Mekong River Commission

Technical Support Division
Information and Knowledge Management Programme

DRAFT Working paper:

Baseline Selection for the Council Study Modelling Support

This paper discusses the issues and options concerning aspects of baseline selection for modelling support to the council study.

It is suggested that consideration be given separately to baseline selection for modelling support in terms of:

- **Hydrological Period**

For the hydrological period the longest period possible would best capture the variation in hydrology needed for flood and drought analysis in particular. Future climate changes such as reported by IPCC relate to a minimum 30 year baseline as recommended by WMO. For probabilistic analysis of impacts a period of 25-50 years are desirable. To demonstrate that a model can predict significant change such as in sediment loads it is very desirable to make use of the latest data collected to 2012/3. Flows can be naturalised where significantly affected by dam construction such as in the upper Mekong. It would also now be possible to extend prior to 1985 through use of the available record from countries with the global or regional gridded meteorological datasets though this would take additional effort in data preparation though much is already available in CCAI.

- **Infrastructure Baseline**

The Baseline Infrastructure used in the various DSF and WUP-FIN models should be consistent in the LMB for a specific moment in time (ie nominally 2000 or 2007 for example). As many changes are occurring in the basin consideration should be given, for example, as to whether salinity control structures and flood compartmentalisation in the delta, major road improvements in Cambodia, river bank and irrigation development in the upper part and urbanisation should be included. This is important not only for flows but also the sediment and nutrient and impact analysis. If necessary an up to date infrastructure together with a pre-dam situation in the Upper Basin could be used.

- **Land Cover and Land Use**

Similar to Infrastructure the Land Use and Land Cover needs to be appropriate for a specific year. IKMP mapping is available for 1993/7, 2003 and 2010.

14 April 2015

CONTENTS AMENDMENT RECORD

This report has been issued and amended as follows:

Issue	Revision	Description	Date	Signed
1	0	First Version of Documentation	21/01/2015	Henry
2	1	Second Version of Documentation (Baseline Information and option)	18/03/2015	Dat, Ornanong
3	2	Third Version of Documentation (Revised option for model)	25/03/2015	Anthony, Ornanong
4	3	Check	04/04/2015	Phan, Thanapon
5	4	Revised based on Comments from CCAI and additional information consistent with detailed workplan	14/04/2015	Dat, Ornanong,Anthony, Jorma

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Abbreviations

1D	One-dimensional hydrodynamic model
2D	Two-dimensional hydrodynamic model
3D	Three-dimensional hydrodynamic model
BDP	Basin Development Plan
BOD	Biological Oxygen Demand
CCAI	Climate Change and Adaptation Initiative
DHI	Danish Hydraulic Institute
DRIFT DSS	Downstream Response to Imposed Flow Transformation Decision Support System
DSF	Mekong River Commission Decision Support Framework
EIA	Environmental Impact Assessment
EP	Environment Programme
FIN	Finland
FMMP	Flood Mitigation and Management Programme
IBFM	Integrated Basin Flow Management
IKMP	Information and Knowledge Management Programme
IQQM	Integrated Quantity and Quality Model
IWRM	Integrated Water Resources Management
JICA	Japan International Cooperation Agency
LMB	Lower Mekong Basin
MRC	Mekong River Commission
MWRAP	Mekong Water Resources Assistance Programme
NCS	National Case Studies
PMFM	Procedures for the Maintenance of Flows on the Mainstream
SWAT	Soil and Water Assessment Tool
TACT	Technical Assistance and Coordination Team
TSLVP	Tonle Sap Lake and Vicinities Project
VTT	Technical Research Center of Finland
WUP	Water Utilization Programme
WUP-A	Component of WUP contracted to develop DSF
WUP-FIN	Finnish Component of WUP

1 Background

The Council Study was conceived in 2011 in response to the direct requests of the Ministers of the four Member Countries (MCs) of the Mekong River Commission to enhance the understanding of the negative and positive impacts of water-resource developments on people, economies, and the environment of the Lower Mekong River Basin (LMB). This study will fill knowledge gaps and reduce the uncertainty in estimating these impacts, providing the MCs with higher confidence information towards informed decision-making.

The positive and negative environmental and socio-economic impacts associated with several basin-wide water resources development scenarios in six development sectors or thematic areas will be assessed. The six thematic areas include irrigation, agriculture and land use change, domestic and industrial water use, flood protection structures and floodplain infrastructure, hydropower development, and navigation. Impact areas include a number of primary physical and environmental aspects which include:

- Fisheries and fish production including impacts of over-fishing and illegal fishing;
- Environmental condition/health, the definition of which will be agreed upon for the study;
- Biodiversity using internationally established indices;
- Hydrology/water quantity which include ground water;
- Water availability (drought);
- Flood;
- Food production;
- Sediment transport including delta sediment plume
- Morphological change including river bank and coastal erosion, river bank stability, effect of sand mining,; and
- Water quality including salinity intrusion;

And complex social and economic aspects such as the following:

- Food Security including impacts on food safety to the extent practicable;
- Quality of life based on either existing indices of United Nations (UN) organisations, or new indices developed specifically for the MRB;
- Flood risk; hazards, changes in direct and indirect flood damage or benefit, probabilities, impact of catastrophic events and Annual Average
- Drought risk;
- Human health, focusing on standard parameters used to assess health and Millennium Development Goals such as water borne disease;
- Social development including changes in cultural and traditional aspects of life. Impacts of demographic change will also be considered.
- Economic development;
- Employment with a focus on income generation; and
- The impact of climate change and the risk and opportunities it provides for instance in exacerbating or mitigating impacts will also be assessed.

2 Objective

The objective of this working paper to provide the information on baseline model for the Council Study and serves as a reference document for the MCs to make an informed decision on what baseline(s) to use for the Council Study.

When assessing positive and negative impacts of future development scenarios, the impacts will have to be measured in terms of “change in conditions” from a reference state or baseline. Baseline may represent past, current, or future condition as further explained in the following:

- Current baseline representing observable, present-day conditions.
- Future baseline representing projected future set of conditions that exclude the driving factor of interest (i.e., future baseline that already takes into account the impact of the full cascade of Chinese dams)
- Any other baseline that represents conditions in the past.

The choice of the baseline primarily depends on the management or technical question(s) that need to be answered. Another important consideration is the feasibility of completing the assessment within the given budget and schedule. Some baseline may require more budget and time than others depending on the availability of the data and the capability of the organization in implementing the methodology for constructing the baseline and the subsequent assessment of development scenarios against the baseline. It should be noted that multiple baselines can also be adopted to be able to answer several different management questions. For example, if the management question focuses on determining the future changes in conditions from the present-day due to future water resources developments, then a baseline that represents as close as possible the present-day conditions should be selected. However, the present-day baseline cannot be used to answer the management question related to determining the changes from historically natural or predevelopment conditions and so another baseline representing this historical condition should be selected.

3 Components of a Baseline for Simulation Modelling

A Baseline for a physically based model and linked impact tools such as used in the DSF and WUP-FIN modelling can be defined through its individual components which include the following:

- Hydrologic Period
- Level of Development
- Basin Characteristics (i.e., primarily land use)
- Operational Characteristics (i.e., Operational rules such for instance among others, maximizing hydropower energy for the operation of the hydropower dams; assumed percent efficiencies and return flows of irrigation practices; prevailing average water usage for domestic and industrial use)
- Socio-Economic Conditions

The baseline options for modelling will be derived through the permutations of primarily two components: (1) hydrologic baseline period, and (2) level of development. It should be noted however, that the appropriate land use will be selected to be compatible with the hydrologic period and level of development. Other basin characteristics (i.e., soil, topography), operational characteristics, and socio-economic conditions will be kept the same for all the baseline options and this is primarily due to the limited availability of data.

The hydrologic baseline period is selected with the hydro-meteorological data for this period is also used for the calibration and validation of the models (i.e., hydrologic, hydrodynamic, sediment, and water quality). Previous basin-wide scenario assessment studies such as the Basin Development Plan Phase 2 (BDP2) used a hydrologic period from 1985 – 2000. This is a relatively short hydrological period (16 years) that will not include the full range of extremes that could occur during the lifetime of infrastructure (roads, banks etc) or more extreme floods and drought. Extending this period to take advantage of more recent hydro-meteorological and environmental data (data available within MRC enables extension to 2008 or the global hydrological datasets of 100 years or more that are now available) would allow better analysis of extremes. Analysis of the longer flow records (eg 1910-2008 as recently used by FMMP) account for any changes in hydrology that may have been caused by significant water resource developments within the LMB. A longer hydrological baseline is certainly an option that should be considered.

The climatic baseline is a reference period upon which the future climate change scenarios will be applied. To be distinguished from the WMO's 30-year climate baseline for analysis of current climate change, from now on the climatic baseline of the Council Study will be called climate change reference period. The choice of climate change reference period has often been governed by availability of the required climate data and ideally should be the same as the hydrologic baseline period. At the moment, the future climate change scenarios proposed by CCAI using pattern downscaling and bi-linear interpolation of SimCLIM software are calculated for the 20-year climate change reference period 1986-2005

The level of development is normally mostly associated with a specific year. For example, the baseline used for BDP2 was based on the level of development in the year 2000. Options for a level of developments that represent present-day conditions (as closely as possible depending on availability of data) and desired predevelopment conditions should be considered also. Depending on data available for each of the thematic areas, it is also possible that the level of development is a composite from different years (i.e., using a different year to represent the development level for one thematic area, and another year for another thematic area).

4 Data status for Baseline Model

4.1 Key Input data in River Basin for justify base Year for Council study

The data provided from member countries to use for model simulation compose of Time series data (Hydro-meteorological data), spatial data (Topography, Soil, Land use), Crop/irrigation information, Domestic Data (population and water use rate) and infrastructure data (HP Dam, Flood Protection). The status of data is shown in Table 4-1.

As the request and support from MC to update Time series data though PDIES procedure to expand hydrological data up to year 2008, to provide more realistic of hydrologic cycle and including extreme flood and drought situation that occur inside Lower Mekong Basin, therefore the capacity of DSF is able to simulation situation from year 1985 – 2008 as requested.

To justify for base year situation to represent the baseline scenario, we are considering the suitable and reliable information and data that can found inside MRC with support from MC. The main key inputs to consider are (1) Land use (2) Situation of Hydropower dam (3) Irrigation Water Use (4) Domestic and Industrial Water Use.

The detail of the data which provided by the NMC was descripting in the Working Paper namely: Review data_MT.docx which was submitted at the TACT meeting on 03-04 Feb 2015.

Table 4-1. Baselines Data status

(a) China down to Kratie, and around Cambodia Great Lake (for SWAT/IQQM)

Item	Station	Frequency	Status	Source
Spatial Data				
Topography (DEM)	-	-	2000	MRCS
Landuse / Land Cover Map	-	-	2003	MRCS, NMCS
Soil Classification Map	-	-	2002	MRCS, NMCS
Stream Network	-	-	2010	MRCS
Climate and Hydrological Data				
Climatic Data				
Maximum and MinimumTemperature	56	Daily	1985 - 2000	MRCS, NMCS
Relative Humidity	59	Daily	1985 - 2000	MRCS, NMCS
Wind Speed	56	Daily	1985 - 2000	MRCS, NMCS
Sunshine	55	Daily	1985 - 2000	MRCS, NMCS
Rainfall	333	Daily	1985 - 2000	MRCS, NMCS
Flow	97	Daily	1985 - 2000	MRCS, NMCS
Sediment data	60	monthly	1985 - 2000	MRCS, NMCS
Crop / Irrigation Data				
Crop Calendar	-	-	2000, 2007	MRCS (WUP, BDP)
Irrigation Efficiency	-	-	2000	MRCS (WUP)
Crop Type	-	-	2000	MRCS (WUP)
Crop Factor	-	-	2000	MRCS (WUP)
Statistic of Irrigation area	-	-	1985 - 2000	MRCS (WUP)
Irrigation Area	-	-	2000, 2007	MRCS (WUP, BDP)
Domestic Data				
Population	-	-	2000, 2007	MRCS (WUP, BDP)
Rate of water use	-	-	2000, 2007	MRCS (WUP, BDP)
Reservoir Data				
Reservoir Characteristic	-	-	2007	MRCS (BDP)
Release data	-	Daily/ Monthly	1985 - 2000	NMCS
Location of Hydropower data (Existing, Planned)	-	-	-	MRCS (BDP)
Rule Curve for HP Dam	-	-	-	MRCS (BDP)

(b) Around Cambodia Great Lake and Mekong Delta (for ISIS model)

No	Item	Station	Parameter	Status of the Data Input		
				Year 1998 - 2000	Year 2007 - 2008	Year 2009 - 2012
Climate and Hydrological Data						
1	Flow Kratie	1		Rating curve Modelled	Rating curve Modelled	Rating curve Rating curve
2	Flow around GreatLake (Tributaries)	13	Daily	Measurement Modelled	Modelled Rating curve	Rating curve
3	Rainfall + Evaporation					
	Cambodia	7	Daily	Observed	Observed	Observed (Not all)
	Vietnam	5	Daily	Observed	Observed	Observed
4	Downstream Boundaries					
	Water level	7	Hourly	Observed	Observed	
			Daily	Observed	Observed	Observed
	Salinity	7	Hourly	Observed	Observed	
			Daily	Observed	Observed	Observed
5	Irrgation + Water demand		Daily	Modelled (issue with rainfed area)	Modelled	Modeller
6	Flow Key station and Interior Field					
	Cambodia	10	Daily	Measurement (Not all)	Measurement (Not all)	
	VietNam	6		Measurement	Measurement	Measurement
Basin Feature						
1	*Terrain*					
	DEM			Develop 2003	No change	No change
	Flood cell				2007	
	River *Channel/Canal System* *Embankment*			2000	2007 (Not all)	
2	*Infrastructures*					
	Sluice	*94*		Full	Full	Not enough
	Rubber Dam	*2*				
3	*Regulated (Rule curve)*					
	Schedule of the Opreration Gate	*32*	*Weekly*	Observed	Observed	Not enough
4	*Salinity*					
	Key station and Interior Field	*14*	*Hourly*	Observed	Observed	Not enough
5	*Water Quality*					
	Sedimend	48	Daily	Measurement	Observed	Observed (Not all)
	Nutrient	32				
Other resources						
1	*Dimension Volume*		Seasonal	Measurement Modelled	No Modelled	No

(1) ***Land Use:*** Currently land use data that MRC carried for 4 member country have 3 sets:

- Year 1997: Land Cover MRCs Landcover/Landuse map was derived from interpretation of satellite images for 1993 and 1997 under the Forest Cover Monitoring Project (MRC, 1998).

- Year 2003: Land Cover MRCs has been classified from satellite imagery with field observation, as undertaken by individual countries in 2002-2003 and compiled by the Food and Agriculture Organization (FAO). Land use can be broadly divided into three major components; Paddy, Forested Land and Land Cultivated for filed crop.

- Year 2010: The Land cover 2010 is based on a synthesis of the results of field surveys coupled with interpretations of satellite imagery. Field surveys was conducted to cover 9,357 points in 703 areas across the Lower Mekong Basin. The land cover data set covers both the dry and wet seasons in 2009 and 2010 as well as a separate annual data comprising a combination of the two. The annual map for 2010 shows that broadleaved deciduous forest and paddy rice accounted for more than half the land cover of the Lower Mekong Basin. Shrubland was the next most common type of land cover followed by broadleaved evergreen forest, annual crops, industrial plantations and urban areas. Broadleaved deciduous forest alone accounted for 30 percent of the basin's land cover, up from 20 percent in the previous map of land cover produced for 2003. Paddy rice accounted for 22 percent, down from 25 percent. In addition to providing updated estimates for other types of land cover, the map for 2010 also features new seasonal crop data for shrimp rotating with paddy rice between the dry and wet seasons and paddy rice rotating with annual crops. However, Land use 2010 was presented for approval by TACT on 3 Feb 2015 for public and using for other study.

2) Dam Development at Current Situation (until Year 2012)

The information about Hydropower dams data in the Mekong basin that prepared by BDP (sources: Hydropower Sector Review for joint basin planning process report 2009) was used for improvement DSF model. The location and operation year of hydropower projects in Upper and Lower Mekong basin has shown in Figure 4-1, 4-2 , Table 4-2 and can summary as below:

Year	China	Cambodia	Laos	Thailand	Vietnam
Before2000	Manwan	O Chum 2	Xelabam,Nam Dong,Nam Ngum 1,Xeset 1,Nam Ko,Theun-Hinboun,Houayho, Nam Leuk	Ubol Ratana, Nam Pung, Sirindhorn,Chulabhorn, Huai Kum, Pak Mun	Dray Hlinh 1
2001			Nam Ngay		Yali
2002					
2003	Dachaoshan				
2004			Nam Mang 3		
2005					
2006					Se San 3
2007					Dray Hlinh 2, Se San 3A
2008	Jinghong				Plei Krong, Se San
2009			Nam Theun 2, Xekaman 3, Xeset 2		Se San 4, Buon Tua Srah, Buon Kuop, Sre Pok 3, Sre Pok 4
2010	Xiaowan		Nam Ngum 2, Nam Lik 1-2		
2011			Nam Ngum 5, Xekaman 1, Xekaman-Sanxay		Upper Kontum
2012	Nuozhadu				

3) Irrigation Data: Irrigation information for entire LMB was collected base on year 2000 and 2007that was used for model setup process.

- Year 2000; WUP was collected irrigation data in year 2000 through NMC. The main data are existing irrigation data on maximum area for primary crop, minimum area for primary crop, minimum area for secondary crop, and total area. The basic irrigation factor such as crop calendar/pattern, crop factor, irrigation efficiency and statistic of irrigation from year 1985-2000 also included.

- Year 2007; BDP phase II was collected irrigation data in year 2007 and used for scenario alternative in basin development plan. The data consist of existing irrigation data on maximum area for primary crop, minimum area for primary crop, minimum area for secondary crop, and total area. (see Regional Irrigation Sector Review for Joint Basin Planning Process Report, March 2009)

Table 4-2: Current situation of Dam Development in Mekong River Basin

Country	*Dam Name*	*Year*	BF	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
CN	Manwan	1995			■	■	■	■	■	■	■	■	■	■																		
CN	Dachaoshan	2003														■	■	■	■	■	■	■										
CN	Jinghong	2008																				■	■	■	■	■	■					
CN	Xiaowan	2010																			■	■	■	■	■	■	■	■	■			
CN	Nuozhadu	2012																					■	■	■	■	■	■	■	■	■	
CA	O Chum 2	1992									■																					
LA	Xelabam	1969	■																													
LA	Nam Dong	1970	■																													
LA	Nam Ngum 1	1971	■																													
LA	Xeset 1	1994							■	■	■	■	■																			
LA	Nam Song diversion	1996													■																	
LA	Nam Ko	1996													■																	
LA	Theun-Hinboun	1998															■															
LA	Houayho	1999																■														
LA	Nam Leuk	2000																	■													
LA	Nam Ngay	2001																		■												
LA	Nam Mang 3	2004																					■									
LA	Nam Theun 2	2009																										■				
LA	Xekaman 3	2009																										■				
LA	Xeset 2	2009																										■				
LA	Nam Ngum 2	2010																											■			
LA	Nam Lik 1-2	2010																											■			
LA	Nam Ngum 5	2011																												■		
LA	Xekaman 1	2011																												■		
LA	Xekaman-Sanxay	2011																												■		
LA	Theun-Hinboun expansion	2012																													■	
LA	Theun-Hinboun exp. (NG8)	2012																													■	
TH	Ubol Ratana	1966	■																													
TH	Nam Pung	1965	■																													
TH	Sirindhorn	1971	■																													
TH	Chulabhorn	1972	■																													
TH	Huai Kum	1982	■																													
TH	Pak Mun	1994											■																			
TH	Lam Ta Khong P.S.	2001																		■												
VN	Dray Hlinh 1	1990							■																							
VN	Yali	2001																		■												
VN	Se San 3	2006																							■							
VN	Dray Hlinh 2	2007																								■						
VN	Se San 3A	2007																								■						
VN	Se San 4	2009																										■				
VN	Plei Krong	2008																									■					
VN	Se San 4A	2008																									■					
VN	Buon Tua Srah	2009																										■				
VN	Buon Kuop	2009																										■				
VN	Sre Pok 3	2009																										■				
VN	Sre Pok 4	2009																										■				
VN	Upper Kontum	2011																												■		

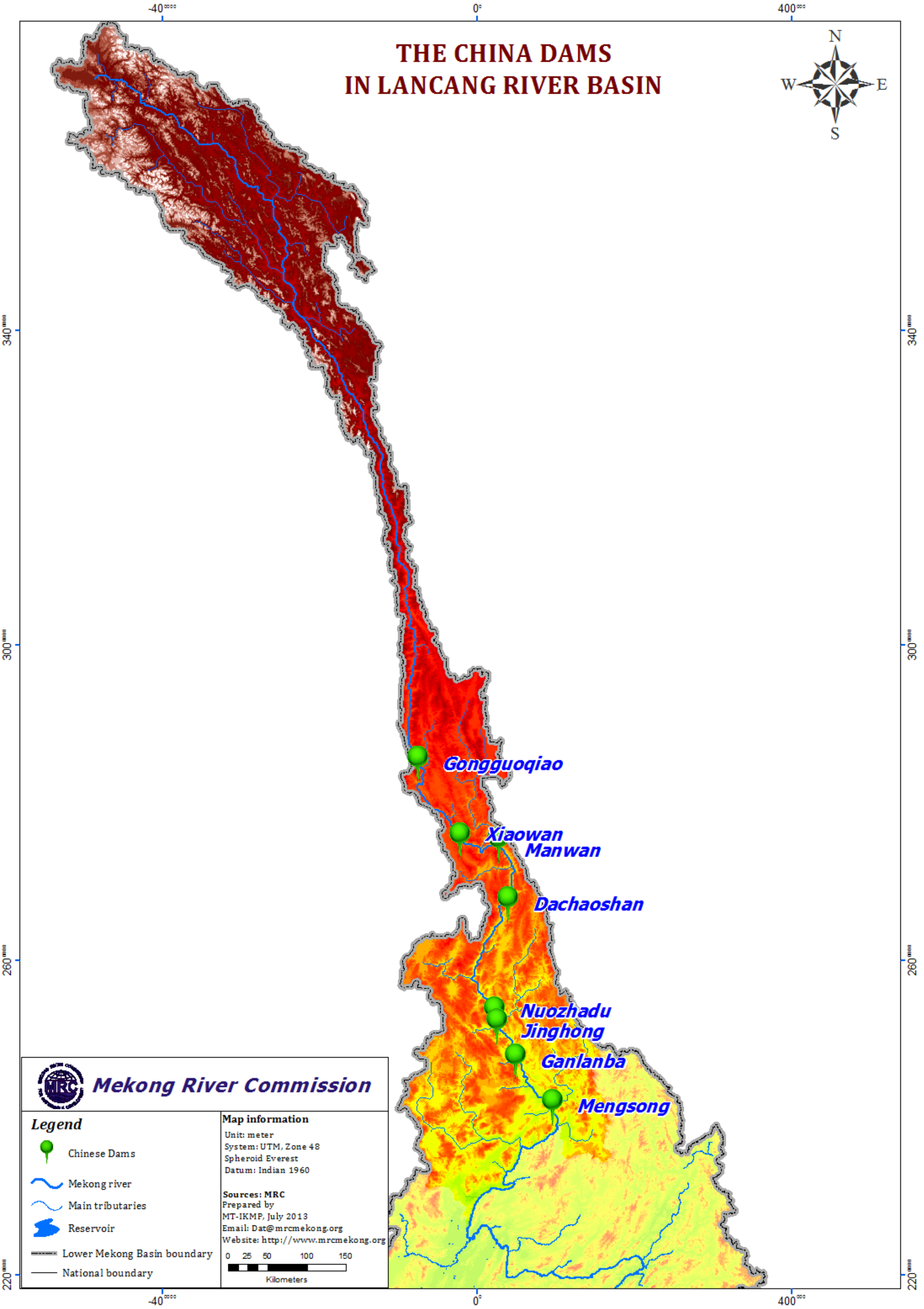

Figure 4-1 Location of Hydropower Dam in Upper Mekong River

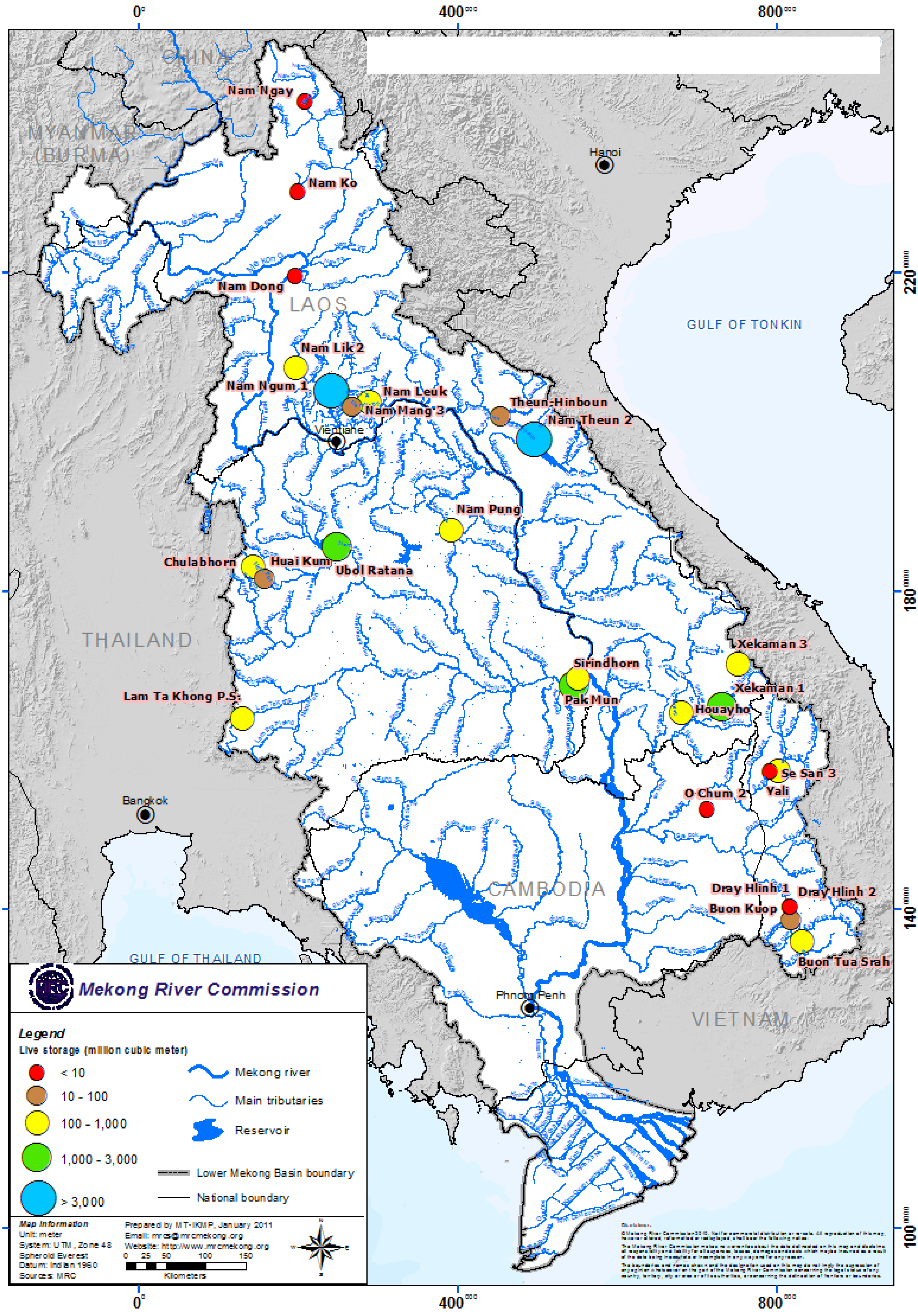

Figure 4-2: Current situation of Dam in Lower Mekong River (up to year 2012)

4) Domestic and Industrial Water Use: Information for estimated D&I :

Water use was calculated using population and rate of water use. The information was based on year 2000 (WUP) and 2007 (BDP) statistics.

5) Records of Flood

The floods of 2008 and 2011 were significant in different parts of the basin and extensive monitoring such as flood extents from Satellite imagery and ground stations is available that can be used for calibration and to greatly enhance the credibility of the model outputs.

An increased level of control and compartmentalization after the 2000 flood is clear from the satellite monitoring available for the Cambodian floodplain and Vietnam delta. Within Lao and Thailand flood infrastructure such as at Vientiane and Chiang Rai has also been improved in recent years.

6) Records of saline Intrusion

The dry year of 1998 for which salinity measurements are available at MRCS could potentially be enhanced by newer measurements for more recent dry years such as 2010. 1998 may be thought of as a near natural condition whereas in later years there was significantly increased infrastructure in the form of control gates and banks. The operation of the salinity control infrastructure takes account of the needs for most rice farmers and farmers requiring brackish water for shrimp and this results in complex operations which are not easy to include in the model. At the present time more recent records are not available at MRCS.

7) Sediment Transport

Considering the available data as of 2012, the sediment data come from three different programmes of work:

- The first programme is started in 1960 within the framework of the Lower Mekong Project under the US Agency for International Development fund. 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), 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

- The second source of data is the Water Quality Monitoring Network Programe 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).

- The monitoring programme 2010-2012 under the Discharge and Sediment Monitoring Project (DSMP) of the MRC was successful in obtaining much new data. 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).

4.2 Baseline situation in the current MRC- DSF inside MT-IKMP

(1) **Base Year Situation for Infrastructure developed by WUP-A for year 2000**: this situation was used by Basin Development Plan Programme, Phase II (2009) after consulting with RTWG and MRC Programme with the JC has approved the scenario classification in principle on August 2008.

This represents the development conditions (physical and management characteristics) that existed in the year 2000. Physical conditions include climate; land use; public and industrial water demand; irrigation areas; cropping pattern, and delivery infrastructure; storage characteristics (location, size, shape and outlet structures) and hydraulic conveyance and flood storage. Management conditions include operating rule curves for storages; water allocation policies; and operation rules for salinity barriers. At the basin scale, this baseline still represents the natural situation, since there is as yet no statistical evidence of man or climate induced change to the hydrological regime of the Mekong mainstream.

(2) **Base Year Situation for year 2007**: this situation was used to simulate situation based on the latest data from member countries in infrastructure inside basin during 2000-2007; public and industrial water demand; irrigation areas; cropping pattern plus the hydropower cascade that is being developed on the Lancang River in the Upper Mekong Basin, such as Manwan Dam (1995) and Dachaoshan Dam (2003)

Table 4-2 Comparison of Long Term Average Discharge at Chiang Saen for different periods.

Condition in River Basin	Base Year Situation on Year 2000	Base Year Situation on Year 2007
Physical Condition		
Climate Data	1986 - 2000	1985 - 2008
Land use Data	2003	2003
public and industrial water demand	2000	2007
Irrigation areas	2000	2007
Cropping pattern	2000	2007
Delivery infrastructure	2000	2007
Storage characteristics	2000	2007
Hydraulic conveyance	2000	2007
Flood storage	2000	2007
Management Conditions		
Operating rule curves for storages	2000	2007
Water allocation policies	2000	2007
Operation rules for salinity barriers	2000	2007

4.3 Analysis for the Hydrological condition at Chiang Saen and Kratie

The analysis for the hydrological condition was made at 2 key stations in Mekong mainstream (1) Chiang Saen (2) Kratie presents the flow change during 1985-2013 for further consideration about the base year. The analysis result shown that, flow condition in year 2007 quite close to the long term average flow, therefore if we define base year as 2007 it is helpful when for initial simulation before a long term record is analyzed.

At the basin scale, this baseline still represents the natural situation, since there is as yet no statistical evidence of man or climate induced change to the hydrological regime of the Mekong mainstream.

Table 4-3 Comparison of Long Term Average Discharge at Chiang Saen for different periods.

Chiang Saen	Annual	Dry Season	Wet Season
Longterm Average 1985-1994 (No Dam)	2,541	1,177	3,905
Longterm Average 1995-2002 (Manwan)	2,835	1,152	4,519
Longterm Average 2003-2006 (Dachaoshan)	2,307	1,028	3,586
Longterm Average from 2007-2009 (JingHong)	2,631	1,207	4,056
Longterm Average 2010-2013 (Xiaowan)	2,298	1,301	3,294
Longterm Average 1985-2013	2,566	1,170	3,962
Annual Discharge			
Year 2000	3,192	1,303	5,082
Year 2003	2,126	1,015	3,237
Year 2007	2,486	1,094	3,878

Table 4-4 Comparison of Long term average Discharge at Kratie

Kratie	Annual	Dry Season	Wet Season
Longterm Average 1985-1994 (No Dam)	11,836	3,406	20,265
Longterm Average 1995-2002 (Manwan)	14,259	4,358	24,161
Longterm Average 2003-2006 (Dachaoshan)	12,904	3,981	21,826
Longterm Average from 2007-2009 (JingHong)	13,115	4,185	22,044
Longterm Average 2010-2013 (Xiaowan)	12,293	3,676	20,911
Longterm Average 1985-2013	12,847	3,866	21,828
Annual Discharge			
Year 2000	17,439	5,095	29,783
Year 2003	11,322	4,265	18,379
Year 2007	12,504	4,098	20,910

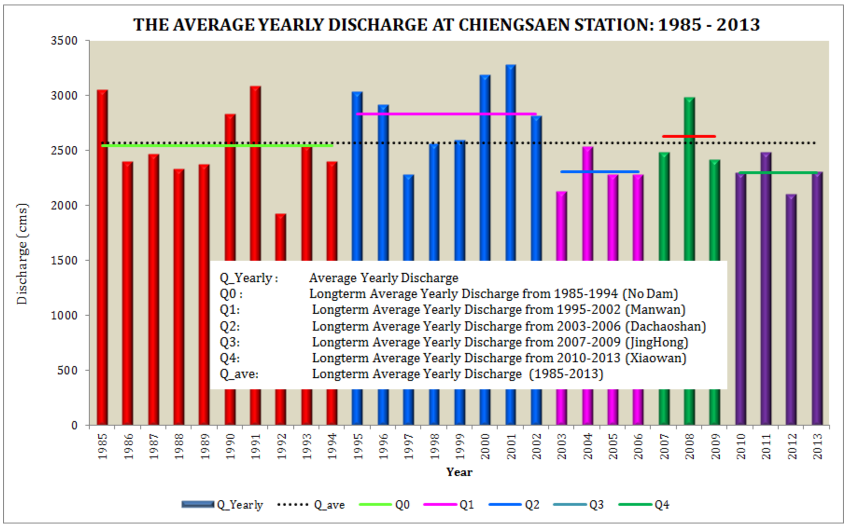

Figure 5-1 The average yearly discharge at Chiang Saen station 1985-2013

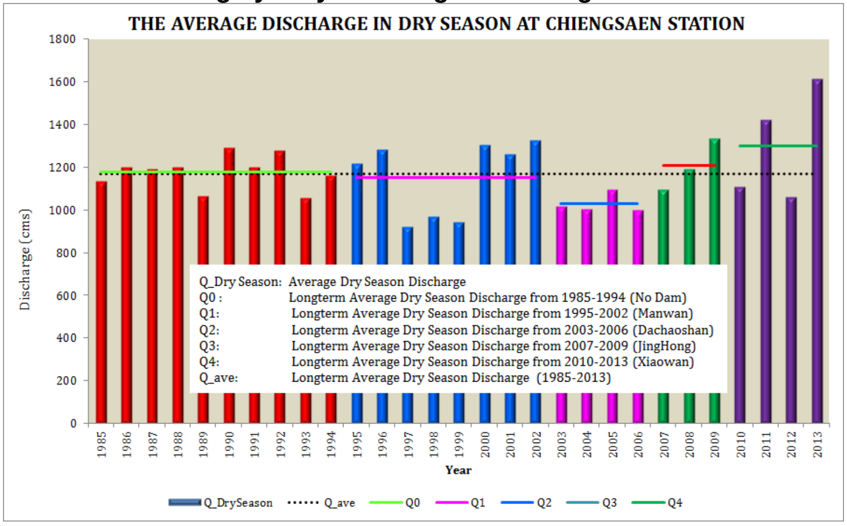

Figure 5-2 The average dry season discharge at ChiangSaen station 1985-2013

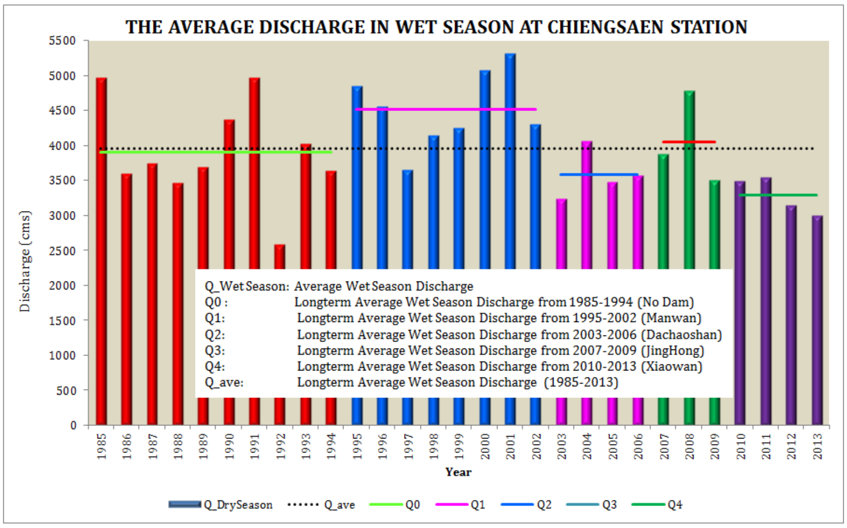

Figure 5-3 The average wet season discharge at ChiangSaen station 1985-2013

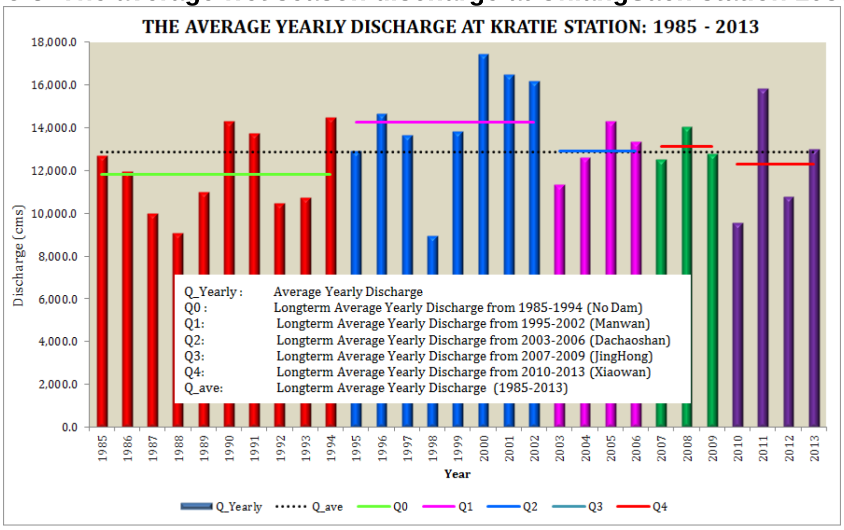

Figure 5-4 The average yearly discharge at Kratie station 1985-2013

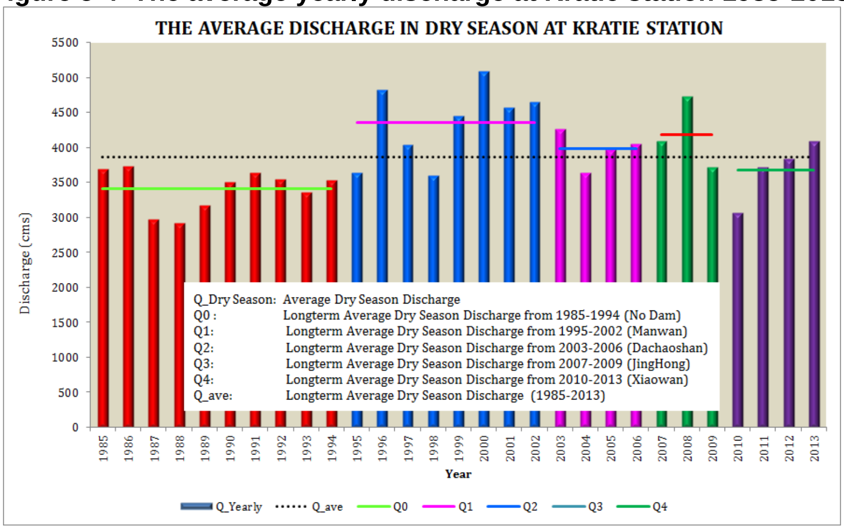

Figure 5-5 The average dry season discharge at Kratie station 1985-2013

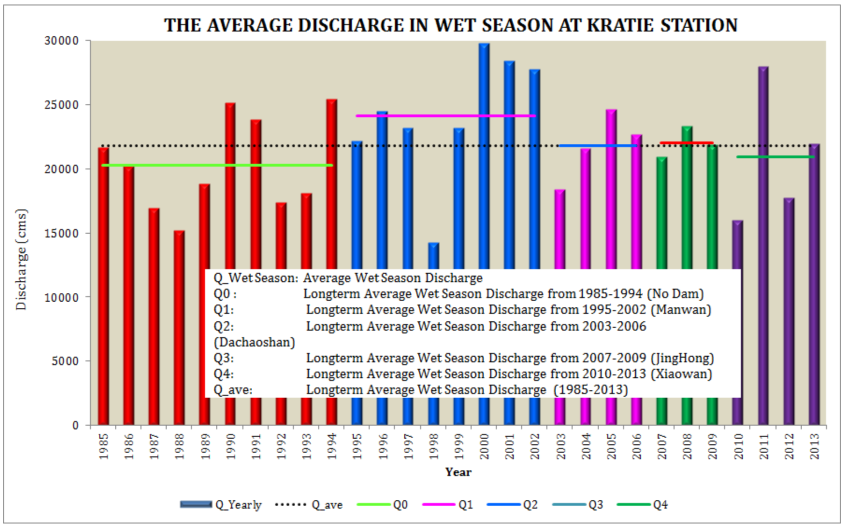

Figure 5-6 The average wet season discharge at Kratie station 1985-2013

5 Baselines Used in Other Studies

Table 5-2 shows adopted baselines for past and ongoing impact assessment studies in the LMB such as the BDP2, Strategic Environmental Assessment (SEA), and Mekong Delta Study (MDS).

(a) Level of Development

The choice of what baseline year was used for BDP2 and MDS was based on the management question that need to be answered and the availability of data. For BDP2, the baseline was chosen to represent natural hydrologic conditions in the Mekong River so that impacts of water resource developments can be against it. The Year 2000 was chosen because it represents near natural hydrologic conditions and data were available to completely and reasonably represent basin-wide water use data (hydropower dams, irrigation, and domestic and industrial water use). For MDS, the management consideration was for the baseline to represent the present-day conditions as recently as possible depending on availability of data. The Year 2007 was chosen which accounts for the influence of the Chinese dams. For SEA, the baseline was chosen to represent a baseline condition in the future (i.e., 2015) that accounts for the six Chinese dams, 40 LMB tributary dams, projected extent of irrigation, and projected domestic and industrial water use but not the LMB Mainstream dams. The management question that needed to be answered is to determine the impacts that can be solely attributed to the Mainstream dams.

(b) Hydrological Period

As noted earlier, the baseline hydrologic period for BDP2 and MDS were selected to include the range of temporal flow fluctuation associated with the baseline condition. For BDP2, the hydrologic period was chosen to be from 1985-2000. The DSF model which was used to determine hydrologic impacts associated with future development scenarios was successfully calibrated and validated to reasonably simulate the hydrologic conditions of the baseline period.

For MDS, the baseline hydrologic period was extended up to 2008 with plans to further extend it to 2012. Similarly, the DHI Mike models were successfully calibrated and validated to reasonably simulate the hydrologic conditions of the baseline period.

For the SEA Study, the baseline hydrologic period is not applicable since a hydrologic model was not directly used to assess the impacts.

Table 5-1. Baselines Used in Past and Ongoing Impact Assessment Studies.

Baseline Components	BDP2 (2010)	SEA* (2010)	MDS (ongoing)	CCCAI IKMP (ongoing)	FMMP CCAI IS (ongoing)
Level of Development	2000 Includes existing HEPs in 2000	2015 (Definite Future Scenario) 6 Chinese Dams 0 LMB Mainstream Dam 40 LMB Tributary Dams Irrigation = $4x10^6$ ha Water Supply = 2,938 $x10^6$ m3	2007 Extended based on influence of Chinese dams	2007	2013
Hydrologic Period	1985-2000	Not Applicable	1985 – 2008 (ongoing activities to extend to 2012)	1985 – 2008	1985 – 2008
Basin Characteristics - Land Use/Land Cover	2003		Composite from MRC (1999-2002), Cambodia land use (2002), and USGS for UMB	2003	2003
Operational Characteristics – Hydropower	Maximum hydropower energy production		2007	As BDP2	As BDP2
Operational Characteristics – Irrigation	10-14 percent return flow		2007	As BDP2	As BDP2
Socio-Economic Conditions	2008-2009		2010- 2011	TBA	TBA

(c) Other Baseline Components

While the other baseline components such as land use, operational characteristics, and socio-economic conditions have to be compatible with the selected baseline level of development, they were chosen primarily based on availability of data. For example, the socio-economic data used for BDP2 was from 2008-09 which is closer to present-day conditions instead of being more consistent with the 2000 level of development.

6 Baseline Options for the Council Study

As noted earlier, the baseline options for the Council Study are based primarily on variations of the two baseline components: (1) hydrologic period, and (2) level of development, and using a compatible land use. Table 6-1 shows five baseline options for consideration, with the first two options (Options 1 and 2) representing the options that use existing modelling set up and thus could be completed more quickly.

Table 6-1: Baseline Options for the Council Study.

Baseline Option	Hydrologic Period	Development Level (HP and Water Used)	Land use
Option 1: Base Year Situation on Year 2000	1986–2008	2000	2003
Option 2: Base Year Situation Year 2007	1985-2008	2007	2003
Option 3: Base Year 2007, extended hydrology to near present day	1985-2012	2007	2003
Option 4: Base Year 2011, extended hydrology to near present day	1985-2012 (naturalise flows and sediment flux from UMB)	Current day 2011/2 (possible removal of UMB dams from baseline)	2010
Option 5: Base Year 2011, extended hydrology to 63 years variability	1950-2012 (naturalise flows and sediment flux from UMB)	Current day 2011/2(possible removal of UMB dams from baseline)	2010

Option 1 – Base Year Situation on Year 2000, Natural Conditions Similar to Baseline Used by WUP and BDP2 1985-2000

This option represents near natural conditions of the mainstream hydrology (based upon statistical analysis of data) with Year 2000 selected for the development level and the period 1986 to 2000 for the hydrologic period. Since this option is the same baseline that BDP2 used, then the Council Study may be able to take advantage of the BDP2 database and enhance it with more recent collected data.

Option 2 – Base Year Situation on Year 2007, latest database without significant change 1985-2008

This option represents near present-day conditions with Year 2007 selected for the development level and the period 1985 to 2008 for the hydrologic period. Since this option is the same baseline that MT-IKMP present in TACT meeting on 3-4 Feb 2015, and involved National modeler/Expert to verify model on Mar 2015, therefore it will be reduce time to set-up, calibration and verification Baseline scenario for council study.

Option 3 – Base Year Situation on Year 2007, latest database without significant change from year 2000 with further extension to 2012

The hydrological baseline to 2008 does not include major events such as 2011 flood for which much data is available. For this option the hydrological baseline should thus be extended

Remark*: This option, IKMP have to spent time for check quality of extended data 2009-2012 before using for model simulation.*

Option 4 – Base Year Infrastructure near current day 2011/12, latest database without significant change from year 2000 with further extension to 2012

The hydrological baseline to 2008 does not include major events such as 2011 flood for which much data is available. For this option the hydrological baseline should thus be extended. To continue the approach of using a natural condition the flows (and sediment discharges) above Chiang Saen would be naturalized using standard techniques. There has been significant infrastructure in Cambodia particularly but also other countries (Vientiane flood protection, NT2) that could be included in the Physical baseline

Remark: *This option, IKMP have to spent time for check quality of extended data 2009-2012 before using for model simulation. The preparation process of Landuse and development of HP/Irrigation for year 2011/2011 also needed.*

Option 5 – Base Year Situation on Year 2011/12, hydrological baseline 1900-2012 (further extension to 2012 and back to 1900)

The hydrological baseline to 2008 does not include major events such as 2011 flood for which much data is available. For this option the hydrological baseline should thus be extended. To continue the approach of using a natural condition the flows (and sediment discharges) above Chiang Saen would be naturalized using standard techniques. The longer baseline period would allow probabilistic analyss of floods and droughts with better accuracy that can be achieved with a short baseline.

Remark: *This option, IKMP have to spent time for check the quality of the extended data 2009-2012 and data back to 1950 before using for model simulation. The preparation and processing of Landuse 2010 and development of HP/Irrigation and flood control for year 2011/2011 also needed.*

7 Conclusions

This document presents 5 options for baseline for the Council Study to assist the Council Study Team to make an informed decision in selecting the appropriate baseline or baselines to use.

The first level of choice related to Infrastructure and Land Use is based on the management consideration – Should the baseline Year represent present day conditions that already take into account impacts of developments such as the Chinese dams; or should the baseline represent near natural conditions. Once this has been decided, then the next level of choice is based on the availability of data, the requirements and compatability with impact study requirements and the ability to leverage other studies such as MDS and BDP2, respectively.

The base years for infrastructure of 2000 or 2007 could be recommended by the Modelling Team based on the data and models that MRC have on hand. However, changes to the base year selection can be considered based if time is available for data collection and checking of the simulation.

The development in the upper basin is significant especially for discharge and sediment flux beyond any change in the LMB to date. Changes can be traced back to the first UMB dam in 1993. For a baseline infrastructure what should be included for the UMB must be carefully considered, whatever the choice it should be possible to naturalise the record to give a valid comparison as required for impact analysis.

The hydrological period used it is argued should be maximized to give the best results for impact analysis. This is likely to require a probabilistic approach and thus the hydrological period used for testing scenarios should be as long as practical and for which time and resources allow. There is some variations in long term averages depending on the period selected so scenario changes must use the same period as the baseline.