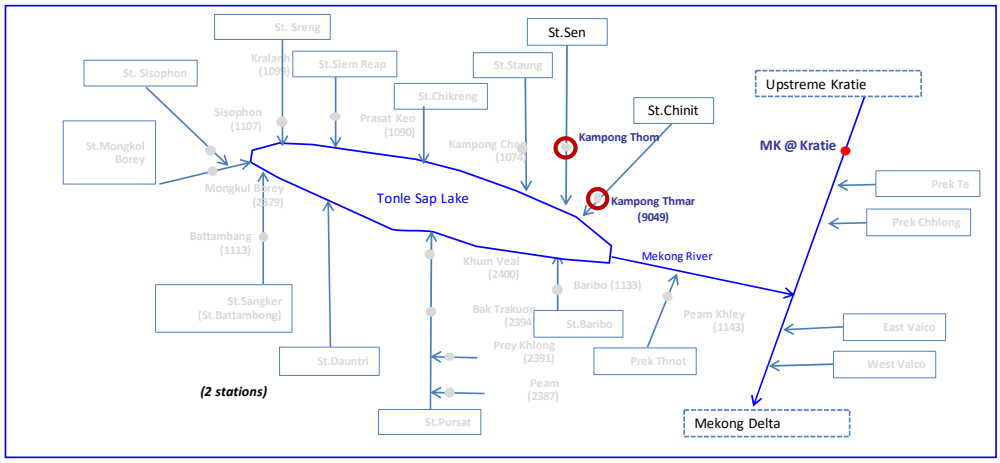
SWAT Area	Mainstream	Tributary
A0	0	0
A1	1	0
A2	1	5
A3	1	1
A4	3	6
A5	2	5
A6	2	4
A7	0	4
A8	0	1
A9	0	2
Total	10	28



Note
Grey Character = No Sediment data for calibration
Grey Character with ** in the front = Too little Sediment data for calibration

Dot : HM station
Circle: EP station
Dot & Circle : HM & EP Station

Figure 3-1: Schematic Map for Sediment/Nutrient Calibration Point using for Loadest Estimation



Schematic map for Calibration Point around Great Lake

Figure 3-1: Schematic Map for Sediment/Nutrient Calibration Point using for Loadest Estimation

4. Loadest Estimation

Measurement of the Sediment and nutrient concentrations in the stream is usually done on weekly, biweekly or monthly basis due to limited resources. There is 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) is a FORTRAN program for estimating constituent loads in streams and rivers. Given a time series of streamflow, additional data variables, and constituent concentration, LOADEST assists the user in developing a regression model for the estimation of constituent load (calibration).

Explanatory variables within the regression model include various functions of streamflow, decimal time, and additional user-specified data variables. The formulated regression model then is used to estimate loads over a user-specified time interval (estimation).

The summary statistics of comparison between observed and estimated loads for all dates/times within the calibration data set at each station was presented in Table 4-1 to 4-6

The statistics for comparison are:

1. E (Nash Sutcliffe Efficiency Index)

   E ranges from -infinity to 1.0

   when; E = 1; a perfect fit to observed data.
   E = 0; model estimates are as accurate as the mean of observed data.
   E<0; the observed mean is a better estimate than the model estimates.

2. PLR Partial Load Ratio is Sum of estimated loads divided by sum of observed loads.
   when; values > 1 indicate overestimation;
   values < 1 indicate underestimation.

3. Bp Load Bias in Percent
   Positive (negative) values indicate over (under) estimation.
   The model should not be used when the + or - bias exceeds 25%

(1) The Sediment Estimation

Mainstream: totally 11 stations was check using Hymos and EP and divide data to be 2 period pre 1993 and post 1993 found that:

- Hymos data have a good relation (COE >0.4) pre 1993 at Chiang Khan (2 years data) , Nong Khai, Mukdahan and Khong Chiam whereas post 1993 Chiang Saen, Luang Prabang, and Nong Khai have a good relation between observation and estimation.
- EP data have a good relation between observation and estimation after year 1993 at Chiang Saen, Vientiane and Nakhon Phanom
- DSMP dataset have a good relation for all station except at Mukdahan.

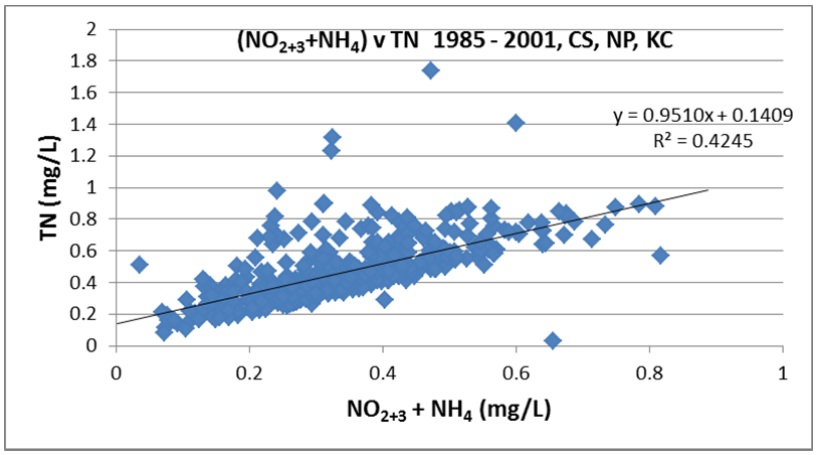
Tributary: 28 stations had evaluated the relationship, and some station was measurement by both source of dataset. The load from Hymos dataset will be used for the calibration.

Dataset	Total station	COE > 0.4	COE < 0.4	% different Load Ratio > 25 %
Hymos	21	14	7	1
EP	16	8	8	7

SWAT sub-basin	No	Gauge Name	Source
SA2	1	Nam Ou at Muong Ngoy	HYMOS
	2	Nam Mae Kok at Ban Tha Ton	HYMOS
	3	Nam Mae Kok at Chiang Rai	HYMOS
	4	Nam Mae Lao at Ban Tha Sai	HYMOS
	5	Nam Mae Ing at Thoeng	HYMOS
SA3	6	Nam Loei at Ban Wang Saphung	HYMOS
SA4	7	Nam Leak at Ban Hin Heup	HYMOS
	8	Nam Ngum at Ban Pak Ka nhoung	HYMOS
	9	Nam Theun at Ban Signo	HYMOS
	10	Se Bang Fai at Mahaxai	HYMOS
	11	Nam SongKram at Ban Thakok Deang	EP
	12	Nam Kam at Na Kae	HYMOS
SA5	13	Se Bang Hieng at Ban Keng Done	HYMOS
	14	Se Done at Souvannakhili	HYMOS
	15	Nam Mun at Ubon	HYMOS
	16	Huai Khayung at SaphanHuai Khayung	HYMOS
	17	Lam Dom Yai at Ban Fang Phe	HYMOS
SA6	18	Krong Ko Po at Trung Nghai	EP
	19	Se San at Kon Tum	EP
	20	Srepok at Ban Don	EP
	21	Srepok at Lomphat	EP
SA7	22	Huai Rai at Ban Non Kiang	HYMOS
	23	Nam Yang at Ban Na Thom	HYMOS
	24	Nam Chi at Ban Chot	HYMOS
	25	Nam Chi at Yasothon	HYMOS
SA8	26	Nam Mun at Rasi Salai	HYMOS
SA9	27	Kampong Thom	EP
	28	Kampong Thmar	EP

(2) Total nitrogen Estimation

Mainstream: 8 stations from EP were estimated to create rating curve; however based on no TOTN data is not available at station Luang Prabang, Vientiane and Pakse, therefore the relationship between NO2, NO3, NH4 and TOTN from Chiang Saen, Nakhon Phanom and Khong Chiam will use to estimate TOTN data at said station.



Tributary: 13 stations have been check and 12 stations have good relation (CEO > 0.4 and Load ratio < 25%). With the limitation of station in tributary, the station that have very low ratio and load higher than 25% still be used to check the pattern of load in calibration process.

Swat Sub basin	No	Gauge Name	status of use
SA2	1	Nam Mae Kok at Chiang Rai	Use for calibrate
SA4	2	Nam Songkhram at Ban Tha Kok Daeng	Use for calibrate
	3	Se Bang Fai at Mahaxai	Use for calibrate
	4	Nam Kam at Ban Na Kae	Use for calibrate
SA5	5	Se Bang Hieng at Ban Keng Done	Use for calibrate
	6	Nam Mun at Ubon	Use for calibrate
	7	Se Done at Souvannakhili	Use for calibrate
SA6	8	Krong ko po at Trung Nghia	Use for calibrate
	9	Sesan at Kon Tum	use for check Pattern
	10	Seprok at Ban Don	Use for calibrate
	11	Nam Chi at Ban Chot	Use for calibrate
	12	Nam Chi at Yasothon	Use for calibrate
SA8	13	Nam Mun at Rasi Salai	Use for calibrate

D:\Nutrient_CS\3 Analysis_Loadest\summaryTOTN\1 summaryResult-TOTN

(3) Total Phosphorus estimation

Mainstream: 8 stations from EP were estimated to create rating curve; however only year 1985-2001 was used based on the abnormal value during year 2002-2006. Except Stung Treng had been use year 2004-2008 and Pakse selected year 1995-2001 for create rating curve based on available data. After comparing the relation result, 2 stations namely Stung Trang and Kratie have lower COE especially Strung Treng cannot find the correlation and overestimate of Load, therefore only 7 stations will be used for calibration.

Tributary: 16 stations have been check and 10 stations have good relation (CEO > 0.4 and Load ratio < 25%). With the limitation of station in tributary, the station that have very low ratio and load higher than 25% still be used to check the pattern of load in calibration process.

Swat Sub basin	No	Gauge Name	status of use
SA2	1	Nam Mae Kok at Chiang Rai	use for calibrate
SA4	2	Nam Songkhram at Ban Tha Kok Daeng	use for calibrate
	3	Se Bang Fai at Mahaxai	use for calibrate
	4	Nam Kam at Ban Na Kae	use for calibrate
SA5	5	Se Bang Hieng at Ban Keng Done	use for check Pattern
	6	Nam Mun at Ubon	use for calibrate
	7	Se Done at Souvannakhili	use for check Pattern
SA6	8	Krong ko po at Trung Nghia	use for calibrate
	9	Sesan at Kon Tum	use for calibrate
	10	Seprok at Lumphat	use for calibrate
	11	Seprok at Ban Don	use for calibrate
	12	Nam Chi at Ban Chot	use for check Pattern
	13	Nam Chi at Yasothon	use for calibrate
SA8	14	Nam Mun at Rasi Salai	use for calibrate
SA9	15	Kampong Thom	use for calibrate
	16	Kompong Thmar	use for calibrate

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Table 4-1: Statistics comparing between Loadest Estimation and Observation of the Sediment data on the Mainstream

No	Station	HYMOS (Before year 1993)			HYMOS (After year 1993)			EP (Before year 1993)			EP (After year 1993)			DSMP		
		Sediment Available	Statistic		Sediment Available	Statistic		Sediment Available	Statistic		Sediment Available	Statistic		Sediment Available	Statistic	
			COE	Load Ratio		COE	Load Ratio		COE	Load Ratio		COE	Load Ratio		COE	Load Ratio
1	Chiang Saen	1968 - 1975	0.08	1.29	1994 - 2003	0.72	1.13	1985 - 1992	0.36	1.25	1993 - 2008	0.55	1.18	2009 - 2013	0.75	1.09
2	Luang Prabang	1985 - 1992	0.13	1.39	1997 - 2002	0.70	1.08	1985 - 1992	0.01	1.40	1993 - 2008	0.25	1.19	2011 - 2013	0.80	1.10
3	Chiang Khan	1967 - 1976	0.64	1.13	-	-	-							2009 - 2013	0.72	1.13
4	Vientiane	1962, 1968	0.83	1.42	-	-	-	1985 - 1992	0.06	1.41	1993 - 2008	0.41	0.99			
5	Nong Khai	1985 - 1992	0.59	1.07	1994 - 2005	0.48	1.24							2009 - 2013	0.78	1.08
6	Nakhon Phanom							1985 - 1992	0.34	1.31	1993 - 2008	0.51	1.11	2012 - 2013	0.82	1.22
7	Mukdahan	1985 - 1992	0.72	1.17	1993 - 2005	0.13	1.37							2009 - 2013	0.10	1.33
8	Khong Chiam	1966-1969, 1972-1980,1982-1986	0.63	1.14	-	-	-	1985 - 1992	-1.64	1.76	1993 - 2008	0.23	1.39	2009 - 2013	0.47	1.21
9	Pakse	1962, 1990	0.38	0.99	1997 - 2002	0.11	1.27	1985 - 1992	-0.07	1.64	1993 - 2008	-0.66	1.59	2011 - 2013	0.63	1.06
10	Strung treng	-	-	-	-	-	-	-	-	-	2004 - 2008	-0.16	1.55	2011 - 2013	0.70	1.20
11	Kratie	-	-	-	-	-	-	-	-	-	1995 - 2008	0.15	1.48	2011 - 2013	0.62	1.21

Table 4-2: Statistics comparing between Loadest Estimation and Observation of the Sediment data on Tributary

a) Hymos database

Sub-Area	No	Name	Data Availability		Loadest	Statistic			Remark	status of use
			SS	Flow		COE	Load Ratio	Bp [%]		
SA2	1	Nam Mae Kok at Ban Tha Ton	69-04	85-05	equation 10	0.29	1.09	9.09		✓
	2	Nam Mae Kok at Chiang Rai	77-81;85-94	60-05	equation 10	0.71	1.04	3.79		✓
	3	Nam Mae Lao at Ban Tha Sai	72-03	72-03	equation 10	0.71	1.06	5.62		✓
	4	Nam Mae Ing at Thoeng	69-03	69-08	equation 10	0.48	0.98	-1.68		✓
	5	Nam Ou at Muong Ngoy	90;96-02	86-10	equation 1	0.10	1.21	20.90		✓
SA3	6	Nam Loei at Wang Saphung	68-87;89-03	67-07	equation 10	0.59	1.06	6.14		✓
SA4	7	Nam Songkhram at Ban Tha Kok Daeng								
	8	Nam Lik at Ban Hin Heup	67;90-93;97-02; 05	85-11	equation 10	0.86	1.11	11.43		✓
	9	Nam Ngum at Ban Pak Kanhoung	93;97-02; 05	63-11	equation 1	0.81	1.09	8.57		✓
	10	Nam Theun at Ban Signo	96-02; 05	86-08	equation 10	0.89	1.06	5.61		✓
	11	Se Bang Fai at Mahaxai	90-92;96;98-02; 05	85-11	equation 1	0.42	1.15	15.00		✓
	12	Nam Kam at Nam Kae	75-00	86-99	equation 10	0.53	1.00	0.05		✓
SA5	13	Se Bang Hieng at Ban Keng Done	62;91-92;97-00	60-08	equation 1	0.97	1.05	5.24		✓
	14	Huai Khayung at Ban Huai Khayuong	79-03	79-05	equation 1	0.81	1.07	6.82		✓
	15	Nam Mun at Ubon	62-03	85-08	equation 10	0.78	1.09	8.61		✓
	16	Lam Dom Yai at Ban Fang Phe	69-99	69-99	equation 1	0.68	1.13	12.49		✓
	17	Se Done at Souvannakhili	93;96-02; 05	85-08	equation 1	0.90	1.06	5.47		✓
SA6	18	Krong ko po at Trung Nghia								
	19	Sesan at Kon Tum								
	20	Seprok at Lumphat								
	21	Seprok at Ban Don								
SA7	22	Huai Rai at Ban Nong Kiang	75-78;81-03	75-03	equation 10	0.37	1.20	19.94		✓
	23	Nam Chi at Ban Chot	75-03	75-08	equation 1	-0.95	1.57	56.98		✓
	24	Nam Yang at Ban Na Thom	79-03	85-05	equation 10	0.12	1.14	14.12		✓
	25	Nam chi at Yasothon	62-03	52-08	equation 10	0.32	1.07	6.48		✓
SA8	26	Nam Mun at Rasi Salai	79-03	85-08	equation 10	0.22	0.89	-10.72		✓
SA9	27	Kampong Thom								
	28	Kompong Thmar								

Table 4-2: Statistics comparing between Loadest Estimation and Observation of the Sediment data on Tributary (Cont'd)

b) EP database

Sub-Area	No	Name	Data Availability		Loadest	Statistic			Remark	status of use
			SS	Flow		COE	Load Ratio	Bp [%]		
SA2	1	Nam Mae Kok at Ban Tha Ton								
	2	Nam Mae Kok at Chiang Rai	85-11	60-05	equation 10	-4.70	1.40	40.18		×
	3	Nam Mae Lao at Ban Tha Sai								
	4	Nam Mae Ing at Thoeng								
	5	Nam Ou at Muong Ngoy								
SA3	6	Nam Loei at Wang Saphung								
SA4	7	Nam Songkhram at Ban Tha Kok Daeng	85-04	85-08	equation 1	0.52	1.13	12.88		✓
	8	Nam Lik at Ban Hin Heup								
	9	Nam Ngum at Ban Pak Kanhoung								
	10	Nam Theun at Ban Signo								
	11	Se Bang Fai at Mahaxai	85-11	85-11	equation 1	0.11	1.44	43.69		×
	12	Nam Kae at Ban Na Kae	85-11	85-99	equation 10	0.52	1.18	17.82		×
SA5	13	Se Bang Hieng at Ban Keng Done	85-11	85-08	equation 1	-1.28	1.84	83.56		×
	14	Huai Khayung at Ban Huai Khayuong								
	15	Nam Mun at Ubon	85-11	85-08	equation 10	-0.24	1.32	32.00		×
	16	Lam Dom Yai at Ban Fang Phe								
	17	Se Done at Souvannakhili	89-08	85-08	equation 1	-0.33	1.43	43.18		×
SA6	18	Krong ko po at Trung Nghia	92-95	85-98	equation 1	0.63	1.14	13.86		✓
	19	Sesan at Kon Tum	92-95	85-06	equation 1	0.48	1.18	17.98		✓
	20	Seprok at Lumphat	04-11	00-08	equation 1	0.72	1.09	8.76		✓
	21	Seprok at Ban Don	04-11	85-08	equation 1	0.76	1.19	18.83		✓
SA7	22	Huai Rai at Ban Nong Kiang								
	23	Nam Chi at Ban Chot	85-04	85-04	equation 1	-0.19	1.45	45.31		×
	24	Nam Yang at Ban Na Thom								
	25	Nam chi at Yasothon	85-04	85-05	equation 10	0.39	1.20	20.32		×
SA8	26	Nam Mun at Rasi Salai	85-05	85-04	equation 10	0.016	1.327	32.728		×
SA9	27	Kampong Thom	04-08	95-11	equation 1	0.66	0.98	-1.61		✓
	28	Kompong Thmar	04-08	97-11	equation 1	0.53	1.00	-0.17		✓

Table 4-3: Statistics comparing between Loadest Estimation and Observation of the TOTN data on the Mainstream

No	Name	Data Availability			Loadest	Statistic			Remark	status of use
		Flow	TOTN	NO2, NO32, NH4		COE	Load Ratio	Bp [%]		
1	Chaing Saen	1985-2013	1987-2011		equation 1	0.65	1.01	0.74	TOTN	Use for SWAT calibration
2	Luang Prabang	1985-2013	2007-2011	1985 - 2001	equation 1	0.26	0.89	-11.34	NO2, NO32, NH4	Not use for calibration
3	Vientaine	1985-2013	2007-2011	1985 - 2001	equation 1	0.72	1.04	4.44	NO2, NO32, NH4	Use for SWAT calibration
4	Nakhon Phanom	1985-2013	1986-2011		equation 1	0.70	1.05	4.69	TOTN	Adjust Nutrient based on flow
5	Khong Chiam	1985-2007	1987-2007		equation 1	0.62	1.04	3.59	TOTN	Use for SWAT calibration
6	Pakse	1985-2013	2001-2011	1985 - 2001	equation 1	0.67	1.11	11.44	1985 -2001 use NO2, NO32, NH4 /2002 -2008 use TOTN	Use for SWAT calibration
7	Strung Treng	1985-2013	2008-2011		equation 1	0.85	1.08	8.41	TOTN	Use for SWAT calibration
8	Kratie	1985-2013	2008-2011		equation 1	0.73	1.13	13.23	TOTN	Use for SWAT calibration

Relationship of NO_{2+3} + $NH_{4\ and}$ TOTN at Chiang Saen, Nakhon Phanom and Kong Chiam will use to Estimate TOTN at LPB, VTE, PKS

D:\Nutrient_CS\3 Analysis_Loadest\summaryTOTN\1 summaryResult-TOTN

Table 4-4: Statistics comparing between Loadest Estimation and Observation of the TOTP data on the Mainstream

No	Name	Data Availability		Selected for Loadest	Loadest	Statistic			status of use
		Flow	TOTP			COE	Load Ratio	Bp [%]	
1	Chaing Saen	1985-2013	1985-2011	1985 - 2001	equation 1	0.43	0.96	-3.67	use for calibrate
2	Luang Prabang	1985-2013	1985-2011	1985 - 2001	equation 1	0.40	1.01	0.56	use for calibrate
3	Vientaine	1985-2013	1985-2011	1985 - 2001	equation 1	0.51	1.04	4.22	use for calibrate
4	Nakhon Phanom	1985-2013	1985-2011	1985 - 2001	equation 1	0.55	0.96	-4.10	use for calibrate
5	Khong Chiam	1985-2007	1985-2007	1985 - 2001	equation 1	0.43	0.98	-2.08	use for calibrate
6	Pakse	1985-2013	1985-2011	1985 - 2001	equation 1	0.56	1.13	12.72	use for calibrate
7	Strung Treng	1985-2013	2004-2011	2004 - 2008	equation 1	0.02	1.37	37.36	Not use for calibration
8	Kratie	1985-2013	1995-2011	1995 - 2001	equation 1	0.29	1.06	6.14	use for calibrate

D:\Nutrient_CS\3 Analysis_Loadest\summaryTOTP\1 summaryResult-TOTP

Table 5-4: Statistics comparing between Loadeset Estimation and Observation of TOTN data on Tributary

Sub-Area	TOTN	Name	Data Availability		Loadest	Statistic			status of use
			TOTN	Flow		COE	Load Ratio	Bp [%]	
SA2	1	Nam Mae Kok at Chiang Rai	87-05	85-05	equation 1	0.56	1.03	3.26	Use for calibrate
SA4	2	Nam Songkhram at Ban Tha Kok Daeng	87-04	85-08	equation 1	0.80	1.07	7.23	Use for calibrate
	3	Se Bang Fai at Mahaxai	07-08	85-08	equation 1	0.59	1.22	21.89	Use for calibrate
	4	Nam Kam at Ban Na Kae	87-99	85-99	equation 1	0.60	1.08	8.23	Use for calibrate
SA5	5	Se Bang Hieng at Ban Keng Done	07-08	85-08	equation 1	0.88	0.84	-16.54	Use for calibrate
	6	Nam Mun at Ubon	87-08	85-08	equation 10	0.63	1.02	2.40	Use for calibrate
	7	Se Done at Souvannakhili	07-08	85-08	equation 1	0.83	1.05	5.36	Use for calibrate
SA6	8	Krong ko po at Trung Nghia	92-95	85-98	equation 1	0.41	0.99	-1.22	Use for calibrate
	9	Sesan at Kon Tum	92-95	85-06	equation 1	0.10	0.99	-0.97	use for check Pattern
	10	Seprok at Ban Don	04-07	85-07	equation 1	0.75	1.14	14.05	Use for calibrate
SA7	11	Nam Chi at Ban Chot	87-04	85-08	equation 1	0.72	1.14	13.88	Use for calibrate
	12	Nam Chi at Yasothon	87-05	85-08	equation 10	0.77	1.03	2.72	Use for calibrate
SA8	13	Nam Mun at Rasi Salai	87-05	85-08	equation 10	0.82	1.06	5.90	Use for calibrate

Table 5-6: Statistics comparing between Loadeset Estimation and Observation of TOTP data on Tributary

Sub-Area	TOTP	Name	Data Availability		Loadest	Statistic			status of use
			TOTP	Flow		COE	Load Ratio	Bp [%]	
SA2	1	Nam Mae Kok at Chiang Rai	1985-2005	1985-2005	equation 1	0.52	1.02	2.38	use for calibrate
SA4	2	Nam Songkhram at Ban Tha Kok Daeng	1985-2004	1985-2008	equation 1	0.61	1.16	16.32	use for calibrate
	3	Se Bang Fai at Mahaxai	1985-2011	1985-2011	equation 1	0.35	1.10	9.91	use for calibrate
	4	Nam Kam at Ban Na Kae	1985-1999	1985-1999	equation 1	0.62	1.03	2.85	use for calibrate
SA5	5	Se Bang Hieng at Ban Keng Done	1985-2008	1985-2008	equation 1	0.32	1.37	36.65	use for check Pattern
	6	Nam Mun at Ubon	1985-2008	1985-2008	equation 10	0.46	1.22	21.69	use for calibrate
	7	Se Done at Souvannakhili	1989-2008	1985-2008	equation 1	-0.18	1.29	29.27	use for check Pattern
SA6	8	Krong ko po at Trung Nghia	1992-1995	1985-1997	equation 1	0.77	1.03	2.97	use for calibrate
	9	Sesan at Kon Tum	1992-1995	1983-2006	equation 1	0.35	0.91	-8.63	use for calibrate
	10	Seprok at Lumphat	2004-2008	2000-2008	equation 1	0.38	1.24	23.85	use for calibrate
	11	Seprok at Ban Don	2004-2007	1985-2007	equation 1	0.71	0.94	-6.41	use for calibrate
SA7	12	Nam Chi at Ban Chot	1985-2004	1985-2008	equation 1	0.04	1.20	19.46	use for check Pattern
	13	Nam Chi at Yasothon	1985-2005	1985-2008	equation 10	0.52	1.07	6.70	use for calibrate
SA8	14	Nam Mun at Rasi Salai	1985-2005	1985-2008	equation 10	0.52	1.17	17.32	use for calibrate
SA9	15	Kampong Thom	2004-2008	1995-2011	equation 1	0.61	1.00	0.27	use for calibrate
	16	Kompong Thmar	2004-2009	1997-2011	equation 1	0.52	1.01	1.37	use for calibrate

5. QA/QC Sediment and Nutrient Data for the DSF model

(Reference to QA/QC report by Water quality Expert (Dr.Lois Kohnhen))

Sediment and nutrient transport will be incorporated into the DSF by expanding the existing SWAT model. Model calibration will be completed using historical data available for the period 1985 to 2008 held by the MRC in the Master Catalogue. Unfortunately, the temporal and spatial range of existing sediment data is limited, and rating equations, linking discharge levels to sediment loads, need to be derived for each of the tributary sites using the historical flow and sediment results. The Modelling Team (MT) at IKMP are using an established computer program (Loadest) to derive these rating equations, and are requesting assistance with the QA/QC of the input sediment data sets, and testing of the model output to evaluate the validity of the derived sediment regression equations.

QA/QC of the historic sediment results is limited. When historic hydrological and sediment data were imported onto the Master Catalogue, considerable analysis and evaluation of the hydrometerological parameters was completed, however QA/QC of the suspended sediment results was limited to conversion of the existing results to a standard file format, and provision of a metafile which specified the number of samples available in each month of the overall period of record, and a statistical summary of the range of the data (Halcrow Group, 2010).

Walling (2005) analysed available suspended sediment data collected in **mainstream** sites, and identified numerous issues with using the data to derive rating curves. These included:

- Discontinuity of records at sites;
- Low numbers of samples;
- Unreliable / inappropriate sampling methods.

To date, no such analysis has been completed on the available tributary results, and some basic QA/QC is required to provide confidence in the calibration data for the model.

The sediment load regression equations derived using Loadest also need to be checked and the 'fit' of the equations needs to be evaluated for use in the SWAT model.

Approach

The QA/QC of the sediment results will be limited to an analysis of the historic data because the lack of meta-data describing the methods employed to collect the suspended sediment samples, or analytical methods used to produce the results precludes the evaluation of sampling methodology. This QA/QC of the sediment data sets and model output is proposed to include the following steps:

1. Review of input data sets

- The number of samples collected within each monitoring year, and within each calendar month will be reviewed to evaluate the temporal coverage of the data set. Walling (2005) when evaluating the main stream results suggested that a minimum of 20 data points per year is desirable to provide an accurate basis for an annual rating equation. He suggested that years with fewer results could be grouped together but the accuracy of the resultant equation was like to decrease considerably. For this analysis, sites for which there are fewer than 20 suspended sediment samples in any calendar year will be identified, and recommendations as to whether some years should be excluded from the analysis will be made on a case-by-case basis;

- The suspended sediment concentrations will be compared with the flow regime in the river. Although absolute suspended sediment concentrations are highly variable, the seasonal pattern of sediment transport is typically similar between years. By comparing the suspended sediment concentrations with the flow regime, irregular or unusual years (or data points) can be identified;

- The flow regime at each of the sites will also be examined to determine if there are changes or trends over the calibration period which need to be considered by the MT;

- The sediment data set will be examined to identify unusual trends or step-changes. Rapid or sudden changes in the concentration or pattern of sediment concentrations can indicate catchment changes or changes to sampling methodology. These types of changes need to be investigated on a case by case basis to determine whether the data set is suitable for model calibration;

2. Review of Loadest Output

- The observed and estimated (Loadest) suspended sediment concentrations will be compared graphically, and plotted with the flow regime. A graph showing the entire period (ideally 1985 – 2008) will be presented to provide an overview of the input data and modelling results; a second graph will present a shorter time period to provide more detail;

- For each site, a Table comparing the minimum, 25th percentile, median, 75th percentile, 95th percentile, 99th percentile and maximum daily load will be constructed. The ratio between the Observed and Estimated values will be shown which will provide an indication of whether the Loadest estimation is showing a positive or negative bias for the different flow components;

- The overall model fit will be tested for bias using three parameters which are recommended by the USGS in the Loadest Software Manual. All three of these parameters are based on comparison of the measured sediment loads, and the modelled sediment loads for the same days. The parameters include

    - Partial Load Ratio (PLR): determines whether the model over estimates or underestimates the load relative to the observations;

    - Load Bias % (Bp): Expresses the PLR as a percentage, with positive indicating an overestimation of loads and negative values an underestimation of loads;

    - Nash-Sutclifffe Efficiency Index (E): Determines if the fit of the model provides a better estimation as compared to using the mean of the observed

values to calculate loads. Positive E values indicate the model provides a better fit than the mean value.

- Where possible, the estimated sediment loads derived using Loadest will be compared to historic tributary sediment transport estimates (eg., Harden and Sundborg, 1992);

- Where warranted, a review of the 'residual' error results from the Loadest application will be examined to further investigate whether the Loadest estimate is reasonable.

3. Recheck quantity & timing of sediment input from different geomorphic regions

- 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

4. Use Loadest results to better understand quantity & timing of sediment input from different geomorphic regions

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

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

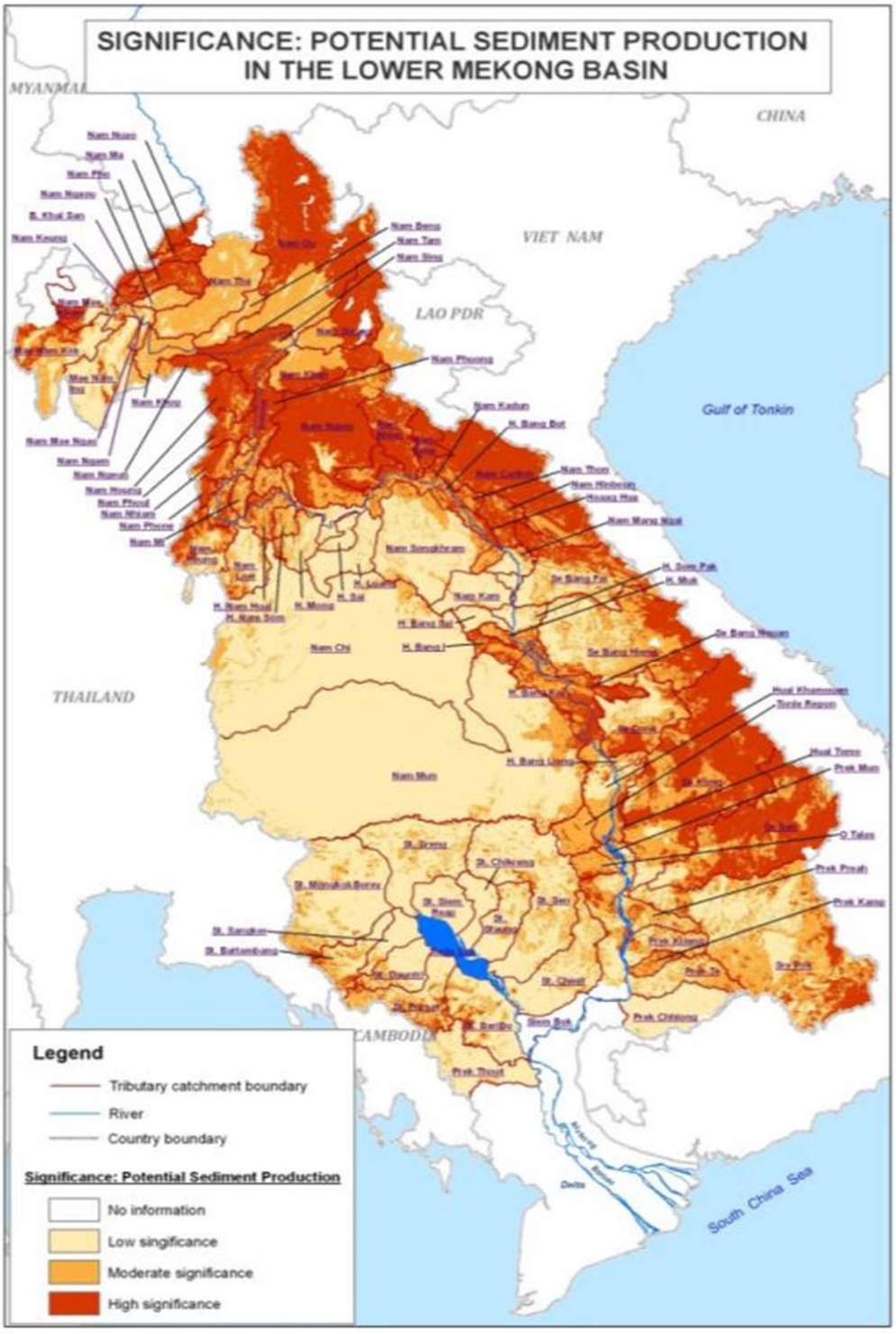
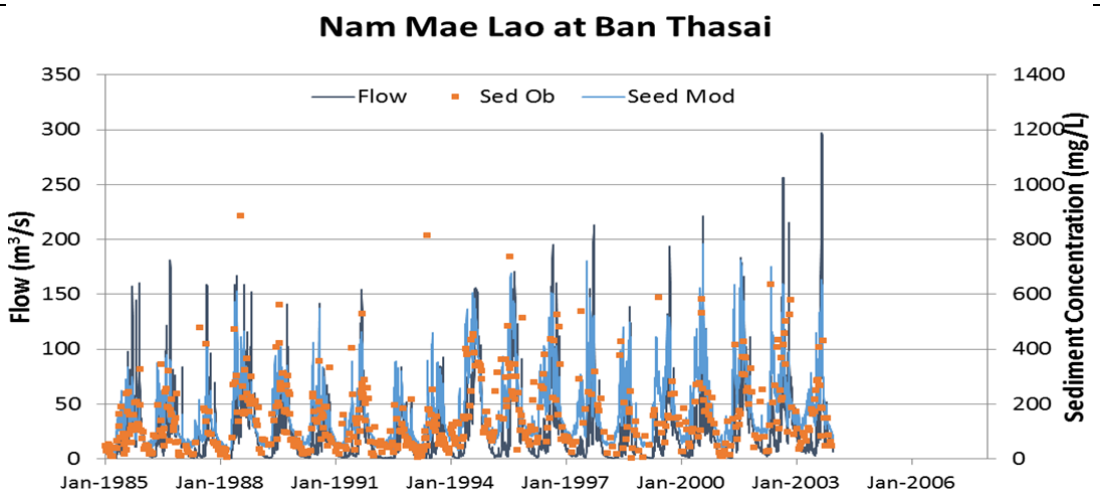
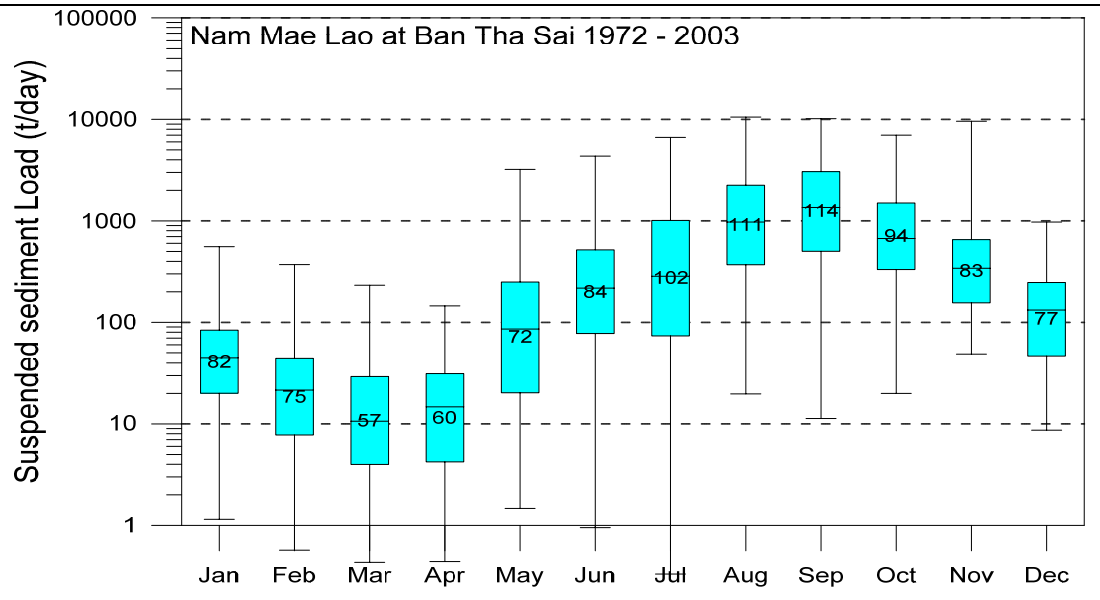


Figure 5-1 : Significance Potential Sediment Production in the Lower Mekong Basin

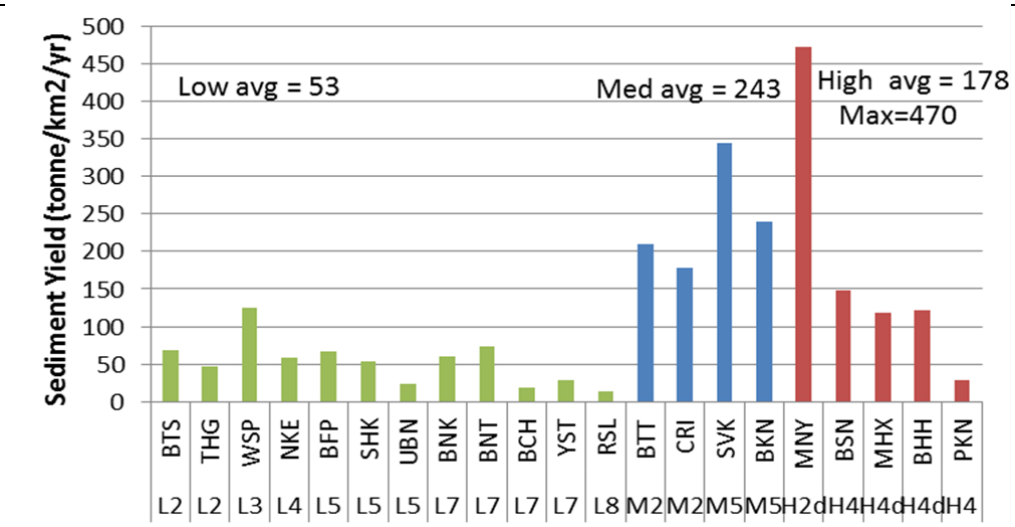
(Sources : Potential sediment production in the Lower Mekong River BAsin based on GIS analysis and sediment monitoring result, L Koehnken)



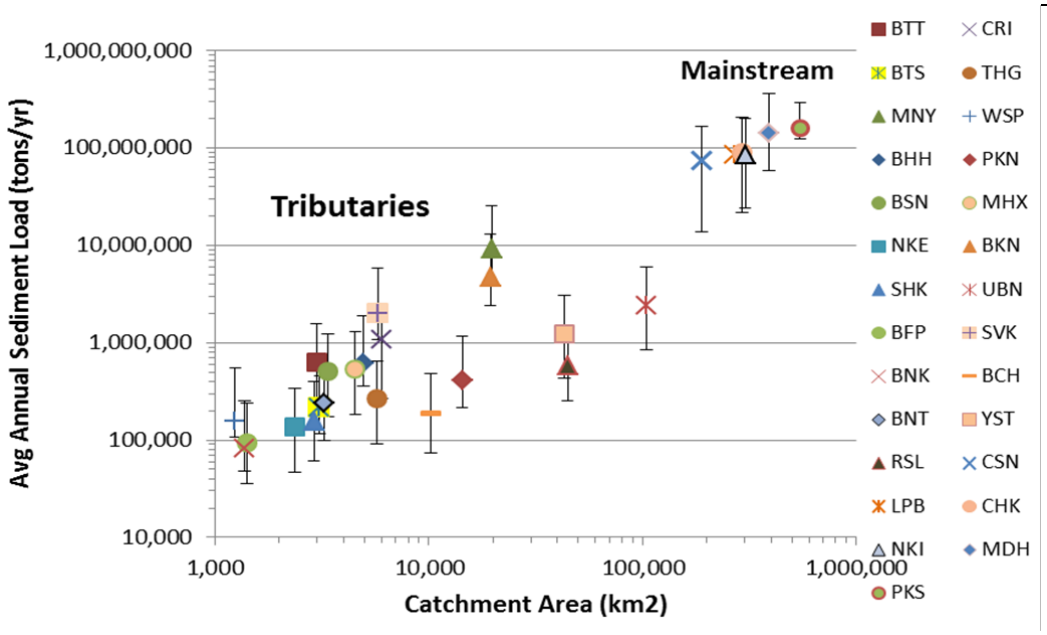
Graph of river flow, SSC measurements (mg/L, Ob sed), and Loadest output (Model Sed, mg/L)



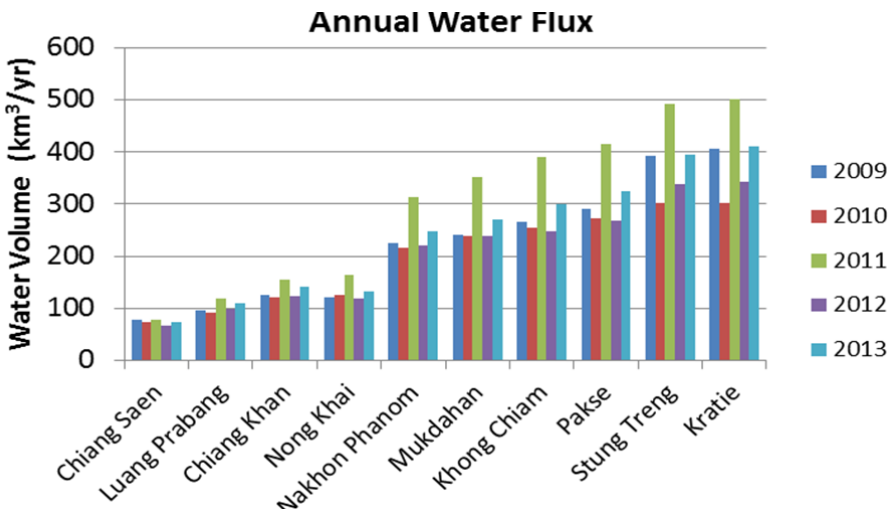
Graph of Suspend Sediment Load (T/day) for each month during year 1972 - 2003



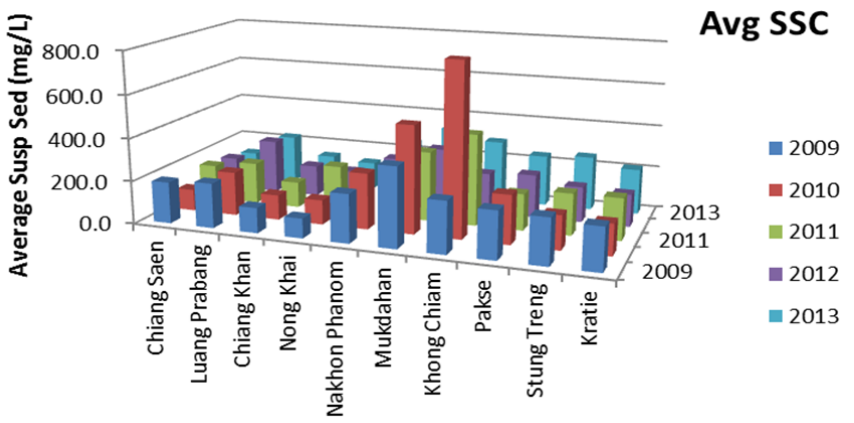
Graph of Suspend Yield (ton/kme/yr) from each tributary



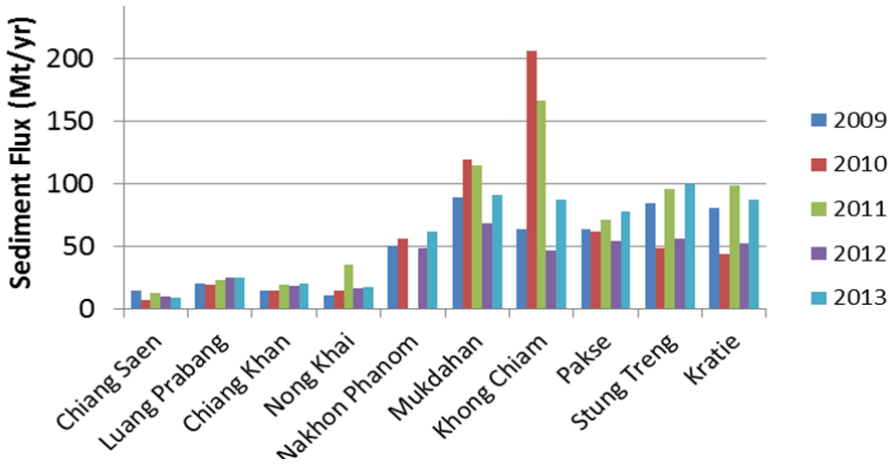
Graph of average annual sediment load (tonns/yr) with Catchment area (km2) for tributaries and Mainstream



Annual Water Flow (cu.km/Yr)



Average Suspend Sediment (mg/L)



Annual Sediment Flux (MT/Yr)

Figure 5-2 : Sediment Flux at Mekong mainstream from DSMP

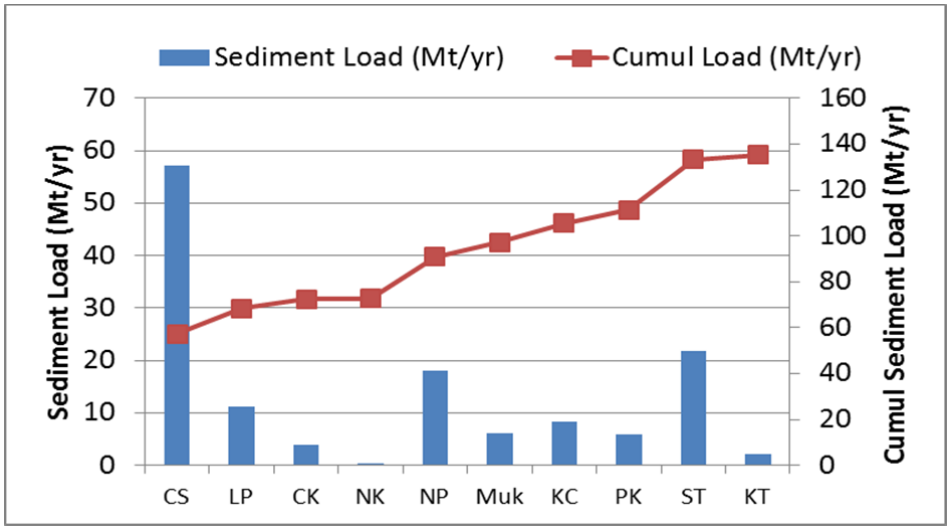


Figure 5-3 : Sediment Flux at Mekong mainstream estimate from sediment budget and DSMP monitoring data

6. The Sediment data analysis on the Mekong Mainstream

Refer to the sediment data on mainstream from HM and EP have the technical issue i.e. missing data (gap) during simulation period (1985- 2008), not consistency of the sediment measurement and data collection from both HM and EP on Mekong mainstream.

Sample of data collection from hymos database start from year 1960 – 2005 as below (Figure 6-1), graph represent annual sediment load at Jing Hong station (before start dam construction) down to Chiang Saen (1962, 1968-1975, 1994-2003), Luang Prabang (1962, 1985-1992, 1997-2002), Nong Khai (1972-1978, 1981-1992,1994-2004), Mukdahan (1962-1982, 1984-2004) and Pakse (1962,1990, 1997-2002). From this information, it might difficult to use measurement clear impact from pre and post Dam.

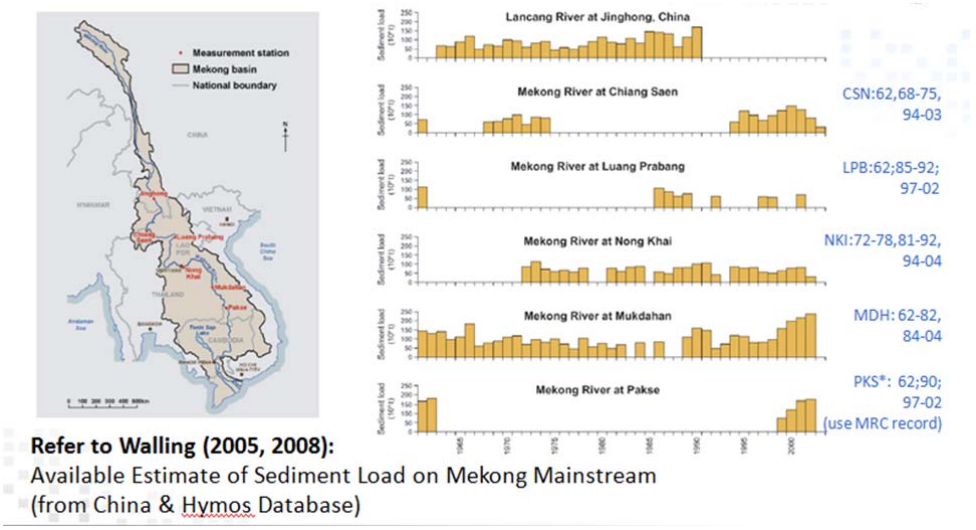


Figure 6-1: Plotting of Annual sediment Load on the Mekong mainstream (after Walling)

Considering on data available by plotting times series concentration (mg/l) on 11 stations from Hymos and EP dataset as figure 6-2, the data will be divided to be pre first dam and post first dam as we can see obviously change from EP dataset at Chiang Saen and Luang Prabang Station during year 1992, 1993 that was the year of dam construction. This change cannot see at Chiang Saen from HM database because no data collected during that time, just see only little bit higher value at Luang Prabang Station. The Statistic of HM and EP data during pre and post Manwan (year 1992/1993) was summary in Table 6-1.

Table 6-1: The Statistic of Sediment concentration (mg/l) during pre and post Manwan (year 1992/1993)

No	Station	statistic	HM - SSC (mg/l)			EP - TSS (mg/l)		
			Available	pre 1992	1992-2008	Available	1985-1991	1992-2008
1	Chiang Saen	Average	1962, 1968-1975,	289	583		544	270
		Max	1994-2003	1,363	3,794	1985-2008	2,372	1,440
		Min		1	1		34	2
2	Luang Prabang	Average	1962, 1985-1992,	382	345		535	205
		Max	1997-2002	2,296	983	1985-2008	3,328	1,876
		Min		0	5		12	2
3	Chiang Khan	Average	1972-1978, 1981-	276				
		Max	1992,1994-2004	1,921	N/A	-	N/A	N/A
		Min		1				
4	Vientiane	Average	1962, 1968	150		1985-2008	656	249
		Max		839	N/A		5,716	3,013
		Min		1			1	5
5	Nong Khai	Average	1972-1979, 1981-	248	162			
		Max	1985, 1987-	1,744	994	-	N/A	N/A
		Min	1992,1994-2006	1	2			
6	Nakhon Phanom	Average		190			276	152
		Max	-	941	N/A	1985-2008	1,133	1,566
		Min		1			7	2
7	Mudhahan	Average	1962-1982, 1984-	212	273			
		Max	2004	1,512	1,714	-	N/A	N/A
		Min		0	1			
8	Khong Chiam	Average	1966,1969, 1972-	197	-		239	158
		Max	1980,1982-	1,418	-	1985-2008	830	1,675
		Min	1984,1986	1	-		3	3
9	Pakse	Average	1962,1990, 1997-	172	216		279	146
		Max	2002	1,368	844	1985-2008	1,526	1,343
		Min		1	1		2	1
10	Strung Treng	Average						78
		Max	-	N/A	N/A	2005-2008	N/A	590
		Min						-
11	Kratie	Average						88
		Max	-	N/A	N/A	1995-2008	N/A	680
		Min						2

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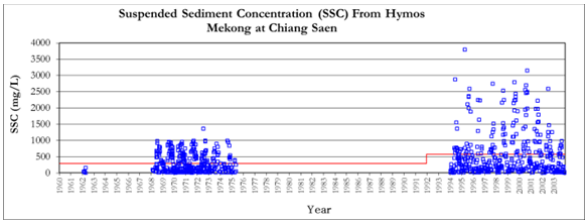
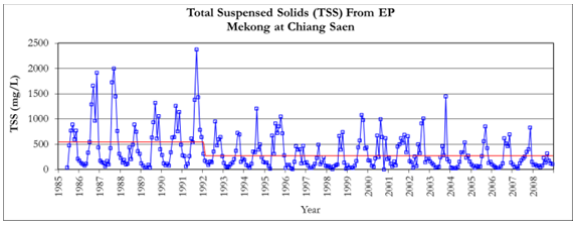
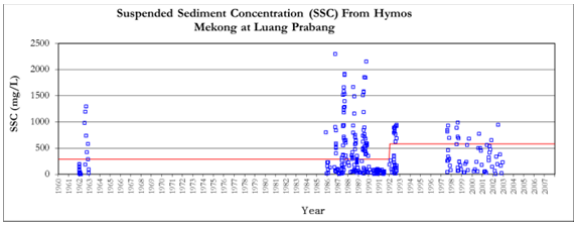
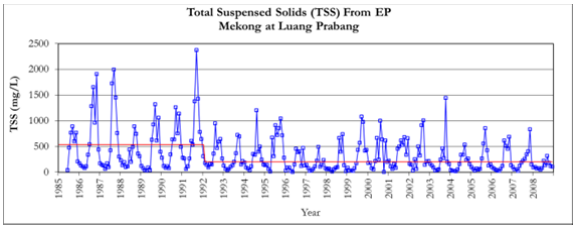
** This table divided analysis to be pre and post at year 1992 as the graph from EP database can see change during 1992-1993, however when do further analysis will divide at year 1993*

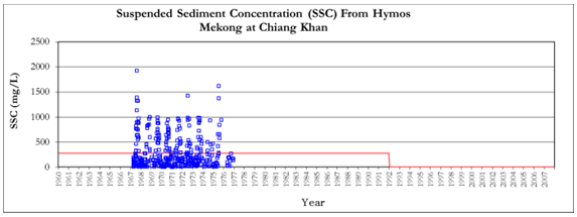
Suspended Sediment Concentration (SSC) from Hymos *Total Suspensed Soild (TSS) from EP*











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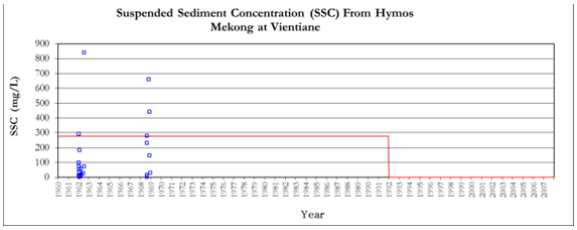

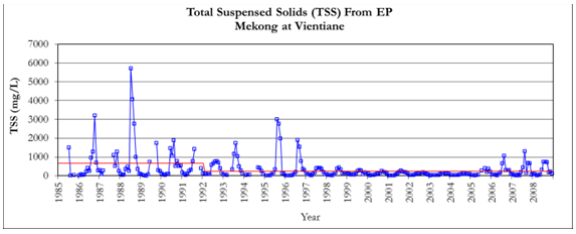

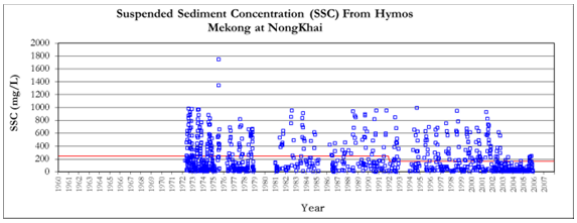

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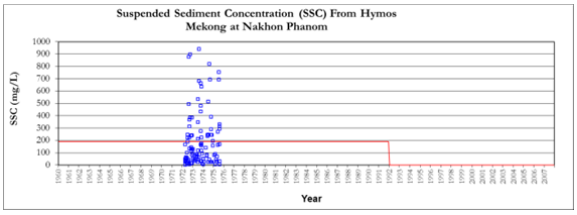


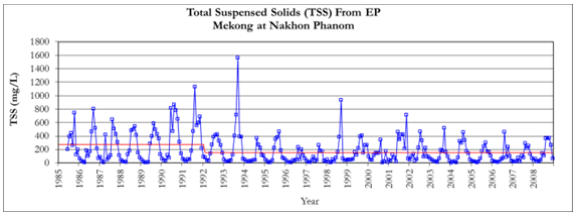


Figure 6 -1 : Sediment Concentration (mg/l) at 11 key sediment monitoring station

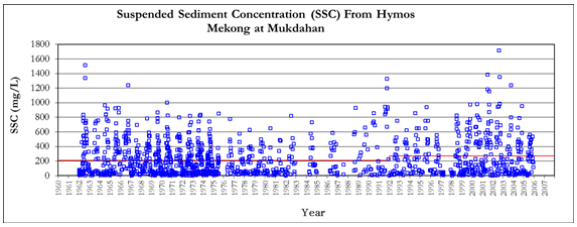
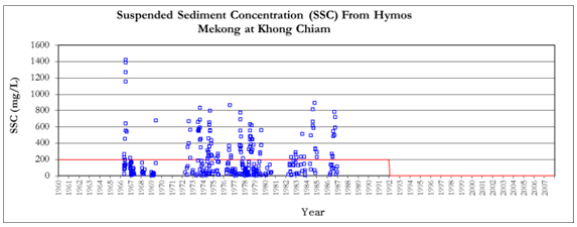
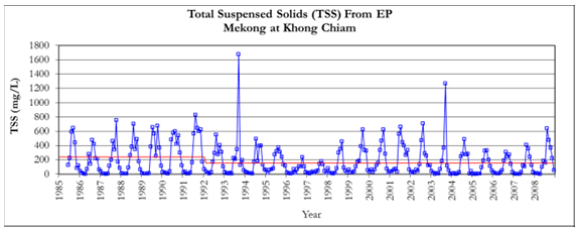
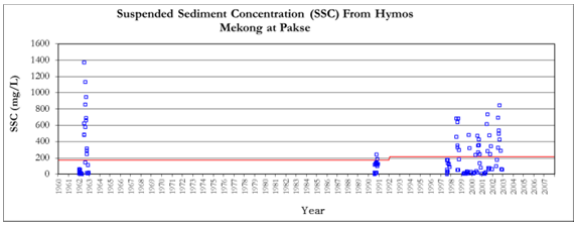
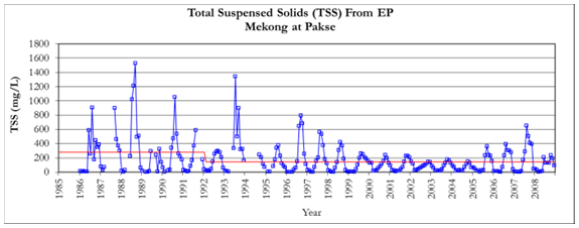
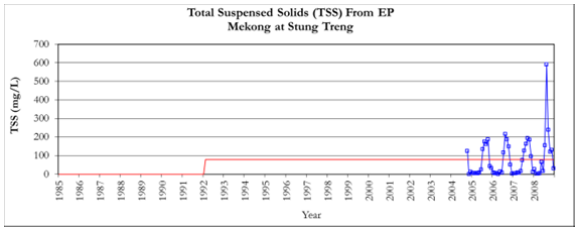
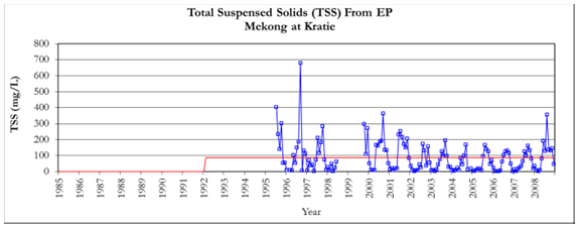
Suspended Sediment Concentration (SSC) from Hymos	*Total Suspensed Soild (TSS) from EP*
	Not Available
	
	
Not Available	
Not Available	

Figure 6 -1 : Sediment Concentration (mg/l) at 11 key sediment monitoring station (Cont'd)

The sediment concentration (mg/l) from 11 stations was estimated to be sediment load (Ton) using loadest, the correlation between concentration (mg/l) and flow (cms) was evaluation below

		HYMOS (Before year 1993)			HYMOS (After year 1993)			EP (Before year 1993)			EP (After year 1993)			DSMP		
No	Station	Sediment Available	Statistic		Sediment Available	Statistic		Sediment Available	Statistic		Sediment Available	Statistic		Sediment Available	Statistic	
			COE	Load Ratio		COE	Load Ratio		COE	Load Ratio		COE	Load Ratio		COE	Load Ratio
1	Chiang Saen	1968 - 1975	0.08	1.29	1994 - 2003	0.72	1.13	1985 - 1992	0.36	1.25	1993 - 2008	0.55	1.18	2009 - 2013	0.75	1.09
2	Luang Prabang	1985 - 1992	0.13	1.39	1997 - 2002	0.70	1.08	1985 - 1992	0.01	1.40	1993 - 2008	0.25	1.19	2011 - 2013	0.80	1.10
3	Chiang Khan	1967 - 1976	0.64	1.13	-	-	-							2009 - 2013	0.72	1.13
4	Vientiane	1962, 1968	0.83	1.42	-	-	-	1985 - 1992	0.06	1.41	1993 - 2008	0.41	0.99			
5	Nong Khai	1985 - 1992	0.59	1.07	1994 - 2005	0.48	1.24							2009 - 2013	0.78	1.08
6	Nakhon Phanom							1985 - 1992	0.34	1.31	1993 - 2008	0.51	1.11	2012 - 2013	0.82	1.22
7	Mukdahan	1985 - 1992	0.72	1.17	1993 - 2005	0.13	1.37							2009 - 2013	0.10	1.33
8	Khong Chiam	1966-1969, 1972-1980,1982-1986	0.63	1.14	-	-	-	1985 - 1992	-1.64	1.76	1993 - 2008	0.23	1.39	2009 - 2013	0.47	1.21
9	Pakse	1962, 1990	0.38	0.99	1997 - 2002	0.11	1.27	1985 - 1992	-0.07	1.64	1993 - 2008	-0.66	1.59	2011 - 2013	0.63	1.06
10	Strung treng	-	-	-	-	-	-	-	-	-	2004 - 2008	-0.16	1.55	2011 - 2013	0.70	1.20
11	Kratie	-	-	-	-	-	-	-	-	-	1995 - 2008	0.15	1.48	2011 - 2013	0.62	1.21

The summarises the results of QA/QC analysis from HM and EP dataset and selected database for each station as below. (Refer to report Sediment and Nutrient Data Available for DSF model Simulation).

Table 6-1: Statistics comparing correlation between Loadeset Estimation and Observation of Sediment data on the Mainstream

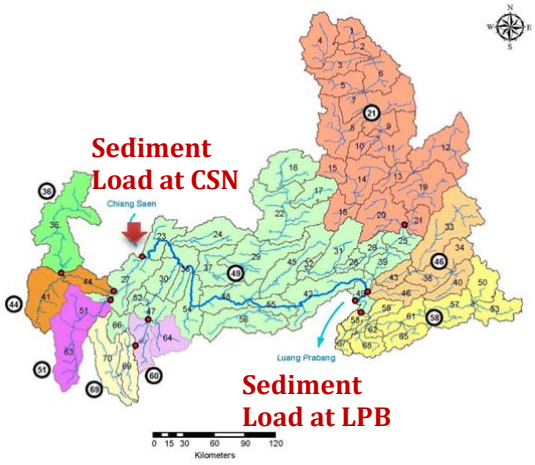
No	Station	Before Manwan Dam (1985 – 1992)	After Manwan Dam 1993 - 2008
1	Chiang Saen	EP	EP or scaled HM
2	Luang Prabang	~~Exclude~~	HM (investigate change in flow)
3	Chiang Khan	HM	~~None available~~
4	Vientiane	~~Exclude~~	~~Exclude~~
5	Nong Khai	HM	HM (1993 – 2003)
6	Nakhon Phanom	EP – scale high loads (>90th percentile) down by ~30%	EP
7	Mukdahan	HM-scale loads to achieve a catchment balance	~~Exclude~~
8	Khong Chiam	HM	~~Exclude~~
9	Pakse	Do not use this site for calibration. If this is not possible then use loads based on the mean of the EP TSS data set for calibration.	HM (with caution)
10	Strung Treng	~~Exclude~~	~~Exclude~~
11	Kratie	~~Exclude~~	~~Exclude~~

After discussion among Expert and modelling team, the mixing of two dataset with different measurement method might difficult to estimate and build understanding in this initial study, therefore the approach to use the lastest dataset of DSMP under IKMP that have more consistency than select by combine 2 different sources of data set.

The step to estimate sediment Load:

(1) The data from DSMP (2009-2013) will used to Estimate Sediment Load for year 1985 – 2008 using Loadest software, However some station in the middle reach will be consider to adjust based on sediment balance in River Basin.

(2) 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)



The SWAT model for each area can use the similar concept as flow calibration, using Observed Load (from loadest estimation) to be inlet then calibrated the area between 2 key monitoring stations.

(3) Sediment Load at Chiang Saen will be consider from EP dataset and downscale based on compare data from 2009-2013 between EP and DSMP dataset

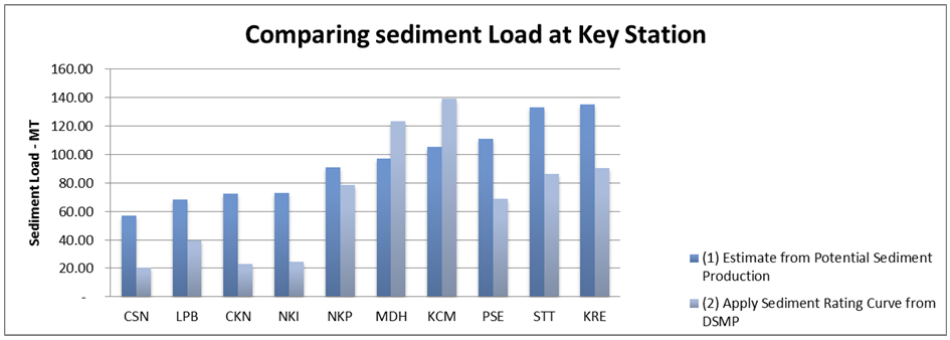
Estimation of Load using DSMP data (2009- 2013)

- Estimation from Potential Sediment Production can provide estimate Sediment for each sub area:

From China	A =	189,000	sq.km.	Sediment Yield =	300	T/sq.km.
CSN - LPB	A =	268,000	sq.km.	Sediment Yield =	149	T/sq.km.
LPB - CKN	A =	292,000	sq.km.	Sediment Yield =	148	T/sq.km.
CKN - NKI	A =	302,000	sq.km.	Sediment Yield =	148	T/sq.km.
NKI - NKP	A =	373,000	sq.km.	Sediment Yield =	280	T/sq.km.
NKP - MDH	A =	391,000	sq.km.	Sediment Yield =	280	T/sq.km.
MDH - KCM	A =	419,000	sq.km.	Sediment Yield =	280	T/sq.km.
KCM - PSE	A =	545,000	sq.km.	Sediment Yield =	46	T/sq.km.
PSE- STT	A =	635,000	sq.km.	Sediment Yield =	466	T/sq.km.
STT - KRE	A =	646,000	sq.km.	Sediment Yield =	182	T/sq.km.

- Then DSMP data from year 2009 -2013 was used to create "Sediment Rating Curved" for 10 stations, these equation then further to estimate Sediment Load from flow in year 1985-2008. However the measurement of DSMP data was starts from year 2009 that already have Dam in Upper Mekong that effect to Sediment Load in downstream i.e. Manwan Dam (1993), Dachaoshan Dam (2003), Jinghong Dam (2008) and Xiaowan Dam (2009). The further step to improved sediment Load at Chiang Saen to represent the situation of 1985 2008 is needed.

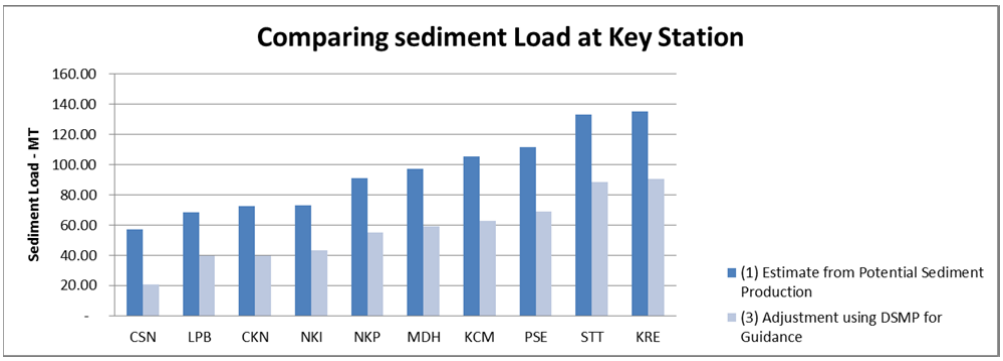
  The comparing of Load from potential of Sediment production with Loadest result from year 1985-2008 (using DSMP) is presented in graph below. Per suggestion from sediment expert that some station should be adjusted to get the realistic sediment budget for entire basin and consider possibility of sediment yield from each key tributary:
  The stations that need further adjust are:
    - Chiang Khan
    - Nong Khai
    - Nakhon Phanom
    - Mukdahan
    - Khong Chiam
    - Strung Treng



- Sediment yield (T/sq.km) from each tributary (Table 6-2 and 6-3) was used to estimate sediment from tributary to mainstream, this information will used to support when we do further adjustment. The adjust load as shown in graph below.

Station	*unit*	*CSN*	*LPB*	*CHK*	*NKI*	*NKP*	*MDH*	*KCM*	*PSE*	*STT*	*KTE*
Before Adjust											
Average Sediment Load	MT / year	20.66	39.74	23.23	24.90	78.61	123.59	139.62	68.72	86.32	90.41
Different between station	MT / year		19.08	-16.50	1.67	53.71	44.99	16.03	-70.90	17.60	4.09
Factor to consider											
1 Yield from area	T / sq.km	300	149	148	148	280	280	280	46	466*	182
2 Possible Sediment from Tributary	MT / Year		26.87	3.35	1.12	3.57	1.45	8.47	4.65	16.83	0.26
After Adjust											
Apply by Factor		none	none	increase 70 %	increase 73 %	reduce 30 %	reduce 52%	reduce 55%	none	increase 2.5 %	none
Average Sediment Load	MT / year	20.66	39.74	39.50	43.08	55.02	59.32	62.83	68.72	88.48	90.41
Different between station	MT / year		19.08	-0.24	3.58	11.95	4.30	3.51	5.89	19.76	1.93
Yield from area after adjust		109	241	-10	105	168	239	125	47	220	176

* too high yield



- Define sediment load at Chiang Saen, as per susgest the EP data will be use to estimate Load and will scale up by comparing EP and DSMP data during year 2009-2013 that both source have dataset.

Simulation Period (1985 -2008)

Station	Sediment Load from Area (T/Yr)	Cumulative Sediment Load (T/Yr)	Catchment Area km2	Sediment Yield T/km2	Percent of Total Load from Area (%)	Cumulative Percent of Total Load from Area (%)	Adjust by
CSN	80,298,642	80,298,642	189,000	425	54%	54%	-
LPB	19,078,132	99,376,774	79,000	241	13%	66%	-
CHK	(238,873)	99,137,902	24,000	(10)	0%	66%	increase 70 % - ignore
NKI	3,582,443	102,720,344	10,000	105	2%	68%	increase 73 %
NKP	11,945,057	114,665,401	71,000	168	8%	76%	reduce 30 %
MDH	4,299,654	118,965,055	18,000	239	3%	79%	reduce 52%
KCM	3,506,157	122,471,213	28,000	125	2%	82%	reduce 55%
PSE	5,888,996	128,360,209	126,000	47	4%	86%	-
STT	19,760,804	148,121,013	90,000	220	13%	99%	increase 2.5 %
KRE	1,932,870	150,053,883	11,000	176	1%	100%	-
Total	69,755,241	150,053,883		174			

Summary of adjustment was present in table 6-2 and table 6-4 is summary of Estimation of Sediment Load (in Million Ton) at calibration station from Loadest using for SWAT calibration

7. The Nutrient data analysis on the Mekong Mainstream

To be continued

Table 7-1: Estimation of Total Nitrogen Load (in Ton) at calibration station from Loadest using for SWAT calibration

Table 7-2: Estimation of Total Phosphorus Load (in Ton) at calibration station from Loadest using for SWAT calibration

Table 6-1: Estimation of Sediment Load at Key Station based on Potential Sediment Production, DSMP and adjustment

Station	Catchment Area		(1) Estimate from Potential Sediment Production			(2) Apply Sediment Rating Curve from DSMP			(3) Adjustment using DSMP for Guidance		
	Different	Total	Sediment Yield*	Load from Area	Cumulative Sediment	Load from Area	Cumulative Sediment	Suggestion	Load from Area	Cumulative Sediment	Adjust by
	sq.km.	sq.km.	T/sq.km.	(T/Yr)	(T/Yr)	(T/Yr)	(T/Yr)		(T/Yr)	(T/Yr)	
CSN	189,000	189,000	300	57.23	57.23	20.66	20.66		20.66	20.66	-
LPB	79,000	268,000	149	11.21	68.44	19.08	39.74		19.08	39.74	-
CKN	24,000	292,000	148	3.94	72.37	(16.50)	23.23	should adjust	(0.24)	39.50	increase 70 % - use with caution
NKI	10,000	302,000	148	0.48	72.85	1.67	24.90	should adjust	3.58	43.08	increase 73 %
NKP	71,000	373,000	280	18.12	90.97	53.71	78.61	should adjust	11.95	55.02	reduce 30 %
MDH	18,000	391,000	280	6.14	97.11	44.99	123.59	should adjust	4.30	59.32	reduce 52%
KCM	28,000	419,000	280	8.34	105.45	16.03	139.62	should adjust	3.51	62.83	reduce 55%
PSE	126,000	545,000	46	5.89	111.34	(70.90)	68.72		5.89	68.72	-
STT	90,000	635,000	466	21.80	133.14	17.60	86.32	should adjust	19.76	88.48	increase 2.5 %
KRE	11,000	646,000	182	2.07	135.21	4.09	90.41		1.93	90.41	-
Total		646,000	227.9		135.21		90.41			90.41	

note (1) Estimate from Potential Sediment Production (Refer to report : Potential Sediment production in LMB based on GIS analysis and sediemnt monitoring result, L Koehnken)

(2) Apply Sediment Rating Curve from DSMP (2009-2012) for year 1985 - 2008

(3) Adjustment using DSMP for Guildance (based on MT and Sediment Expert (L Koehnken) estimation

Table 6-3 : Estimated Sediment yield from calibration station

No.	Tributaries	Mekong Key Station	Sediment Monitoring Station				
			Station Name	Catchment sq.km.	Sediment Yield (T/Sq.km.)	Sediment Load (M Ton)	Accu Sediment Load (M Ton)
1	UPPER MEKONG	Mekong @ border					
2	NAM NUAO				178.42	0.41	0.41
3	NAM MA				178.42	0.20	0.61
4	B.KHAI SAN				178.42	0.14	0.75
5	NAM MAE KHAM				178.42	0.73	1.48
6	NAM PHO	Mekong @ Chiang Saen			178.42	0.51	1.99
7	NAM MAE KOK		Nam Mae kok at Chiang Rai	6,060	178.42	1.91	3.90
8	NAM MAE ING		Nam Mae Ing at Thoeng	5,700	52.05	0.38	4.28
9	NAM MAE NGAO				464.78	0.23	4.50
10	NAM NGAOU				464.78	0.69	5.20
11	NAM KEUNG				52.05	0.03	5.23
12	NAM NGAM				52.05	0.03	5.25
13	DOI LUANG PAE MUANG				52.05	0.04	5.29
14	NAM THA				464.78	4.14	9.43
15	NAM OU		Nam Ou at Muong Ngoy	19,700	464.78	12.10	21.53
16	NAM SUONG				464.78	3.06	24.59
17	NAM KHAN				464.78	3.48	28.07
18	NAM PHUONG				125.60	0.52	28.59
19	NAM BENG	Mekong @ Luang Prabang			125.60	0.27	28.86
20	NAM NGEUN				125.60	0.23	29.09
21	NAM TAM				125.60	0.19	29.28
22	NAM KHOP				125.60	0.19	29.47
23	NAM NAGO				125.60	0.13	29.60
24	NAM HOUNG				125.60	0.36	29.96
25	NAM SING				125.60	0.34	30.30
26	NAM POUL				125.60	0.26	30.56
27	NAM NHAH				125.60	0.04	30.60
28	MUANG LIEP				125.60	0.06	30.66
29	NAM NHIAM				125.60	0.25	30.91
30	B.NAM SONG				125.60	0.02	30.93
31	NAM PHONE				125.60	0.08	31.01
32	NAM KAI				125.60	0.08	31.09
33	NAM HEUNG				125.60	0.62	31.70
34	NAM LOEI	Mekong @ Chiang Khan	Nam Loei at Ban Wang Saphu	1,240	125.60	0.50	32.21
35	HUAI NAM HUAI				125.60	0.22	32.43
36	HUAI NAM SOM				125.60	0.13	32.56
37	NAM MI				125.60	0.13	32.69
38	PHU LUONG YOT HUAI DUA				125.60	0.06	32.75
39	NAM SANG				125.60	0.16	32.92
40	NAM TON	Mekong @ Vientiane			125.60	0.07	32.99
41	HUAI MONG	Mekong @ Nong Khai			125.60	0.34	33.33
42	PHU PA HUAK				125.60	0.02	33.34
43	NAM SUAI				125.60	0.16	33.50
44	HUAI LUANG				125.60	0.51	34.02
45	NAM NGUM		Nam Leak at Ban Hin Heup	5,115	137.57	2.33	36.34
46	H. KHOK				137.57	0.07	36.42
47	H.MA HIAO				137.57	0.14	36.55
48	NAM MANG				137.57	0.25	36.80
49	H.SOPHAY				137.57	0.03	36.83
50	NAM THONG				137.57	0.06	36.89
51	NAM NHIEP				136.65	0.63	37.52
52	NAM SANE				136.65	0.30	37.82
53	NAM KA DINH		Nam Theun at Ban Signo	3,370	136.65	2.03	39.85
54	NAM KADUN				136.65	0.06	39.91
55	H.BANG BOT				136.65	0.33	40.24
56	NAM THON				136.65	0.11	40.35
57	NAM MANG NGAI				136.65	0.09	40.44
58	NAM SONGKHRAM				52.26	0.69	41.12
59	HUAI THUAI				52.26	0.04	41.16
60	HUAI HO				52.26	0.04	41.20
61	NAM HINBOUN	Mekong @ Nakhon Phanom			136.65	0.35	41.54
62	SE BANG FAI		Se Bang Fai at Mahaxai	4,520	136.42	1.42	42.96
63	NAM MANG NGAI				136.65	0.13	43.09
64	NAM KAM		Nam Kam at Na Kae	2,360	52.26	0.18	43.27
65	HUAI MUK	Mekong @ Mukdahan			52.26	0.04	43.32
66	HUAI SOM PHAK				180.67	0.45	43.77
67	SE BANG HIENG		Se Bang Hieng at Ban Keng D	19,400	180.67	3.61	47.38
68	SE BANG NOUAN	Mekong @ Khong Chiam			136.42	0.42	47.79
69	HUAI BANG SAI				52.26	0.07	47.86
70	HUAI BANG HAAK				52.26	0.05	47.91
71	HUAI BANG I				52.26	0.08	47.99
72	H.BANG KOI				52.26	0.17	48.16
73	NAM MUN	Nam Mun at Pak Mun	Nam Mun at Ubon	104,000	21.43	1.51	49.68
74	NAM CHI				21.43	1.05	50.73
75	HUAI KHAMOUAN				21.43	0.08	50.81
76	TONLE REPOU				21.43	0.05	50.86
77	O TALAS				21.43	0.03	50.89
78	PREK MUN				21.43	0.01	50.90
79	SE DONE	Mekong @Pakse	Se Done at Souvannakhili	5,760	213.11	1.54	52.44
80	HUAI BANG LIENG				37.15	0.03	52.47
81	HUAI TOMO				37.15	0.10	52.57
82	SE KONG				466.00	13.43	65.99
83	SE SAN		Krong Ko Po at Trung Nghai	3,230	37.15	0.70	66.70
84	SRE POK	Mekong @Stung Treng	Sre Pok at Lomphat	25,600	70.31	2.18	68.87
85	PREK PREAH				37.15	0.09	68.96
86	PREK KAMPI				37.15	0.04	69.00
87	PREK KRIENG	Mekong @Kratie			37.15	0.12	69.13
TOTAL for Upper Kratie							**69.13**

Table 6-4 : Estimation of Sediment Load (in Million Ton) at calibration station from Loadest using for SWAT calibration

River	Gauge Name	Catchment Area Up to Gauging station (sq.km)			Average Sediment Load			Total Sediment Load (M ton/year) from Loadest Estimation					
	Name	Gauge station	SWAT Model	Area Different	Load	Yield	Yield	Observed			Estimated		
		sq.km	sq.km	sq.km	M T / Year	M T/sq.km.	M T/Ha	Min	Med	Max	Min	Med	Max
Mainstream	Mekong at Chiang Saen	189,000	193,766	189,000									
	Nam Ou at Muong Ngoy	19,700	20,130		9.2	464.78	4.65	0.02	5.04	160.60	0.00	5.77	127.39
	Nam Mae Kok at Ban Tha Ton	2,980	3,339		0.6	211.25	2.11	0.00	0.20	11.94	0.01	0.27	16.02
	Nam Mae kok at Chiang Rai	6,060	6,086		1.1	178.42	1.78	0.01	0.42	15.29	0.02	0.48	14.53
	Nam Mae Lao at Ban Tha Sai	3,080	3,093		0.2	69.30	0.69	0.00	0.06	3.87	0.00	0.09	4.67
	Nam Mae Ing at Thoeng	5,700	6,305		0.3	52.05	0.52	0.00	0.06	8.18	0.00	0.08	3.98
Mainstream	Mekong at Luang Prabang	268,000	273,866	79,000									
	Nam Loei at Ban Wang Saphung	1,240	1,238		0.2	125.60	1.26	0.00	0.01	14.56	0.00	0.03	11.53
Mainstream	Mekong at Chiang Khan	292,000	297,256	24,000									
Mainstream	Mekong at Vientiane	299,000	304,006	7,000									
Mainstream	Mekong at Nong Khai	302,000	307,233	3,000									
	Nam Leak at Ban Hin Heup	5,115	4,933		0.20	39.31	0.39	0.00	0.14	3.91	0.00	0.12	3.72
	Nam Ngum at Ban Pak Khanoung	14,300	13,680		0.25	17.40	0.17	0.02	0.49	3.39	0.03	0.40	2.89
	Nam Songkhram at Ban Tha kok Daeng	*4,650*	*5,139*		*0.02*	*4.30*	*0.04*	*0.01*	*0.96*	*39.42*	*0.01*	*0.22*	*39.79*
	Nam Theun at Ban Signo	3,370	3,455		0.2	45.55	0.46	0.00	0.19	3.37	0.00	0.20	3.51
	Se Bang Fai at Mahaxai	4,520	5,122		0.5	113.69	1.14	0.00	0.46	13.54	0.00	0.56	6.68
	Nam Kam at Na Kae	2,360	2,330		0.1	52.26	0.52	0.00	0.08	9.67	0.00	0.12	3.18
Mainstream	Mekong at Nakhon Phanom	373,000	375,706	71,000									
Mainstream	Mekong at Mukdahan	391,000	393,906	18,000									
	Se Bang Hieng at Ban Keng Done	19,400	19,340		7.0	361.34	3.61	0.01	0.96	39.42	0.01	0.74	39.79
	Se Done at Souvannakhili	5,760	5,653		1.2	213.11	2.13	0.00	0.56	23.69	0.00	0.49	20.29
Mainstream	Mekong at Khong Chiam	419,000	419,000	28,000									
	Huai Rai at Ban Non Kiang	1,370	1,575		0.1	60.41	0.60	0.00	0.01	1.90	0.00	0.02	2.18
	Nam Yang at Ban Na Thom	3,240	3,338		0.2	74.17	0.74	0.00	0.05	11.79	0.00	0.08	1.14
	Nam Chi at Ban Chot	10,200	10,910		0.2	20.64	0.21	0.00	0.05	2.18	0.00	0.06	4.49
	Nam Chi at Yasothon	43,100	47,110		1.2	28.88	0.29	0.00	0.64	29.27	0.00	0.78	11.24
	Nam Mun at Rasi Salai	44,600	44,830		0.6	12.97	0.13	0.00	0.12	45.26	0.00	0.22	8.87
	Huai Khayung at SaphanHuai Khayung	2,900	3,125		0.1	46.74	0.47	0.00	0.27	1.24	0.00	0.32	1.55
	Lam Dom Yai at Ban Fang Phe	1,410	1,525		0.1	42.95	0.43	0.00	0.04	1.20	0.00	0.05	0.82
	Nam Mun at Ubon	104,000	106,540		2.2	21.43	0.21	0.02	1.61	12.30	0.02	1.76	12.30
Mainstream	Mekong at Pakse	545,000	551,566	126,000									
	Krong Ko Po at Trung Nghai	*3,230*	*3,230*		*0.12*	*37.2*	*0.37*	*0.00*	*0.02*	*0.46*	*0.01*	*0.03*	*0.54*
	Se San (Dac Bla) at Kontum	*3,060*	*2,990*		*0.11*	*35.9*	*0.36*	*0.00*	*0.03*	*0.26*	*0.01*	*0.02*	*0.43*
	Sre Pok at Lomphat	*25,600*	*27,580*		*1.8*	*70.3*	*0.70*	*0.00*	*0.35*	*9.16*	*0.00*	*0.36*	*11.68*
	Sre Pok at Ban Don	*10,580*	*10,580*		*1.51*	*142.7*	*1.43*	*0.00*	*0.29*	*17.78*	*0.01*	*0.35*	*19.56*
Mainstream	Mekong at Stung Treng	635,000	641,146	90,000									
Mainstream	Mekong at Kratie	646,000	652,966	11,000									
	Kampong Thmar	*4,130*	*4,419*		*0.1*	*24.2*	*0.24*	*0.00*	*0.20*	*4.27*	*0.00*	*0.34*	*3.62*
	Kampong Thom	*14,000*	*13,790*		*0.68*	*48.6*	*0.49*	*0.00*	*0.05*	*0.81*	*0.01*	*0.07*	*0.54*

xxx = station from EP database

Table 7-1: Estimation of Total Nitrogen Load (in Ton) at calibration station from Loadest using for SWAT calibration

River	Gauge Name	Catchment Area Up to Gauging station			Total Nitogen			Total Nitrogen Load (Ton/year) from Loadest Estimation					
		Gauge station	SWAT Model	Area Different	Load Ton/Year	Yield T/sq.km.	Yield kg/Ha	Observed			Estimated		
								Min	Med	Max	Min	Med	Max
Mainstream	Mekong at Chiang Saen	189,000	193,766	189,000	46,790	0.25	2.48	7,191	30,733	235,425	4,855	32,960	288,715
	Nam Mae Kok at Chiang Rai	6,060	6,086		1,701	0.28	2.81	145	1,015	31,463	59	996	23,981
Mainstream	Mekong at Luang Prabang	268,000	273,866	79,000	73,811	0.28	2.75	10,549	36,865	327,770	4,271	32,741	952,650
Mainstream	Mekong at Chiang Khan	292,000	297,256					*No observed*					
Mainstream	Mekong at Vientaine	299,000	304,006	31,000	80,122	0.27	2.68	9,928	44,530	452,600	5,037	51,100	408,800
Mainstream	Mekong at Nong Khai	302,000	307,233					*No observed*					
	Nam SongKram at Ban Thakok Daeng	4,650	5,139		2,212	0.48	4.76	19	283	12,009	7	354	14,819
	Xebangfai at Mahaxay	4,520	5,122		3,694	0.82	8.17	191	4,052	38,325	40	2,807	46,720
	Nam Kam at Nakae	2,360	2,330		402	0.17	1.70	15	29	2,635	6	41	3,376
Mainstream	Mekong at Nakham Phnom	373,000	375,706	71,000	115,567	0.31	3.10	13,067	68,620	777,450	3,438	63,875	1,051,200
Mainstream	Mekong at Mukdahan	391,000	393,906					*No observed*					
	Se Bang Hieng at Ban Keng Done	19,400	19,340		9,791	0.50	5.05	442	2,300	101,835	227	1,719	148,920
	Se Done at Ban Souvannakili	5,760	5,653		3,341	0.58	5.80	307	741	19,929	118	956	15,002
Mainstream	Mekong at Khong Chiam	419,000	419,000	46,000	165,941	0.40	3.96	16,535	68,620	930,750	4,964	70,445	1,693,600
	Nam Chi at Ban Chot	10,200	10,910		923	0.09	0.90	0	190	14,089	0	159	10,439
	Nam Chi at Yasothon	43,100	47,110		5,545	0.13	1.29	30	3,128	36,865	26	3,212	54,750
	Nam Mun at Rasi Salai	44,600	44,830		3,016	0.07	0.68	4	334	32,631	5	329	30,624
	Nam Mun at Ubon	104,000	106,540		6,888	0.07	0.66	540	5,110	78,110	387	4,490	160,235
Mainstream	Mekong at Pakse	545,000	551,566	126,000	171,375	0.31	3.14	17,228	61,685	810,300	5,475	88,695	897,900
	Krong Ko Po at Trung Nghai	3,230	3,230		1,629	0.50	5.04	269	894	4,526	189	650	4,928
	Se San at Kontum	3,060	2,990		1,381	0.45	4.51	252	770	4,161	42	460	7,118
	Srepok at Ban Don	10,580	10,580		7,419	0.70	7.01	526	4,709	44,895	301	4,855	39,055
Mainstream	Mekong at Strung Treng	635,000	641,146	90,000	209,781	0.33	3.30	11,644	159,505	850,450	4,271	151,840	788,400
Mainstream	Mekong at Kratie	646,000	652,966	11,000	197,404	0.31	3.06	8,979	178,120	908,850	3,606	198,560	1,113,250

Great Lake Area

River	Gauge Name	Catchment Area Up to Gauging station			Total Nitogen			Total Nitrogen Load (Ton/year) from Loadest Estimation					
		Gauge station	SWAT Model	Area Different	Load Ton/Year	Yield T/sq.km.	Yield kg/Ha	Observed			Estimated		
								Min	Med	Max	Min	Med	Max
	Kampong Thmar	4,130	4,419					*No observed*					
	Kampong Thom	14,000	13,790					*No observed*					

Location : D:\WorkingSony\Nutrient_CS\3 Analysis_Loadest\summaryTOTN\4 TOTN_TributaryLMB_14Oct2015.xls

Table 7-2: Estimation of Total Phosphorus Load (in kg) at calibration station from Loadest using for SWAT calibration

River	Gauge Name	Catchment Area Up to Gauging station			Total Nitogen			Total Nitrogen Load (Ton / year) from Loadest Estimation					
	Name							Observed			Estimated		
		Gauge station	SWAT Model	Area Different	Load Ton/Year	Yield T/sq.km.	Yield kg/Ha	Min	Med	Max	Min	Med	Max
Mainstream	Mekong at Chiang Saen	189,000	193,766	189,000	5,018	0.03	0.27	1,044	3,230	23,944	199	2,862	37,960
	Nam Mae Kok at Chiang Rai	6,060	6,086		277	0.05	0.46	27	175	4,563	18	145	3,942
Mainstream	Mekong at Luang Prabang	268,000	273,866	79,000	7,566	0.03	0.28	730	3,869	47,450	82	3,176	92,710
Mainstream	Mekong at Chiang Khan	292,000	297,256					*No observed*					
Mainstream	Mekong at Vientaine	299,000	304,006	31,000	12,824	0.04	0.43	1,033	5,767	83,220	166	5,183	164,250
Mainstream	Mekong at Nong Khai	302,000	307,233					*No observed*					
	Nam SongKram at Ban Thakok Daeng	4,650	5,139		252	0.05	0.54	1	19	1,518	0	20	2,102
	Xebangfai at Mahaxay	4,520	5,122		224	0.05	0.50	1	37	2,938	0	28	4,088
	Nam Kam at Nakae	2,360	2,330		55	0.02	0.23	1	4	391	0	4	591
Mainstream	Mekong at Nakhom Phanom	373,000	375,706	74,000	15,792	0.04	0.42	1,591	7,519	76,285	646	6,388	152,570
Mainstream	Mekong at Mukdahan	391,000	393,906					*No observed*					
	Se Bang Hieng at Ban Keng Done	19,400	19,340		1,233	0.06	0.64	4	162	28,397	3	141	20,002
	Se Done at Ban Souvannakili	5,760	5,653		452	0.08	0.79	1	55	7,410	0	56	3,332
Mainstream	Mekong at Khong Chiam	419,000	419,000	46,000	16,733	0.04	0.40	1,789	7,410	91,250	380	7,629	106,215
	Nam Chi at Ban Chot	10,200	10,910		107	0.01	0.11	0	16	1,639	0	11	1,080
	Nam Chi at Yasothon	43,100	47,110		590	0.01	0.14	2	286	4,271	2	223	8,395
	Nam Mun at Rasi Salai	44,600	44,830		320	0.01	0.07	0	31	4,271	0	27	4,928
	Nam Mun at Ubon	104,000	106,540		1,278	0.01	0.12	35	416	10,038	6	398	8,468
Mainstream	Mekong at Pakse	545,000	551,566	126,000	21,025	0.04	0.39	1,139	7,008	136,875	286	6,205	160,235
	Krong Ko Po at Trung Nghai	3,230	3,230		271	0.08	0.84	21	91	891	11	83	1,102
	Se San at Kontum	3,060	2,990		240	0.08	0.79	18	82	850	12	59	1,095
	Srepok at Lomphat	25,600	27,580		3,613	0.14	1.41	2	704	18,980	3	712	12,520
	Srepok at Ban Don	10,580	10,580		1,635	0.15	1.55	53	796	13,542	51	668	18,980
~~Mainstream~~	~~Mekong at Strung Treng~~	~~635,000~~	~~641,146~~		~~89,476~~			~~2,033~~	~~13,177~~	~~708,100~~	~~142~~	~~12,739~~	~~441,650~~
Mainstream	Mekong at Kratie	**646,000**	**652,966**	**101,000**	**37,042**	**0.06**	**0.57**	**1,015**	**4,782**	**75,920**	**529**	**5,256**	**186,880**

Great Lake Area

River	Gauge Name	Catchment Area Up to Gauging station			Total Nitogen			Total Nitrogen Load (kg/year) from Loadest Estimation					
	Name							Observed			Estimated		
		Gauge station	SWAT Model	Area Different	Load Ton/Year	Yield T/sq.km.	Yield kg/Ha	Min	Med	Max	Min	Med	Max
	Kampong Thmar	4,130	4,419		743	179.9	1.799	9	102	916	2	55	971
	Kampong Thom	14,000	13,790		169	12.1	0.121	1	350	4,161	2	288	6,132

APPENDIX A: **QA/QC Sediment data on the Mekong mainstream**

APPENDIX B: **QA/QC Sediment data on the Mekong Tributary**

APPENDIX C: **QA/QC Total Nitrogen data on the Mekong mainstream**

APPENDIX D: **QA/QC Total Nitrogen data on the Mekong Tributary**

APPENDIX E: **QA/QC Total Phosphorus data on the Mekong mainstream**

APPENDIX F: **QA/QC Total Phosphorus data on the Mekong Tributary**