Technical Note

Development and update of water level and discharge rating curves for the Mekong mainstream

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Mekong River Commission (MRC)

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1 Introduction

The discharge of a river is an indispensable parameter for analysing hydrological features of a basin, quantifying the water amount to be stored in dams or reservoirs for further development, and calibrating rainfall-runoff models. It provides valuable insights into the behaviour of water systems and supports informed decision-making for the sustainable management of water resources.

The discharge at a station can be obtained by measuring flow velocity, height or stage, and cross-section at the station. However, measurement of flow velocity is not always possible and is time-consuming, expensive, and dangerous, especially during high flows (Chalisgaonkar, 2000; Jain and Chalisgaonkar, 2000; Moramarco et al., 2004; Tayfur et al., 2007). Therefore, direct measurement of flow velocity is not always practical in river discharge estimation. Traditionally, a stage-discharge rating curve is commonly used in hydrology to convert a continuous record of water level into a continuous flow record (discharge) (Chow, 1964; WMO, 1980; ISO, 1983a, 1983b; Maidment, 1993; Herschy, 1999, 2008).

A rating curve is a graphical presentation of the measured discharges plotted against the corresponding water levels (Shaw, 1994). The main limitation of using a rating curve is that it does not account for the hysteresis effect that produces a loop-rating curve (Jain and Chalisgaonkar, 2000). A loop-rating curve is typically observed when the discharge of the rising stream is different from the discharge of the falling stream for the same water level. Loops of this type, in general, occur in periods (a) when the gauging station is affected by variable backwater either from a downstream dam or tributaries, lake and sea, or from the return of overbank flow into the main channel after floods, and (b) when the rate of change of the velocity of the flood wave and slope of water surface per unit height of a rising stream is different from that of a falling stream (Rantz, 1982a).

Several methods have been developed to adjust measured discharges prior to rating curve development and to adjust discharges obtained from the loop-rating curves. Some of these methods are based on an estimate of the slope, either from water levels measured at two gauges or from the rate of change at a single gauge. Another approach that has been suggested (Rantz, 1982b) to improve discharge estimation is to use numerical simulation of the unsteady flow (partial differential equations of continuity and momentum). However, the range of conditions, the number of parameters to simulate, and the number of simulations needed to define a rating curve will vary from case to case, making this approach impractical for rating curve development.

Another alternative method for estimating discharge is an application of Artificial Neural Networks (ANNs) because it can extract the non-linearity and noisy relationship between the input and the output of the process without explicitly considering the physics of the process (ASCE, 2000; Sudheer and Jain, 2004). It was successfully applied to find the relationship between water level and river discharge (Tawfik et al., 1997; Jain and Chalisgaonkar, 2000; Bhattacharya and Solomatine, 2005; Sahoo and Ray, 2006). Specifically, the great performance of the ANNs for estimating the discharge of tributaries of the Tonle Sap Lake could be found in Someth et al., 2009.

A more recent analysis of the rating curves for mainstream and tributaries of the Mekong River for 2009-2012 was conducted and published in 2013 (Someth et al., 2013). This technical note is an update of the rating curves for the Mekong mainstream. The above publication also discusses the approach and methodology of rating curve establishment.

In this technical note, the Mekong River Commission Secretariat (MRCS) reinforces its strong commitment to enhance more integrated data management by utilising the Time Series Management Software, AQUARIUS, which includes the beneficial Rating Development Toolbox functionality. The migration of rating curve development to AQUARIUS aims to establish an easily maintainable system, a centralised and reliable source of accurate water data. This transition promises increased efficiency, accuracy, and defensibility of water data management processes.

Considering this initiative of AQUARIUS application on rating curve development in association with reliable data availability, ten of twenty-two MRC forecasting stations from Chiang Saen to Kratie, where flows are not complicated and not affected by a tide, are selected. Other stations below Kratie station and stations in tributaries will be revisited and updated in the next phase.

2 Data, tool, and methodology

2.1 Dataset

Simultaneously recorded data of water level and discharge at hydrological stations on the Mekong mainstream were collected by Line Agencies in 4 member countries (Department of Hydrology and River Works for Cambodia, Department of Meteorology and Hydrology for Lao PDR, Department of Water Resources for Thailand, and Southern Regional Hydro-Meteorological Center for Viet Nam) under a 13-year discharge and sediment monitoring project funded by the Government of Finland, Fonds Français pour l'Environnement Mondial (FFEM) – Agence Française de Développement (AFD) and European Union Fund, for periods of 2008-2015 and 2018-2022. Location of the mainstream station is shown in Figure 1. A summary of the dataset for the rating curve analysis and its range of applicability for the Mekong mainstream are presented in Table 1 and Table 2. The updated rating curve as rating empirical equation is established to obtain the discharge for the application of river monitoring and flood forecasting.

The "water level" of a river or lake is the height or stage of the water surface above an established datum plan. The water surface elevation, which refers to some arbitrary or predetermined gauge datum, is called the "gauge height". The "gauge height" is often used interchangeably with the more general term "water level", although the former is more appropriate when used to indicate a reading on a gauge (Carter and Davidian, 1968; Rantz, 1982b). It is worth noting that certain water level stations mentioned in this technical note may lack a specific gauge datum. Therefore, the general term "water level" for some stations is used to refer to the water surface elevation.

Figure 1. Location of the mainstream stations for rating curve analysis

Table 1. Summary of the dataset for the Mekong mainstream

No	Code	Station name	Country	Location			Water Level (WL)[a] (m)		Period of data availability	
				Latitude	Longitude	Zero gauge[b]	Max WL	Min WL	Start year	End year
1	010501	Chiang Saen	Thailand	20.273	100.092	357.110	13.80	0.00	1960	2023
2	011201	Luang Prabang	Lao PDR	19.893	102.133	267.195	22.36	2.14	1960	2023
3	011903	Chiang Khan	Thailand	17.901	101.664	194.118	18.09	1.78	1965	2023
4	012001	Nong Khai	Thailand	17.881	102.716	153.648	14.18	0.32	1965	2023
5	013101	Nakhon Phanom	Thailand	17.394	104.799	132.680	13.30	0.18	1975	2023
6	013402	Mukdahan	Thailand	16.541	104.740	124.219	14.22	0.72	1965	2023
7	013801	Khong Chiam	Thailand	15.191	105.300	89.030	17.77	1.02	1966	2023
8	013901	Pakse	Lao PDR	15.118	105.796	86.490	14.48	0.11	1960	2023
9	014501	Stung Treng	Cambodia	13.522	105.934	36.790	13.00	1.27	1910	2023
10	014901	Kratie	Cambodia	12.283	105.997	-0.101	24.28	3.75	1933	2023

[a] Range of minimum and maximum observed water level (to local datum), and the discharge were derived from the previous rating curves.
[b] Zero gauge (m) in Hon Dao for Laos and Viet Nam, Ko Lak for Thailand, Hatien for Cambodia, and Hon Dao for Viet Nam.

Table 2. Summary of data pairs/points observed water level and discharge dataset for the Mekong mainstream

No	Code	Station name	Country	Number of WL-Q pairs/points[b]												
				2008	2009	2010	2011	2012	2013	2014	2015	2018	2019	2020	2021	2022
1	010501	Chiang Saen	Thailand	-	34	38	26	-	-	10	34	20	26	24	24	36
2	011201	Luang Prabang	Lao PDR	-	32	40	23	32	14	27	6	-	19	22	21	28
3	011903	Chiang Khan	Thailand	-	46	41	36	28	14	17	25	18	25	15	25	34
4	012001	Nong Khai	Thailand	-	39	41	28	35	14	17	13	19	28	25	36	33
5	013101	Nakhon Phanom	Thailand	-	38	38	36	32	14	-	22	-	-	-	-	-
6	013402	Mukdahan	Thailand	-	38	42	36	32	14	11	22	18	26	23	16	31
7	013801	Khong Chiam	Thailand	-	39	42	36	34	34	36	32	33	28	36	13	36
8	013901	Pakse	Lao PDR	-	31	36	22	22	14	30	6	-	15	1	22	28
9	014501	Stung Treng	Cambodia	35	24	41	21	26	16	30	36	18	19	26	27	28
10	014901	Kratie	Cambodia	35	23	41	21	16	16	30	36	18	19	26	27	28

[b] Total number of pairs/points of observed water level and discharge in the dataset.

2.2 AQUARIUS tools

AQUARIUS is a time series data management software for easy visualisation, scanning, and performance of Quality Assessment and Quality Control (QA/QC) of data with best-in-class rating curves and automatic error detection. It consists of intuitive correction tools that help compare historical time series or discrete data with a defensible trail. It is the premier platform for managing environmental data. Both water flow and continuous water quality data can be stored in the system, along with supporting information from meteorological and many other types of sensors. Extend the value of data with powerful tools that enhance water resource management. Water monitoring agencies worldwide trust AQUARIUS to acquire, process, model, and publish water information in real-time such as NIWA, USGS, Canada, IDAHO POWER, and South Dakota.

The Rating Development Toolbox (**Figure 2**) is AQUARIUS's extended function, allowing to develop rating curves. The Rating Development Toolbox is used for developing and maintaining (shifting) rating curves.

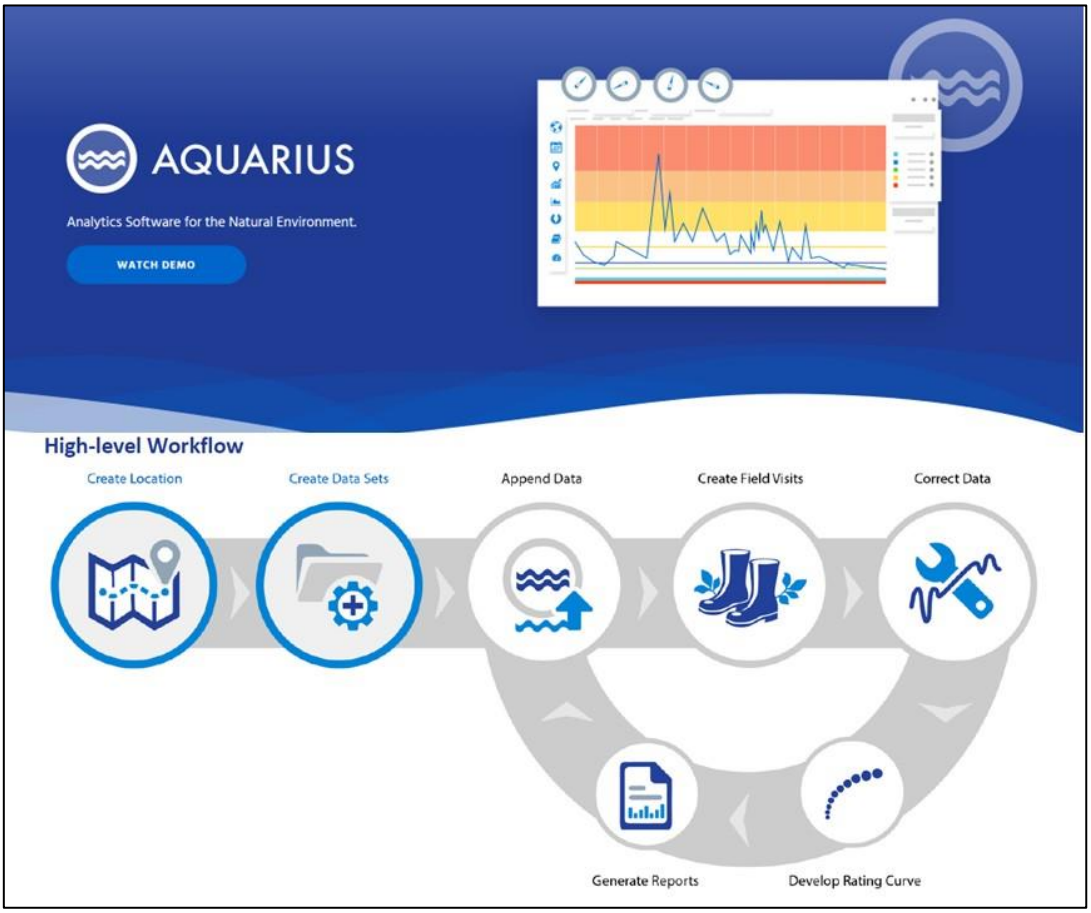


Figure 2. General functions of AQUARIUS software

2.3 Methodology

The rating curves are developed with three main steps (1) the preparation of required data and import to the AQUARIUS; (2) the verification and correction of data then; and (3) the development of the rating curves by the Rating Development Toolbox and the test of developed rating curve equations.
The overall processes can be found in **Figure 3** as follows:

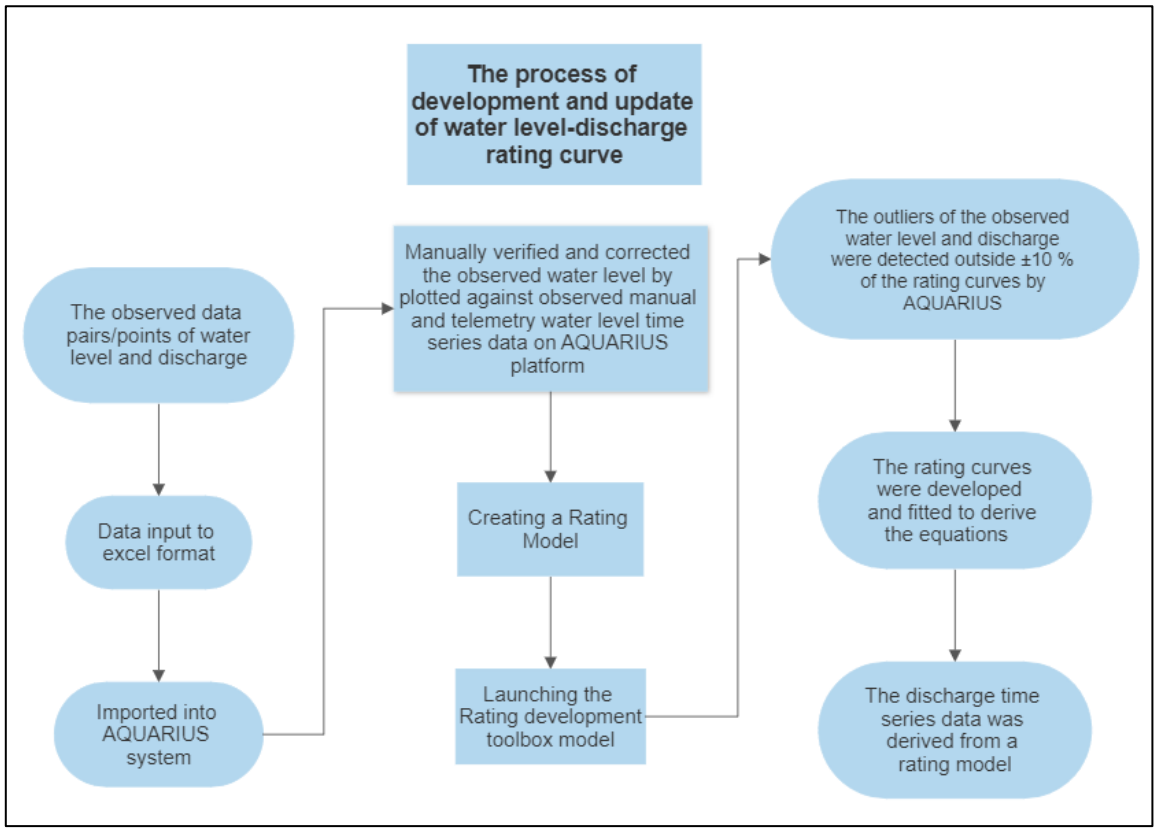


Figure 3. The overall workflow of the development and update of rating curves

The workflow above can be elaborated as follows. All the data pairs/points of the observed water level and discharge of the Mekong mainstream stations (**Table 2**) were imported into the field measurement in the AQUARIUS system. Then the preliminary quality control (QC) data was conducted based on combined plots of the observed manual and telemetry (from the Mekong-HYCOS: Mekong Hydrological Cycle Observing System) time series data of water level. Those data were manually verified and corrected in the AQUARIUS system. Near real-time water level was compared to the observed manual water level. The threshold of validation was defined within ±10 cm (**Figure 4**).

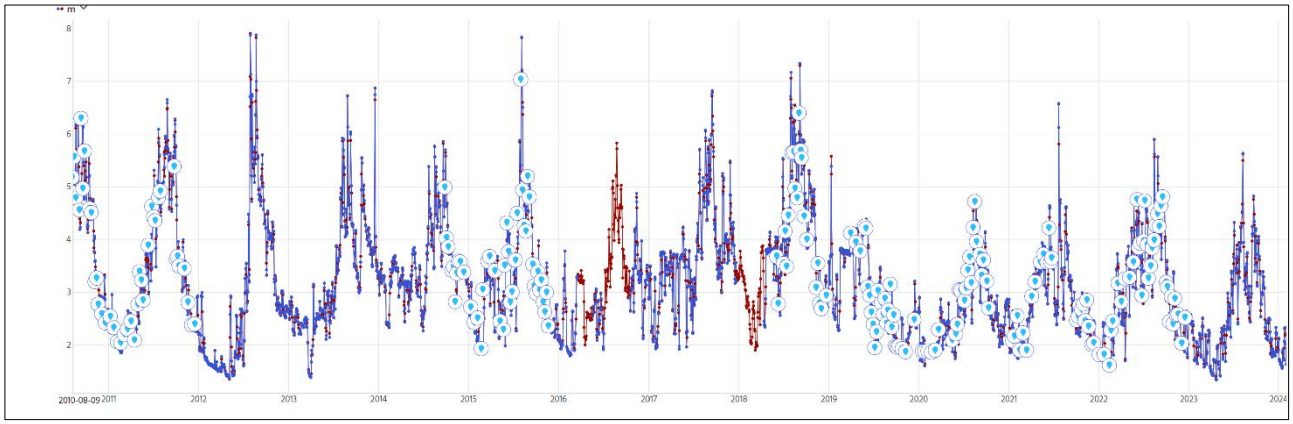


Figure 4. An example of a review of the field measurements (dots) plotted against observed manual (blue line) and telemetry water level (red line) time-series data

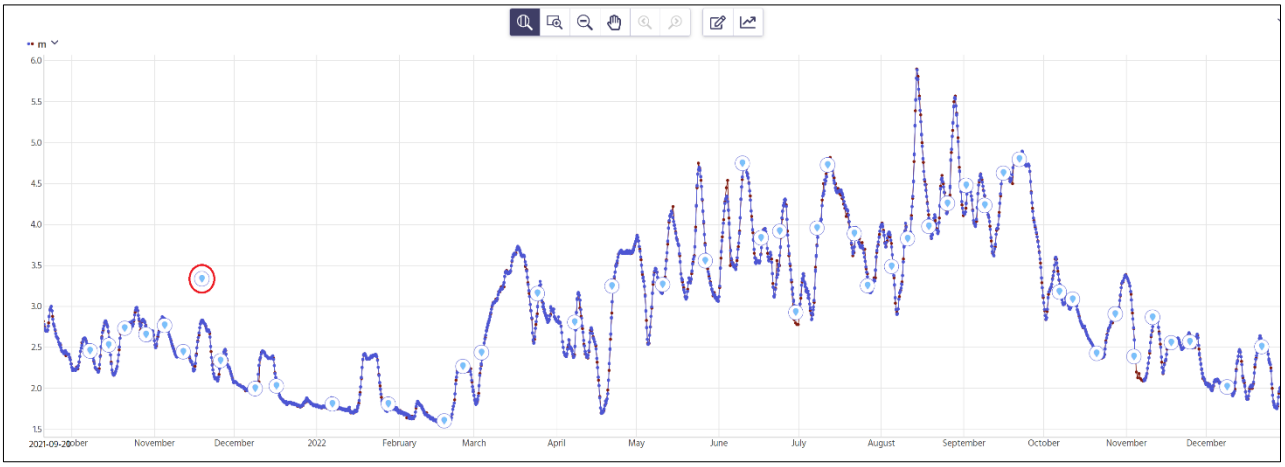


Figure 5. An example of outlier detection for the preliminary QA/QC process. The pairs of observed water level and discharge (dots) were plotted with observed manual water level (blue line) time-series data

Figure 4 shows an example of the QA/QC data process, in which the data pairs/points of observed water level and discharge were plotted with observed manual water level data. The data pairs/points of observed water level and discharge were manually verified and corrected to the observed water level. A pair/point in the red circle (**Figure 5**) was considered error typing. Generally, the water level during the discharge measurement was obtained by averaging the water level reading at the beginning and the end of the discharge measurement campaign.

The field measurement was used to create a basic rating curve in the Rating Development Toolbox of AQUARIUS. Rating curve analysis for manually observed water level and discharge were performed at two levels:

- Initially, obvious outliers were removed before proceeding with the rating curve analysis. However, it is crucial to cross-reference this data with the original data from the ADCP (Acoustic Doppler Current Profiler) file to ensure the accuracy of discharge calculations. This step is essential to avoid the accidental removal of valid data points.
- Outliers located beyond the range of ±10% from the proposed rating curves were also identified and discarded. **Figure 6** shows a typical example of process of removing outliers.

A compound curve with a breakpoint corresponding to a complex channel cross-section is developed to understand the power and flexibility of the Rating Curve Development Toolbox. The curve is shifted to handle the change of stream channel morphology over time.

The constructed rating curves for the stations (without backwater effect) are of the form of the Shifted Power Equation:

$$Q = a\,(H - H_0)^m$$

Where:

Q is water discharge in m^3/s; **H** is gauge height in meters;
a and **m** are coefficients; H_0 is the gauge height, at which the flow in the river is zero.

3 Results and discussion

The analysis and findings of the rating curve development are indicated in **Table 3**. The Rating Development Toolbox with the proposed expression of the rating curves was applied simultaneously to recorded data of water level and discharge of the mainstream stations: Chiang Saen, Luang Prabang, Chiang Khan, Nong Khai, Mukdahan, Khong Chiam, Pakse, Stung Treng and Kratie stations. Detailed datasets of observed manual and automatic water level and discharge and rating curves are listed in **Appendix – Dataset**.

3.1 Variation of data quality of water level and discharge measurement

The Mekong River's mainstream at **Chiang Saen** has exhibited irregularities in measured water level and discharge, as illustrated by the scatter points in **Figure 6**. These anomalies typically occur during the period from April to June when the water level varies within the range of approximately 2 meters to 4 meters, corresponding to discharges ranging from around 1,000 m^3/s to 3,000 m^3/s. Notably, in the years 2009, 2010, and 2011, a portion of the data points from of 71 (26%) exceeded the ±10% range of the established rating curves.

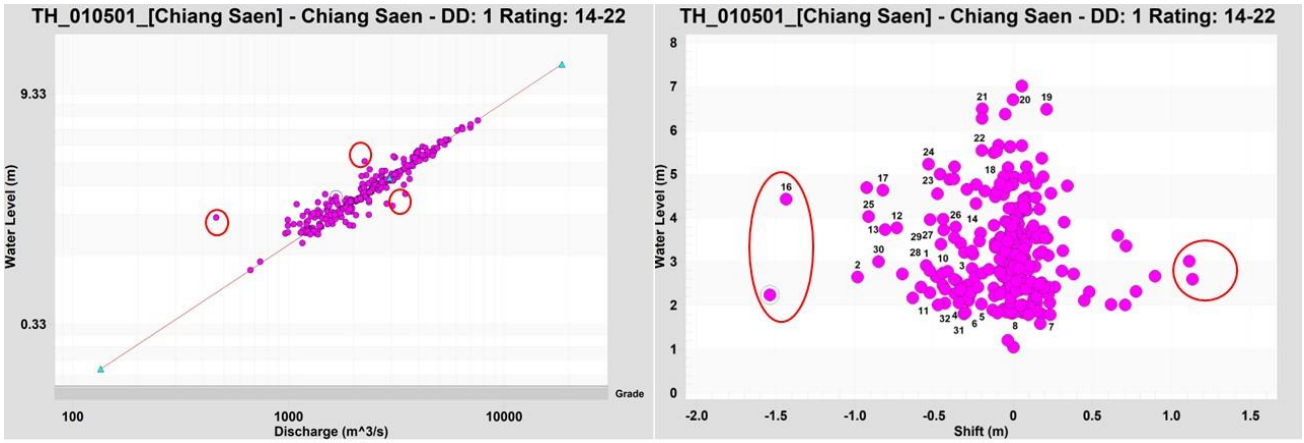


Figure 6. Rating development toolbox (data of Chiang Saen)

Similarly, at **Chiang Khan** station, where data was collected over a five-year span from 2009 to 2013, 156 (48%) of data points fell outside the ±10% range of the rating curves (Figure C.1).

The situation repeats itself at the **Nong Khai** station for the years 2009, 2010, 2011, and 2012, where 128 (39%) of the data points were found to deviate from the ±10% range of the rating curves (Figure D.1).

The commissioning of the Xayaburi Hydropower Dam has caused a backwater effect at **Luang Prabang** station, leading to the establishment of two rating curves at this site: one for 2009-2015 and another for 2019-2022. The revised rating curve for Luang Prabang is based on data from 2009 to 2015, making it applicable for the period from 2012 to 2018. Additionally, a new rating curve was established using datasets from 2019 to 2022, and it is deemed applicable from 2019 onwards, particularly after the impoundment of the Xayaburi dam. Furthermore, MRCS is actively monitoring ongoing developments at this station and will reconsider revising the rating from time to time to reflect any emerging changes.

In the case of **Nakhon Phanom**, the existing rating curve has been in use since 2013, based on data collected from 2009 to 2012. However, there has been a lack of updated discharge data for this site since 2015. Although

a few data points from 2013 and 2015 were collected, they are insufficient to update the rating curve for this station. Therefore, there is currently no updated rating curve available, and the existing one remains valid.

It is important to note that these anomalies do not extend to all measurement stations. Other stations have demonstrated normal data patterns.

Table 3. Rating equations for the Mekong mainstream derived from the AQUARIUS system

No	Code	Station name	Rating equation	Outlier analysis[a]			Min – Max of the observed water level and discharge	
				Point 1	Outlier (± 10%)	Point 2	Water level (m)	Discharge (m^3/s)
1	010501	Chiang Sean	Q = 279.147 * (H+0.670) ^1.617	272	71	201	1.05 – 7.01	417 – 7,546
2	011201	Luang Prabang	Q[b] = 204.234 * (H-0.490) ^1.529	174	2	172	2.53 – 13.85	689 – 10,736
			Q[c] = 580.703 * (H-5.700) ^1.333	90	16	67	6.67–13.20	1,466 – 7,931
3	011903	Chiang Khan	Q = 17.587 * (H+2.550) ^2.380	324	156	168	2.20 – 14.30	832 – 14,608
4	012001	Nong Khai	Q = 104.725 * (H+3.520) ^1.822	329	128	201	0.34 – 12.36	692 – 16,522
5	013101	Nakhon Phanom[d]	Q = 323.896 * (H+1.801) ^1.717	112	22	90	0.21–11.85	1,067 – 31,339
6	013402	Mukdahan	Q = 291.655 * (H+1.800) ^1.786	309	15	294	0.76 – 12.79	1,604 – 34,829
7	013801	Khong Chiam	Q = 356.511 * (H+1.130) ^1.706	399	24	375	1.23 – 15.71	1,122 – 44,340
8	013901	Pakse	Q = 322.132 * (H+2.220) ^1.808	228	34	194	0.13 – 12.23	605 – 44,565
9	014501	Stung Treng	Q = 2149.387 * (H-1.220) ^1.365	347	20	327	1.82 – 12.01	1,640 – 57,349
10	014901	Kratie	Q = 249.180 * (H-2.820) ^1.771	296	9	287	5.96 – 22.77	1,438 – 55,467

[a] Outlier analysis: obvious outliers are eliminated by simply unselecting the pairs/points of water level and discharge. Outlier is detected by ±10% in the discharge of the proposed rating equations; Point 1 is the total number of pairs/points of water level and discharge; Outlier is the number of outliers detected by ±10% in shift diagram; Point 2 is the number of pairs/points of water and discharge used analysis of the rating equations.

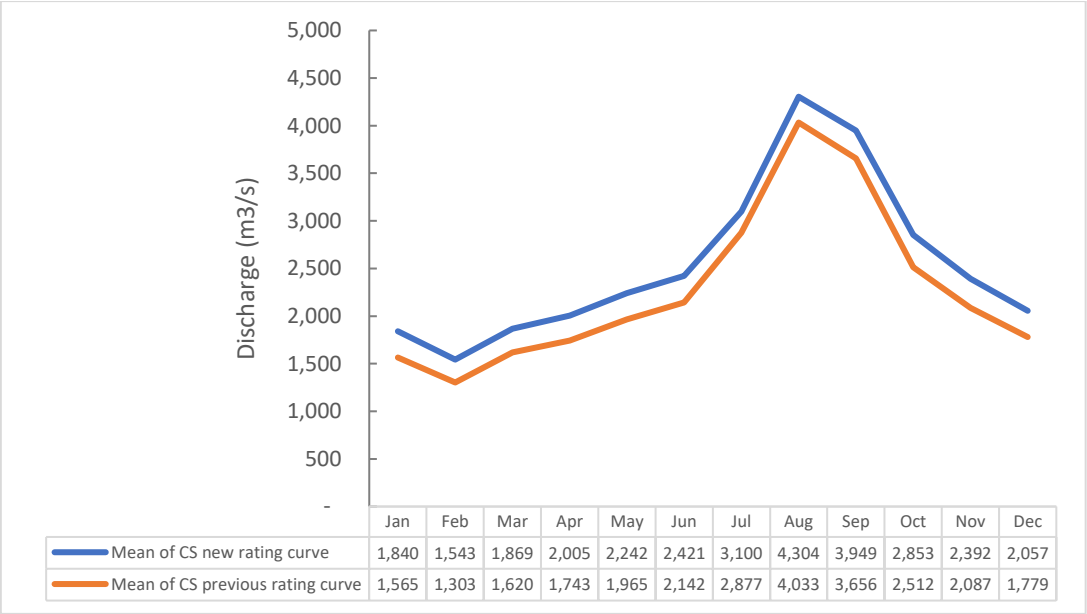
[b] The updated rating curve at Luang Prabang was derived from the datasets between 2009-2015, so this rating curve could be applicable from 2012-2018.

[c] The updated rating curve at Luang Prabang was derived from the datasets between 2019-2022. The rating curve at this station could be applicable from 2019 onwards after the impoundment of Xayaburi dam.

[d] Rating curve at Nakhom Phanom were derived from the datasets between 2009-2011. This rating curve could not be updated due to a lack of discharge measurement after 2015.

3.2 Improvement with new rating curves

The updated rating curve for **Chiang Saen** (**Figure 7**) provides higher flow throughout the year than the derived flow from the previous rating curve. It was discussed that more data available from 2013 onwards can capture a changed range of high and low flow, which the upstream dam operation may also influence. Moreover, this station's possible cross-sections and river morphology change might also affect yearly measured water levels. This result aligns with the historical records (**Figure 8**) that the Chiang Saen flow pattern has significantly changed since 2013, higher in the dry season and lower peak in the wet season. In this regard, it is recommended that the updated rating curve be applicable for 2013 onwards.



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean of CS new rating curve	1,840	1,543	1,869	2,005	2,242	2,421	3,100	4,304	3,949	2,853	2,392	2,057
Mean of CS previous rating curve	1,565	1,303	1,620	1,743	1,965	2,142	2,877	4,033	3,656	2,512	2,087	1,779

Figure 7. Comparison of monthly discharge using updated and existing rating curves for Chiang Saen station

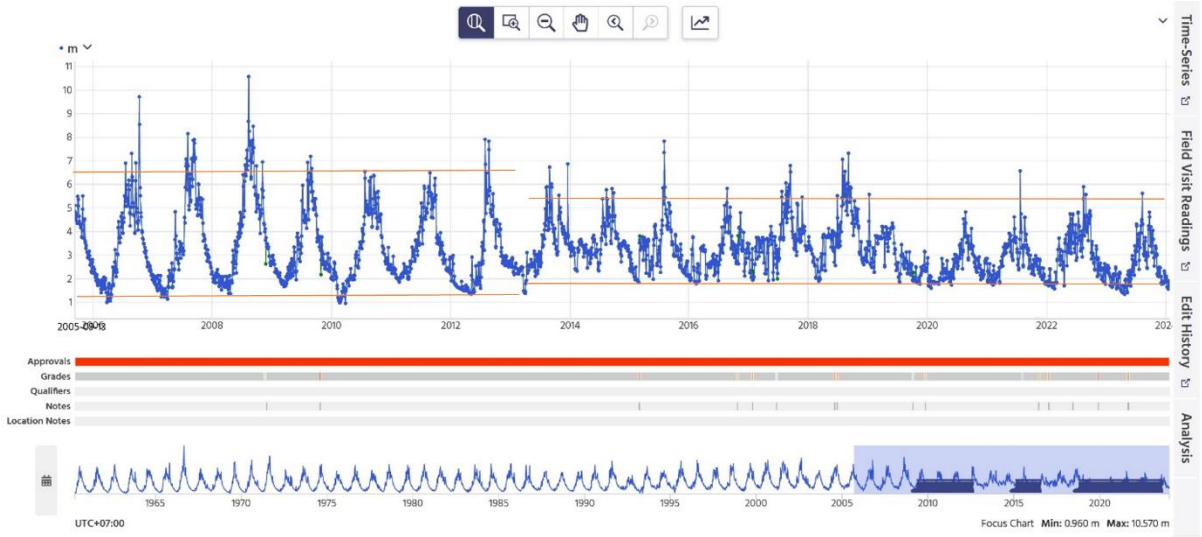
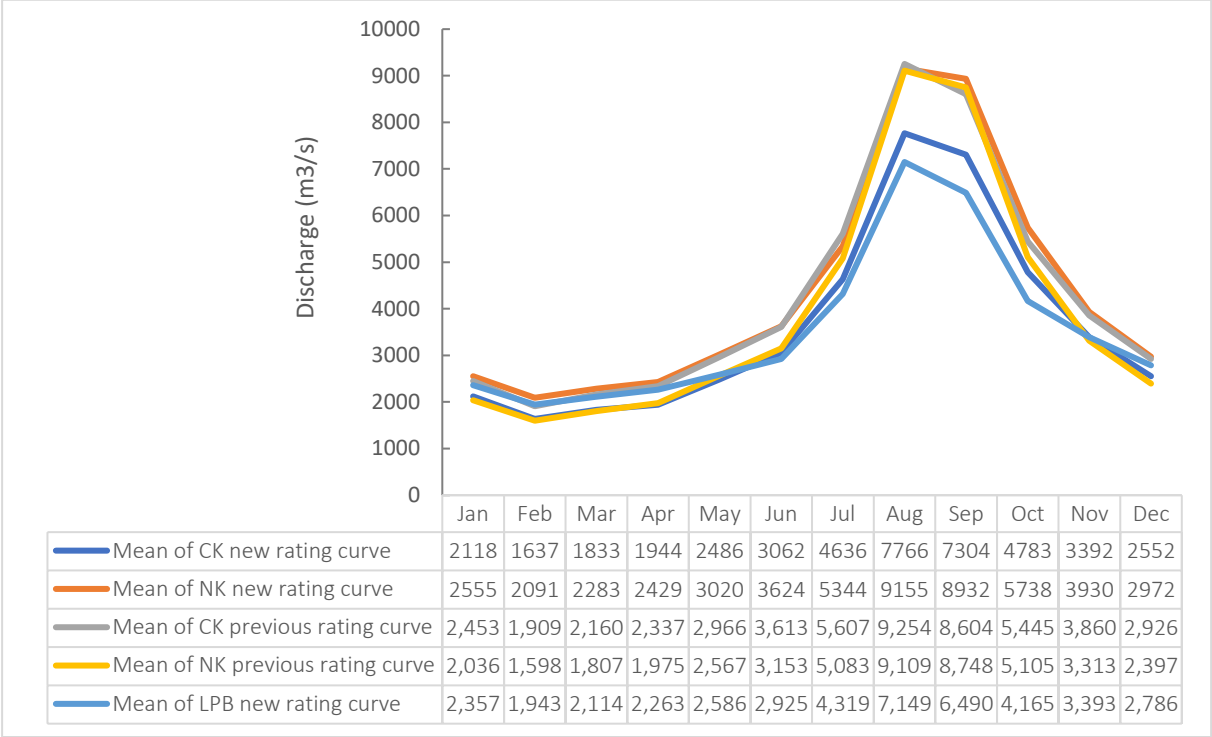


Figure 8. Pattern change from historical observed water level at Chiang Saen station

The initial evaluation of the rating curves for the Mekong River was based on data from 2009-2011. However, because reliable data was limited at **Chiang Khan and Nong Khai** stations, as well as at the **Stung Treng and Kratie** during that period, there exists a possibility that the discharge estimations at these stations were either underestimated or overestimated.

The rating curves for these four stations were reevaluated by incorporating additional water level and discharge observations in 2009-2022 as indicated in **Figure 9** and **Figure 10**. The updated rating curves are applied to estimate discharge for these stations.

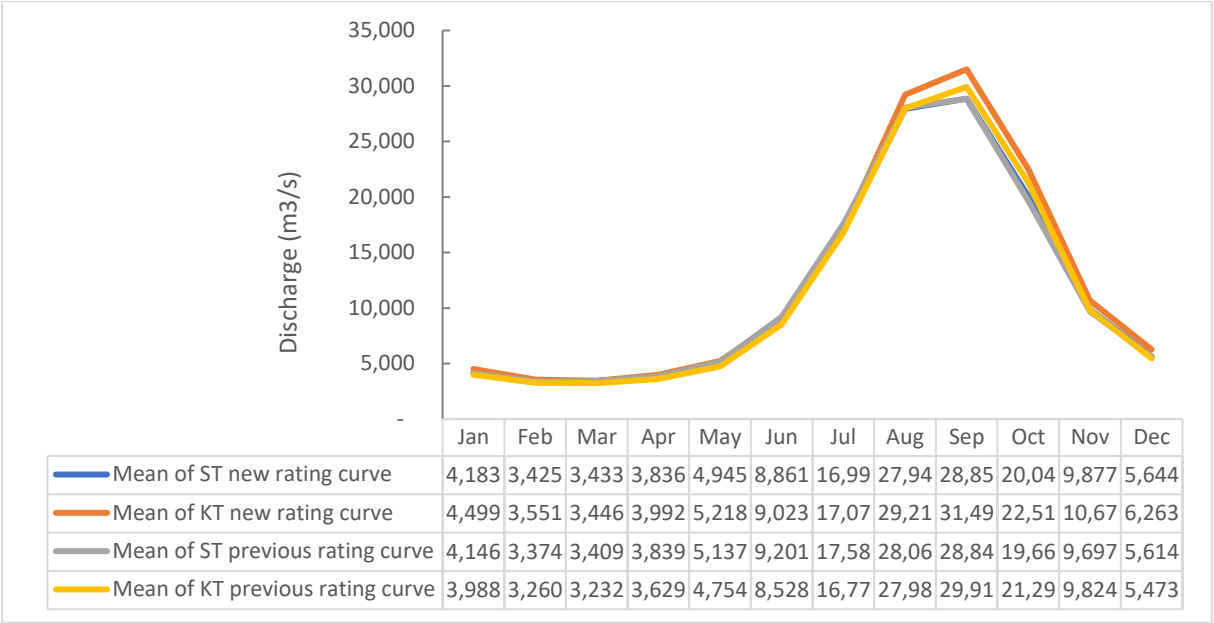
An extra dataset focusing on the wet season, particularly July to October, was incorporated into the ensemble to enhance the reliability of the rating curves at Chiang Khan. The analysis reveals a more accurate representation of lower flows at Chiang Khan, resulting in rating curves that are both more reliable and consistent when compared to those of Nong Khai (**Figure 9**).



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean of CK new rating curve	2118	1637	1833	1944	2486	3062	4636	7766	7304	4783	3392	2552
Mean of NK new rating curve	2555	2091	2283	2429	3020	3624	5344	9155	8932	5738	3930	2972
Mean of CK previous rating curve	2,453	1,909	2,160	2,337	2,966	3,613	5,607	9,254	8,604	5,445	3,860	2,926
Mean of NK previous rating curve	2,036	1,598	1,807	1,975	2,567	3,153	5,083	9,109	8,748	5,105	3,313	2,397
Mean of LPB new rating curve	2,357	1,943	2,114	2,263	2,586	2,925	4,319	7,149	6,490	4,165	3,393	2,786

Figure 9. Comparison of monthly discharge using updated and existing rating curves for Chiang Khan and Nong Khai stations

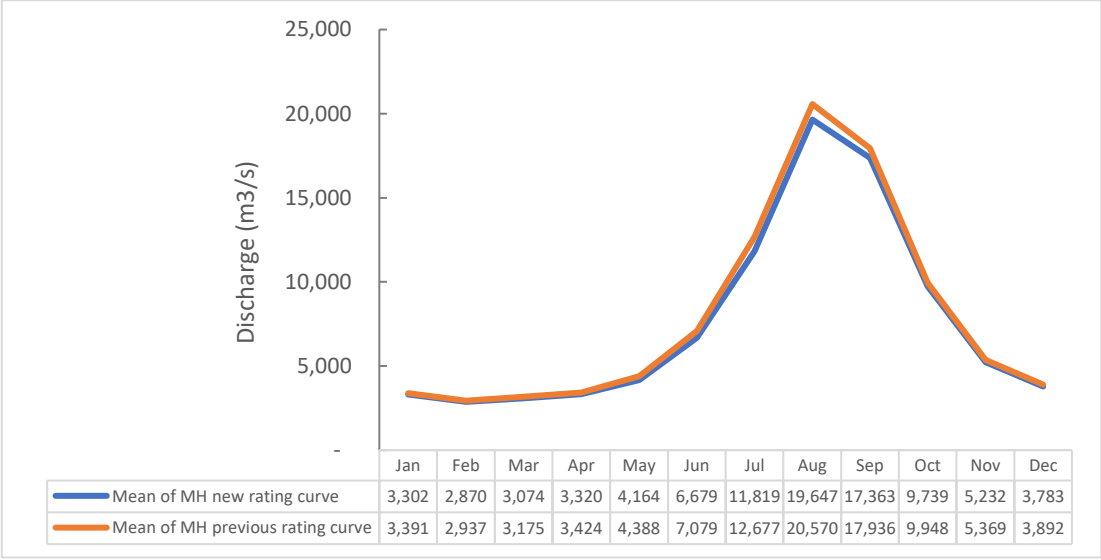
Likewise, additional data for Kratie spanning August to October indicates an increase in flow during this timeframe. Consequently, the rating curve at Kratie has been adjusted to reflect these updated observations (**Figure 10**).



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean of ST new rating curve	4,183	3,425	3,433	3,836	4,945	8,861	16,99	27,94	28,85	20,04	9,877	5,644
Mean of KT new rating curve	4,499	3,551	3,446	3,992	5,218	9,023	17,07	29,21	31,49	22,51	10,67	6,263
Mean of ST previous rating curve	4,146	3,374	3,409	3,839	5,137	9,201	17,58	28,06	28,84	19,66	9,697	5,614
Mean of KT previous rating curve	3,988	3,260	3,232	3,629	4,754	8,528	16,77	27,98	29,91	21,29	9,824	5,473

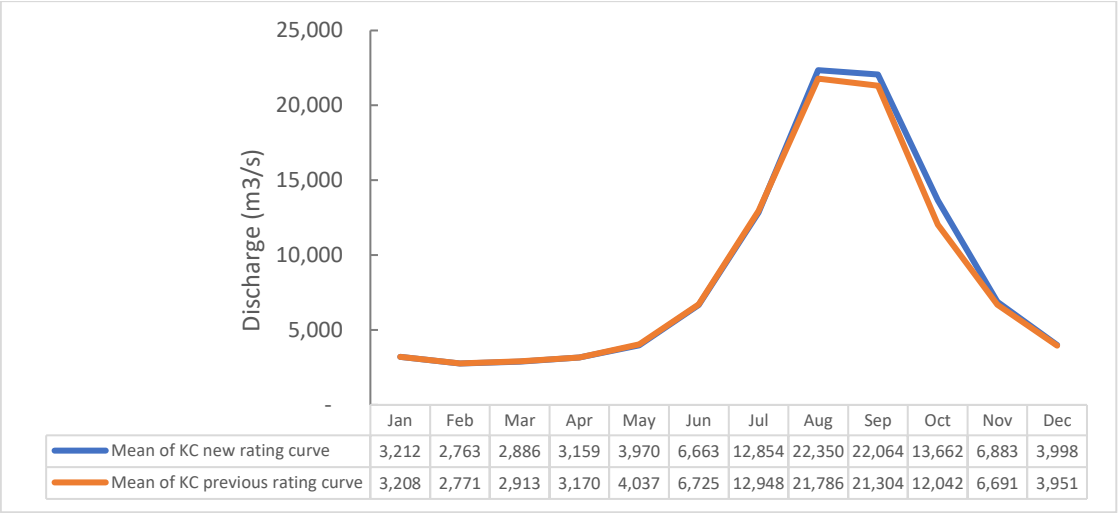
Figure 10. Comparison of monthly discharge using updated and existing rating curves for Stung Treng and Kratie stations

The updated rating curves for Mukdahan (**Figure 11**), Khong Chiam (**Figure 12**), and Pakse (**Figure 13**) have undergone slight improvements and are now employed to estimate discharge for these specific stations. The improvement is attributed to the increased completeness of additional datasets (at these stations) for the wet season, resulting in a subtle shift in representation.



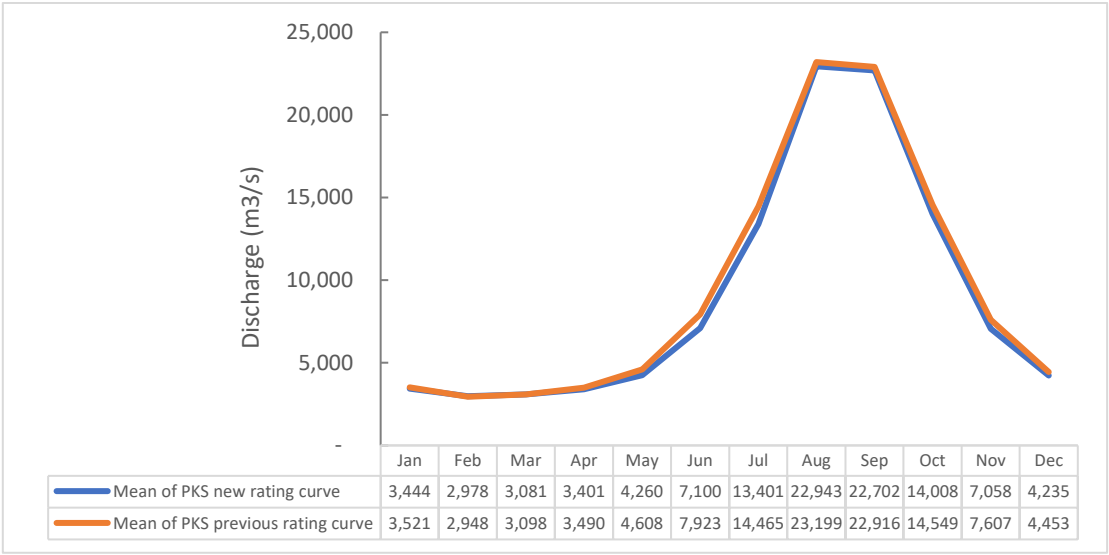
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean of MH new rating curve	3,302	2,870	3,074	3,320	4,164	6,679	11,819	19,647	17,363	9,739	5,232	3,783
Mean of MH previous rating curve	3,391	2,937	3,175	3,424	4,388	7,079	12,677	20,570	17,936	9,948	5,369	3,892

Figure 11. Comparison of monthly discharge using updated and existing rating curves for Mukdahan station



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean of KC new rating curve	3,212	2,763	2,886	3,159	3,970	6,663	12,854	22,350	22,064	13,662	6,883	3,998
Mean of KC previous rating curve	3,208	2,771	2,913	3,170	4,037	6,725	12,948	21,786	21,304	12,042	6,691	3,951

Figure 12. Comparison of monthly discharge using updated and existing rating curves for Khong Chiam station



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean of PKS new rating curve	3,444	2,978	3,081	3,401	4,260	7,100	13,401	22,943	22,702	14,008	7,058	4,235
Mean of PKS previous rating curve	3,521	2,948	3,098	3,490	4,608	7,923	14,465	23,199	22,916	14,549	7,607	4,453

Figure 13. Comparison of monthly discharge using updated and existing rating curves for Pakse station

3.3 Extension of the rating curves

Extrapolation of the rating curves has been conducted to extend the range of discharge estimates beyond the observation range. There are sufficient historical data points to make these extrapolations reliable. However, there are potential uncertainties and risks associated with extrapolation. Extrapolating beyond the range of existing observation data can introduce errors and uncertainties, hence using these rating equations within the range indicated in Table 3 is essential.

4 Conclusions

The release of this technical note signifies the unveiling of the newly updated rating curves for the Mekong mainstream. Because of data availability challenges and the complex nature of flow in the floodplain downstream of Kratie, MRCS is presently prioritising the update of rating curve analysis using datasets from 2009 to 2015 and 2018 to 2022. This update will cover nine mainstream stations: Chiang Saen, Luang Prabang, Chaing Khan, Nong Khai, Mukdahan, Khong Chiam, Pakse, Stung Treng and Kratie. Other remaining stations will be updated later when more data is available and the exploration of the functions in AQUARIUS.

These updated rating curves for Mekong mainstream stations are recommended for MRC activities on river monitoring, modelling, forecasting, assessment, studies, and other publications. The updated rating curves can be used directly for most individual stations except Chiang Saen (updated rating curve is applicable from 2013 onwards) and Luang Prabang (1st updated rating curve is suitable from 2018 backwards for pre-Xayaburi dam operation and 2nd updated rating curve is appropriate from 2019 onwards for post-Xayaburi dam operation).

This newly updated study provides an opportunity to verify each pair/point of the measured water level and discharge. More reasonable efforts were made to publish a reliable dataset and the derived rating equations. It is also the commitment of the MRCS to more integrated databases aligned to the Reinvigoration Project.

Integrating the rating curves directly into AQUARIUS time-series management tool enables the automatic generation of discharge values from observed water levels. This streamlined approach eliminates unintentional errors that may arise during the discharge estimation process. By facilitating faster response to changes in the river's mainstream and providing improved support to the data use community, this integration enhances the reliability and efficiency of utilising discharge data and also reinforce the role of MRC as regional Knowledge Hub.

5 References

American Society of Civil Engineers (ASCE) Task Committee, 2000. Artificial neural network in hydrology. Journal of Hydrologic Engineering 5 (2), 124–144.

Carter, R.W., Davidian, J., 1968. General procedure for gaging streams. Techniques of Water-Resources Investigations of the United States Geological Survey, United States Department of the Interior, USGS publication, Denver, Colorado.

Chow, V.T., 1964. Handbook of Applied Hydrology. McGraw-Hill, New York.

Herschy, R.W., 1999. Hydrometry: Principle and Practice, second ed. John Wiley and Sons, New York.

Herschy, R.W., 2008. Streamflow Measurement third ed. Routledge, Taylor & Francis Group, London, UK.

International Organization for Standardization (ISO), 1983a. Liquid Flow Measurement in Open Channels – Part 1: Establishment and Operation of a Gauging Station, ISO Standard 1100/1-1981. In: Measurement of Liquid Flow in Open Channels – ISO Standards Handbook 16. International Organization for Standardization, Genève, Switzerland, pp. 133–153.

International Organization for Standardization (ISO), 1983b. Liquid Flow Measurement in Open Channels – Part 2: Establishment and Operation of a Gauging Station, ISO Standard 1100/2-1982. In: Measurement of Liquid Flow in Open Channels – ISO Standards Handbook 16. International Organization for Standardization, Genève, Switzerland, pp. 154–186.

Jain, S.K., Chalisgaonkar, D., 2000. Setting up stage–discharge relations using ANN. Journal of Hydrologic Engineering 5 (4), 428–433.

Maidment, D.R., 1993. Handbook of Hydrology. McGraw-Hill, New York.

Someth P., Naritaka K., Hajime T., (2008). Estimating the Discharge of the Tributaries of the Tonle Sap Lake Using Artificial Neural Networks. 3rd International Conference on Sustainable Development in the Mekong River Basin, Kohn Kaen Thailand, pp.91-100, 11- 12,9, 2008.

Someth P., Seebacher F., Khem S., Kong S., Preap S., (2013). Preliminary analysis – Rating curves for mainstream and tributaries of the Mekong River, Information and Knowledge Management Programme (IKMP), Mekong River Commission Secretariat (MRCS).

Rantz, S.E., 1982a. Measurement and Computation of Streamflow: Volume 2. Computation of Discharge. Geological Survey Water Supply Paper 2175, United States Department of the Interior, USGS publication, US Government Printing Office, Washington D.C.

Rantz, S.E., 1982b. Measurement and Computation of Streamflow: Volume 1. Measurement of Stage and Discharge. Geological Survey Water Supply Paper 2175, United States Department of the Interior, USGS publication, Washington D.C.

Tayfur, G., Moramarco, T., Singh, V.P., 2007. Predicting and forecasting flow discharge at sites receiving significant lateral inflow. Hydrological Process 21, 1848–1859.

World Meteorological Organization (WMO), 1980. Manual on Stream Gaging, ume II: Computation of Discharge. Operational Hydrology Report No. 13, WMO No. 519, Secretariat of the World Meteorological Organization.

Appendix – Dataset

It is important to note that datasets for 2008-2011 can be found in Preliminary analysis – Rating curves for mainstream and tributaries of the Mekong River, 2013, Mekong River Commission Secretariat (MRCS).

Table A: Water level and discharge observation of Mekong mainstream at Chiang Saen station

WL-Q Observation				Mekong-HYCOS			QA/QC		
No	Date	WL1[a] (m)	Q (m3/s)	Start time	End time	WL2[b] (m)	1[c]	2[d]	3[e]
1	02-10-2014	4.96	4640.59	7:00	12:00	4.96	1	1	1
2	09-10-2014	4.00	3368.01	7:00	12:00	4.00	1	1	1
3	16-10-2014	3.83	3007.95	7:00	12:00	3.83	1	1	1
4	30-10-2014	3.39	2587.19	7:00	12:00	3.39	1	1	1
5	06-11-2014	3.45	2684.78	7:00	12:00	3.47	1	1	1
6	13-11-2014	2.79	1973.16	7:00	12:00	2.79	1	1	1
7	20-11-2014	3.33	2481.55	7:00	12:00	3.34	1	1	1
8	27-11-2014	3.56	2759.05	7:00	12:00	3.57	1	1	1
9	04-12-2014	3.55	2751.40	7:00	12:00	3.55	1	1	1
10	18-12-2014	3.35	2514.24	7:00	12:00	3.35	1	1	1
11	15-01-2015	2.69	1943.57	7:00	12:00	2.69	1	1	1
12	29-01-2015	2.40	1587.71	7:00	12:00	2.40	1	1	1
13	12-02-2015	2.48	1766.18	7:00	12:00	2.50	1	1	1
14	27-02-2015	1.90	1170.56	7:00	12:00	1.89	1	1	1
15	05-03-2015	3.02	2221.95	7:00	12:00	2.98	1	1	1
16	26-03-2015	3.56	2821.96	7:00	12:00	3.51	1	1	1
17	02-04-2015	3.65	2995.58	7:00	12:00	3.66	1	1	1
18	23-04-2015	3.38	2727.27	7:00	12:00	3.39	1	1	1
19	14-05-2015	2.42	1701.82	7:00	12:00	2.43	1	1	1
20	28-05-2015	2.26	1561.57	7:00	12:00	2.26	1	1	1
21	02-06-2015	3.48	2734.85	7:00	12:00	3.48	1	1	1
22	11-06-2015	4.29	3771.82	7:00	12:00	4.29	1	1	1
23	18-06-2015	3.74	3172.70	7:00	12:00	3.73	1	1	1
24	25-06-2015	2.78	2012.39	7:00	12:00	2.78	1	1	1
25	02-07-2015	2.98	2232.95	7:00	12:00	3.00	1	1	1
26	09-07-2015	3.59	3009.67	7:00	12:00	3.62	1	1	1
27	16-07-2015	3.58	2903.59	7:00	12:00	3.57	1	1	1
28	23-07-2015	4.47	4003.78	7:00	12:00	4.48	1	1	1
29	06-08-2015	7.01	7546.01	7:00	12:00	7.00	1	1	1
30	13-08-2015	4.91	4538.55	7:00	12:00	4.92	1	1	1
31	20-08-2015	4.23	3643.98	7:00	12:00	4.24	1	1	1
32	27-08-2015	4.13	3507.81	7:00	12:00	4.11	1	1	1
33	03-09-2015	5.17	4902.15	7:00	12:00	5.19	1	1	1
34	10-09-2015	4.78	4468.52	7:00	12:00	4.78	1	1	1
35	24-09-2015	3.50	2859.41	7:00	12:00	3.49	1	1	1
36	30-09-2015	3.09	2427.74	7:00	12:00	3.09	1	1	1
37	08-10-2015	2.95	2219.54	7:00	12:00	2.98	1	1	1

Table A: Water level and discharge observation of Mekong mainstream at Chiang Saen (continued)

WL-Q Observation				Mekong-HYCOS			QA/QC		
No	Date	WL1[a] (m)	Q (m3/s)	Start time	End time	WL2[b] (m)	1[c]	2[d]	3[e]
38	15-10-2015	3.36	2681.29	7:00	12:00	3.38	1	1	1
39	22-10-2015	3.01	2239.33	7:00	12:00	3.03	1	1	1
40	29-10-2015	3.20	2424.83	7:00	12:00	3.20	1	1	1
41	05-11-2015	2.78	2045.20	7:00	12:00	2.78	1	1	1
42	12-11-2015	2.60	1926.85	7:00	12:00	2.65	1	1	1
43	19-11-2015	2.97	2237.84	7:00	12:00	2.98	1	1	1
44	26-11-2015	2.33	1741.27	7:00	12:00	2.33	1	1	1
45	08-06-2018	3.65	2962.76	7:00	12:00	3.68	1	1	1
46	15-06-2018	2.75	2048.46	7:00	12:00	2.76	1	1	1
47	06-07-2018	3.52	2784.40	7:00	12:00	3.53	1	1	1
48	13-07-2018	4.13	3526.32	7:00	12:00	4.12	1	1	1
49	19-07-2018	3.46	2716.42	7:00	12:00	3.51	1	1	1
50	26-07-2018	4.43	3930.69	7:00	12:00	4.44	1	1	1
51	10-08-2018	5.62	5374.01	7:00	12:00	5.64	1	1	1
52	17-08-2018	5.63	5389.79	7:00	12:00	5.64	1	1	1
53	22-08-2018	4.94	4410.29	7:00	12:00	4.92	1	1	1
54	31-08-2018	4.76	4255.92	7:00	12:00	4.75	1	1	1
55	07-09-2018	6.37	6406.71	7:00	12:00	6.42	1	1	1
56	14-09-2018	5.66	5328.62	7:00	12:00	5.68	1	1	1
57	18-09-2018	5.52	5120.68	7:00	12:00	5.54	1	1	1
58	28-09-2018	4.41	3905.27	7:00	12:00	4.41	1	1	1
59	09-10-2018	3.97	2808.68	7:00	12:00	3.97	1	1	1
60	16-11-2018	3.06	2237.05	7:00	12:00	3.09	1	1	1
61	23-11-2018	3.52	2796.18	7:00	12:00	3.53	1	1	1
62	30-11-2018	2.76	2073.08	7:00	12:00	2.77	1	1	1
63	07-12-2018	2.66	1872.22	7:00	12:00	2.65	1	1	1
64	27-12-2018	2.91	2213.02	7:00	12:00	2.92	1	1	1
65	05-04-2019	4.09	3460.00	7:00	12:00	4.08	1	1	1
66	26-04-2019	3.92	3190.00	7:00	12:00	3.91	1	1	1
67	14-05-2019	3.75	3060.00	7:00	12:00	3.74	1	1	1
68	31-05-2019	4.22	3593.43	7:00	12:00	4.21	1	1	1
69	06-06-2019	4.18	3650.00	7:00	12:00	4.19	1	1	1
70	14-06-2019	3.07	2390.00	7:00	12:00	3.07	1	1	1
71	21-06-2019	2.91	2220.00	7:00	12:00	2.90	1	1	1
72	28-06-2019	2.59	1870.00	7:00	12:00	2.59	1	1	1
73	05-07-2019	2.36	1642.18	7:00	12:00	2.35	1	1	1
74	12-07-2019	1.92	1240.69	7:00	12:00	1.92	1	1	1
75	19-07-2019	2.22	1436.95	7:00	12:00	2.22	1	1	1
76	25-07-2019	3.00	2214.47	7:00	12:00	3.00	1	1	1
77	08-08-2019	2.77	2080.94	7:00	12:00	2.77	1	1	1
78	15-08-2019	2.55	1834.05	7:00	12:00	2.52	1	1	1

Table A: Water level and discharge observation of Mekong mainstream at Chiang Saen (continued)

WL-Q Observation				Mekong-HYCOS			QA/QC		
No	Date	WL1[a] (m)	Q (m3/s)	Start time	End time	WL2[b] (m)	1[c]	2[d]	3[e]
79	22-08-2019	2.85	2100.32	7:00	12:00	2.85	1	1	1
80	30-08-2019	2.38	1641.47	7:00	12:00	2.39	1	1	1
81	03-09-2019	2.63	1875.63	7:00	12:00	2.62	1	1	1
82	13-09-2019	3.12	2374.73	7:00	12:00	3.12	1	1	1
83	19-09-2019	2.31	1561.04	7:00	12:00	2.32	1	1	1
84	27-09-2019	2.54	1802.85	7:00	12:00	2.54	1	1	1
85	04-10-2019	1.95	1286.61	7:00	12:00	1.95	1	1	1
86	11-10-2019	1.93	1283.53	7:00	12:00	1.94	1	1	1
87	18-10-2019	1.95	1294.99	7:00	12:00	1.95	1	1	1
88	31-10-2019	1.90	1278.81	7:00	12:00	1.90	1	1	1
89	14-11-2019	1.84	1273.22	7:00	12:00	1.85	1	1	1
90	19-12-2019	2.45	1730.35	7:00	12:00	2.41	1	1	1
91	22-01-2020	1.85	1240.00	7:00	12:00	1.86	1	1	1
92	31-01-2020	1.85	1200.00	7:00	12:00	1.85	1	1	1
93	13-02-2020	1.86	1230.00	7:00	12:00	1.87	1	1	1
94	27-02-2020	1.83	1140.00	7:00	12:00	1.84	1	1	1
95	13-03-2020	1.87	1279.82	7:00	12:00	1.88	1	1	1
96	27-03-2020	2.26	1500.00	7:00	12:00	2.26	1	1	1
97	22-05-2020	2.06	1390.00	7:00	12:00	2.06	1	1	1
98	05-06-2020	2.18	1490.00	7:00	12:00	2.18	1	1	1
99	11-06-2020	2.36	1700.00	7:00	12:00	2.35	1	1	1
100	18-06-2020	3.02	2320.00	7:00	12:00	3.00	1	1	1
101	25-06-2020	3.00	2320.00	7:00	12:00	3.01	1	1	1
102	10-07-2020	2.81	2170.00	7:00	12:00	2.81	1	1	1
103	17-07-2020	3.05	2370.00	7:00	12:00	3.03	1	1	1
104	24-07-2020	3.39	2750.00	7:00	12:00	3.39	1	1	1
105	31-07-2020	3.64	3070.00	7:00	12:00	3.65	1	1	1
106	07-08-2020	3.15	2440.00	7:00	12:00	3.16	1	1	1
107	14-08-2020	4.20	3770.00	7:00	12:00	4.20	1	1	1
108	21-08-2020	4.69	3070.00	7:00	12:00	4.70	1	1	1
109	28-08-2020	3.93	3250.00	7:00	12:00	3.93	1	1	1
110	11-09-2020	3.69	2970.00	7:00	12:00	3.69	1	1	1
111	18-09-2020	3.29	2630.00	7:00	12:00	3.29	1	1	1
112	25-09-2020	3.58	2850.00	7:00	12:00	3.58	1	1	1
113	09-10-2020	3.18	2430.00	7:00	12:00	3.18	1	1	1
114	16-10-2020	2.66	2850.00	7:00	12:00	2.67	1	1	1
115	22-01-2021	2.05	1520.00	7:00	12:00	2.05	1	1	1
116	29-01-2021	2.14	1580.00	7:00	12:00	2.14	1	1	1
117	10-02-2021	2.52	1970.00	7:00	12:00	2.52	1	1	1
118	19-02-2021	1.87	1370.00	7:00	12:00	1.88	1	1	1

Table A: Water level and discharge observation of Mekong mainstream at Chiang Saen (continued)

WL-Q Observation				Mekong-HYCOS			QA/QC		
No	Date	WL1[a] (m)	Q (m3/s)	Start time	End time	WL2[b] (m)	1[c]	2[d]	3[e]
119	05-03-2021	2.20	1650.00	7:00	12:00	2.21	1	1	1
120	19-03-2021	1.87	1310.00	7:00	12:00	1.87	1	1	1
121	09-04-2021	2.89	2290.00	7:00	12:00	2.90	1	1	1
122	23-04-2021	3.17	2600.00	7:00	12:00	3.17	1	1	1
123	14-05-2021	3.54	3060.00	7:00	12:00	3.55	1	1	1
124	27-05-2021	3.69	3200.00	7:00	12:00	3.70	1	1	1
125	11-06-2021	3.54	2980.00	7:00	12:00	3.55	1	1	1
126	18-06-2021	4.19	3660.00	7:00	12:00	4.19	1	1	1
127	25-06-2021	3.55	3020.00	7:00	12:00	3.56	1	1	1
128	29-06-2021	3.62	3080.00	7:00	12:00	3.62	1	1	1
129	08-10-2021	2.44	1880.00	7:00	12:00	2.43	1	1	1
130	15-10-2021	2.51	1800.00	7:00	12:00	2.46	1	1	1
131	21-10-2021	2.72	2360.00	7:00	12:00	2.72	1	1	1
132	29-10-2021	2.64	1880.00	7:00	12:00	2.61	1	1	1
133	05-11-2021	2.75	1940.00	7:00	12:00	2.75	1	1	1
134	12-11-2021	2.43	1710.00	7:00	12:00	2.43	1	1	1
135	19-11-2021	2.82	2080.00	7:00	12:00	2.81	1	1	1
136	26-11-2021	2.32	1640.00	7:00	12:00	2.32	1	1	1
137	09-12-2021	1.98	1420.00	7:00	12:00	1.98	1	1	1
138	17-12-2021	2.01	1410.00	7:00	12:00	1.99	1	1	1
139	07-01-2022	1.79	1373.00	7:00	12:00	1.78	1	1	1
140	28-01-2022	1.79	1262.00	7:00	12:00	1.78	1	1	1
141	18-02-2022	1.59	1160.00	7:00	12:00	1.59	1	1	1
142	04-03-2022	2.25	1915.20	7:00	12:00	2.26	1	1	1
143	25-03-2022	2.42	2632.79	7:00	12:00	2.43	1	1	1
144	08-04-2022	3.14	2359.98	7:00	12:00	3.21	1	1	1
145	22-04-2022	2.79	2687.12	7:00	12:00	2.86	1	1	1
146	11-05-2022	3.23	2848.15	7:00	12:00	3.26	1	1	1
147	25-02-2022	3.25	1760.00	7:00	12:00	3.26	1	1	1
148	27-05-2022	3.54	3046.00	7:00	12:00	3.54	1	1	1
149	10-06-2022	4.73	4663.00	7:00	12:00	4.73	1	1	1
150	17-06-2022	3.82	3278.00	7:00	12:00	3.82	1	1	1
151	24-06-2022	3.90	3598.00	7:00	12:00	3.99	1	1	1
152	30-06-2022	2.91	2272.00	7:00	12:00	2.91	1	1	1
153	08-07-2022	3.94	3270.00	7:00	12:00	3.96	1	1	1
154	12-07-2022	4.71	4150.00	7:00	12:00	4.71	1	1	1
155	22-07-2022	3.87	3150.00	7:00	12:00	3.94	1	1	1
156	27-07-2022	3.24	2450.00	7:00	12:00	3.23	1	1	1
157	05-08-2022	3.47	2710.00	7:00	12:00	3.51	1	1	1
158	11-08-2022	3.81	3110.00	7:00	12:00	3.77	1	1	1

Table A: Water level and discharge observation of Mekong mainstream at Chiang Saen (continued)

WL-Q Observation				Mekong-HYCOS			QA/QC		
No	Date	WL1[a] (m)	Q (m3/s)	Start time	End time	WL2[b] (m)	1[c]	2[d]	3[e]
159	19-08-2022	3.96	2710.00	7:00	12:00	3.93	1	1	1
160	26-08-2022	4.24	3700.00	7:00	12:00	4.25	1	1	1
161	02-09-2022	4.46	4060.00	7:00	12:00	4.46	1	1	1
162	09-09-2022	4.22	3560.00	7:00	12:00	4.22	1	1	1
163	16-09-2022	4.61	3850.00	7:00	12:00	4.61	1	1	1
164	22-09-2022	4.78	4180.00	7:00	12:00	4.79	1	1	1
165	07-10-2022	3.16	2440.00	7:00	12:00	3.17	1	1	1
166	12-10-2022	3.07	4180.00	7:00	12:00	3.09	1	1	1
167	21-10-2022	2.41	1880.00	7:00	12:00	2.42	1	1	1
168	28-10-2022	2.89	2160.00	7:00	12:00	2.89	1	1	1
169	04-11-2022	2.37	1740.00	7:00	12:00	2.38	1	1	1
170	11-11-2022	2.85	2150.00	7:00	12:00	2.86	1	1	1
171	18-11-2022	2.54	1930.00	7:00	12:00	2.55	1	1	1
172	25-11-2022	2.55	1850.00	7:00	12:00	2.56	1	1	1
173	09-12-2022	2.00	1390.00	7:00	12:00	2.00	1	1	1
174	22-12-2022	2.49	1930.00	7:00	12:00	2.50	1	1	1

[a] WL1 is manually observed water level from staff gauges.

[b] WL2 is near real-time water level from the Mekong-HYCOS network.

[c] QA/QC1: Rating curves analysis for manually observed water level and discharge; "-1" outliers detected outside ±10 % of the rating curves; "1" pairs/points were in range of ±10 % of the rating curves.

[d] QA/QC2: validation analysis for near real-time water level from the Mekong-HYCOS network; "0" no data for near real-time water level from the Mekong-HYCOS network; "-1" difference between manually observed and near real-time water level is outside the range of ±10 cm; "1" difference between manually observed and near real-time water level is within the range of ±10 cm, therefore, near real-time water level is considered reliable.

[e] QA/QC3: Validation of rating curves developed for manually observed water level for near real-time water level; "-1" invalidated for near real-time water level; "1" validated for near real-time water level.

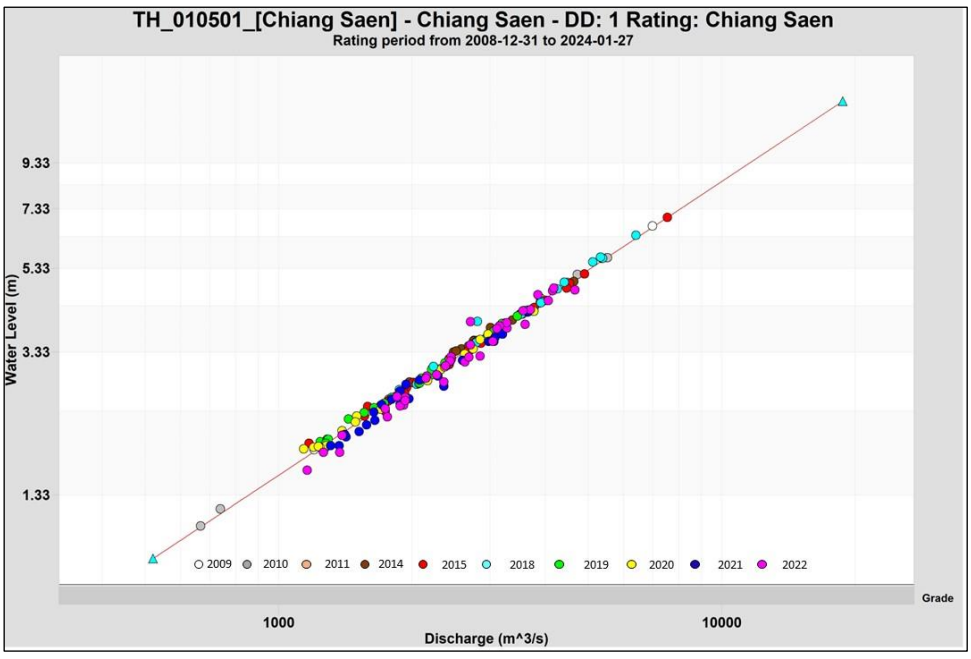


Figure A.1. Rating curve and rating equations of the Mekong mainstream at Chiang Saen for the dataset after applying ±10 % in discharge off the curve. Solid line is proposed rating curves

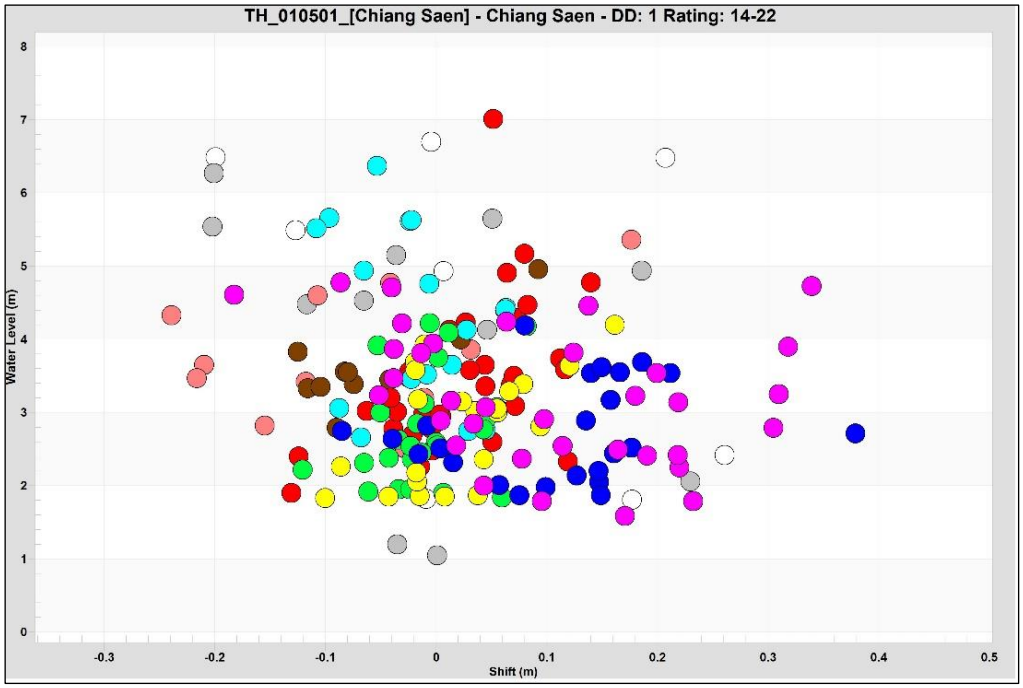


Figure A.2. The shift diagram was displayed data pairs/points observed water level and discharge scattering points around the rating curves of the Mekong mainstream at Chiang Saen for the dataset after applying ±10 % in discharge off the curve

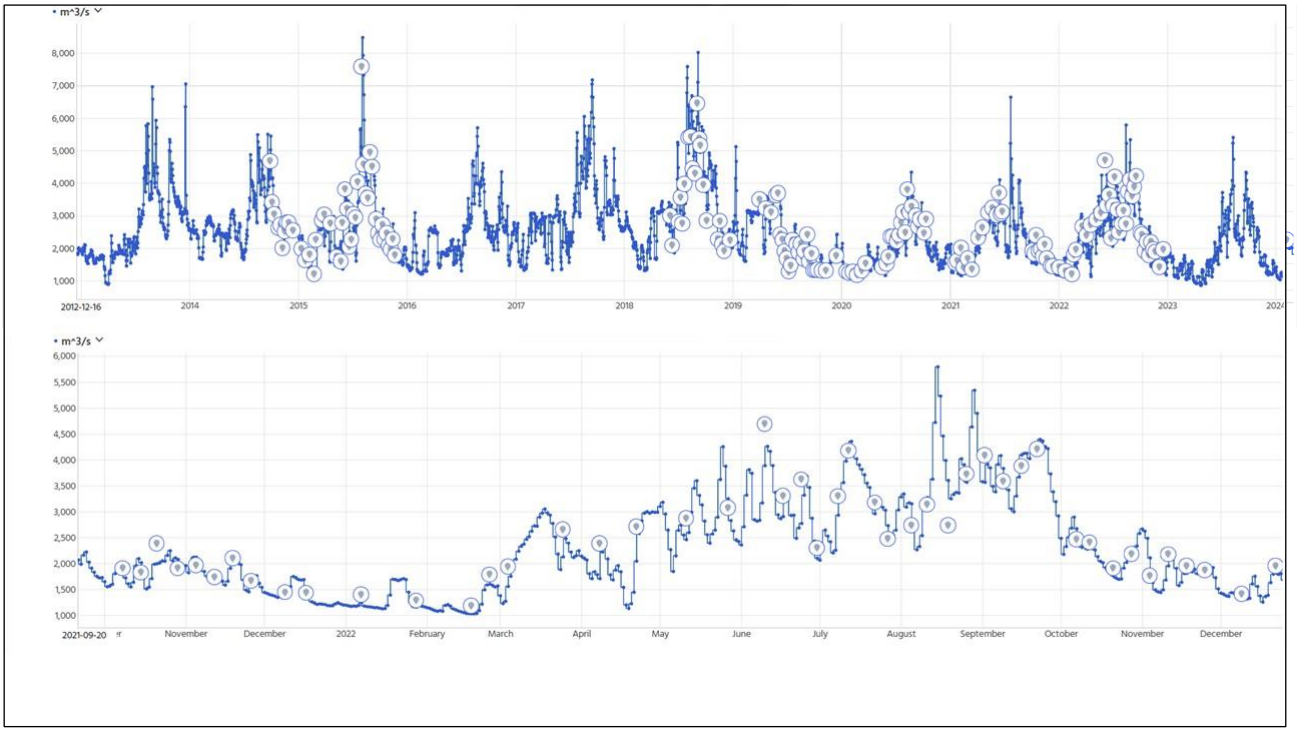


Figure A.3. The data pairs/points observed water level and discharge (dots) plotted against the derived discharge (blue line) from new rating curve at Chiang Saen station

Table B. Water level and discharge observation of Mekong mainstream at Luang Prabang station

WL-Q Observation				Mekong-HYCOS		QA/QC			
No	Date	WL1a (m)	Q (m3/s)	Start time	End time	WL2b (m)	1c	2d	3e
1	04-01-2012	4.00	1805.37	7:00	12:00	4.48	-1	-1	-1
2	23-01-2012	3.88	1234.77	7:00	12:00	3.99	-1	-1	-1
3	09-02-2012	3.46	1088.07	7:00	12:00	3.46	-1	-1	-1
4	20-02-2012	3.26	894.69	7:00	12:00	3.26	-1	-1	-1
5	05-03-2012	3.08	837.18	7:00	12:00	3.09	-1	-1	-1
6	19-03-2012	3.08	890.13	7:00	12:00	3.08	-1	-1	-1
7	09-04-2012	3.34	1081.93	7:00	12:00	3.38	-1	-1	-1
8	23-04-2012	3.04	852.25	7:00	12:00	-	-1	0	-1
9	07-05-2012	2.99	746.40	7:00	12:00	-	-1	0	-1
10	21-05-2012	3.34	1350.33	7:00	12:00	3.36	-1	-1	-1
11	09-07-2012	7.04	3623.87	7:00	12:00	6.91	-1	-1	-1
12	16-07-2012	6.52	3165.39	7:00	12:00	6.65	-1	-1	-1
13	23-07-2012	8.87	5228.45	7:00	12:00	8.78	-1	-1	-1
14	30-07-2012	13.85	10735.87	7:00	12:00	14.06	-1	-1	-1
15	06-08-2012	12.27	8895.88	7:00	12:00	12.29	-1	-1	-1
16	13-08-2012	11.72	7956.11	7:00	12:00	11.55	-1	-1	-1
17	20-08-2012	13.60	10414.04	7:00	12:00	13.64	-1	-1	-1
18	25-08-2012	13.81	10609.89	7:00	12:00	13.63	-1	-1	-1
19	03-09-2012	10.92	7157.43	7:00	12:00	10.88	-1	-1	-1
20	10-09-2012	10.08	6103.29	7:00	12:00	10.11	-1	-1	-1
21	17-09-2012	11.23	7359.82	7:00	12:00	11.15	-1	-1	-1
22	24-09-2012	9.34	5627.00	7:00	12:00	9.29	-1	-1	-1
23	08-10-2012	8.52	4801.86	7:00	12:00	8.52	-1	-1	-1
24	15-10-2012	7.96	4359.35	7:00	12:00	8.00	-1	-1	-1
25	22-10-2012	7.98	4326.83	7:00	12:00	7.99	-1	-1	-1
26	29-10-2012	7.76	3981.25	7:00	12:00	7.77	-1	-1	-1
27	05-11-2012	6.76	3299.55	7:00	12:00	6.70	-1	-1	-1
28	12-11-2012	6.22	2831.82	7:00	12:00	6.25	-1	-1	-1
29	19-11-2012	6.00	2713.75	7:00	12:00	6.06	-1	-1	-1
30	26-11-2012	5.55	2280.77	7:00	12:00	5.55	-1	-1	-1
31	17-12-2012	4.96	2139.96	7:00	12:00	5.06	-1	-1	-1
32	24-12-2012	5.05	2192.32	7:00	12:00	5.06	-1	-1	-1
33	14-01-2013	4.99	1854.05	7:00	12:00	5.00	-1	-1	-1
34	28-01-2013	4.41	1645.19	7:00	12:00	4.43	-1	-1	-1
35	11-02-2013	4.45	1658.38	7:00	12:00	4.44	-1	-1	-1
36	25-02-2013	4.27	1579.56	7:00	12:00	4.28	-1	-1	-1
37	11-03-2013	4.54	1590.12	7:00	12:00	4.53	-1	-1	-1
38	25-03-2013	3.15	1048.77	7:00	12:00	3.14	-1	-1	-1
39	08-04-2013	3.55	1141.99	7:00	12:00	3.56	-1	-1	-1
40	23-04-2013	4.03	1483.94	7:00	12:00	-	-1	-1	-1
41	13-05-2013	4.87	2052.19	7:00	12:00	4.88	-1	-1	-1
42	27-05-2013	5.11	2198.02	7:00	12:00	5.16	-1	-1	-1

Table B. Water level and discharge observation of Mekong mainstream at Luang Prabang station (continued)

WL-Q Observation				Mekong-HYCOS			QA/QC		
No	Date	WL1a (m)	Q (m3/s)	Start time	End time	WL2b (m)	1c	2d	3e
43	07-06-2013	4.88	1967.01	7:00	12:00	4.95	-1	-1	-1
44	14-06-2013	5.30	2204.09	7:00	12:00	5.30	-1	-1	-1
45	21-06-2013	4.42	1632.92	7:00	12:00	4.43	-1	-1	-1
46	28-06-2013	6.38	2960.36	7:00	12:00	-	-1	0	-1
47	07-04-2014	5.50	2422.64	7:00	12:00	-	-1	0	-1
48	21-04-2014	5.10	2184.32	7:00	12:00	-	-1	0	-1
49	12-05-2014	5.30	2066.75	7:00	12:00	-	-1	0	-1
50	26-05-2014	6.15	2869.36	7:00	12:00	6.16	-1	-1	-1
51	04-06-2014	5.56	2621.76	7:00	12:00	-	-1	0	-1
52	09-06-2014	5.33	2278.04	7:00	12:00	-	-1	0	-1
53	16-06-2014	5.85	2528.38	7:00	12:00	-	-1	0	-1
54	22-06-2014	5.60	2392.75	7:00	12:00	-	-1	0	-1
55	07-07-2014	5.20	2348.89	7:00	12:00	-	-1	0	-1
56	14-07-2014	7.52	4004.28	7:00	12:00	-	-1	0	-1
57	21-07-2014	8.78	5304.47	7:00	12:00	-	-1	0	-1
58	28-07-2014	9.80	6483.51	7:00	12:00	-	-1	0	-1
59	04-08-2014	8.85	5508.43	7:00	12:00	-	-1	0	-1
60	11-08-2014	9.24	5863.14	7:00	12:00	-	-1	0	-1
61	18-08-2014	12.00	9445.96	7:00	12:00	-	-1	0	-1
62	25-08-2014	10.65	7424.22	7:00	12:00	-	-1	0	-1
63	01-09-2014	11.58	8701.85	7:00	12:00	-	-1	0	-1
64	08-09-2014	10.69	7471.07	7:00	12:00	-	-1	0	-1
65	15-09-2014	8.50	4965.02	7:00	12:00	-	-1	0	-1
66	22-09-2014	12.20	9028.02	7:00	12:00	-	-1	0	-1
67	06-10-2014	9.50	5989.72	7:00	12:00	-	-1	0	-1
68	13-10-2014	7.93	4395.58	7:00	12:00	-	-1	0	-1
69	20-10-2014	7.52	4027.11	7:00	12:00	-	-1	0	-1
70	27-10-2014	7.70	4173.42	7:00	12:00	-	-1	0	-1
71	13-11-2014	6.68	3213.35	7:00	12:00	-	-1	0	-1
72	17-11-2014	6.01	2736.10	7:00	12:00	-	-1	0	-1
73	28-11-2014	6.58	3254.31	7:00	12:00	-	-1	0	-1
74	12-01-2015	5.94	2708.78	7:00	12:00	-	-1	0	-1
75	26-01-2015	4.78	1932.29	7:00	12:00	-	-1	0	-1
76	09-02-2015	4.10	1546.77	7:00	12:00	-	-1	0	-1
77	23-02-2015	3.84	1406.56	7:00	12:00	-	-1	0	-1
78	15-03-2015	5.53	2665.29	7:00	12:00	-	-1	0	-1
79	31-03-2015	5.34	2415.33	7:00	12:00	-	-1	0	-1
80	23-06-2019	8.20	2222.57	7:00	12:00	8.00	1	-1	-1
81	28-06-2019	7.58	1909.49	7:00	12:00	6.61	-1	-1	-1
82	08-07-2019	7.47	2097.95	7:00	12:00	7.43	-1	1	1
83	10-07-2019	6.97	2222.57	7:00	12:00	6.93	-1	1	1
84	19-07-2019	6.67	1611.40	7:00	12:00	6.33	-1	-1	-1

Table B. Water level and discharge observation of Mekong mainstream at Luang Prabang station (continued)

WL-Q Observation					Mekong-HYCOS		QA/QC			
No	Date	WL1a (m)	Q (m3/s)		Start time	End time	WL2b (m)	1c	2d	3e
85	01-08-2019	9.38	3649.84		7:00	12:00	9.42	1	1	1
86	06-08-2019	9.60	4087.33		7:00	12:00	9.63	1	1	1
87	12-08-2019	9.42	3495.50		7:00	12:00	9.41	1	1	1
88	19-08-2019	9.92	2976.11		7:00	12:00	9.81	1	-1	-1
89	02-09-2019	8.83	2976.11		7:00	12:00	8.91	1	1	1
90	09-09-2019	8.99	2940.00		7:00	12:00	9.02	1	1	1
91	16-09-2019	9.16	3431.98		7:00	12:00	9.17	1	1	1
92	23-09-2019	7.41	2095.40		7:00	12:00	7.41	-1	-1	-1
93	19-10-2019	7.87	1728.37		7:00	12:00	6.94	1	-1	-1
94	21-10-2019	6.90	1682.42		7:00	12:00	6.85	-1	1	1
95	18-11-2019	8.46	1465.90		7:00	12:00	8.56	1	1	1
96	09-12-2019	8.75	1713.11		7:00	12:00	-	1	0	-1
97	19-12-2019	8.75	2126.71		7:00	12:00	-	1	0	-1
98	30-12-2019	8.21	1786.90		7:00	12:00	-	1	0	-1
99	27-04-2020	8.84	1709.76		7:00	12:00	-	1	0	-1
100	11-05-2020	8.07	1664.97		7:00	12:00	-	1	0	-1
101	25-05-2020	8.24	1552.01		7:00	12:00	-	1	0	-1
102	17-06-2020	8.51	2317.05		7:00	12:00	-	1	0	-1
103	24-06-2020	8.45	2489.23		7:00	12:00	-	1	0	-1
104	01-07-2020	8.47	2469.17		7:00	12:00	-	1	0	-1
105	06-07-2020	8.62	2385.88		7:00	12:00	-	1	0	-1
106	13-07-2020	9.32	2896.73		7:00	12:00	-	1	0	-1
107	20-07-2020	9.33	3207.71		7:00	12:00	-	1	0	-1
108	29-07-2020	8.30	2776.25		7:00	12:00	-	1	0	-1
109	03-08-2020	9.80	3507.97		7:00	12:00	-	1	0	-1
110	10-08-2020	10.08	4239.76		7:00	12:00	10.14	1	1	1
111	20-08-2020	11.28	7009.95		7:00	12:00	12.42	1	-1	-1
112	24-08-2020	11.36	6650.08		7:00	12:00	12.07	1	-1	-1
113	28-09-2020	10.38	4578.76		7:00	12:00	10.47	1	1	1
114	08-10-2020	9.40	3550.51		7:00	12:00	9.72	1	-1	-1
115	14-10-2020	9.00	3020.32		7:00	12:00	9.10	1	1	1
116	19-10-2020	8.88	2392.87		7:00	12:00	8.82	1	1	1
117	25-10-2020	9.10	2633.62		7:00	12:00	8.77	1	-1	-1
118	09-11-2020	8.62	2593.93		7:00	12:00	8.75	1	-1	-1
119	16-11-2020	8.92	2545.90		7:00	12:00	9.10	1	-1	-1
120	07-12-2020	8.60	1704.64		7:00	12:00	8.79	1	-1	-1
121	12-04-2021	8.96	2428.94		7:00	12:00	9.01	1	1	1
122	24-05-2021	9.78	3305.43		7:00	12:00	9.82	1	1	1
123	07-06-2021	8.90	2581.62		7:00	12:00	8.98	1	1	1
124	12-06-2021	9.80	1853.00		7:00	12:00	9.95	-1	-1	-1
125	17-06-2021	10.70	5201.08		7:00	12:00	10.88	1	-1	-1
126	25-06-2021	9.66	3656.75		7:00	12:00	9.74	1	-1	-1

Table B. Water level and discharge observation of Mekong mainstream at Luang Prabang station (continued)

WL-Q Observation					Mekong-HYCOS		QA/QC			
No	Date	WL1a (m)	Q (m3/s)		Start time	End time	WL2b (m)	1c	2d	3e
127	30-06-2021	9.40	3587.98		7:00	12:00	9.51	1	-1	-1
128	05-07-2021	9.84	3477.71		7:00	12:00	9.97	1	-1	-1
129	15-07-2021	9.26	2732.13		7:00	12:00	9.34	1	1	1
130	19-07-2021	9.61	2744.32		7:00	12:00	9.53	1	1	1
131	26-07-2021	12.44	6607.63		7:00	12:00	12.29	1	-1	-1
132	06-09-2021	10.24	4148.08		7:00	12:00	-	1	0	-1
133	13-09-2021	9.70	3723.19		7:00	12:00	-	1	0	-1
134	20-09-2021	9.42	3289.48		7:00	12:00	-	1	0	-1
135	27-09-2021	9.48	3181.52		7:00	12:00	-	1	0	-1
136	05-10-2021	9.26	2672.21		7:00	12:00	-	1	0	-1
137	14-10-2021	9.20	2713.79		7:00	12:00	-	1	0	-1
138	26-10-2021	9.34	3029.08		7:00	12:00	-	1	0	-1
139	01-11-2021	9.56	2674.40		7:00	12:00	-	1	0	-1
140	15-11-2021	9.26	2655.63		7:00	12:00	-	1	0	-1
141	17-12-2021	8.98	2040.23		7:00	12:00	-	1	0	-1
142	20-01-2022	8.74	2133.16		7:00	12:00	-	1	0	-1
143	28-02-2022	8.82	1948.13		7:00	12:00	8.44	1	-1	-1
144	22-03-2022	9.70	3247.10		7:00	12:00	9.25	1	-1	-1
145	05-04-2022	9.16	2289.20		7:00	12:00	8.60	1	-1	-1
146	10-05-2022	9.20	3200.51		7:00	12:00	8.83	1	-1	-1
147	17-05-2022	10.03	4016.52		7:00	12:00	9.86	1	-1	-1
148	20-06-2022	10.30	4352.62		7:00	12:00	10.14	1	-1	-1
149	23-06-2022	9.70	3635.69		7:00	12:00	9.46	1	-1	-1
150	26-06-2022	9.83	4061.17		7:00	12:00	9.67	1	-1	-1
151	29-06-2022	10.13	3934.79		7:00	12:00	9.95	1	-1	-1
152	04-07-2022	9.71	4003.14		7:00	12:00	9.52	1	-1	-1
153	11-07-2022	10.77	5045.69		7:00	12:00	10.70	1	-1	-1
154	18-07-2022	10.90	5148.28		7:00	12:00	10.66	1	-1	-1
155	29-07-2022	10.24	4175.53		7:00	12:00	10.04	1	-1	-1
156	08-08-2022	10.17	4074.97		7:00	12:00	10.00	1	-1	-1
157	16-08-2022	13.20	7753.15		7:00	12:00	13.08	1	-1	-1
158	29-08-2022	12.84	7931.45		7:00	12:00	13.14	1	-1	-1
159	31-08-2022	12.31	7071.63		7:00	12:00	12.42	1	-1	-1
160	18-09-2022	12.30	7306.81		7:00	12:00	12.39	1	1	1
161	23-09-2022	11.86	6676.09		7:00	12:00	11.86	1	1	1
162	27-09-2022	11.49	5973.96		7:00	12:00	11.36	1	-1	-1
163	30-09-2022	10.80	4973.04		7:00	12:00	10.76	1	1	1
164	18-10-2022	9.66	3616.41		7:00	12:00	9.33	1	-1	-1
165	23-10-2022	9.05	2956.76		7:00	12:00	8.73	1	-1	-1
166	27-10-2022	9.19	3026.62		7:00	12:00	8.79	1	-1	-1
167	31-10-2022	9.26	3076.92		7:00	12:00	8.90	1	-1	-1
168	15-11-2022	9.22	2507.18		7:00	12:00	8.89	1	-1	-1
169	30-11-2022	9.24	2317.42		7:00	12:00	8.89	1	-1	-1

[a] WL1 is manually observed water level from staff gauges.
[b] WL2 is near real-time water level from the Mekong-HYCOS network.
[c] QA/QC1: Rating curves analysis for manually observed water level and discharge; "-1" outliers detected outside ±10 % of the rating curves; "1" pairs/points were in range of ±10 % of the rating curves.
[d] QA/QC2: validation analysis for near real-time water level from the Mekong-HYCOS network; "0" no data for near real-time water level from the Mekong-HYCOS network; "-1" difference between manually observed and near real-time water level is outside the range of ±10 cm; "1" difference between manually observed and near real-time water level is within the range of ±10 cm, therefore, near real-time water level is considered reliable.
[e] QA/QC3: Validation of rating curves developed for manually observed water level for near real-time water level; "-1" invalidated for near real-time water level; "1" validated for near real-time water level.

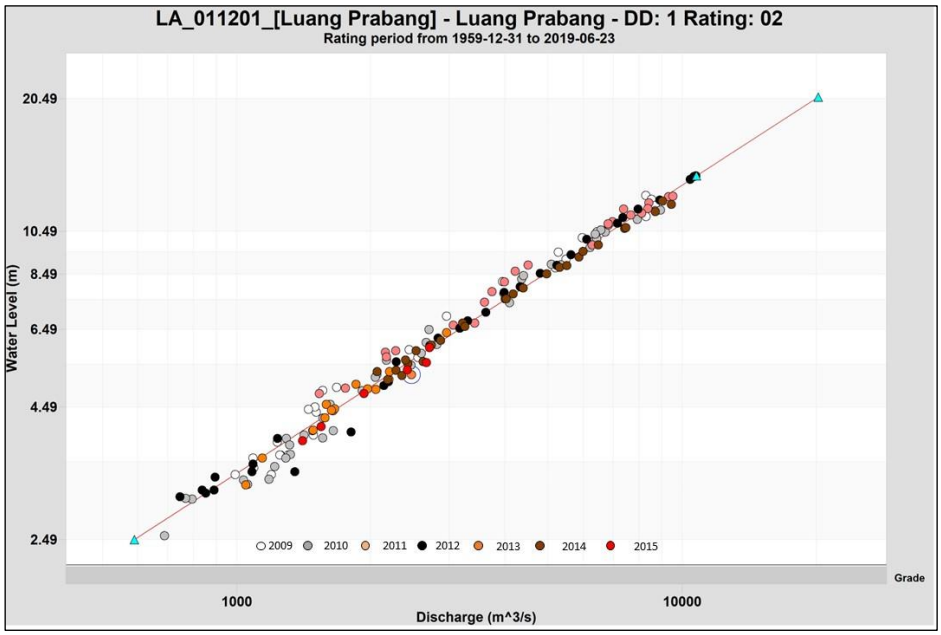


Figure B.1. Rating curve and rating equations of the Mekong mainstream at Luang Prabang for the dataset (2009-2015) after applying ±10 % in discharge off the curve. Solid line is proposed rating curves

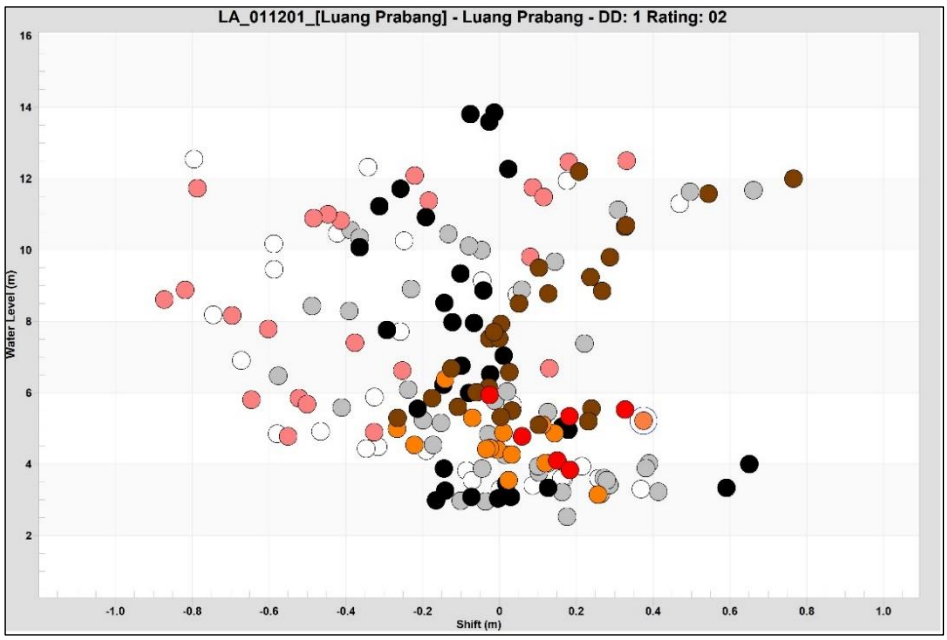


Figure B.2. The shift diagram was displayed data pairs/points observed water level and discharge scattering points around the rating curves of the Mekong mainstream at Luang Prabang for the dataset (2009-2015) after applying ±10 % in discharge off the curve

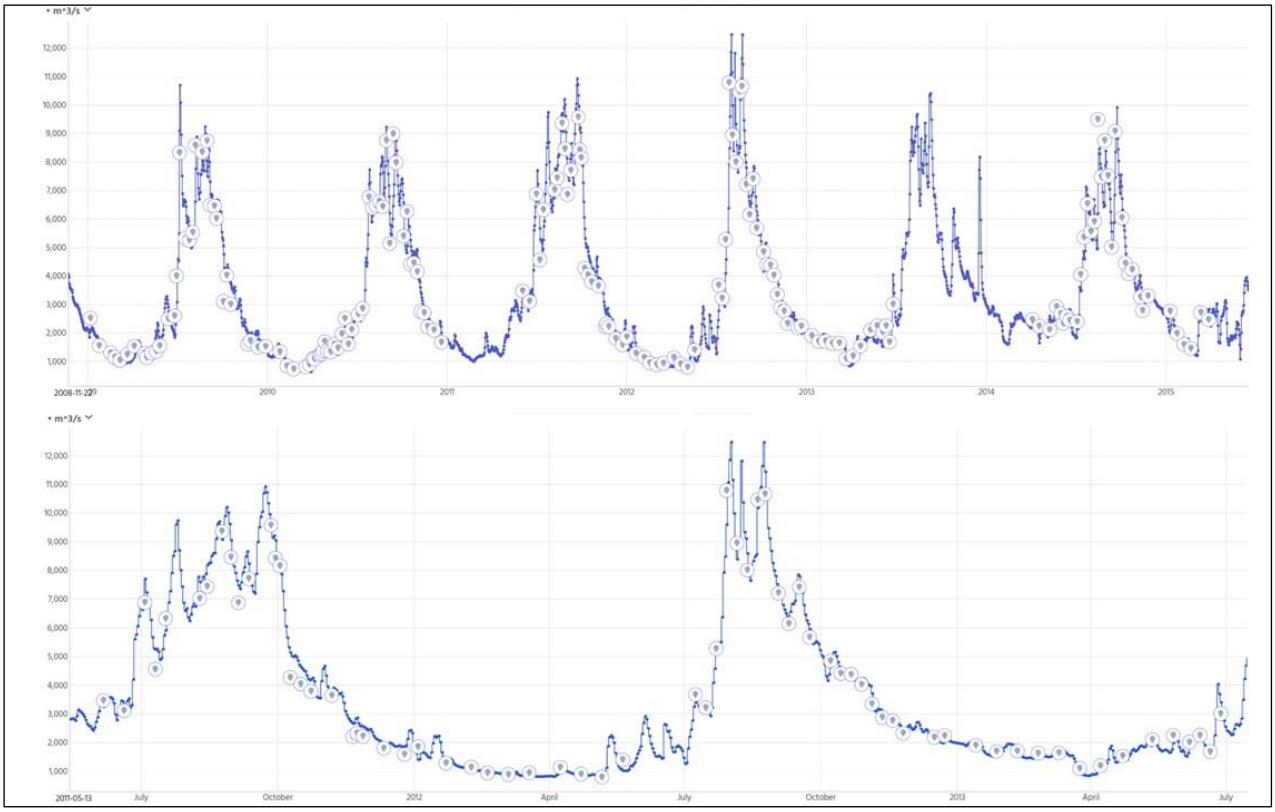


Figure B.3. The data pairs/points observed water level and discharge (dots) plotted against the derived discharge (blue line) from updated rating curve at Luang Prabang station (2009-2015). The graph was displayed that both of data were fitted and go parallel with the new derived discharge

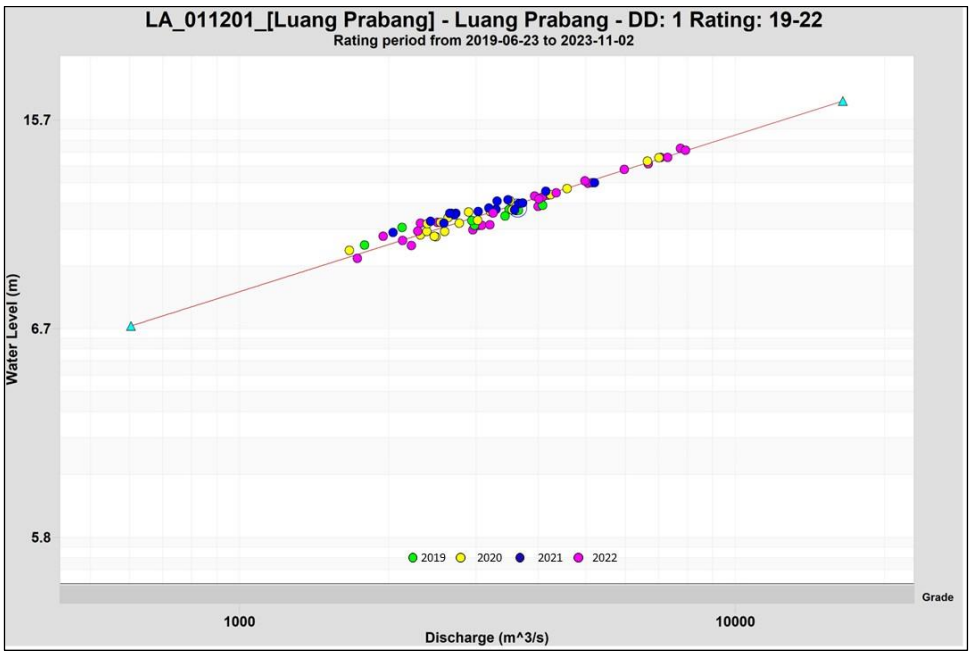


Figure B.4. Rating curve and rating equations of the Mekong mainstream at Luang Prabang for the dataset (2019-2022) after applying ±10 % in discharge off the curve. Solid line is proposed rating curves

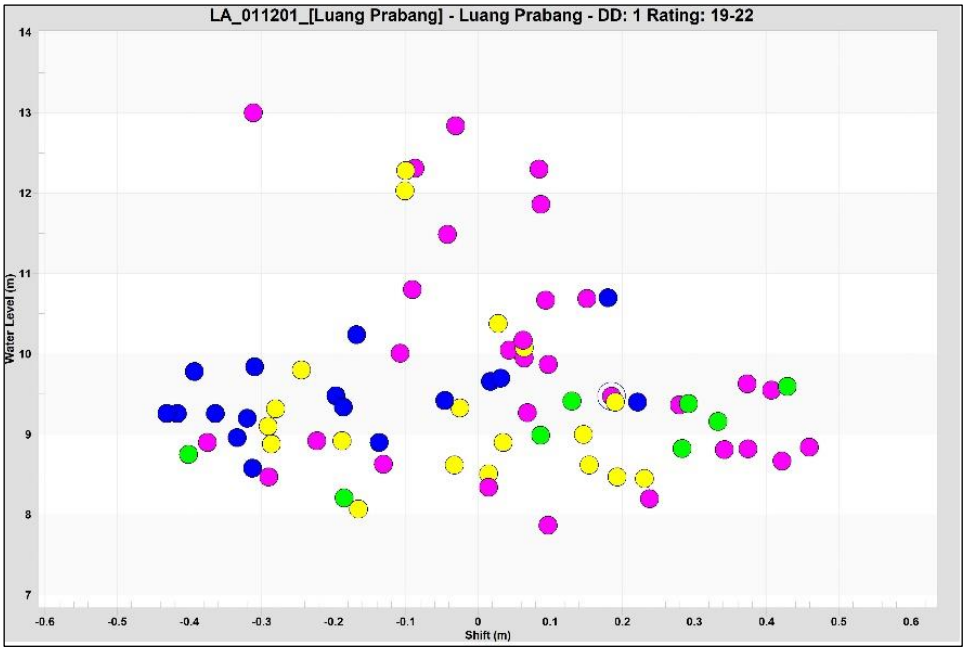


Figure B.5. The shift diagram was displayed data pairs/points observed water level and discharge scattering points around the rating curves of the Mekong mainstream at Luang Prabang for the dataset (2019-2022) after applying ±10 % in discharge off the curve

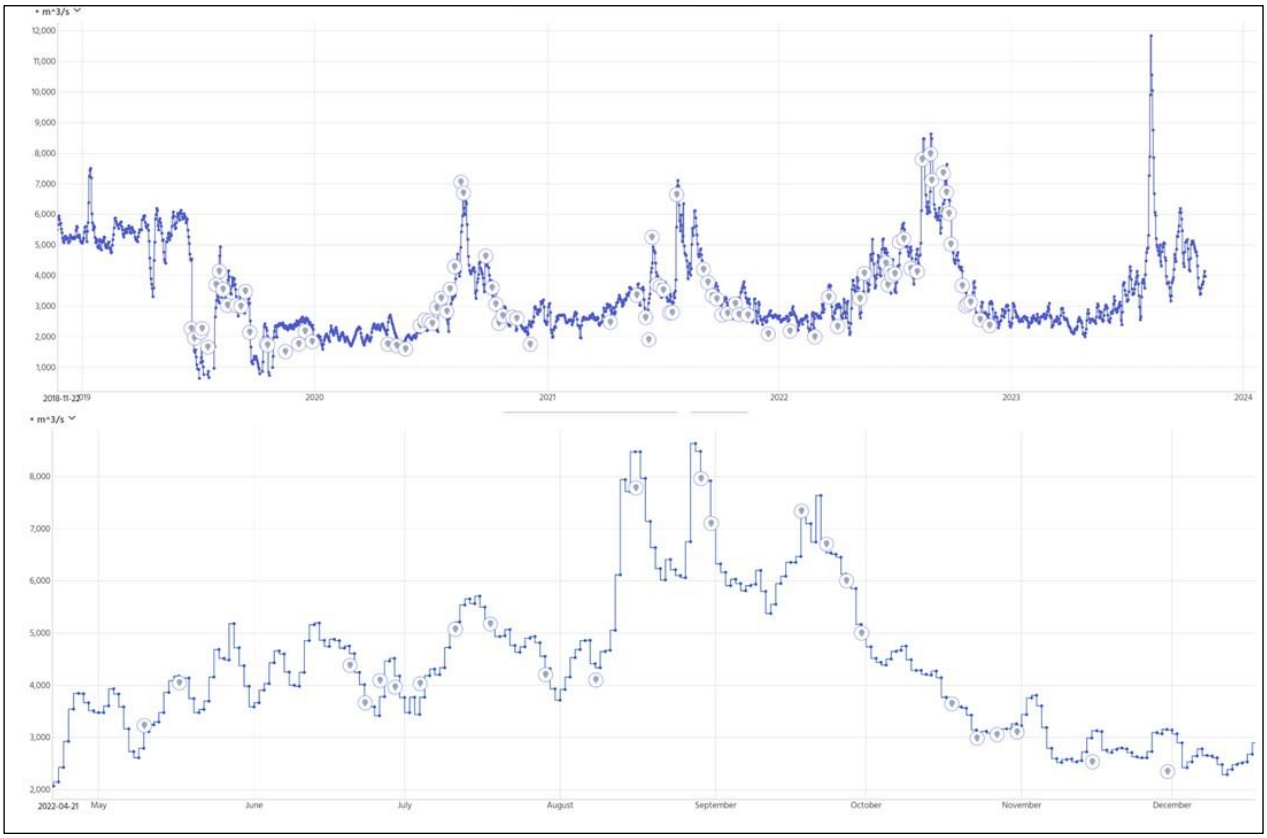


Figure B.6. The data pairs/points observed water level and discharge (dots) plotted against the derived discharge (blue line) from updated rating curve at Luang Prabang station (2019-2022). The graph was displayed that both of data were fitted and go parallel with the new derived discharge

Table C. Water level and discharge observation of Mekong mainstream at Chiang Khan station

WL-Q Observation				Mekong-HYCOS			QA/QC		
No	Date	WL1[a] (m)	Q (m3/s)	Start time	End time	WL2[b] (m)	1[c]	2[d]	3[e]
1	22-01-2012	4.38	1934.71	7:00	12:00	4.36	-1	1	-1
2	25-01-2012	3.79	1757.54	7:00	12:00	3.84	-1	1	-1
3	08-02-2012	3.37	1527.20	7:00	12:00	3.42	-1	1	-1
4	22-02-2012	2.94	1419.47	7:00	12:00	3.01	-1	1	-1
5	14-03-2012	2.64	1244.18	7:00	12:00	2.66	-1	1	-1
6	28-03-2012	2.51	1213.11	7:00	12:00	2.52	-1	1	-1
7	11-04-2012	2.70	1399.03	7:00	12:00	2.70	-1	1	-1
8	25-04-2012	2.39	1239.10	7:00	12:00	2.45	-1	1	-1
9	10-05-2012	2.80	1583.25	7:00	12:00	2.83	-1	1	-1
10	23-05-2012	2.80	1444.62	7:00	12:00	2.82	-1	1	-1
11	06-06-2012	6.54	3574.54	7:00	12:00	6.57	-1	1	-1
12	20-06-2012	5.85	2637.40	7:00	12:00	5.83	1	1	1
13	04-07-2012	3.90	2017.56	7:00	12:00	3.89	-1	1	-1
14	11-07-2012	7.50	4623.83	7:00	12:00	7.46	-1	1	-1
15	18-07-2012	7.00	4119.51	7:00	12:00	7.00	-1	1	-1
16	25-07-2012	8.69	6540.54	7:00	12:00	8.75	-1	1	-1
17	08-08-2012	11.29	10779.42	7:00	12:00	11.31	-1	1	-1
18	15-08-2012	10.65	8719.07	7:00	12:00	10.64	-1	1	-1
19	22-08-2012	12.35	13258.38	7:00	12:00	12.39	-1	1	-1
20	29-08-2012	11.27	10496.83	7:00	12:00	11.26	-1	1	-1
21	05-09-2012	10.50	9162.97	7:00	12:00	10.50	-1	1	-1
22	12-09-2012	10.15	8382.91	7:00	12:00	10.19	-1	1	-1
23	19-09-2012	10.43	9212.80	7:00	12:00	10.43	-1	1	-1
24	26-09-2012	8.97	6556.65	7:00	12:00	8.96	-1	1	-1
25	03-10-2012	8.39	5737.95	7:00	12:00	8.37	-1	1	-1
26	10-10-2012	8.47	5968.80	7:00	12:00	8.47	-1	1	-1
27	17-10-2012	7.83	5078.14	7:00	12:00	7.78	-1	1	-1
28	31-10-2012	7.55	4657.13	7:00	12:00	7.52	-1	1	-1
29	09-01-2013	4.63	2295.99	7:00	12:00	-	-1	0	-1
30	23-01-2013	4.17	1819.11	7:00	12:00	-	-1	0	-1
31	06-02-2013	4.74	2141.07	7:00	12:00	-	-1	0	-1
32	20-02-2013	3.88	1813.83	7:00	12:00	-	-1	0	-1
33	06-03-2013	3.98	2018.87	7:00	12:00	-	-1	0	-1
34	20-03-2013	3.98	2038.99	7:00	12:00	-	-1	0	-1
35	10-04-2013	2.97	1607.16	7:00	12:00	-	-1	0	-1
36	24-04-2013	3.76	2002.19	7:00	12:00	-	-1	0	-1
37	08-05-2013	4.69	2488.89	7:00	12:00	-	-1	0	-1
38	22-05-2013	4.42	2158.33	7:00	12:00	-	-1	0	-1
39	05-06-2013	4.52	2304.19	7:00	12:00	-	-1	0	-1
40	12-06-2013	5.68	2857.19	7:00	12:00	-	-1	0	-1
41	19-06-2013	4.91	2302.33	7:00	12:00	-	-1	0	-1
42	26-06-2013	5.70	3215.46	7:00	12:00	-	-1	0	-1

Table C. Water level and discharge observation of Mekong mainstream at Chiang Khan station (continued)

WL-Q Observation				Mekong-HYCOS			QA/QC		
No	Date	WL1[a] (m)	Q (m3/s)	Start time	End time	WL2[b] (m)	1[c]	2[d]	3[e]
43	09-04-2014	5.60	2940.41	-	-	-	1	0	-1
44	23-04-2014	4.94	2554.29	-	-	-	1	0	-1
45	07-05-2014	5.07	2587.74	7:00	12:00	5.08	1	1	1
46	21-05-2014	5.83	3080.40	7:00	12:00	5.81	1	1	1
47	10-09-2014	10.40	8810.15	7:00	12:00	10.41	1	1	1
48	17-09-2014	8.65	5765.31	7:00	12:00	8.65	1	1	1
49	24-09-2014	12.46	13377.92	7:00	12:00	12.41	-1	1	-1
50	08-10-2014	9.22	6097.00	7:00	12:00	9.21	1	1	1
51	15-10-2014	7.94	4941.13	7:00	12:00	7.97	1	1	1
52	22-10-2014	7.51	4176.10	7:00	12:00	7.55	1	1	1
53	29-10-2014	7.68	4359.62	7:00	12:00	7.72	1	1	1
54	05-11-2014	7.12	3930.70	7:00	12:00	7.16	1	1	1
55	12-11-2014	7.42	4128.56	7:00	12:00	7.47	1	1	1
56	19-11-2014	6.16	3097.19	7:00	12:00	6.20	1	1	1
57	26-11-2014	6.69	3454.79	7:00	12:00	6.74	1	1	1
58	03-12-2014	6.68	3589.92	7:00	12:00	6.73	1	1	1
59	17-12-2014	6.26	2946.91	7:00	12:00	6.32	1	1	1
60	07-01-2015	5.61	2672.84	7:00	12:00	5.59	1	1	1
61	22-01-2015	5.24	2225.75	7:00	12:00	5.15	1	1	1
62	04-02-2015	4.60	1761.56	7:00	12:00	4.64	1	1	1
63	18-02-2015	4.48	1815.50	7:00	12:00	4.53	1	1	1
64	11-03-2015	5.43	2462.46	7:00	12:00	5.43	1	1	1
65	25-03-2015	5.82	3100.69	7:00	12:00	5.83	1	1	1
66	08-04-2015	6.17	3911.59	7:00	12:00	6.15	-1	1	-1
67	22-04-2015	4.32	1960.75	7:00	12:00	4.36	1	1	1
68	06-05-2015	5.83	2867.50	7:00	12:00	5.87	1	1	1
69	20-05-2015	4.84	2128.82	7:00	12:00	4.87	1	1	1
70	03-06-2015	4.28	2290.58	7:00	12:00	4.33	1	1	1
71	10-06-2015	7.12	3901.12	7:00	12:00	7.05	1	1	1
72	17-06-2015	7.46	4683.55	7:00	12:00	7.40	1	1	1
73	24-06-2015	6.49	3851.51	7:00	12:00	6.51	1	1	1
74	08-07-2015	5.61	2710.33	7:00	12:00	5.63	1	1	1
75	15-07-2015	6.13	2909.20	7:00	12:00	6.13	1	1	1
76	22-07-2015	8.13	4913.20	7:00	12:00	8.05	1	1	1
77	05-08-2015	12.38	13025.83	7:00	12:00	12.46	-1	1	-1
78	11-08-2015	11.78	10970.50	7:00	12:00	11.81	1	1	1
79	19-08-2015	9.74	6975.42	7:00	12:00	9.75	1	1	1
80	26-08-2015	9.32	6349.56	7:00	12:00	9.31	1	1	1
81	02-09-2015	10.84	9170.41	7:00	12:00	10.76	1	1	1
82	09-09-2015	10.87	9261.72	7:00	12:00	10.89	1	1	1
83	16-09-2015	9.82	7057.04	7:00	12:00	9.85	1	1	1
84	23-09-2015	8.12	5299.95	7:00	12:00	8.15	1	1	1

Table C. Water level and discharge observation of Mekong mainstream at Chiang Khan (continued)

WL-Q Observation				Mekong-HYCOS			QA/QC		
No	Date	WL1[a] (m)	Q (m3/s)	Start time	End time	WL2[b] (m)	1[c]	2[d]	3[e]
85	06-06-2018	6.98	9477.61	7:00	12:00	6.92	-1	1	-1
86	20-06-2018	6.52	3928.00	7:00	12:00	6.48	1	1	1
87	04-07-2018	9.32	6155.38	7:00	12:00	9.34	1	1	1
88	11-07-2018	7.22	3973.63	7:00	12:00	7.31	1	1	1
89	19-07-2018	9.10	5942.03	7:00	12:00	9.05	1	1	1
90	01-08-2018	13.66	13119.33	7:00	12:00	13.79	1	-1	-1
91	08-08-2018	12.16	10506.13	-	-	-	1	0	-1
92	15-08-2018	11.76	10044.15	-	-	-	1	0	-1
93	22-08-2018	13.70	12879.82	-	-	-	1	0	-1
94	05-09-2018	14.30	14608.21	-	-	-	1	0	-1
95	19-09-2018	11.33	9538.91	-	-	-	1	0	-1
96	26-09-2018	10.16	7532.66	-	-	-	1	0	-1
97	10-10-2018	8.40	5335.07	-	-	-	1	0	-1
98	24-10-2018	8.60	5466.65	-	-	-	1	0	-1
99	07-11-2018	8.60	5467.98	-	-	-	1	0	-1
100	21-11-2018	6.53	3324.35	-	-	-	1	0	-1
101	12-12-2018	5.52	2400.99	-	-	-	1	0	-1
102	26-12-2018	5.95	2739.43	-	-	-	1	0	-1
103	17-04-2019	6.05	2810.01	7:00	12:00	5.98	1	1	1
104	24-04-2019	5.26	2219.75	7:00	12:00	5.29	1	1	1
105	08-05-2019	6.09	2805.96	7:00	12:00	6.06	1	1	1
106	22-05-2019	6.48	3332.90	7:00	12:00	6.51	1	1	1
107	05-06-2019	7.34	4049.29	7:00	12:00	7.33	1	1	1
108	19-06-2019	6.08	2886.25	7:00	12:00	6.09	1	1	1
109	26-06-2019	5.22	2085.41	7:00	12:00	5.11	1	1	1
110	03-07-2019	4.94	2085.41	7:00	12:00	4.92	1	1	1
111	10-07-2019	5.37	2160.97	7:00	12:00	5.36	1	1	1
112	18-07-2019	3.72	1684.53	7:00	12:00	3.72	1	1	1
113	24-07-2019	4.36	1697.19	7:00	12:00	4.37	1	1	1
114	07-08-2019	8.74	5047.64	7:00	12:00	8.65	1	1	1
115	14-08-2019	7.16	3717.94	7:00	12:00	7.13	1	1	1
116	21-08-2019	7.50	4008.88	7:00	12:00	7.46	1	1	1
117	28-08-2019	7.92	4598.18	7:00	12:00	8.07	1	1	1
118	04-09-2019	7.27	3916.46	7:00	12:00	7.25	1	1	1
119	11-09-2019	6.32	3026.68	7:00	12:00	6.37	1	1	1
120	18-09-2019	6.66	3399.75	7:00	12:00	6.72	1	1	1
121	25-09-2019	5.52	2450.60	7:00	12:00	5.56	1	1	1
122	20-11-2019	3.94	1750.02	7:00	12:00	3.97	1	1	1
123	27-11-2019	4.10	1883.96	7:00	12:00	4.14	1	1	1
124	04-12-2019	4.26	1883.73	7:00	12:00	4.30	1	1	1
125	11-12-2019	4.18	1782.19	7:00	12:00	4.22	1	1	1
126	18-12-2019	5.02	2181.04	7:00	12:00	5.07	1	1	1

Table C. Water level and discharge observation of Mekong mainstream at Chiang Khan (continued)

WL-Q Observation				Mekong-HYCOS			QA/QC		
No	Date	WL1[a] (m)	Q (m3/s)	Start time	End time	WL2[b] (m)	1[c]	2[d]	3[e]
127	25-12-2019	4.34	1772.83	7:00	12:00	4.39	1	1	1
128	08-07-2020	5.40	2454.53	7:00	12:00	5.39	1	1	1
129	15-07-2020	6.34	3228.36	7:00	12:00	6.32	1	1	1
130	22-07-2020	6.47	3281.63	7:00	12:00	6.44	1	1	1
131	29-07-2020	6.10	2897.00	7:00	12:00	6.10	1	1	1
132	05-08-2020	8.70	5450.07	7:00	12:00	8.70	1	1	1
133	13-08-2020	8.55	5332.24	7:00	12:00	8.54	1	1	1
134	19-08-2020	9.85	6818.42	7:00	12:00	9.78	1	1	1
135	26-08-2020	10.26	6361.00	7:00	12:00	10.27	1	1	1
136	09-09-2020	7.23	3785.71	7:00	12:00	7.27	1	1	1
137	23-09-2020	8.30	4939.43	7:00	12:00	8.36	1	1	1
138	21-10-2020	5.96	2659.19	7:00	12:00	5.98	1	1	1
139	11-11-2020	5.96	2703.21	7:00	12:00	6.01	1	1	1
140	25-11-2020	4.85	2037.42	7:00	12:00	4.90	1	1	1
141	09-12-2020	4.37	1945.23	7:00	12:00	4.39	1	1	1
142	23-12-2020	5.32	2548.17	7:00	12:00	5.30	1	1	1
143	17-03-2021	4.04	1743.52	7:00	12:00	4.07	1	1	1
144	07-04-2021	5.34	2450.34	7:00	12:00	5.31	1	1	1
145	05-05-2021	6.27	3149.02	7:00	12:00	6.25	1	1	1
146	02-06-2021	6.37	3181.52	7:00	12:00	6.36	1	1	1
147	09-06-2021	5.67	2602.55	7:00	12:00	5.65	1	1	1
148	16-06-2021	9.10	6064.78	7:00	12:00	9.04	1	1	1
149	23-06-2021	7.48	4067.81	7:00	12:00	7.42	1	1	1
150	07-07-2021	6.81	3648.54	7:00	12:00	6.89	1	1	1
151	14-07-2021	6.46	3191.51	7:00	12:00	6.46	1	1	1
152	21-07-2021	6.11	2900.01	7:00	12:00	6.10	1	1	1
153	29-07-2021	9.36	6445.27	7:00	12:00	9.46	1	1	1
154	04-08-2021	9.29	6308.68	7:00	12:00	9.38	1	1	1
155	11-08-2021	7.37	3974.91	7:00	12:00	7.36	1	1	1
156	18-08-2021	8.84	5791.05	7:00	12:00	8.83	1	1	1
157	25-08-2021	8.87	5776.84	7:00	12:00	8.90	1	1	1
158	08-09-2021	8.19	4938.75	7:00	12:00	8.15	1	1	1
159	15-09-2021	8.06	4814.24	7:00	12:00	7.99	1	1	1
160	22-09-2021	7.65	4307.18	7:00	12:00	7.57	1	1	1
161	29-09-2021	8.06	4776.64	7:00	12:00	8.07	1	1	1
162	06-10-2021	6.54	3312.03	7:00	12:00	6.57	1	1	1
163	20-10-2021	6.14	2954.04	7:00	12:00	6.18	1	1	1
164	27-10-2021	6.51	3273.06	7:00	12:00	6.57	1	1	1
165	10-11-2021	6.57	3335.30	7:00	12:00	6.52	1	1	1
166	24-11-2021	5.69	2577.01	7:00	12:00	5.65	1	1	1
167	15-12-2021	4.88	2123.38	7:00	12:00	4.87	1	1	1
168	05-01-2022	4.03	1641.67	7:00	12:00	4.04	1	1	1

Table C. Water level and discharge observation of Mekong mainstream at Chiang Khan (continued)

WL-Q Observation				Mekong-HYCOS			QA/QC		
No	Date	WL1[a] (m)	Q (m3/s)	Start time	End time	WL2[b] (m)	1[c]	2[d]	3[e]
169	19-01-2022	3.87	1596.25	7:00	12:00	3.89	1	1	1
170	09-02-2022	3.63	1486.20	7:00	12:00	3.63	1	1	1
171	23-02-2022	4.25	2056.18	7:00	12:00	4.26	1	1	1
172	02-03-2022	4.70	2056.18	7:00	12:00	4.69	1	1	1
173	15-03-2022	5.76	2754.35	7:00	12:00	5.74	1	1	1
174	20-04-2022	5.73	2713.73	7:00	12:00	5.75	1	1	1
175	27-04-2022	6.34	3253.59	7:00	12:00	6.36	1	1	1
176	18-05-2022	7.73	4524.38	7:00	12:00	7.37	1	1	1
177	25-05-2022	9.00	6028.11	7:00	12:00	9.05	1	1	1
178	08-06-2022	7.89	4536.66	7:00	12:00	7.84	1	1	1
179	15-06-2022	8.19	5093.28	7:00	12:00	8.19	1	1	1
180	22-06-2022	7.61	4519.85	7:00	12:00	7.62	1	1	1
181	29-06-2022	7.91	4774.94	7:00	12:00	7.86	1	1	1
182	04-07-2022	7.47	4324.10	7:00	12:00	4.43	1	1	1
183	12-07-2022	8.69	5569.15	7:00	12:00	8.69	1	1	1
184	20-07-2022	8.80	5680.75	7:00	12:00	8.80	1	1	1
185	27-07-2022	8.77	5688.19	7:00	12:00	8.74	1	1	1
186	03-08-2022	8.06	4871.19	7:00	12:00	8.08	1	1	1
187	10-08-2022	8.40	5342.58	7:00	12:00	8.43	1	1	1
188	17-08-2022	11.92	10154.82	7:00	12:00	11.91	1	1	1
189	24-08-2022	10.18	7499.52	7:00	12:00	10.19	1	1	1
190	07-09-2022	9.58	6828.41	7:00	12:00	9.62	1	1	1
191	14-09-2022	10.03	7460.27	7:00	12:00	10.07	1	1	1
192	21-09-2022	10.16	7664.20	7:00	12:00	10.17	1	1	1
193	28-09-2022	10.22	7765.26	7:00	12:00	10.25	1	1	1
194	05-10-2022	9.77	7201.16	7:00	12:00	9.80	1	1	1
195	12-10-2022	8.36	5300.09	7:00	12:00	8.38	1	1	1
196	19-10-2022	7.36	4080.76	7:00	12:00	7.31	1	1	1
197	26-10-2022	6.45	3304.58	7:00	12:00	6.51	1	1	1
198	09-11-2022	5.67	2646.28	7:00	12:00	5.73	1	1	1
199	23-11-2022	5.75	2761.76	7:00	12:00	5.81	1	1	1
200	07-12-2022	4.73	2761.76	7:00	12:00	4.87	1	-1	-1
201	21-12-2022	4.56	1981.76	7:00	12:00	4.70	1	-1	-1

[a] WL1 is manually observed water level from staff gauges.

[b] WL2 is near real-time water level from the Mekong-HYCOS network.

[c] QA/QC1: Rating curves analysis for manually observed water level and discharge; "-1" outliers detected outside ±10 % of the rating curves; "1" pairs/points were in range of ±10 % of the rating curves.

[d] QA/QC2: validation analysis for near real-time water level from the Mekong-HYCOS network; "0" no data for near real-time water level from the Mekong-HYCOS network; "-1" difference between manually observed and near real-time water level is outside the range of ±10 cm; "1" difference between manually observed and near real-time water level is within the range of ±10 cm, therefore, near real-time water level is considered reliable.

[e] QA/QC3: Validation of rating curves developed for manually observed water level for near real-time water level; "-1" invalidated for near real-time water level; "1" validated for near real-time water level.

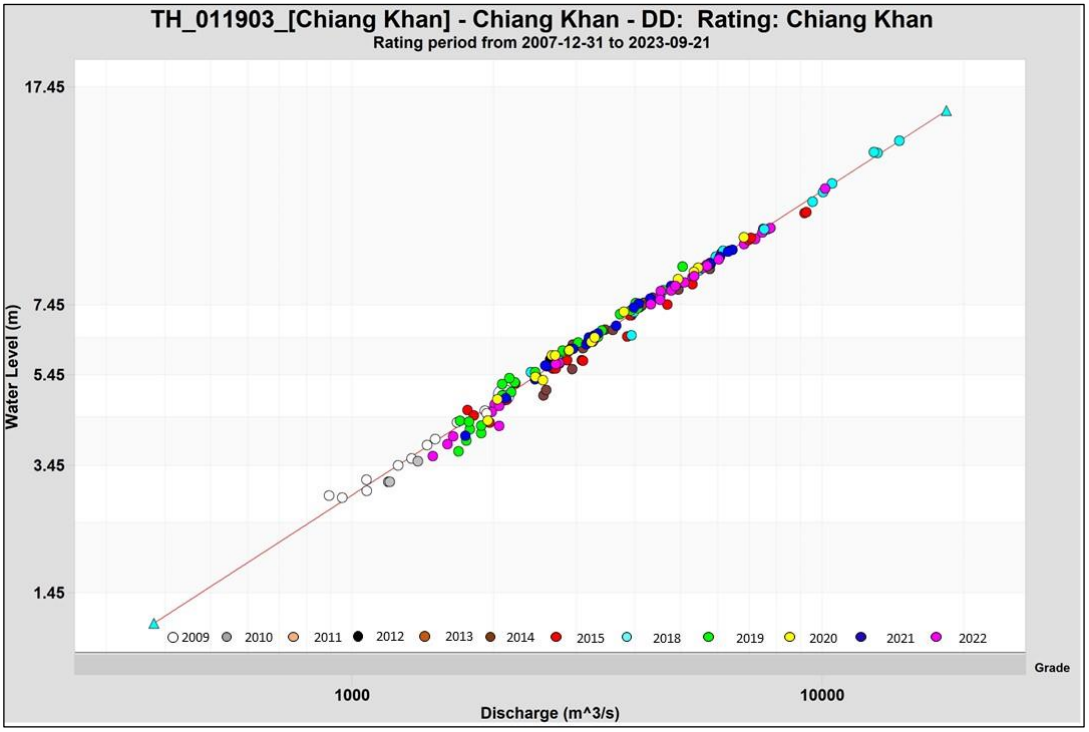


Figure C.1. Rating curve and rating equations of the Mekong mainstream at Chiang Khan for the dataset after applying ±10 % in discharge off the curve. Solid line is proposed rating curves

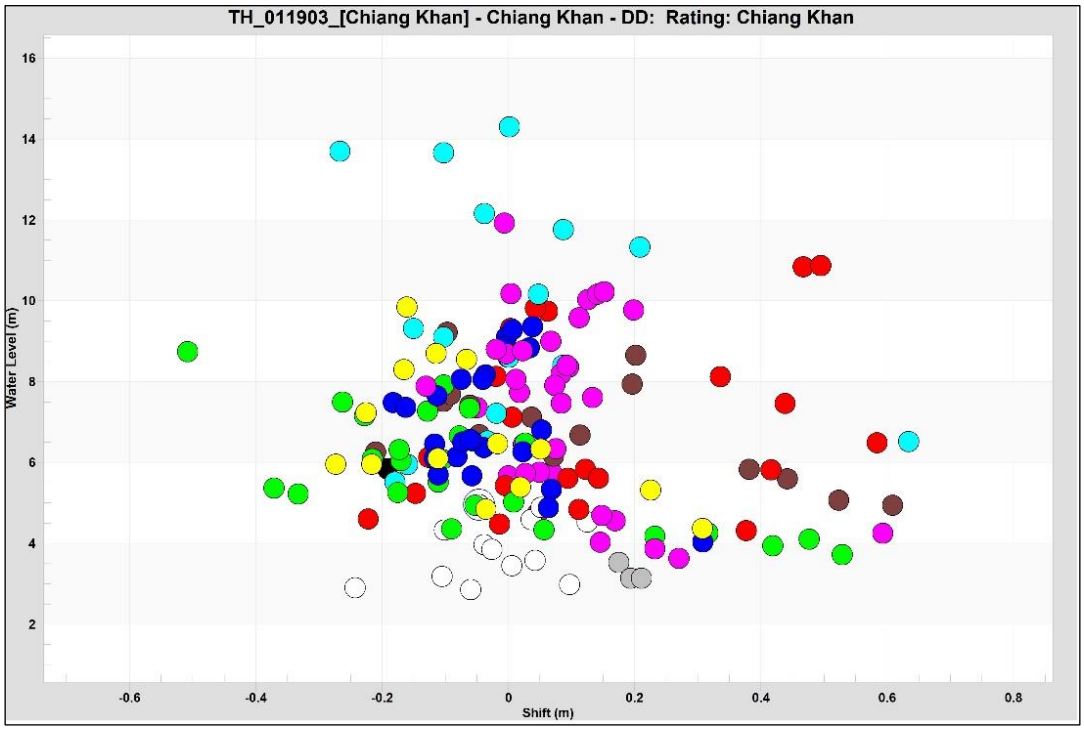


Figure C.2. The shift diagram was displayed data pairs/points observed water level and discharge scattering points around the rating curves of the Mekong mainstream at Chiang khan for the dataset after applying ±10 % in discharge off the curve

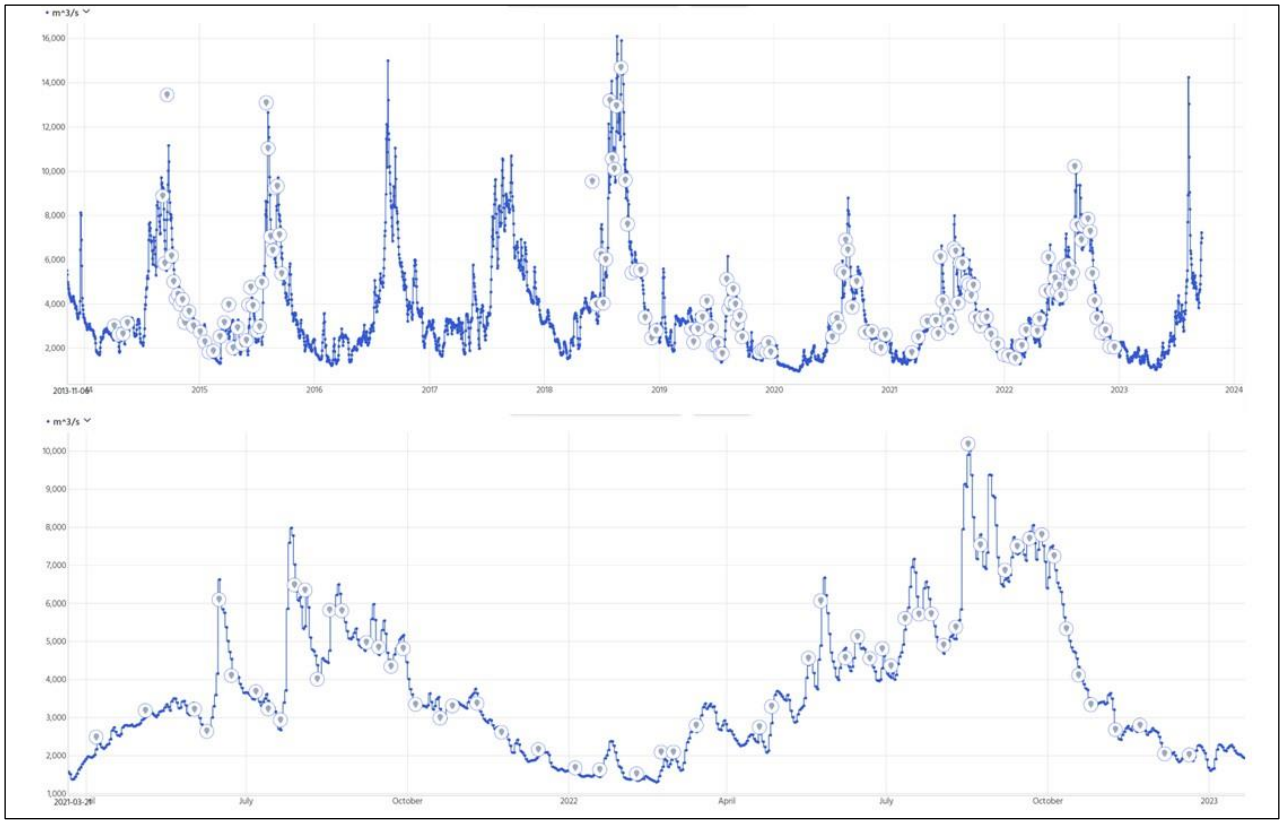


Figure C.3. The data pairs/points observed water level and discharge (dots) plotted against the derived discharge (blue line) from new rating curve at Chiang Khan station

Table D. Water level and discharge observation of Mekong mainstream at Nong Khai station

WL-Q Observation					Mekong-HYCOS			QA/QC		
No	Date	WL1[a] (m)	Q (m3/s)		Start time	End time	WL2[b] (m)	1[c]	2[d]	3[e]
1	01/13/2012	1.80	1648.11		7:00	12:00	1.81	-1	1	-1
2	01/27/2012	1.54	1496.79		7:00	12:00	1.55	-1	1	-1
3	02/10/2012	1.26	1343.90		7:00	12:00	1.25	-1	1	-1
4	02/24/2012	0.98	1201.18		7:00	12:00	0.97	-1	1	-1
5	03/09/2012	0.84	1133.55		7:00	12:00	0.82	-1	1	-1
6	03/23/2012	0.88	1152.62		7:00	12:00	0.85	-1	1	-1
7	04/05/2012	0.78	1105.31		7:00	12:00	0.75	-1	1	-1
8	04/20/2012	0.94	1181.61		7:00	12:00	0.92	-1	1	-1
9	05/21/2012	1.73	1606.47		7:00	12:00	1.80	-1	1	-1
10	05/25/2012	1.19	1307.28		7:00	12:00	1.23	-1	1	-1
11	06/01/2012	2.43	2053.52		7:00	12:00	2.50	-1	1	-1
12	06/15/2012	2.44	2060.41		7:00	12:00	2.46	-1	1	-1
13	06/29/2012	2.25	1931.98		7:00	12:00	2.25	-1	1	-1
14	07/06/2012	2.02	2478.36		7:00	12:00	2.02	-1	1	-1
15	07/13/2012	4.87	4885.56		7:00	12:00	4.92	1	1	1
16	07/20/2012	4.38	4518.05		7:00	12:00	4.42	1	1	1
17	07/27/2012	6.39	6998.45		7:00	12:00	6.31	1	1	1
18	08/10/2012	10.64	15886.26		7:00	12:00	10.76	-1	-1	-1
19	08/17/2012	8.70	11011.38		7:00	12:00	8.70	-1	1	1
20	08/24/2012	10.74	15798.24		7:00	12:00	10.78	-1	1	-1
21	08/31/2012	9.29	11723.93		7:00	12:00	9.22	-1	1	-1
22	09/07/2012	8.43	9810.57		7:00	12:00	8.36	1	1	1
23	09/14/2012	8.17	9864.47		7:00	12:00	8.12	-1	1	-1
24	09/21/2012	7.96	9720.18		7:00	12:00	7.90	-1	1	-1
25	09/28/2012	6.43	7068.51		7:00	12:00	6.43	1	1	1
26	10/08/2012	5.79	6212.39		7:00	12:00	5.75	-1	1	-1
27	10/12/2012	5.92	6775.52		7:00	12:00	5.91	-1	1	-1
28	10/19/2012	5.10	5222.54		7:00	12:00	5.15	1	1	1
29	10/26/2012	4.96	5330.36		7:00	12:00	5.07	1	-1	-1
30	11/09/2012	3.88	3686.97		7:00	12:00	4.05	-1	-1	-1
31	11/16/2012	3.44	3459.15		7:00	12:00	3.53	1	1	1
32	11/23/2012	3.26	3176.58		7:00	12:00	3.15	-1	-1	-1
33	11/30/2012	2.94	3100.85		7:00	12:00	2.92	1	1	1
34	12/07/2012	3.08	3247.03		7:00	12:00	3.06	1	1	1
35	12/21/2012	2.40	2538.13		7:00	12:00	2.37	1	1	1
36	01/11/2013	2.14	2408.95		7:00	12:00	2.08	1	1	1
37	01/25/2013	1.73	2018.50		7:00	12:00	1.69	1	1	1
38	02/08/2013	2.26	2382.75		7:00	12:00	2.19	1	1	1
39	02/22/2013	1.57	1931.10		7:00	12:00	1.51	1	1	1
40	03/08/2013	1.67	1962.13		7:00	12:00	1.62	1	1	1
41	03/22/2013	1.72	2003.72		7:00	12:00	1.63	1	1	1
42	04/09/2013	0.80	1350.39		7:00	12:00	0.68	1	-1	-1
43	04/19/2013	2.15	2235.52		7:00	12:00	2.02	1	-1	-1

Table D. Water level and discharge observation of Mekong mainstream at Nong Khai (continued)

WL-Q Observation				Mekong-HYCOS			QA/QC		
No	Date	WL1[a] (m)	Q (m3/s)	Start time	End time	WL2[b] (m)	1[c]	2[d]	3[e]
44	05/10/2013	2.40	2423.19	7:00	12:00	2.41	1	1	1
45	05/23/2013	2.24	2418.58	7:00	12:00	2.23	1	1	1
46	06/07/2013	2.46	2443.40	7:00	12:00	2.44	1	1	1
47	06/14/2013	3.47	3611.62	7:00	12:00	3.47	1	1	1
48	06/21/2013	2.52	2400.11	7:00	12:00	2.59	1	1	1
49	06/28/2013	3.91	4352.20	7:00	12:00	4.01	1	1	1
50	04/11/2014	2.85	2872.73	7:00	12:00	2.83	1	1	1
51	04/25/2014	2.39	2502.30	7:00	12:00	2.33	1	1	1
52	05/08/2014	2.62	2839.95	7:00	12:00	2.85	1	1	1
53	09/05/2014	10.04	13420.23	7:00	12:00	10.09	1	1	1
54	09/12/2014	8.22	9727.27	7:00	12:00	8.19	1	1	1
55	09/19/2014	6.30	7243.38	7:00	12:00	6.30	1	1	1
56	09/26/2014	9.97	12703.32	7:00	12:00	9.81	1	-1	-1
57	10/03/2014	8.25	10692.74	7:00	12:00	7.99	-1	-1	-1
58	10/10/2014	6.56	6547.78	7:00	12:00	6.35	1	-1	-1
59	10/17/2014	5.10	5382.71	7:00	12:00	6.00	1	-1	-1
60	10/31/2014	4.80	4656.57	7:00	12:00	5.09	1	-1	-1
61	11/07/2014	4.31	4471.25	7:00	12:00	4.18	1	-1	-1
62	11/14/2014	4.54	4594.92	7:00	12:00	4.72	1	-1	-1
63	11/21/2014	3.38	2901.64	7:00	12:00	3.58	1	-1	-1
64	11/28/2014	3.86	3793.98	7:00	12:00	3.34	1	-1	-1
65	12/16/2014	3.52	3792.36	7:00	12:00	0.00	1	0	0
66	12/26/2014	3.30	3434.37	7:00	12:00	3.36	1	1	1
67	01/09/2015	2.76	3057.17	7:00	12:00	3.01	1	-1	-1
68	01/23/2015	2.46	2649.81	7:00	12:00	2.74	1	-1	-1
69	02/13/2015	1.62	2181.85	7:00	12:00	1.74	1	-1	-1
70	02/27/2015	1.38	1841.99	7:00	12:00	1.50	1	-1	-1
71	03/13/2015	2.68	3082.33	7:00	12:00	2.25	1	-1	-1
72	03/27/2015	3.14	3152.16	7:00	12:00	3.16	1	1	1
73	04/10/2015	3.41	3619.26	7:00	12:00	3.38	1	1	1
74	04/24/2015	1.91	2203.62	7:00	12:00	1.87	1	1	1
75	05/07/2015	3.24	3482.44	7:00	12:00	3.19	1	1	1
76	05/22/2015	2.30	2536.51	7:00	12:00	2.24	1	1	1
77	06/12/2015	4.45	4915.75	7:00	12:00	4.51	1	1	1
78	06/19/2015	4.62	4656.05	7:00	12:00	4.61	1	1	1
79	06/26/2015	3.68	3309.87	7:00	12:00	3.68	1	1	1
80	06/08/2018	4.10	4125.75	7:00	12:00	4.10	1	1	1
81	06/22/2018	3.59	3664.75	7:00	12:00	3.50	1	1	1
82	07/06/2018	6.22	6394.25	7:00	12:00	6.37	1	-1	-1
83	07/13/2018	4.62	5340.15	7:00	12:00	4.48	1	-1	-1
84	07/20/2018	6.38	6603.00	7:00	12:00	6.30	1	1	1
85	07/25/2018	10.10	12508.00	7:00	12:00	10.27	1	-1	-1
86	08/03/2018	11.70	15714.25	7:00	12:00	11.74	1	1	1
87	08/10/2018	10.28	12583.50	7:00	12:00	10.28	1	1	1

Table D. Water level and discharge observation of Mekong mainstream at Nong Khai (continued)

WL-Q Observation					Mekong-HYCOS			QA/QC		
No	Date	WL1[a] (m)	Q (m3/s)		Start time	End time	WL2[b] (m)	1[c]	2[d]	3[e]
88	08/16/2018	9.79	11479.75		7:00	12:00	9.72	1	1	1
89	08/24/2018	11.32	13586.75		7:00	12:00	11.37	1	1	1
90	09/07/2018	12.36	16522.00		7:00	12:00	12.37	1	1	1
91	09/14/2018	10.05	11564.25		7:00	12:00	10.16	1	-1	-1
92	09/21/2018	9.79	11482.25		7:00	12:00	9.72	1	1	1
93	10/05/2018	6.68	7115.75		7:00	12:00	6.75	1	1	1
94	10/19/2018	6.22	6703.00		7:00	12:00	6.18	1	1	1
95	11/02/2018	5.72	5620.75		7:00	12:00	5.73	1	1	1
96	11/09/2018	5.40	6739.38		7:00	12:00	5.44	-1	1	-1
97	11/16/2018	4.02	4177.50		7:00	12:00	4.04	1	1	1
98	12/07/2018	2.64	2810.25		7:00	12:00	2.60	1	1	1
99	12/21/2018	2.62	2852.75		7:00	12:00	2.58	1	1	1
100	05/03/2019	3.47	3614.25		7:00	12:00	3.37	1	1	1
101	05/17/2019	3.32	3448.50		7:00	12:00	3.13	1	-1	-1
102	06/07/2019	4.26	4421.25		7:00	12:00	4.14	1	-1	-1
103	06/14/2019	3.86	3941.75		7:00	12:00	3.89	1	1	1
104	06/28/2019	2.19	2456.25		7:00	12:00	2.32	1	-1	-1
105	07/05/2019	1.88	2174.25		7:00	12:00	1.87	1	1	1
106	07/12/2019	2.22	2484.00		7:00	12:00	2.21	1	1	1
107	07/19/2019	0.85	1461.25		7:00	12:00	0.96	1	1	1
108	07/26/2019	1.50	1939.25		7:00	12:00	1.41	1	1	1
109	08/02/2019	3.68	4038.25		7:00	12:00	3.39	1	-1	-1
110	08/09/2019	4.76	4852.00		7:00	12:00	4.89	1	-1	-1
111	08/16/2019	4.50	4631.25		7:00	12:00	4.42	1	1	1
112	08/23/2019	4.92	5015.25		7:00	12:00	4.92	1	1	1
113	08/30/2019	5.80	5954.25		7:00	12:00	5.75	1	1	1
114	09/06/2019	4.57	4631.25		7:00	12:00	4.61	1	1	1
115	09/12/2019	3.64	3705.50		7:00	12:00	3.69	1	1	1
116	09/19/2019	3.76	3869.50		7:00	12:00	3.73	1	1	1
117	09/27/2019	2.44	2675.00		7:00	12:00	2.40	1	1	1
118	10/04/2019	2.22	2482.75		7:00	12:00	2.19	1	1	1
119	10/11/2019	1.58	1975.25		7:00	12:00	1.38	1	-1	-1
120	10/18/2019	1.72	2136.75		7:00	12:00	1.53	1	-1	-1
121	10/25/2019	2.00	2310.00		7:00	12:00	1.85	1	-1	-1
122	11/08/2019	1.12	1679.25		7:00	12:00	0.99	1	-1	-1
123	11/15/2019	1.12	1727.25		7:00	12:00	1.04	1	1	1
124	11/22/2019	1.12	1643.00		7:00	12:00	0.94	1	-1	-1
125	11/29/2019	1.34	1826.50		7:00	12:00	1.13	1	-1	-1
126	12/06/2019	1.47	1954.50		7:00	12:00	1.24	1	-1	-1
127	12/20/2019	2.07	2455.50		7:00	12:00	1.78	1	-1	-1
128	06/05/2020	1.35	1760.00		7:00	12:00	1.17	1	-1	-1
129	06/12/2020	1.78	2100.00		7:00	12:00	1.50	1	-1	-1
130	06/19/2020	2.85	2930.00		7:00	12:00	2.68	1	-1	-1

Table D. Water level and discharge observation of Mekong mainstream at Nong Khai (continued)

WL-Q Observation				Mekong-HYCOS			QA/QC		
No	Date	WL1[a] (m)	Q (m3/s)	Start time	End time	WL2[b] (m)	1[c]	2[d]	3[e]
131	06/25/2020	3.06	3120.00	7:00	12:00	2.94	1	-1	-1
132	07/03/2020	2.70	2800.00	7:00	12:00	2.55	1	-1	-1
133	07/10/2020	2.55	2710.00	7:00	12:00	2.35	1	-1	-1
134	07/17/2020	3.65	3730.00	7:00	12:00	3.33	1	-1	-1
135	07/24/2020	3.63	3600.00	7:00	12:00	3.47	1	-1	-1
136	07/31/2020	3.09	3100.00	7:00	12:00	3.01	1	1	1
137	08/07/2020	5.45	5080.00	7:00	12:00	5.45	1	1	1
138	08/14/2020	5.68	5760.00	7:00	12:00	5.50	1	-1	-1
139	08/21/2020	7.99	8400.00	7:00	12:00	7.83	1	-1	-1
140	08/27/2020	8.22	8200.00	7:00	12:00	8.21	1	1	1
141	09/11/2020	4.63	4480.00	7:00	12:00	4.52	1	1	1
142	09/18/2020	5.02	5080.00	7:00	12:00	4.99	1	1	1
143	09/25/2020	5.79	6010.00	7:00	12:00	5.78	1	1	1
144	10/01/2020	6.10	6380.00	7:00	12:00	5.92	1	-1	-1
145	10/09/2020	4.56	4630.00	7:00	12:00	4.56	1	1	1
146	10/16/2020	3.78	3980.00	7:00	12:00	3.73	1	1	1
147	10/30/2020	2.65	2940.00	7:00	12:00	2.65	1	1	1
148	11/06/2020	2.42	2770.00	7:00	12:00	2.35	1	1	1
149	11/13/2020	2.84	3330.00	7:00	12:00	2.73	1	1	1
150	11/27/2020	1.89	2353.00	7:00	12:00	1.79	1	1	1
151	12/17/2020	1.95	2300.00	7:00	12:00	1.79	1	-1	-1
152	12/25/2020	2.27	2730.00	7:00	12:00	2.06	1	-1	-1
153	01/08/2021	2.06	2410.00	7:00	12:00	1.88	1	-1	-1
154	01/22/2021	1.62	2190.00	7:00	12:00	1.41	1	-1	-1
155	02/05/2021	1.24	1860.00	7:00	12:00	1.09	1	-1	-1
156	02/19/2021	1.32	2130.00	7:00	12:00	1.25	1	-1	-1
157	03/05/2021	1.32	2050.00	7:00	12:00	1.17	1	-1	-1
158	03/19/2021	1.35	1920.00	7:00	12:00	1.22	1	-1	-1
159	04/08/2021	2.20	2580.00	7:00	12:00	1.89	1	-1	-1
160	04/23/2021	2.76	3190.00	7:00	12:00	2.54	1	-1	-1
161	05/07/2021	3.25	3640.00	7:00	12:00	3.07	1	-1	-1
162	05/21/2021	3.56	3800.00	7:00	12:00	3.35	1	-1	-1
163	06/04/2021	3.29	3560.00	7:00	12:00	3.20	1	1	1
164	06/11/2021	2.94	3300.00	7:00	12:00	2.71	1	-1	-1
165	06/17/2021	6.60	6960.00	7:00	12:00	6.55	1	1	1
166	06/25/2021	4.21	4380.00	7:00	12:00	4.19	1	1	1
167	07/01/2021	3.88	4040.00	7:00	12:00	3.78	1	1	1
168	07/16/2021	3.47	3670.00	7:00	12:00	3.36	1	1	1
169	07/23/2021	3.15	3600.00	7:00	12:00	3.06	1	1	1
170	08/06/2021	6.02	6370.00	7:00	12:00	5.93	1	1	1
171	08/11/2021	4.58	5010.00	7:00	12:00	4.49	1	1	1
172	08/20/2021	5.92	6660.00	7:00	12:00	5.83	1	1	1
173	08/26/2021	6.03	6290.00	7:00	12:00	5.96	1	1	1

Table D. Water level and discharge observation of Mekong mainstream at Nong Khai (continued)

WL-Q Observation					Mekong-HYCOS			QA/QC		
No	Date	WL1[a] (m)	Q (m3/s)		Start time	End time	WL2[b] (m)	1[c]	2[d]	3[e]
174	09/03/2021	5.43	6450.00		7:00	12:00	5.34	1	1	1
175	09/10/2021	5.43	5770.00		7:00	12:00	5.34	1	1	1
176	09/17/2021	5.97	6220.00		7:00	12:00	5.94	1	1	1
177	09/23/2021	5.01	5230.00		7:00	12:00	4.90	1	-1	-1
178	10/01/2021	5.13	5440.00		7:00	12:00	4.98	1	-1	-1
179	10/08/2021	3.55	3750.00		7:00	12:00	3.43	1	-1	-1
180	10/15/2021	3.82	3990.00		7:00	12:00	3.73	1	1	1
181	10/21/2021	3.26	3740.00		7:00	12:00	3.11	1	-1	-1
182	10/29/2021	3.26	3950.00		7:00	12:00	3.41	1	-1	-1
183	11/05/2021	3.34	4030.00		7:00	12:00	3.25	1	1	1
184	11/12/2021	3.31	3650.00		7:00	12:00	3.17	1	-1	-1
185	11/18/2021	2.90	3600.00		7:00	12:00	2.80	1	1	1
186	11/26/2021	2.51	2961.00		7:00	12:00	2.41	1	1	1
187	12/03/2021	2.13	2690.00		7:00	12:00	1.90	1	-1	-1
188	12/17/2021	1.82	2290.00		7:00	12:00	1.66	1	-1	-1
189	01/07/2022	1.18	2110.00		7:00	12:00	1.12	1	1	1
190	01/28/2022	2.04	2460.00		7:00	12:00	1.97	1	1	1
191	02/11/2022	0.98	1720.00		7:00	12:00	0.88	1	1	1
192	02/25/2022	1.54	2130.00		7:00	12:00	1.33	1	-1	-1
193	03/17/2022	2.71	3180.00		7:00	12:00	2.63	1	1	1
194	03/25/2022	3.41	3680.00		7:00	12:00	3.29	1	-1	-1
195	04/08/2022	2.23	2752.50		7:00	12:00	2.13	1	1	1
196	04/22/2022	2.50	2830.00		7:00	12:00	2.35	1	-1	-1
197	05/12/2022	3.04	3753.00		7:00	12:00	2.91	1	-1	-1
198	05/20/2022	4.75	4960.00		7:00	12:00	4.66	1	1	1
199	06/10/2022	4.60	4840.00		7:00	12:00	4.63	1	1	1
200	06/17/2022	5.07	5330.00		7:00	12:00	5.09	1	1	1
201	06/24/2022	4.45	4590.00		7:00	12:00	4.51	1	1	1
202	07/01/2022	4.66	4997.00		7:00	12:00	4.70	1	1	1
203	07/08/2022	4.43	4900.00		7:00	12:00	4.47	1	1	1
204	07/21/2022	6.07	6480.00		7:00	12:00	6.18	1	1	1
205	08/05/2022	5.22	5840.00		7:00	12:00	5.25	1	1	1
206	08/11/2022	5.80	6040.00		7:00	12:00	5.85	1	1	1
207	08/19/2022	9.00	10500.00		7:00	12:00	9.09	1	1	1
208	08/26/2022	7.65	8490.00		7:00	12:00	7.72	1	1	1
209	09/02/2022	8.36	9370.00		7:00	12:00	8.38	1	1	1
210	09/09/2022	7.18	7800.00		7:00	12:00	7.28	1	1	1
211	09/16/2022	7.75	8710.00		7:00	12:00	7.83	1	1	1
212	09/23/2022	8.27	9720.00		7:00	12:00	8.27	1	1	1
213	09/30/2022	7.47	8630.00		7:00	12:00	7.79	1	1	-1
214	10/07/2022	7.47	8150.00		7:00	12:00	7.61	1	1	-1
215	10/11/2022	6.39	6840.00		7:00	12:00	6.51	1	1	-1
216	10/21/2022	4.18	4580.00		7:00	12:00	4.28	1	1	1
217	10/28/2022	3.63	3740.00		7:00	12:00	3.40	1	1	-1
218	11/18/2022	2.52	2840.00		-	-	-	1	0	-1
219	11/25/2022	2.64	2970.00		7:00	12:00	2.63	1	1	1
220	12/09/2022	1.76	2290.00		7:00	12:00	1.77	1	1	1
221	12/22/2022	1.59	2220.00		7:00	12:00	1.59	1	1	1

[a] WL1 is manually observed water level from staff gauges.

[b] WL2 is near real-time water level from the Mekong-HYCOS network.

[c] QA/QC1: Rating curves analysis for manually observed water level and discharge; "-1" outliers detected outside ±10 % of the rating curves; "1" pairs/points were in range of ±10 % of the rating curves.

[d] QA/QC2: validation analysis for near real-time water level from the Mekong-HYCOS network; "0" no data for near real-time water level from the Mekong-HYCOS network; "-1" difference between manually observed and near real-time water level is outside the range of ±10 cm; "1" difference between manually observed and near real-time water level is within the range of ±10 cm, therefore, near real-time water level is considered reliable.

[e] QA/QC3: Validation of rating curves developed for manually observed water level for near real-time water level; "-1" invalidated for near real-time water level; "1" validated for near real-time water level.

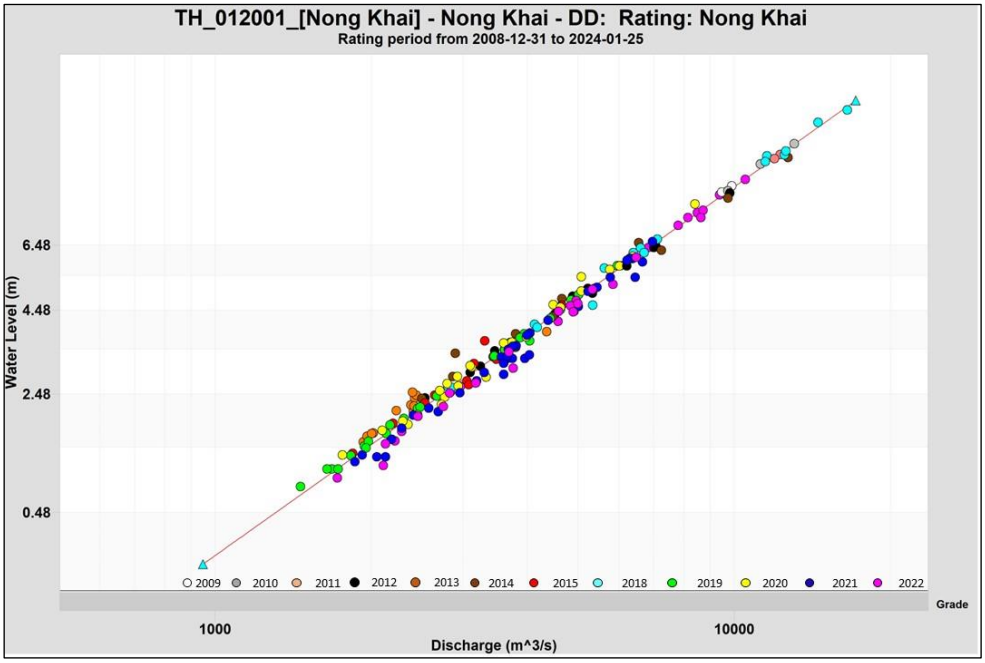


Figure D.1. Rating curve and rating equations of the Mekong mainstream at Nong Khai for the dataset after applying ±10 % in discharge off the curve. Solid line is proposed rating curve

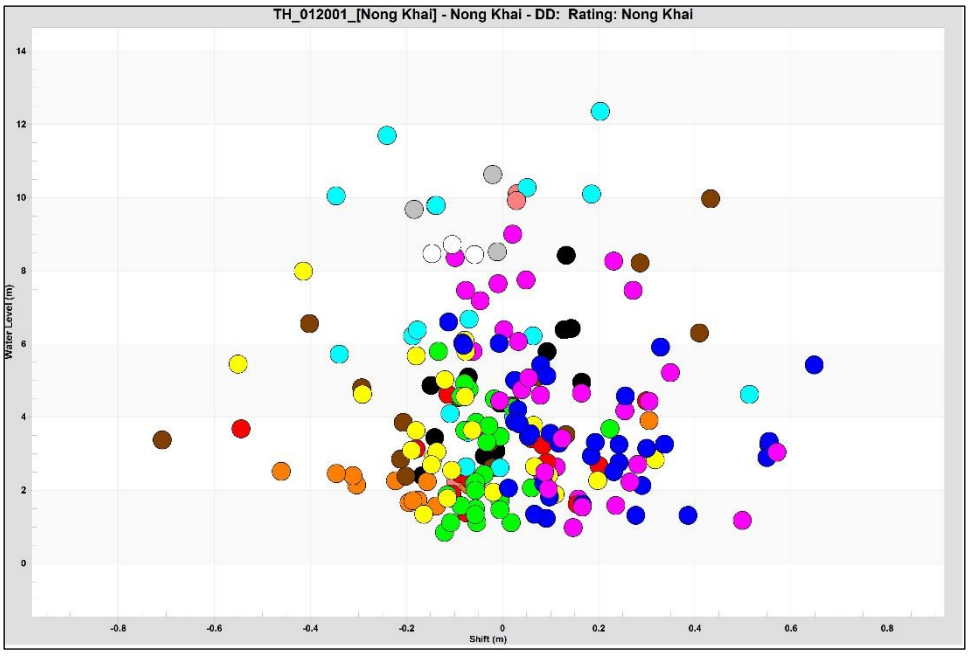


Figure D.2. The shift diagram was displayed data pairs/points observed water level and discharge scattering points around the rating curves of the Mekong mainstream at Nong Khai for the dataset after applying ±10 % in discharge off the curve

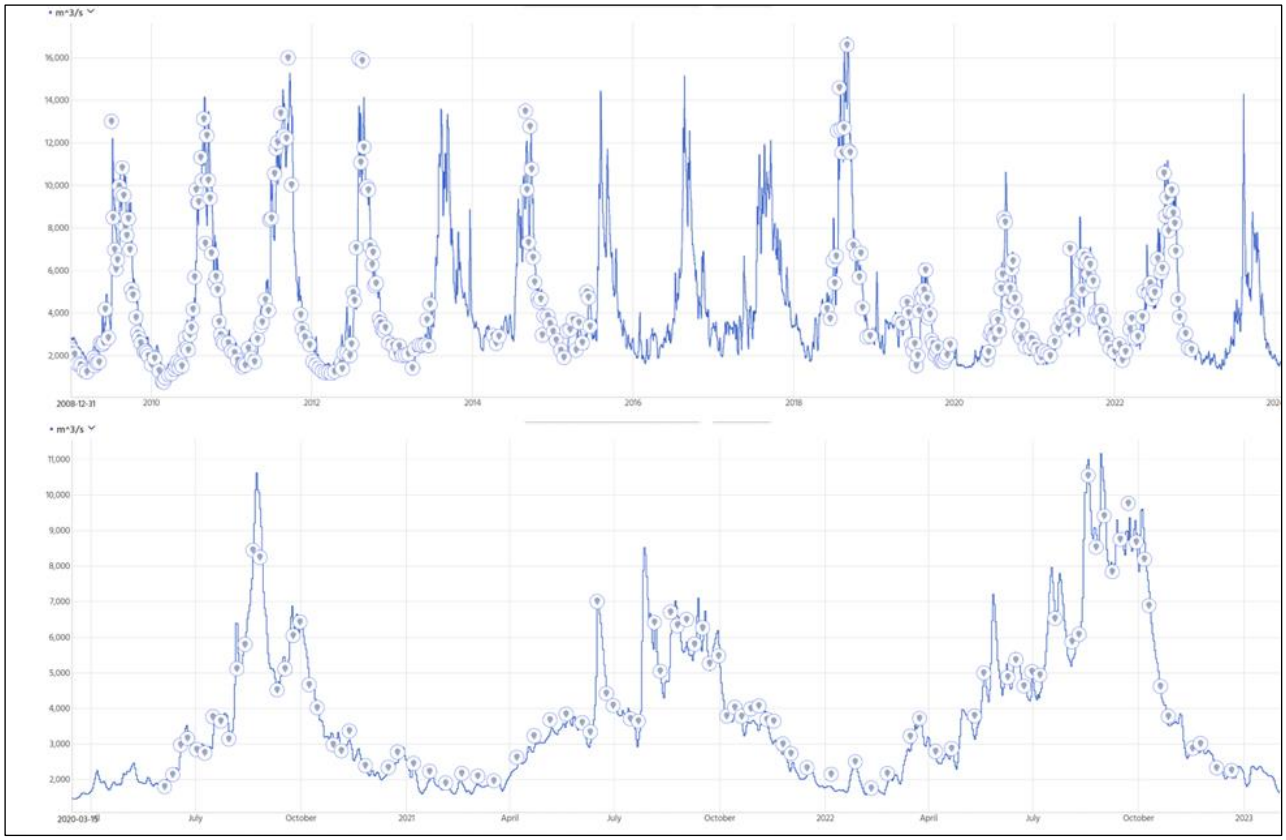


Figure D.3. The data pairs/points observed water level and discharge (dots) plotted against the derived discharge (blue line) from new rating curve at Nong Khai station

Table E. Water level and discharge observation of Mekong mainstream at Mukdahan station

WL-Q Observation					Mekong-HYCOS			QA/QC		
No	Date	WL1[a] (m)	Q (m3/s)		Start time	End time	WL2[b] (m)	1[c]	2[d]	3[e]
1	10-01-2012	2.06	3362.12		7:00	12:00	2.06	1	1	1
2	24-01-2012	2.24	3650.31		7:00	12:00	2.26	1	1	1
3	07-02-2012	1.68	2787.93		7:00	12:00	1.71	1	1	1
4	21-02-2012	1.57	2630.52		7:00	12:00	1.58	1	1	1
5	06-03-2012	1.58	2644.66		7:00	12:00	1.60	1	1	1
6	20-03-2012	1.46	2477.10		7:00	12:00	1.48	1	1	1
7	03-04-2012	1.38	2368.05		7:00	12:00	1.38	1	1	1
8	25-04-2012	1.58	2644.66		7:00	12:00	1.58	1	1	1
9	15-05-2012	1.79	2949.32		7:00	12:00	1.81	1	1	1
10	22-05-2012	2.85	4702.76		7:00	12:00	2.84	1	1	1
11	03-07-2012	4.96	10255.33		7:00	12:00	5.09	1	1	-1
12	10-07-2012	6.98	14369.25		7:00	12:00	7.00	1	1	1
13	17-07-2012	6.36	14212.60		7:00	12:00	6.34	1	1	1
14	24-07-2012	4.71	9284.04		7:00	12:00	4.69	1	1	1
15	07-08-2012	9.11	21161.94		7:00	12:00	9.05	1	1	1
16	15-08-2012	9.94	24930.92		7:00	12:00	9.81	1	1	1
17	21-08-2012	9.04	21244.42		7:00	12:00	9.01	1	1	1
18	28-08-2012	9.56	25304.39		7:00	12:00	9.54	-1	1	1
19	04-09-2012	9.19	23143.50		7:00	12:00	9.18	1	1	1
20	11-09-2012	8.40	19521.25		7:00	12:00	8.40	1	1	1
21	18-09-2012	7.01	15214.69		7:00	12:00	7.01	1	1	1
22	25-09-2012	6.23	13033.42		7:00	12:00	6.22	1	1	1
23	02-10-2012	5.09	9489.83		7:00	12:00	5.08	1	1	1
24	09-10-2012	4.39	8332.40		7:00	12:00	4.38	1	1	1
25	16-10-2012	4.37	8048.74		7:00	12:00	4.35	1	1	1
26	24-10-2012	3.83	6273.45		7:00	12:00	3.82	1	1	1
27	08-11-2012	3.42	5698.18		7:00	12:00	3.42	1	1	1
28	13-11-2012	2.92	4661.86		7:00	12:00	2.91	1	1	1
29	20-11-2012	2.63	4268.12		7:00	12:00	2.64	1	1	1
30	27-11-2012	2.56	4150.40		-	-	-	1	0	-1
31	04-12-2012	2.48	4105.16		-	-	-	1	0	-1
32	24-12-2012	2.12	3346.42		-	-	-	1	0	-1
33	08-01-2013	1.92	3143.68		-	-	-	1	0	-1
34	21-01-2013	1.92	2948.74		-	-	-	1	0	-1
35	05-02-2013	1.80	2701.07		-	-	-	1	0	-1
36	19-02-2013	1.85	3026.70		-	-	-	1	0	-1
37	05-03-2013	1.74	2861.90		-	-	-	1	0	-1
38	19-03-2013	1.91	3021.13		-	-	-	1	0	-1
39	02-04-2013	1.42	2108.46		-	-	-	1	0	-1
40	23-04-2013	2.00	3304.36		-	-	-	1	0	-1
41	08-05-2013	2.27	3686.35		-	-	-	1	0	-1
42	22-05-2013	2.52	4634.30		-	-	-	1	0	-1
43	04-06-2013	2.72	4964.17		-	-	-	1	0	-1
44	11-06-2013	3.01	5046.57		-	-	-	1	0	-1

Table E. Water level and discharge observation of Mekong mainstream at Mukdahan (continued)

WL-Q Observation				Mekong-HYCOS			QA/QC		
No	Date	WL1[a] (m)	Q (m3/s)	Start time	End time	WL2[b] (m)	1[c]	2[d]	3[e]
45	18-06-2013	3.20	4884.99	-	-	-	1	0	-1
46	27-06-2013	6.22	12565.34	-	-	-	1	0	-1
47	09-09-2014	8.41	18974.58	-	-	-	1	0	-1
48	19-09-2014	7.59	15617.16	-	-	-	1	0	-1
49	23-09-2014	7.70	16669.55	-	-	-	1	0	-1
50	07-10-2014	6.52	13066.95	-	-	-	1	0	-1
51	14-10-2014	5.19	9338.14	-	-	-	1	0	-1
52	21-10-2014	4.01	7012.26	-	-	-	1	0	-1
53	28-10-2014	3.70	5671.86	-	-	-	1	0	-1
54	11-11-2014	3.40	5671.63	-	-	-	1	0	-1
55	25-11-2014	2.77	4991.62	-	-	-	1	0	-1
56	09-12-2014	2.82	4254.96	-	-	-	1	0	-1
57	23-12-2014	2.58	4279.32	-	-	-	1	0	-1
58	13-01-2015	2.14	3183.01	-	-	-	1	0	-1
59	27-01-2015	2.02	3052.58	-	-	-	1	0	-1
60	10-02-2015	1.83	2417.01	-	-	-	1	0	-1
61	24-02-2015	1.86	3114.31	-	-	-	1	0	-1
62	10-03-2015	1.68	2711.47	-	-	-	1	0	-1
63	24-03-2015	2.36	2920.21	-	-	-	1	0	-1
64	08-04-2015	2.46	3207.84	-	-	-	1	0	-1
65	21-04-2015	2.75	3643.17	-	-	-	1	0	-1
66	05-05-2015	2.72	4287.06	-	-	-	1	0	-1
67	26-05-2015	2.26	3175.39	7:00	12:00	2.25	1	1	1
68	09-06-2015	2.09	3211.61	7:00	12:00	2.09	1	1	1
69	16-06-2015	3.14	4850.64	7:00	12:00	3.15	1	1	1
70	24-06-2015	3.32	5621.72	7:00	12:00	3.31	1	1	1
71	30-06-2015	2.94	4658.09	7:00	12:00	2.92	1	1	1
72	07-07-2015	2.27	3728.78	7:00	12:00	2.27	1	1	1
73	14-07-2015	2.74	4114.48	7:00	12:00	2.75	1	1	1
74	21-07-2015	6.42	12375.17	7:00	12:00	6.37	1	1	1
75	28-07-2015	8.57	19003.26	-	-	-	1	0	-1
76	04-08-2015	10.85	27245.30	-	-	-	1	0	-1
77	11-08-2015	10.47	23929.15	-	-	-	1	0	-1
78	18-08-2015	7.86	15884.90	-	-	-	1	0	-1
79	25-08-2015	6.83	13173.13	-	-	-	1	0	-1
80	05-06-2018	3.94	6901.63	7:00	12:00	3.93	1	1	1
81	19-06-2018	4.63	7845.07	7:00	12:00	4.64	1	1	1
82	03-07-2018	6.12	10099.53	7:00	12:00	6.11	1	1	1
83	17-07-2018	7.85	14992.61	7:00	12:00	7.90	1	1	1
84	24-07-2018	9.95	23978.16	7:00	12:00	9.92	1	1	1
85	07-08-2018	12.60	32148.23	7:00	12:00	12.60	1	1	1
86	15-08-2018	11.42	29076.26	7:00	12:00	11.40	1	1	1
87	21-08-2018	11.73	30291.37	7:00	12:00	11.75	1	1	1
88	28-08-2018	12.79	34038.61	7:00	12:00	12.78	1	1	1

Table E. Water level and discharge observation of Mekong mainstream at Mukdahan (continued)

WL-Q Observation					Mekong-HYCOS			QA/QC		
No	Date	WL1[a] (m)	Q (m3/s)		Start time	End time	WL2[b] (m)	1[c]	2[d]	3[e]
89	04-09-2018	12.66	33058.37		7:00	12:00	12.65	1	1	1
90	11-09-2018	11.41	28920.05		7:00	12:00	11.42	1	1	1
91	25-09-2018	8.40	18940.01		7:00	12:00	8.42	1	1	1
92	02-10-2018	6.70	13749.82		7:00	12:00	6.71	1	1	1
93	17-10-2018	4.66	8551.97		7:00	12:00	4.69	1	1	1
94	06-11-2018	4.32	6244.11		7:00	12:00	4.31	1	1	1
95	20-11-2018	3.24	5271.81		7:00	12:00	3.23	1	1	1
96	04-12-2018	2.88	4638.63		7:00	12:00	2.87	1	1	1
97	18-12-2018	2.35	3776.08		7:00	12:00	2.36	1	1	1
98	02-04-2019	2.87	2735.39		7:00	12:00	2.87	-1	1	1
99	18-04-2019	2.92	4808.11		7:00	12:00	2.93	1	1	1
100	07-05-2019	3.07	4607.51		7:00	12:00	3.08	1	1	1
101	22-05-2019	2.89	4723.38		7:00	12:00	2.90	1	1	1
102	05-06-2019	4.21	6076.39		7:00	12:00	4.22	1	1	1
103	18-06-2019	3.92	4837.81		7:00	12:00	3.94	-1	1	1
104	02-07-2019	2.98	4859.10		7:00	12:00	3.02	1	1	1
105	09-07-2019	3.83	6293.46		7:00	12:00	3.73	1	1	1
106	18-07-2019	2.75	3957.95		7:00	12:00	2.72	1	1	1
107	23-07-2019	2.05	2749.40		7:00	12:00	2.01	1	1	1
108	06-08-2019	4.62	8454.43		7:00	12:00	4.58	1	1	1
109	14-08-2019	4.91	8172.79		7:00	12:00	4.95	1	1	1
110	20-08-2019	7.55	16363.94		7:00	12:00	7.59	1	1	1
111	27-08-2019	8.45	18514.39		7:00	12:00	8.45	1	1	1
112	03-09-2019	8.83	20038.53		7:00	12:00	8.81	1	1	1
113	10-09-2019	7.98	17543.30		7:00	12:00	7.97	1	1	1
114	17-09-2019	6.78	12793.89		7:00	12:00	6.80	1	1	1
115	24-09-2019	4.41	10665.78		7:00	12:00	4.47	-1	1	1
116	10-10-2019	2.50	3987.57		7:00	12:00	2.50	1	1	1
117	16-10-2019	1.96	3360.43		7:00	12:00	2.00	1	1	1
118	22-10-2019	2.01	3211.54		7:00	12:00	2.06	1	1	1
119	29-10-2019	1.90	3161.30		7:00	12:00	1.91	1	1	1
120	11-11-2019	1.44	2972.33		7:00	12:00	1.45	1	1	1
121	19-11-2019	1.47	2214.76		7:00	12:00	1.50	1	1	1
122	11-12-2019	1.63	3213.70		7:00	12:00	1.57	1	1	1
123	24-12-2019	1.99	3520.83		7:00	12:00	1.97	1	1	1
124	12-05-2020	2.08	3821.19		7:00	12:00	2.12	1	1	1
125	27-05-2020	2.01	3278.72		7:00	12:00	2.10	1	1	1
126	02-06-2020	2.27	3439.72		7:00	12:00	2.31	1	1	1
127	09-06-2020	2.24	3385.30		7:00	12:00	2.28	1	1	1
128	16-06-2020	2.31	3485.56		7:00	12:00	2.33	1	1	1
129	23-06-2020	3.55	5747.22		7:00	12:00	3.52	1	1	1
130	06-07-2020	4.37	7951.17		7:00	12:00	4.38	1	1	1
131	14-07-2020	3.36	5369.00		7:00	12:00	3.35	1	1	1
132	21-07-2020	3.39	5573.98		7:00	12:00	3.44	1	1	1

Table E. Water level and discharge observation of Mekong mainstream at Mukdahan (continued)

WL-Q Observation				Mekong-HYCOS			QA/QC		
No	Date	WL1[a] (m)	Q (m3/s)	Start time	End time	WL2[b] (m)	1[c]	2[d]	3[e]
133	27-07-2020	3.46	5696.13	7:00	12:00	3.46	1	1	1
134	07-08-2020	6.99	7912.87	7:00	12:00	7.12	-1	1	-1
135	11-08-2020	6.45	10150.17	7:00	12:00	6.53	1	1	1
136	18-08-2020	7.90	14148.52	7:00	12:00	8.01	-1	1	-1
137	26-08-2020	8.89	19082.23	7:00	12:00	8.90	1	1	1
138	15-09-2020	4.86	8715.12	7:00	12:00	4.93	1	1	1
139	22-09-2020	5.52	10038.08	7:00	12:00	5.62	1	1	-1
140	06-10-2020	5.07	8963.29	7:00	12:00	5.11	1	1	1
141	14-10-2020	4.90	8422.44	7:00	12:00	4.93	1	1	1
142	20-10-2020	4.61	7920.43	7:00	12:00	4.65	1	1	1
143	27-10-2020	3.79	6696.34	7:00	12:00	3.81	1	1	1
144	03-11-2020	3.31	5749.53	7:00	12:00	3.34	1	1	1
145	24-11-2020	2.40	4125.02	7:00	12:00	2.40	1	1	1
146	14-12-2020	1.97	3323.21	7:00	12:00	2.04	1	1	1
147	12-01-2021	1.83	3332.05	7:00	12:00	1.86	1	1	1
148	26-01-2021	1.83	3192.62	7:00	12:00	1.81	1	1	1
149	09-02-2021	1.63	3047.12	7:00	12:00	1.64	1	1	1
150	23-02-2021	1.62	3016.89	7:00	12:00	1.62	1	1	1
151	09-03-2021	1.76	3266.92	7:00	12:00	1.76	1	1	1
152	23-03-2021	1.92	3489.28	7:00	12:00	1.92	1	1	1
153	05-04-2021	2.10	3949.34	7:00	12:00	2.14	1	1	1
154	20-04-2021	2.52	4272.12	7:00	12:00	2.57	1	1	1
155	11-05-2021	2.79	4647.88	7:00	12:00	2.82	1	1	1
156	25-05-2021	3.07	5061.49	7:00	12:00	3.09	1	1	1
157	09-06-2021	3.15	5061.85	7:00	12:00	3.20	1	1	1
158	15-06-2021	5.05	8531.26	7:00	12:00	5.21	1	1	-1
159	22-06-2021	5.13	8429.61	7:00	12:00	5.16	1	1	1
160	29-06-2021	4.25	7314.15	7:00	12:00	4.23	1	1	1
161	07-07-2021	4.07	7318.73	7:00	12:00	4.12	1	1	1
162	13-07-2021	4.47	7495.54	7:00	12:00	4.53	1	1	1
163	11-01-2022	1.68	3465.68	7:00	12:00	1.71	1	1	1
164	25-01-2022	1.63	2505.88	7:00	12:00	1.67	1	1	1
165	08-02-2022	1.43	2166.61	7:00	12:00	1.47	1	1	1
166	22-02-2022	1.56	2304.37	7:00	12:00	1.58	1	1	1
167	08-03-2022	1.96	3512.69	7:00	12:00	1.98	1	1	1
168	22-03-2022	2.65	4351.23	7:00	12:00	2.66	1	1	1
169	12-04-2022	2.40	4247.75	7:00	12:00	2.40	1	1	1
170	26-04-2022	2.40	4228.10	7:00	12:00	2.46	1	1	1
171	10-05-2022	3.20	5285.14	7:00	12:00	3.20	1	1	1
172	24-05-2022	4.47	7444.73	7:00	12:00	4.47	1	1	1
173	07-06-2022	5.03	8978.58	7:00	12:00	5.03	1	1	1
174	14-06-2022	4.61	7570.26	7:00	12:00	4.58	1	1	1
175	21-06-2022	4.76	7922.77	7:00	12:00	4.67	1	1	1
176	28-06-2022	4.32	7349.82	-	-	-	1	0	-1

Table E. Water level and discharge observation of Mekong mainstream at Mukdahan (continued)

WL-Q Observation				Mekong-HYCOS			QA/QC		
No	Date	WL1[a] (m)	Q (m3/s)	Start time	End time	WL2[b] (m)	1[c]	2[d]	3[e]
177	12-07-2022	5.87	10435.91	7:00	12:00	5.90	1	1	1
178	19-07-2022	6.23	11812.27	7:00	12:00	6.25	1	1	1
179	26-07-2022	6.16	11129.23	-	-	-	1	0	-1
180	09-08-2022	6.39	12992.15	7:00	12:00	6.41	1	1	1
181	16-08-2022	7.18	15268.96	7:00	12:00	7.20	1	1	1
182	23-08-2022	8.23	17305.24	7:00	12:00	8.22	1	1	1
183	30-08-2022	8.06	16513.18	7:00	12:00	8.02	1	1	1
184	06-09-2022	7.01	14976.95	7:00	12:00	7.02	1	1	1
185	13-09-2022	6.29	12831.76	7:00	12:00	6.29	1	1	1
186	20-09-2022	6.41	13434.39	7:00	12:00	6.41	1	1	1
187	27-09-2022	6.37	12692.40	7:00	12:00	6.37	1	1	1
188	18-10-2022	4.62	8368.96	7:00	12:00	4.64	1	1	1
189	25-10-2022	3.86	6077.33	7:00	12:00	3.71	1	-1	-1
190	08-11-2022	2.81	5017.55	7:00	12:00	2.83	1	1	1
191	22-11-2022	2.17	3910.94	7:00	12:00	2.17	1	1	1
192	06-12-2022	2.25	4231.90	7:00	12:00	2.24	1	1	1
193	20-12-2022	1.82	3775.93	7:00	12:00	1.80	1	1	1

[a] WL1 is manually observed water level from staff gauges.
[b] WL2 is near real-time water level from the Mekong-HYCOS network.
[c] QA/QC1: Rating curves analysis for manually observed water level and discharge; "-1" outliers detected outside ±10 % of the rating curves; "1" pairs/points were in range of ±10 % of the rating curves.
[d] QA/QC2: validation analysis for near real-time water level from the Mekong-HYCOS network; "0" no data for near real-time water level from the Mekong-HYCOS network; "-1" difference between manually observed and near real-time water level is outside the range of ±10 cm; "1" difference between manually observed and near real-time water level is within the range of ±10 cm, therefore, near real-time water level is considered reliable.
[e] QA/QC3: Validation of rating curves developed for manually observed water level for near real-time water level; "-1" invalidated for near real-time water level; "1" validated for near real-time water level.

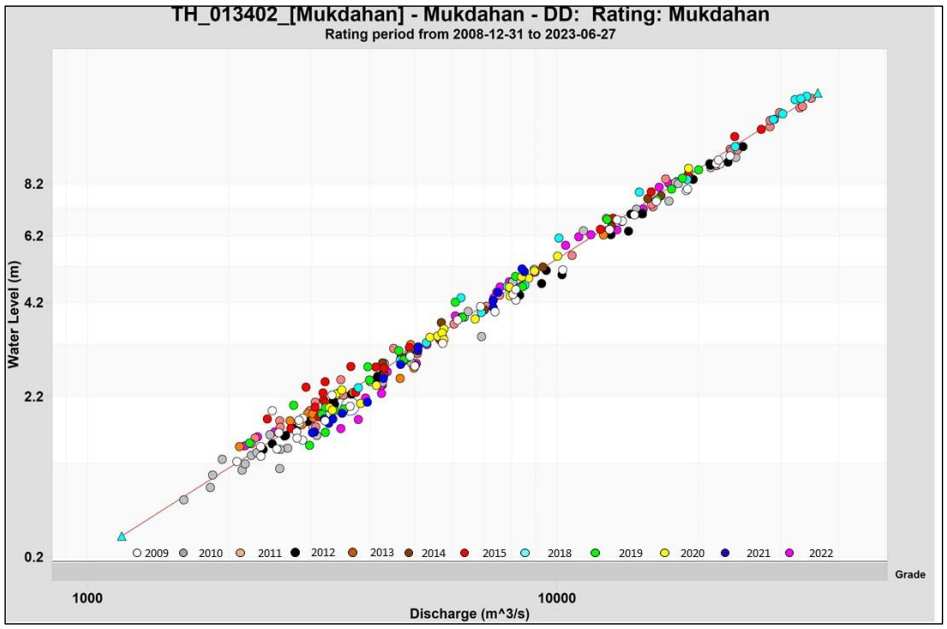


Figure E.1. Rating curve and rating equations of the Mekong mainstream at Mukdahan for the dataset after applying ±10 % in discharge off the curve. Solid line is proposed rating curves

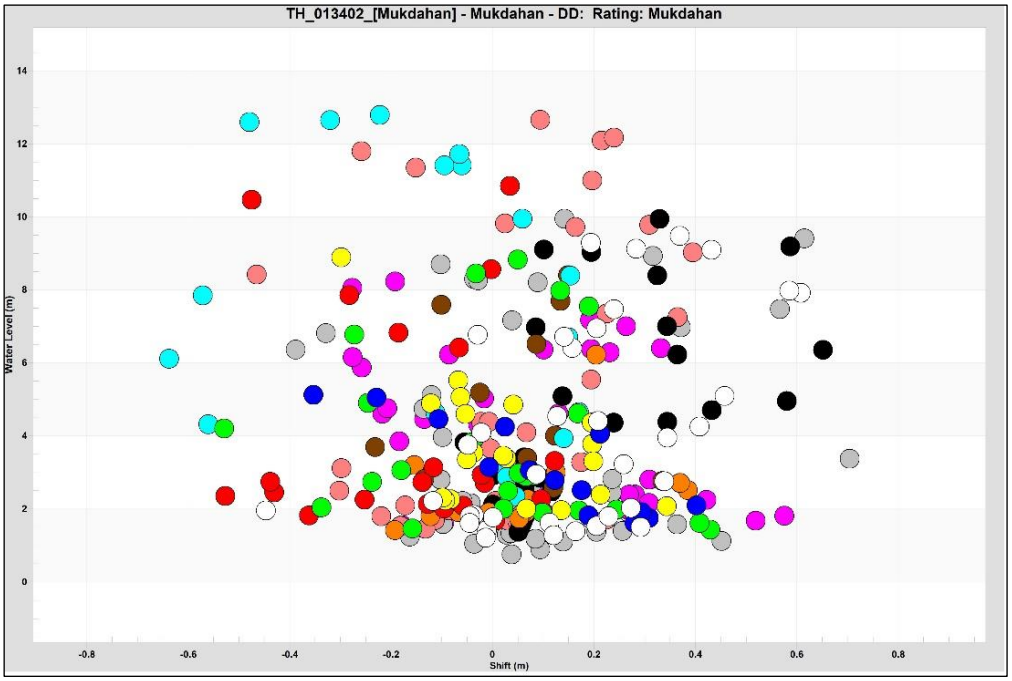


Figure E.2. The shift diagram was displayed data pairs/points observed water level and discharge scattering points around the rating curves of the Mekong mainstream at Mukdahan for the dataset after applying ±10 % in discharge off the curve

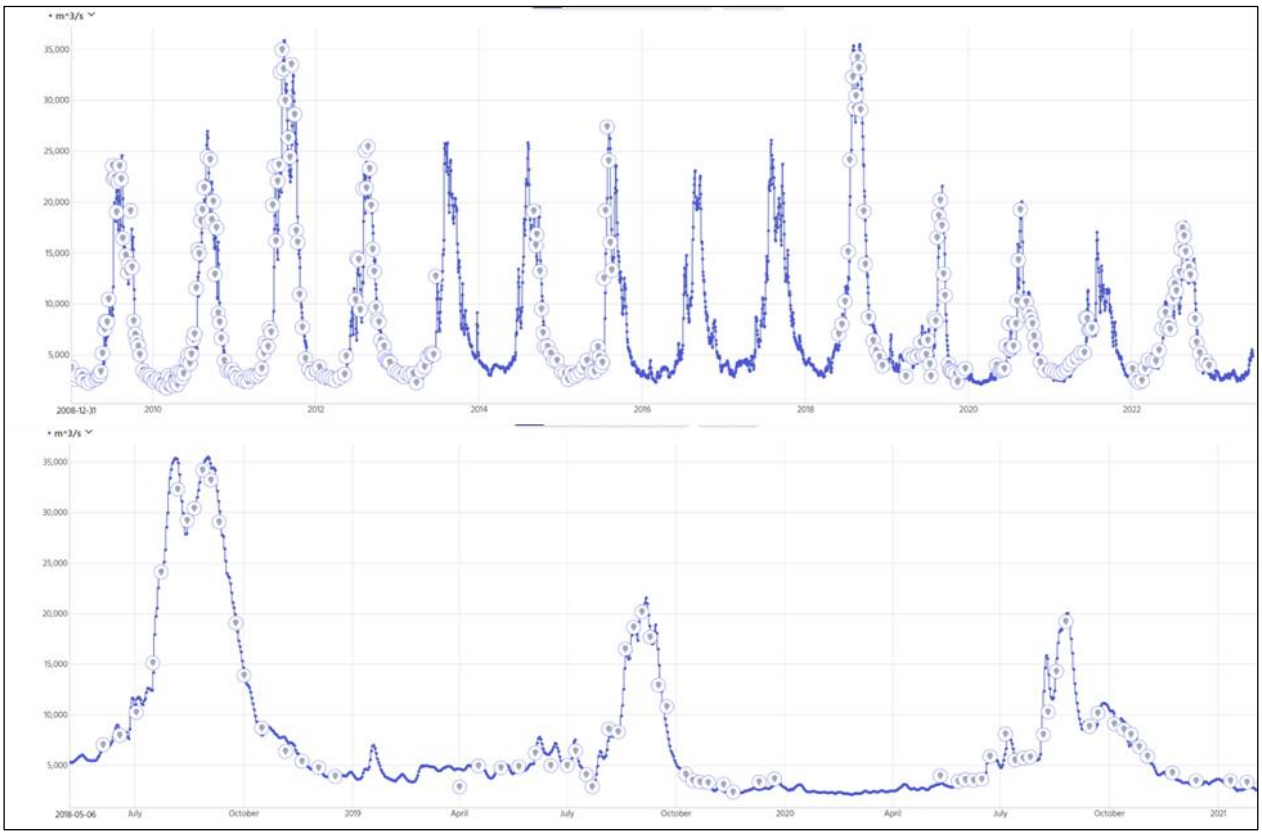


Figure E.3. The data pairs/points observed water level and discharge (dots) plotted against the derived discharge (blue line) from new rating curve at Mukdahan station

Table F. Water level and discharge observation of Mekong mainstream at Khong Chiam station

WL-Q Observation					Mekong-HYCOS			QA/QC		
No	Date	WL1[a] (m)	Q (m3/s)		Start time	End time	WL2[b] (m)	1[c]	2[d]	3[e]
1	12-01-2012	2.53	3195.76		7:00	12:00	2.53	1	1	1
2	26-01-2012	2.77	3334.61		7:00	12:00	2.73	1	1	1
3	09-02-2012	2.25	2920.34		7:00	12:00	2.22	1	1	1
4	23-02-2012	2.11	2726.77		7:00	12:00	2.09	1	1	1
5	08-03-2012	2.13	2754.97		7:00	12:00	2.10	1	1	1
6	22-03-2012	2.01	2587.52		7:00	12:00	2.00	1	1	1
7	12-04-2012	2.10	2712.72		7:00	12:00	2.10	1	1	1
8	26-04-2012	2.18	2825.95		7:00	12:00	2.16	1	1	1
9	10-05-2012	2.26	2941.00		7:00	12:00	2.25	1	1	1
10	24-05-2012	3.29	4578.30		7:00	12:00	3.30	1	1	1
11	14-06-2012	5.67	9371.29		7:00	12:00	5.58	1	1	1
12	28-06-2012	5.99	10114.67		7:00	12:00	5.91	1	1	1
13	05-07-2012	7.58	15886.38		7:00	12:00	7.56	1	1	1
14	12-07-2012	7.54	14845.49		7:00	12:00	7.57	1	1	1
15	19-07-2012	6.65	11948.07		7:00	12:00	6.63	1	1	1
16	26-07-2012	5.48	9382.79		7:00	12:00	5.56	1	1	1
17	09-08-2012	9.47	21696.84		7:00	12:00	9.38	1	1	1
18	16-08-2012	10.67	25136.70		7:00	12:00	10.64	1	1	1
19	23-08-2012	9.67	21810.34		7:00	12:00	9.68	1	1	1
20	30-08-2012	10.97	25227.02		7:00	12:00	10.92	1	1	1
21	06-09-2012	10.37	21285.26		7:00	12:00	10.32	1	1	1
22	13-09-2012	9.83	20124.28		7:00	12:00	9.89	1	1	1
23	20-09-2012	8.44	15349.48		7:00	12:00	8.49	1	1	1
24	27-09-2012	7.21	12882.76		7:00	12:00	7.23	1	1	1
25	05-10-2012	5.92	9434.85		7:00	12:00	5.90	1	1	1
26	11-10-2012	5.44	8450.70		7:00	12:00	5.44	1	1	1
27	18-10-2012	5.02	7818.97		7:00	12:00	5.02	1	1	1
28	25-10-2012	4.44	6269.74		7:00	12:00	4.43	1	1	1
29	08-11-2012	3.90	5397.08		7:00	12:00	3.88	1	1	1
30	15-11-2012	3.36	4055.24		7:00	12:00	3.29	1	1	1
31	22-11-2012	3.01	3409.12		7:00	12:00	3.01	1	1	1
32	27-11-2012	2.95	3320.23		-	-	-	1	0	-1
33	13-12-2012	2.82	2981.13		-	-	-	1	0	-1
34	27-12-2012	2.41	2689.00		-	-	-	1	0	-1
35	10-01-2013	2.29	2551.62		-	-	-	1	0	-1
36	24-01-2013	2.33	2700.81		-	-	-	1	0	-1
37	14-02-2013	2.40	2755.42		-	-	-	1	0	-1
38	27-02-2013	2.01	2689.41		-	-	-	1	0	-1
39	14-03-2013	2.12	2525.80		-	-	-	1	0	-1
40	28-03-2013	2.10	2463.22		-	-	-	1	0	-1
41	04-04-2013	1.80	2263.75		-	-	-	1	0	-1
42	25-04-2013	2.22	2999.88		-	-	-	1	0	-1
43	09-05-2013	2.68	3557.56		-	-	-	1	0	-1
44	23-05-2013	2.83	3900.31		-	-	-	1	0	-1

Table F. Water level and discharge observation of Mekong mainstream at Khong Chiam (continued)

WL-Q Observation				Mekong-HYCOS			QA/QC		
No	Date	WL1[a] (m)	Q (m3/s)	Start time	End time	WL2[b] (m)	1[c]	2[d]	3[e]
45	06-06-2013	3.03	3993.11	-	-	-	1	0	-1
46	13-06-2013	3.30	4587.59	-	-	-	1	0	-1
47	19-06-2013	3.47	4593.00	-	-	-	1	0	-1
48	27-06-2013	6.72	13613.12	-	-	-	1	0	-1
49	04-07-2013	5.63	10031.04	-	-	-	1	0	-1
50	11-07-2013	4.83	8669.06	-	-	-	1	0	-1
51	18-07-2013	6.45	12573.75	-	-	-	1	0	-1
52	25-07-2013	8.64	19105.57	-	-	-	1	0	-1
53	08-08-2013	11.38	27885.02	-	-	-	1	0	-1
54	15-08-2013	11.34	27108.72	-	-	-	1	0	-1
55	22-08-2013	9.35	21655.48	-	-	-	1	0	-1
56	29-08-2013	11.36	26681.30	-	-	-	1	0	-1
57	05-09-2013	9.74	21854.38	-	-	-	1	0	-1
58	12-09-2013	9.45	22101.85	-	-	-	1	0	-1
59	19-09-2013	12.89	32221.47	-	-	-	1	0	-1
60	26-09-2013	12.44	24867.10	-	-	-	-1	0	-1
61	03-10-2013	9.87	19965.27	-	-	-	1	0	-1
62	10-10-2013	7.98	12670.12	-	-	-	-1	0	-1
63	17-10-2013	6.89	11551.52	-	-	-	1	0	-1
64	24-10-2013	6.90	10025.46	-	-	-	-1	0	-1
65	14-11-2013	5.93	9098.64	-	-	-	1	0	-1
66	29-11-2013	4.34	6324.52	-	-	-	1	0	-1
67	12-12-2013	3.55	4703.48	-	-	-	1	0	-1
68	19-12-2013	3.42	4974.62	-	-	-	1	0	-1
69	09-01-2014	3.05	4412.80	-	-	-	1	0	-1
70	23-01-2014	2.84	3767.59	-	-	-	1	0	-1
71	12-02-2014	2.48	2875.86	-	-	-	1	0	-1
72	27-02-2014	2.48	3014.36	-	-	-	1	0	-1
73	13-03-2014	2.80	3687.21	-	-	-	1	0	-1
74	28-03-2014	2.74	3560.89	-	-	-	1	0	-1
75	10-04-2014	2.65	3542.51	-	-	-	1	0	-1
76	24-04-2014	2.63	3181.87	-	-	-	1	0	-1
77	08-05-2014	2.71	3272.82	-	-	-	1	0	-1
78	22-05-2014	2.80	3750.08	-	-	-	1	0	-1
79	05-06-2014	3.19	4427.55	-	-	-	1	0	-1
80	12-06-2014	3.33	4383.14	-	-	-	1	0	-1
81	19-06-2014	4.71	8646.53	-	-	-	1	0	-1
82	26-06-2014	7.14	13900.66	-	-	-	1	0	-1
83	07-07-2014	5.36	10140.28	-	-	-	1	0	-1
84	17-07-2014	8.29	17305.77	-	-	-	1	0	-1
85	24-07-2014	11.35	25103.11	-	-	-	1	0	-1
86	31-07-2014	13.35	34632.83	-	-	-	1	0	-1
87	06-08-2014	13.65	34401.31	-	-	-	1	0	-1
88	14-08-2014	11.50	26355.55	-	-	-	1	0	-1

Table F. Water level and discharge observation of Mekong mainstream at Khong Chiam (continued)

WL-Q Observation				Mekong-HYCOS			QA/QC		
No	Date	WL1[a] (m)	Q (m3/s)	Start time	End time	WL2[b] (m)	1[c]	2[d]	3[e]
89	21-08-2014	8.91	19300.33	-	-	-	1	0	-1
90	28-08-2014	8.45	15666.36	-	-	-	1	0	-1
91	04-09-2014	9.37	19899.34	-	-	-	1	0	-1
92	11-09-2014	9.77	20393.70	-	-	-	1	0	-1
93	18-09-2014	8.26	16496.28	-	-	-	1	0	-1
94	25-09-2014	10.15	22381.36	-	-	-	1	0	-1
95	09-10-2014	7.47	13886.89	-	-	-	1	0	-1
96	16-10-2014	5.63	9942.27	-	-	-	1	0	-1
97	22-10-2014	4.57	6813.33	-	-	-	1	0	-1
98	30-10-2014	4.39	6208.91	-	-	-	1	0	-1
99	06-11-2014	4.41	6736.23	-	-	-	1	0	-1
100	13-11-2014	4.16	6293.01	-	-	-	1	0	-1
101	20-11-2014	3.77	5416.05	-	-	-	1	0	-1
102	27-11-2014	3.31	4481.55	-	-	-	1	0	-1
103	11-12-2014	3.23	4607.61	-	-	-	1	0	-1
104	25-12-2014	2.94	4330.74	-	-	-	1	0	-1
105	15-01-2015	2.49	3173.26	-	-	-	1	0	-1
106	29-01-2015	2.38	2816.11	-	-	-	1	0	-1
107	12-02-2015	2.18	2649.03	-	-	-	1	0	-1
108	26-02-2015	2.17	2581.14	-	-	-	1	0	-1
109	12-03-2015	2.03	2527.70	-	-	-	1	0	-1
110	26-03-2015	2.65	3453.77	-	-	-	1	0	-1
111	09-04-2015	2.79	3507.93	-	-	-	1	0	-1
112	23-04-2015	3.01	4196.82	-	-	-	1	0	-1
113	04-05-2015	2.81	3812.65	-	-	-	1	0	-1
114	28-05-2015	2.55	3383.18	7:00	12:00	2.55	1	1	1
115	11-06-2015	2.44	3055.46	7:00	12:00	2.46	1	1	1
116	18-06-2015	3.47	3321.98	7:00	12:00	3.49	1	1	1
117	25-06-2015	4.02	6915.19	7:00	12:00	4.00	1	1	1
118	09-07-2015	2.77	3919.68	7:00	12:00	2.77	1	1	1
119	16-07-2015	3.43	3919.68	7:00	12:00	3.43	1	1	1
120	23-07-2015	7.91	15873.62	7:00	12:00	7.83	1	1	1
121	06-08-2015	11.84	28416.26	-	-	-	1	0	-1
122	13-08-2015	11.34	26335.45	-	-	-	1	0	-1
123	20-08-2015	8.04	16617.55	-	-	-	1	0	-1
124	27-08-2015	7.44	14318.79	-	-	-	1	0	-1
125	03-09-2015	10.81	27357.40	-	-	-	1	0	-1
126	10-09-2015	10.29	22045.42	-	-	-	1	0	-1
127	17-09-2015	9.58	21952.78	7:00	12:00	9.64	1	1	1
128	24-09-2015	7.31	13622.98	7:00	12:00	7.38	1	1	1
129	08-10-2015	6.43	10688.15	7:00	12:00	6.49	1	1	1
130	15-10-2015	7.70	14500.31	7:00	12:00	7.74	1	1	1
131	22-10-2015	6.49	10688.14	7:00	12:00	6.57	1	1	1
132	29-10-2015	4.50	6473.79	7:00	12:00	4.52	1	1	1

Table F. Water level and discharge observation of Mekong mainstream at Khong Chiam (continued)

WL-Q Observation					Mekong-HYCOS			QA/QC		
No	Date	WL1[a] (m)	Q (m3/s)		Start time	End time	WL2[b] (m)	1[c]	2[d]	3[e]
133	06-11-2015	3.97	5620.41		7:00	12:00	3.99	1	1	1
134	12-11-2015	3.64	5161.77		7:00	12:00	3.66	1	1	1
135	19-11-2015	3.00	4057.44		7:00	12:00	3.04	1	1	1
136	26-11-2015	3.07	4060.06		7:00	12:00	3.08	1	1	1
137	11-01-2018	3.02	4223.39		-	-	-	1	0	-1
138	25-01-2018	2.85	3716.60		-	-	-	1	0	-1
139	08-02-2018	2.62	3613.68		-	-	-	1	0	-1
140	08-03-2018	2.19	2777.71		-	-	-	1	0	-1
141	22-03-2018	2.11	2589.49		-	-	-	1	0	-1
142	05-04-2018	2.55	3484.12		-	-	-	1	0	-1
143	26-04-2018	2.38	3085.04		-	-	-	1	0	-1
144	10-05-2018	3.53	5259.71		7:00	12:00	3.56	1	1	1
145	24-05-2018	3.77	5600.62		7:00	12:00	3.72	1	1	1
146	07-06-2018	4.39	6812.12		7:00	12:00	4.39	1	1	1
147	21-06-2018	5.20	8677.32		7:00	12:00	5.16	1	1	1
148	05-07-2018	6.50	11484.35		7:00	12:00	6.52	1	1	1
149	12-07-2018	8.60	18037.28		7:00	12:00	8.70	1	1	1
150	19-07-2018	11.78	27034.11		7:00	12:00	11.71	1	1	1
151	26-07-2018	12.75	27620.48		7:00	12:00	12.63	-1	1	1
152	09-08-2018	14.56	43761.57		7:00	12:00	14.54	1	1	1
153	16-08-2018	13.91	39186.07		7:00	12:00	13.89	1	1	1
154	23-08-2018	13.88	38343.36		7:00	12:00	13.87	1	1	1
155	30-08-2018	14.98	44333.59		7:00	12:00	14.99	1	1	1
156	06-09-2018	14.09	40163.80		7:00	12:00	14.10	1	1	1
157	13-09-2018	13.01	30113.68		7:00	12:00	13.07	1	1	1
158	20-09-2018	11.36	26159.26		7:00	12:00	11.33	1	1	1
159	27-09-2018	9.41	19205.58		-	-	-	1	0	-1
160	04-10-2018	7.50	13590.06		7:00	12:00	7.52	1	1	1
161	11-10-2018	6.04	9557.23		7:00	12:00	6.09	1	1	1
162	18-10-2018	5.14	8082.01		7:00	12:00	5.15	1	1	1
163	26-10-2018	5.24	9254.72		7:00	12:00	5.27	1	1	1
164	08-11-2018	4.67	7146.65		7:00	12:00	4.70	1	1	1
165	15-11-2018	4.33	6284.86		7:00	12:00	4.35	1	1	1
166	22-11-2018	3.61	5366.10		7:00	12:00	3.66	1	1	1
167	29-11-2018	3.34	4890.08		7:00	12:00	3.38	1	1	1
168	13-12-2018	2.85	3683.75		7:00	12:00	2.93	1	1	1
169	27-12-2018	2.88	3811.93		7:00	12:00	2.95	1	1	1
170	10-05-2019	3.49	4800.55		7:00	12:00	3.54	1	1	1
171	23-05-2019	3.18	4376.58		7:00	12:00	3.19	1	1	1
172	07-06-2019	4.63	7106.62		7:00	12:00	4.66	1	1	1
173	13-06-2019	4.03	5930.44		7:00	12:00	4.05	1	1	1
174	20-06-2019	4.27	6369.16		7:00	12:00	4.30	1	1	1
175	27-06-2019	3.60	4959.24		7:00	12:00	3.60	1	1	1
176	04-07-2019	3.48	4660.75		7:00	12:00	3.47	1	1	1

Table F. Water level and discharge observation of Mekong mainstream at Khong Chiam (continued)

WL-Q Observation					Mekong-HYCOS			QA/QC		
No	Date	WL1[a] (m)	Q (m3/s)		Start time	End time	WL2[b] (m)	1[c]	2[d]	3[e]
177	11-07-2019	3.93	5763.11		7:00	12:00	3.95	1	1	1
178	18-07-2019	3.22	4376.58		7:00	12:00	3.23	1	1	1
179	25-07-2019	2.72	3422.39		7:00	12:00	2.66	1	1	1
180	08-08-2019	5.23	8677.32		7:00	12:00	5.18	1	1	1
181	16-08-2019	5.77	10071.01		7:00	12:00	5.70	1	1	1
182	22-08-2019	8.63	18980.95		7:00	12:00	8.47	1	1	-1
183	29-08-2019	10.45	23274.85		7:00	12:00	10.34	1	1	-1
184	05-09-2019	15.71	44340.18		7:00	12:00	15.57	1	1	-1
185	12-09-2019	13.50	36424.29		7:00	12:00	13.38	1	1	-1
186	19-09-2019	9.90	20603.08		7:00	12:00	9.78	1	1	-1
187	26-09-2019	7.07	12529.50		7:00	12:00	7.09	1	1	1
188	03-10-2019	5.08	8316.73		7:00	12:00	5.07	1	1	1
189	10-10-2019	3.26	4480.67		7:00	12:00	3.29	1	1	1
190	17-10-2019	2.69	3570.92		7:00	12:00	2.77	1	1	1
191	24-10-2019	2.74	3755.42		7:00	12:00	2.76	1	1	1
192	07-11-2019	2.40	3140.62		7:00	12:00	2.46	1	1	1
193	14-11-2019	2.02	2500.99		7:00	12:00	2.09	1	1	1
194	21-11-2019	1.98	2498.40		7:00	12:00	2.07	1	1	1
195	28-11-2019	1.97	2498.40		7:00	12:00	2.07	1	1	1
196	12-12-2019	2.14	2713.09		7:00	12:00	2.22	1	1	1
197	26-12-2019	2.52	3310.53		-	-	-	1	0	-1
198	09-01-2020	2.09	2559.20		7:00	12:00	2.17	1	1	1
199	23-01-2020	1.90	2343.81		7:00	12:00	1.99	1	1	1
200	06-02-2020	1.85	2265.33		7:00	12:00	1.93	1	1	1
201	20-02-2020	1.77	2135.41		7:00	12:00	1.85	1	1	1
202	12-03-2020	1.86	2265.33		7:00	12:00	1.94	1	1	1
203	26-03-2020	1.89	2314.19		7:00	12:00	1.97	1	1	1
204	09-04-2020	2.25	2774.37		7:00	12:00	2.30	1	1	1
205	23-04-2020	1.99	2407.85		7:00	12:00	2.06	1	1	1
206	08-05-2020	2.32	2887.37		7:00	12:00	2.39	1	1	1
207	21-05-2020	2.21	2770.85		7:00	12:00	2.10	1	1	1
208	04-06-2020	2.85	3817.01		7:00	12:00	2.83	1	1	1
209	11-06-2020	2.71	3571.30		7:00	12:00	2.74	1	1	1
210	18-06-2020	2.80	3644.61		7:00	12:00	2.84	1	1	1
211	25-06-2020	3.76	5373.11		7:00	12:00	3.77	1	1	1
212	10-07-2020	4.79	7133.37		7:00	12:00	4.83	1	1	1
213	16-07-2020	3.60	5021.84		7:00	12:00	3.78	1	-1	-1
214	23-07-2020	3.85	5456.28		7:00	12:00	3.97	1	-1	-1
215	30-07-2020	3.87	5456.28		7:00	12:00	4.02	1	-1	-1
216	06-08-2020	5.88	9884.39		7:00	12:00	6.06	1	-1	-1
217	13-08-2020	6.84	11792.47		7:00	12:00	7.07	1	-1	-1
218	20-08-2020	9.03	18629.72		7:00	12:00	9.03	1	1	1
219	27-08-2020	9.74	19739.73		7:00	12:00	9.83	1	1	1
220	03-09-2020	6.99	12479.24		7:00	12:00	6.99	1	1	1

Table F. Water level and discharge observation of Mekong mainstream at Khong Chiam (continued)

WL-Q Observation				Mekong-HYCOS			QA/QC		
No	Date	WL1[a] (m)	Q (m3/s)	Start time	End time	WL2[b] (m)	1[c]	2[d]	3[e]
221	10-09-2020	5.51	9354.36	7:00	12:00	5.54	1	1	1
222	17-09-2020	5.51	9386.51	7:00	12:00	5.98	1	-1	-1
223	24-09-2020	7.51	13938.15	7:00	12:00	7.42	1	1	1
224	08-10-2020	6.23	10159.61	7:00	12:00	6.30	1	1	1
225	15-10-2020	8.89	18107.87	7:00	12:00	8.88	1	1	1
226	22-10-2020	9.35	19068.52	7:00	12:00	9.33	1	1	1
227	29-10-2020	6.99	12480.08	7:00	12:00	7.02	1	1	1
228	05-11-2020	5.50	8901.42	7:00	12:00	5.48	1	1	1
229	12-11-2020	4.36	6340.73	7:00	12:00	4.37	1	1	1
230	18-11-2020	4.09	5967.68	7:00	12:00	4.10	1	1	1
231	26-11-2020	3.42	4669.16	7:00	12:00	3.40	1	1	1
232	09-12-2020	2.76	3614.66	7:00	12:00	2.74	1	1	1
233	24-12-2020	2.50	3299.29	7:00	12:00	2.61	1	1	1
234	07-01-2021	2.56	3320.50	7:00	12:00	2.55	1	1	1
235	21-01-2021	1.99	2509.39	7:00	12:00	2.01	1	1	1
236	04-02-2021	1.93	2421.33	7:00	12:00	2.03	1	1	1
237	18-02-2021	1.92	2407.29	7:00	12:00	1.94	1	1	1
238	11-03-2021	2.11	2646.58	7:00	12:00	2.09	1	1	1
239	25-03-2021	2.25	2864.10	7:00	12:00	2.32	1	1	1
240	08-04-2021	2.46	3218.37	7:00	12:00	2.39	1	1	1
241	20-04-2021	2.75	3841.79	7:00	12:00	2.79	1	1	1
242	22-04-2021	2.85	3756.35	7:00	12:00	2.86	1	1	1
243	06-05-2021	2.99	3906.98	7:00	12:00	2.95	1	1	1
244	14-05-2021	3.11	4251.31	7:00	12:00	3.08	1	1	1
245	20-05-2021	3.14	4267.63	7:00	12:00	3.18	1	1	1
246	27-05-2021	3.46	4800.55	7:00	12:00	3.42	1	1	1
247	06-01-2022	2.00	2515.54	7:00	12:00	2.01	1	1	1
248	20-01-2022	1.94	2477.67	7:00	12:00	1.92	1	1	1
249	03-02-2022	2.25	2864.10	7:00	12:00	2.00	1	1	1
250	17-02-2022	1.85	2381.01	7:00	12:00	1.76	1	1	1
251	10-03-2022	2.24	2825.02	7:00	12:00	2.26	1	1	1
252	25-03-2022	3.14	4253.74	7:00	12:00	3.15	1	1	1
253	07-04-2022	3.12	4245.36	7:00	12:00	3.05	1	1	1
254	21-04-2022	2.76	3702.68	7:00	12:00	2.76	1	1	1
255	05-05-2022	3.47	4651.94	7:00	12:00	3.39	1	1	1
256	19-05-2022	4.07	5829.94	7:00	12:00	4.00	1	1	1
257	01-06-2022	5.90	9654.00	7:00	12:00	6.13	1	-1	-1
258	16-06-2022	5.12	8080.32	7:00	12:00	5.21	1	1	1
259	23-06-2022	5.10	7532.09	7:00	12:00	5.13	1	1	1
260	30-06-2022	4.59	6987.32	-	-	-	1	0	-1
261	04-07-2022	4.86	7512.18	7:00	12:00	4.93	1	1	1
262	21-07-2022	7.34	13377.81	7:00	12:00	7.26	1	1	1
263	25-07-2022	7.34	13087.92	-	-	-	1	0	1
264	27-07-2022	7.22	13938.58	7:00	12:00	7.20	1	1	1

Table F. Water level and discharge observation of Mekong mainstream at Khong Chiam (continued)

WL-Q Observation				Mekong-HYCOS			QA/QC		
No	Date	WL1[a] (m)	Q (m3/s)	Start time	End time	WL2[b] (m)	1[c]	2[d]	3[e]
265	04-08-2022	6.33	10780.40	7:00	12:00	6.33	1	1	1
266	11-08-2022	9.26	18956.15	7:00	12:00	9.27	1	1	1
267	18-08-2022	8.95	17784.42	7:00	12:00	8.94	1	1	1
268	25-08-2022	10.18	22258.81	7:00	12:00	10.16	1	1	1
269	01-09-2022	9.68	21160.65	7:00	12:00	9.63	1	1	1
270	07-09-2022	9.60	20669.43	7:00	12:00	9.60	1	1	1
271	10-09-2022	8.66	16787.17	7:00	12:00	8.64	1	1	1
272	15-09-2022	8.49	16408.91	7:00	12:00	8.49	1	1	1
273	05-10-2022	10.47	21024.81	7:00	12:00	10.47	1	1	1
274	12-10-2022	9.22	17308.09	7:00	12:00	9.22	1	1	1
275	20-10-2022	8.21	15415.65	7:00	12:00	8.23	1	1	1
276	27-10-2022	6.62	10985.04	7:00	12:00	6.66	1	1	1
277	10-11-2022	4.98	7791.21	7:00	12:00	4.98	1	1	1
278	17-11-2022	4.13	5802.24	7:00	12:00	4.14	1	1	1
279	24-11-2022	3.83	5222.27	7:00	12:00	3.84	1	1	1
280	30-11-2022	3.72	4938.46	7:00	12:00	3.72	1	1	1
281	08-12-2022	3.16	4361.24	7:00	12:00	3.17	1	1	1
282	22-12-2022	2.37	2990.88	7:00	12:00	2.38	1	1	1

[a] WL1 is manually observed water level from staff gauges.

[b] WL2 is near real-time water level from the Mekong-HYCOS network.

[c] QA/QC1: Rating curves analysis for manually observed water level and discharge; "-1" outliers detected outside ±10 % of the rating curves; "1" pairs/points were in range of ±10 % of the rating curves.

[d] QA/QC2: validation analysis for near real-time water level from the Mekong-HYCOS network; "0" no data for near real-time water level from the Mekong-HYCOS network; "-1" difference between manually observed and near real-time water level is outside the range of ±10 cm; "1" difference between manually observed and near real-time water level is within the range of ±10 cm, therefore, near real-time water level is considered reliable.

[e] QA/QC3: Validation of rating curves developed for manually observed water level for near real-time water level; "-1" invalidated for near real-time water level; "1" validated for near real-time water level.

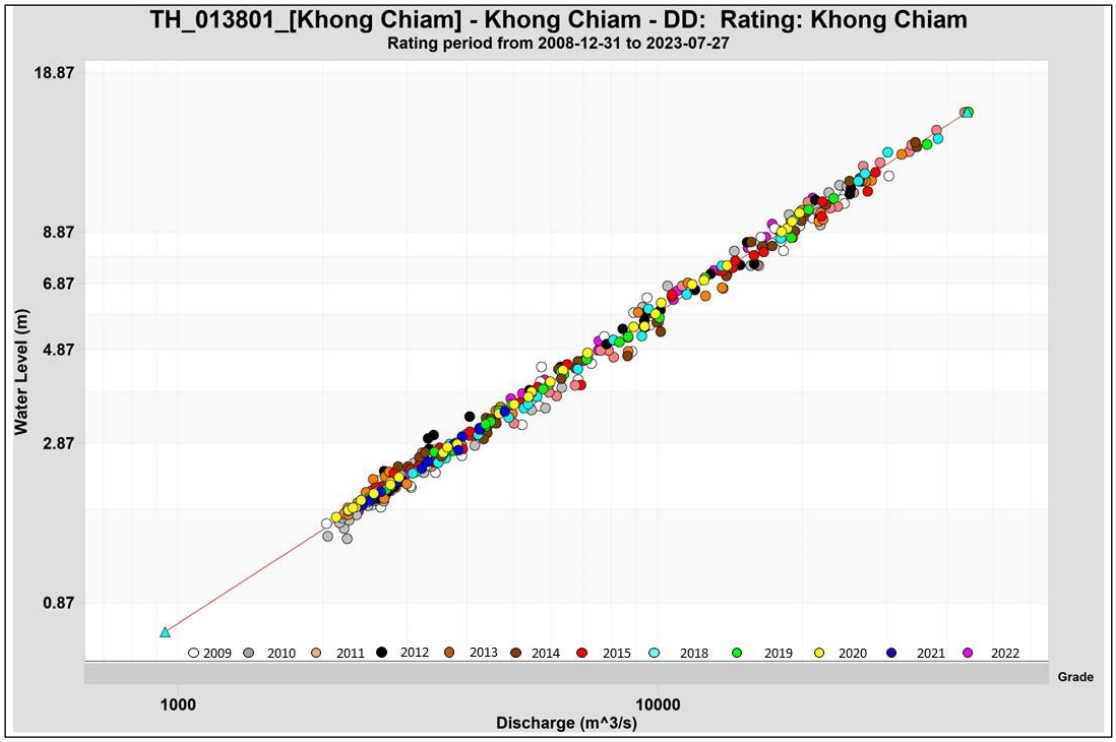


Figure F.1. Rating curve and rating equations of the Mekong mainstream at Khong Chiam for the dataset after applying ±10 % in discharge off the curve. Solid line is proposed rating curves

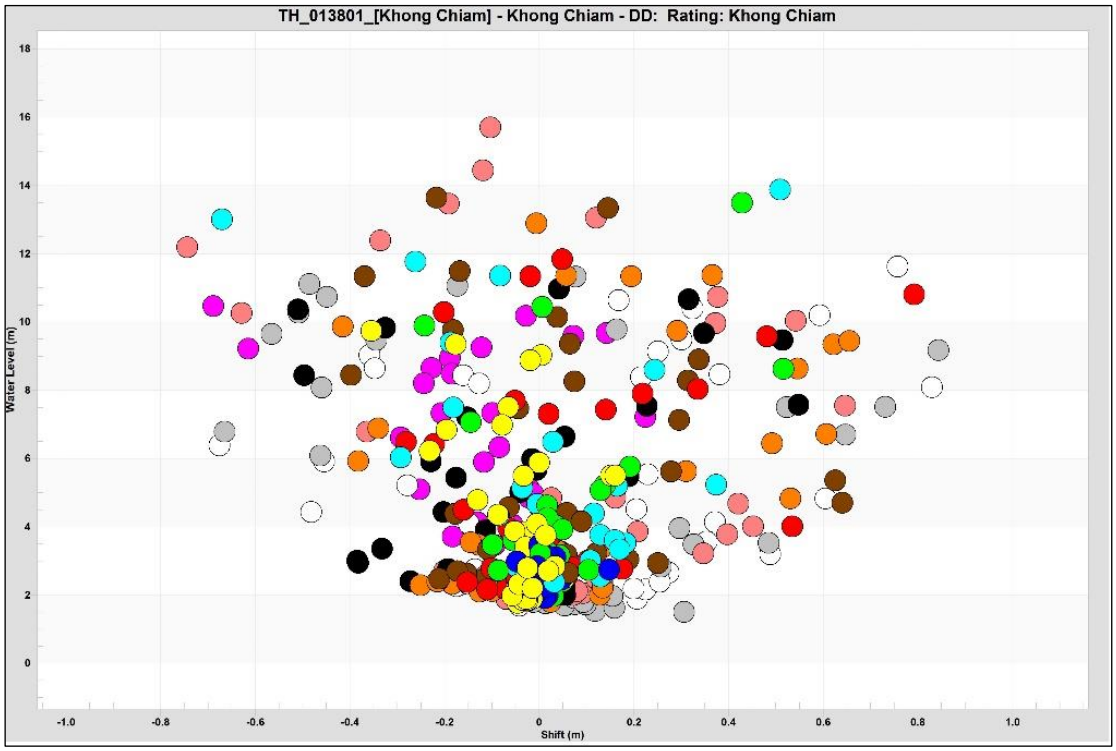


Figure F.2. The shift diagram was displayed data pairs/points observed water level and discharge scattering points around the rating curves of the Mekong mainstream at Khong Chiam for the dataset after applying ±10 % in discharge off the curve

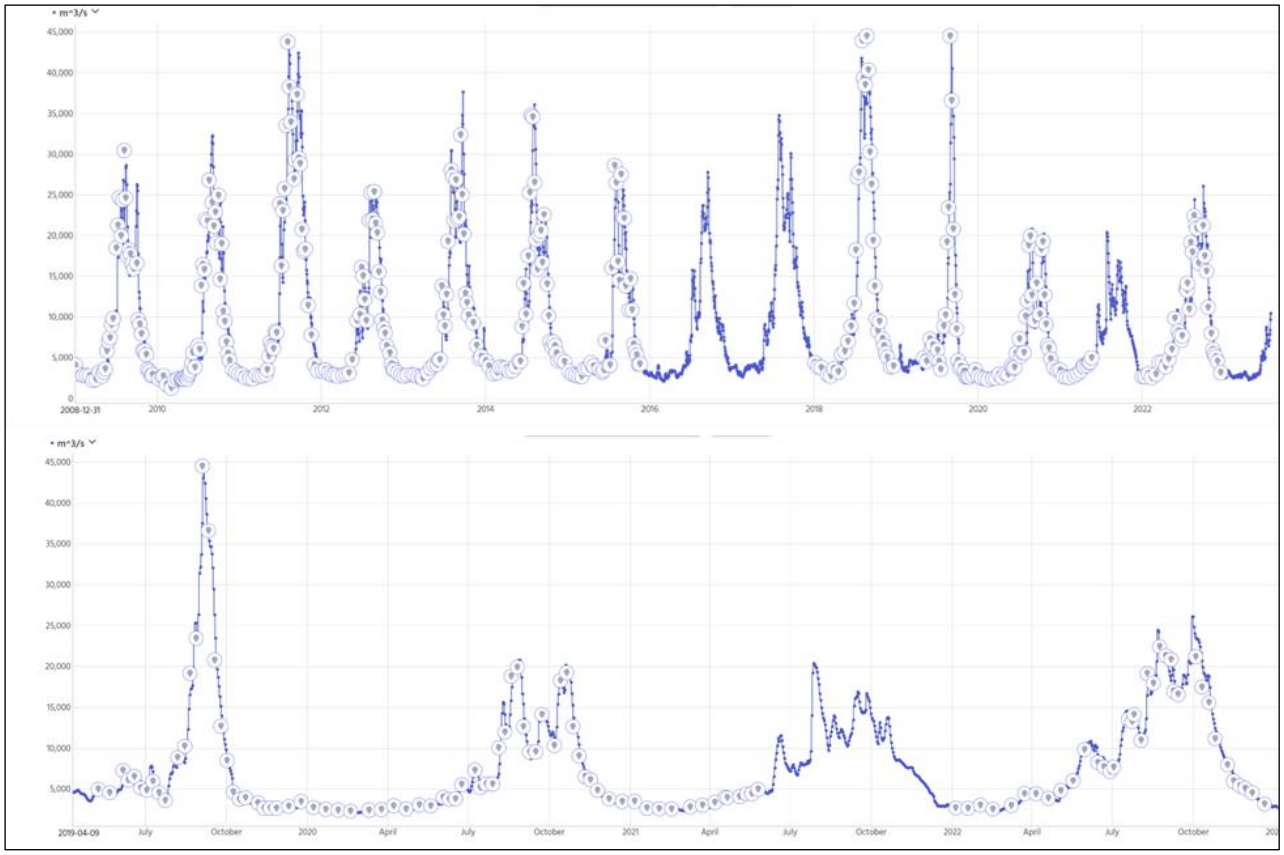


Figure F.3. The data pairs/points observed water level and discharge (dots) plotted against the derived discharge (blue line) from new rating curve at Khong Chiam station

Table G. Water level and discharge observation of Mekong mainstream at Pakse station

WL-Q Observation					Mekong-HYCOS			QA/QC		
No	Date	WL1[a] (m)	Q (m3/s)		Start time	End time	WL2[b] (m)	1[c]	2[d]	3[e]
1	09-07-2012	6.58	17745.92		7:00	12:00	6.44	1	-1	-1
2	16-07-2012	5.59	14888.24		7:00	12:00	5.58	1	1	1
3	26-07-2012	4.36	9122.74		7:00	12:00	4.37	1	1	1
4	30-07-2012	5.78	16823.20		7:00	12:00	5.78	1	1	1
5	10-08-2012	7.64	25462.85		7:00	12:00	7.65	-1	1	-1
6	16-08-2012	8.70	28033.15		7:00	12:00	8.70	1	1	1
7	21-08-2012	8.08	25519.46		7:00	12:00	8.07	1	1	1
8	29-08-2012	9.04	22782.61		7:00	12:00	9.06	1	1	1
9	04-09-2012	9.33	24131.96		7:00	12:00	9.32	1	1	1
10	11-09-2012	8.31	20785.35		7:00	12:00	8.31	1	1	1
11	14-09-2012	8.45	21431.27		7:00	12:00	8.46	1	1	1
12	25-09-2012	6.43	14808.12		-	-	-	1	0	-1
13	09-10-2012	4.30	9867.65		-	-	-	1	0	-1
14	15-10-2012	3.90	9061.23		-	-	-	1	0	-1
15	23-10-2012	3.27	6951.95		-	-	-	1	0	-1
16	29-10-2012	3.22	6502.44		7:00	12:00	3.21	1	1	1
17	06-11-2012	2.88	7114.23		7:00	12:00	2.84	1	1	1
18	14-11-2012	2.48	4933.28		7:00	12:00	2.44	1	1	1
19	20-11-2012	2.15	4442.55		7:00	12:00	2.15	1	1	1
20	27-11-2012	1.92	4048.80		7:00	12:00	1.94	1	1	1
21	11-12-2012	1.80	4096.11		7:00	12:00	1.81	1	1	1
22	19-12-2012	1.70	3714.23		7:00	12:00	1.70	1	1	1
23	14-01-2013	1.31	3264.70		7:00	12:00	1.34	1	1	1
24	21-01-2013	1.32	3289.01		7:00	12:00	1.32	1	1	1
25	11-02-2013	1.33	3300.49		7:00	12:00	1.35	1	1	1
26	25-02-2013	1.11	2778.79		7:00	12:00	1.14	1	1	1
27	13-03-2013	1.14	2709.02		7:00	12:00	1.17	1	1	1
28	25-03-2013	1.24	2766.34		7:00	12:00	1.27	1	1	1
29	08-04-2013	0.87	2330.70		7:00	12:00	0.93	1	1	1
30	23-04-2013	1.14	2772.19		7:00	12:00	1.21	1	1	1
31	08-05-2013	1.77	3858.11		7:00	12:00	1.76	1	1	1
32	22-05-2013	1.96	3869.63		7:00	12:00	1.92	1	1	1
33	03-06-2013	2.14	4387.06		7:00	12:00	2.17	1	1	1
34	10-06-2013	2.18	4776.99		7:00	12:00	2.22	1	1	1
35	18-06-2013	2.46	5420.15		7:00	12:00	2.49	1	1	1
36	26-06-2013	4.42	11266.19		7:00	12:00	4.55	1	-1	-1
37	08-04-2014	1.75	3793.87		-	-	-	1	0	-1
38	23-04-2014	1.78	3703.37		-	-	-	1	0	-1
39	06-05-2014	1.81	4024.71		-	-	-	1	0	-1
40	20-05-2014	2.02	4608.29		-	-	-	1	0	-1
41	06-06-2014	2.18	4780.18		-	-	-	1	0	-1
42	13-06-2014	3.03	7228.55		-	-	-	1	0	-1
43	20-06-2014	3.65	9487.85		-	-	-	1	0	-1
44	27-06-2014	6.02	17006.37		-	-	-	1	0	-1

Table G. Water level and discharge observation of Mekong mainstream at Pakse (continued)

WL-Q Observation				Mekong-HYCOS			QA/QC		
No	Date	WL1[a] (m)	Q (m3/s)	Start time	End time	WL2[b] (m)	1[c]	2[d]	3[e]
45	07-07-2014	4.45	12152.51	-	-	-	1	0	-1
46	16-07-2014	6.58	19080.51	-	-	-	1	0	-1
47	23-07-2014	9.17	30197.97	-	-	-	1	0	-1
48	27-07-2014	8.48	31510.63	-	-	-	1	0	-1
49	08-08-2014	11.65	44564.62	-	-	-	-1	0	-1
50	13-08-2014	10.07	35354.82	-	-	-	-1	0	-1
51	19-08-2014	7.87	25420.25	-	-	-	-1	0	-1
52	26-08-2014	7.18	22994.60	-	-	-	-1	0	-1
53	05-09-2014	7.84	24725.83	-	-	-	1	0	-1
54	09-09-2014	8.21	26669.67	-	-	-	-1	0	-1
55	15-09-2014	7.32	23529.02	-	-	-	-1	0	-1
56	19-09-2014	6.63	20076.93	-	-	-	1	0	-1
57	06-10-2014	6.43	19188.39	-	-	-	1	0	-1
58	15-10-2014	4.60	12025.42	-	-	-	1	0	-1
59	21-10-2014	3.49	9037.94	-	-	-	1	0	-1
60	28-10-2014	3.37	8457.12	-	-	-	1	0	-1
61	11-11-2014	3.01	6783.29	-	-	-	1	0	-1
62	17-11-2014	3.08	7375.87	-	-	-	1	0	-1
63	24-11-2014	2.29	5021.40	-	-	-	1	0	-1
64	28-11-2014	2.32	5335.79	-	-	-	1	0	-1
65	09-12-2014	2.24	4902.38	-	-	-	1	0	-1
66	23-12-2014	1.95	4387.09	-	-	-	1	0	-1
67	12-01-2015	1.67	3634.89	-	-	-	1	0	-1
68	27-01-2015	1.53	3446.38	-	-	-	1	0	-1
69	10-02-2015	1.22	2897.64	-	-	-	1	0	-1
70	25-02-2015	1.32	3019.99	-	-	-	1	0	-1
71	13-03-2015	1.07	2561.70	-	-	-	1	0	-1
72	25-03-2015	1.74	3607.42	-	-	-	1	0	-1
73	07-07-2019	3.52	7182.45	7:00	12:00	3.86	1	-1	-1
74	14-07-2019	2.27	4787.29	7:00	12:00	2.26	1	1	1
75	28-07-2019	2.80	5933.02	7:00	12:00	3.01	1	-1	-1
76	13-08-2019	3.90	9114.36	7:00	12:00	3.94	1	1	1
77	19-08-2019	5.85	14496.97	7:00	12:00	5.74	1	1	1
78	23-08-2019	6.78	16865.64	7:00	12:00	6.81	1	1	1
79	26-08-2019	9.19	23781.49	7:00	12:00	8.95	1	-1	-1
80	02-09-2019	11.35	30727.27	7:00	12:00	10.64	-1	-1	-1
81	09-09-2019	12.19	33286.33	7:00	12:00	12.32	-1	-1	-1
82	13-09-2019	11.18	14496.97	7:00	12:00	11.12	-1	1	-1
83	16-09-2019	10.29	14328.88	7:00	12:00	10.21	-1	1	-1
84	25-09-2019	5.92	14328.88	7:00	12:00	6.06	1	-1	-1
85	03-10-2019	3.90	8179.75	-	-	-	1	0	-1
86	19-11-2019	0.81	2441.95	-	-	-	1	0	-1
87	18-12-2019	1.08	2642.51	-	-	-	1	0	-1
88	21-12-2020	1.42	3938.88	-	-	-	1	0	-1

Table G. Water level and discharge observation of Mekong mainstream at Pakse (continued)

WL-Q Observation					Mekong-HYCOS			QA/QC		
No	Date	WL1[a] (m)	Q (m3/s)		Start time	End time	WL2[b] (m)	1[c]	2[d]	3[e]
89	17-03-2021	1.10	2873.61		-	-	-	1	0	-1
90	23-03-2021	1.20	2848.61		-	-	-	1	0	-1
91	20-04-2021	1.64	3841.79		-	-	-	1	0	-1
92	20-04-2021	1.64	3841.79		-	-	-	1	0	-1
93	21-04-2021	1.67	3900.84		-	-	-	1	0	-1
94	25-05-2021	2.22	4921.40		-	-	-	1	0	-1
95	07-07-2021	3.17	7135.57		7:00	12:00	3.19	1	1	1
96	13-07-2021	3.72	8567.24		7:00	12:00	3.73	1	1	1
97	19-07-2021	3.87	8674.63		7:00	12:00	3.87	1	1	1
98	26-07-2021	7.72	19589.19		7:00	12:00	7.66	1	1	1
99	04-08-2021	6.57	16145.59		7:00	12:00	6.55	1	1	1
100	09-08-2021	5.47	13208.79		7:00	12:00	5.49	1	1	1
101	16-08-2021	5.11	12327.25		7:00	12:00	5.14	1	1	1
102	24-08-2021	5.01	11491.71		7:00	12:00	4.95	1	1	1
103	08-09-2021	5.12	12256.55		7:00	12:00	5.15	1	1	1
104	15-09-2021	7.00	17355.43		7:00	12:00	7.00	1	1	1
105	22-09-2021	5.98	14596.42		7:00	12:00	6.00	1	1	1
106	12-10-2021	5.20	12099.44		7:00	12:00	5.16	1	1	1
107	19-10-2021	5.97	14567.58		7:00	12:00	5.99	1	1	1
108	27-10-2021	3.99	9340.81		7:00	12:00	4.00	1	1	1
109	10-11-2021	3.50	8069.26		7:00	12:00	3.52	1	1	1
110	07-12-2021	2.16	4855.63		7:00	12:00	2.13	1	1	1
111	12-01-2022	1.12	2666.07		7:00	12:00	1.14	1	1	1
112	12-01-2022	1.12	2666.07		7:00	12:00	1.14	1	1	1
113	20-01-2022	1.02	2133.16		7:00	12:00	1.01	1	1	1
114	09-02-2022	0.98	2482.41		7:00	12:00	1.01	1	1	1
115	09-02-2022	0.98	2482.41		7:00	12:00	1.01	1	1	1
116	09-03-2022	1.29	3115.72		7:00	12:00	1.27	1	1	1
117	11-04-2022	1.93	4403.17		7:00	12:00	1.92	1	1	1
118	10-05-2022	2.63	5924.58		-	-	-	1	0	-1
119	03-06-2022	4.64	10761.22		-	-	-	1	0	-1
120	17-06-2022	3.83	8651.11		-	-	-	1	0	-1
121	22-06-2022	3.84	8335.25		-	-	-	1	0	-1
122	05-07-2022	3.78	8612.91		-	-	-	1	0	-1
123	12-07-2022	5.52	13334.07		-	-	-	1	0	-1
124	19-07-2022	5.78	13975.48		-	-	-	1	0	-1
125	26-07-2022	5.61	13739.54		-	-	-	1	0	-1
126	04-08-2022	4.78	11721.25		-	-	-	1	0	-1
127	11-08-2022	8.17	19907.53		-	-	-	1	0	-1
128	17-08-2022	7.13	17364.56		-	-	-	1	0	-1
129	23-08-2022	8.62	21354.78		-	-	-	1	0	-1
130	06-09-2022	7.40	19091.19		-	-	-	1	0	-1
131	19-09-2022	7.48	19108.05		-	-	-	1	0	-1
132	27-09-2022	7.89	19734.35		-	-	-	1	0	-1

Table G. Water level and discharge observation of Mekong mainstream at Pakse (continued)

WL-Q Observation					Mekong-HYCOS			QA/QC		
No	Date	WL1[a] (m)	Q (m3/s)		Start time	End time	WL2[b] (m)	1[c]	2[d]	3[e]
133	07-10-2022	8.50	21833.45		-	-	-	1	0	-1
134	13-10-2022	7.37	18714.45		-	-	-	1	0	-1
135	20-10-2022	6.54	16966.51		-	-	-	1	0	-1
136	25-10-2022	5.32	12819.40		-	-	-	1	0	-1
137	08-11-2022	3.72	8540.76		-	-	-	1	0	-1
138	22-11-2022	2.73	6153.12		-	-	-	1	0	-1

[a] WL1 is manually observed water level from staff gauges.
[b] WL2 is near real-time water level from the Mekong-HYCOS network.
[c] QA/QC1: Rating curves analysis for manually observed water level and discharge; "-1" outliers detected outside ±10 % of the rating curves; "1" pairs/points were in range of ±10 % of the rating curves.
[d] QA/QC2: validation analysis for near real-time water level from the Mekong-HYCOS network; "0" no data for near real-time water level from the Mekong-HYCOS network; "-1" difference between manually observed and near real-time water level is outside the range of ±10 cm; "1" difference between manually observed and near real-time water level is within the range of ±10 cm, therefore, near real-time water level is considered reliable.
[e] QA/QC3: Validation of rating curves developed for manually observed water level for near real-time water level; "-1" invalidated for near real-time water level; "1" validated for near real-time water level.

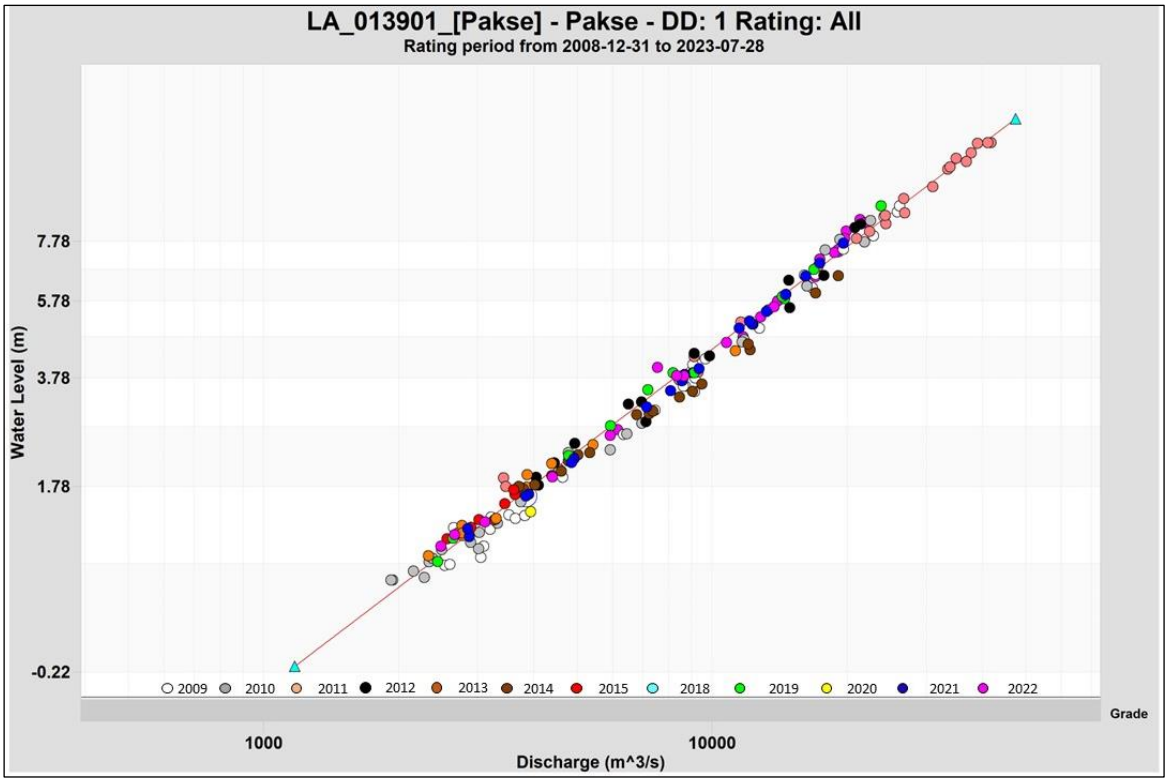


Figure G.1. Rating curve and rating equations of the Mekong mainstream at Pakse for the dataset after applying ±10 % in discharge off the curve. Solid line is proposed rating curves

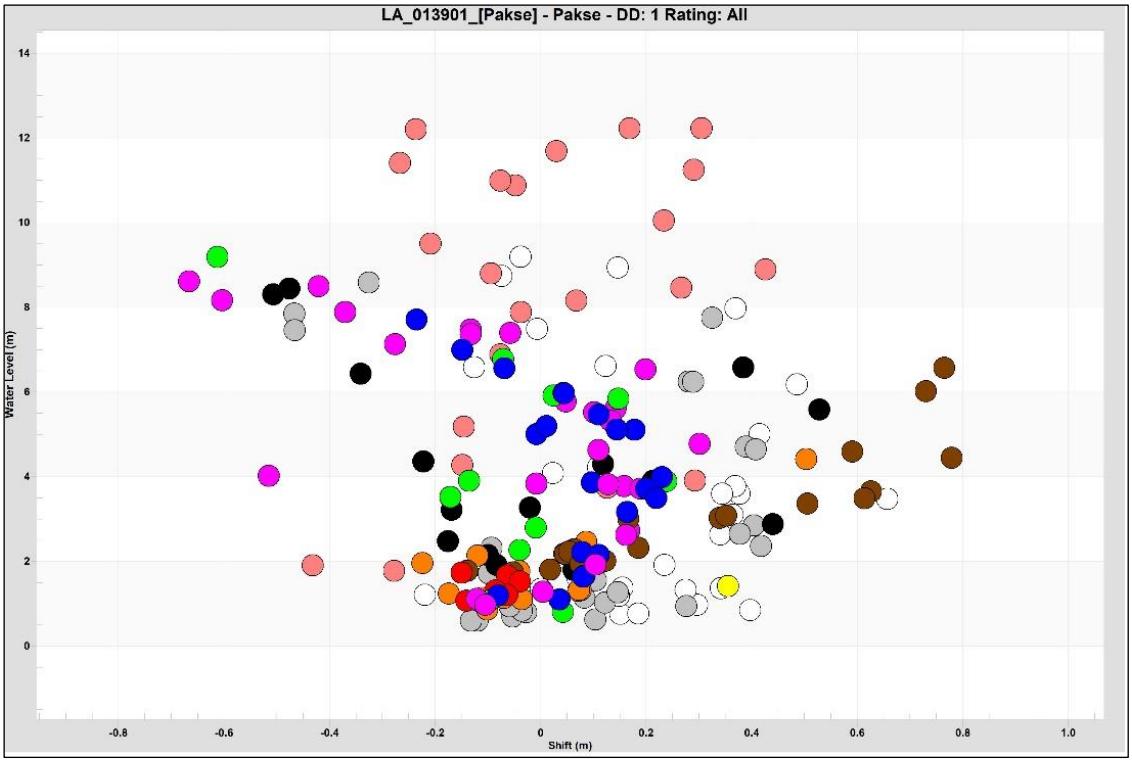


Figure G.2. The shift diagram was displayed data pairs/points observed water level and discharge scattering points around the rating curves of the Mekong mainstream at Pakse for the dataset after applying ±10 % in discharge off the curve

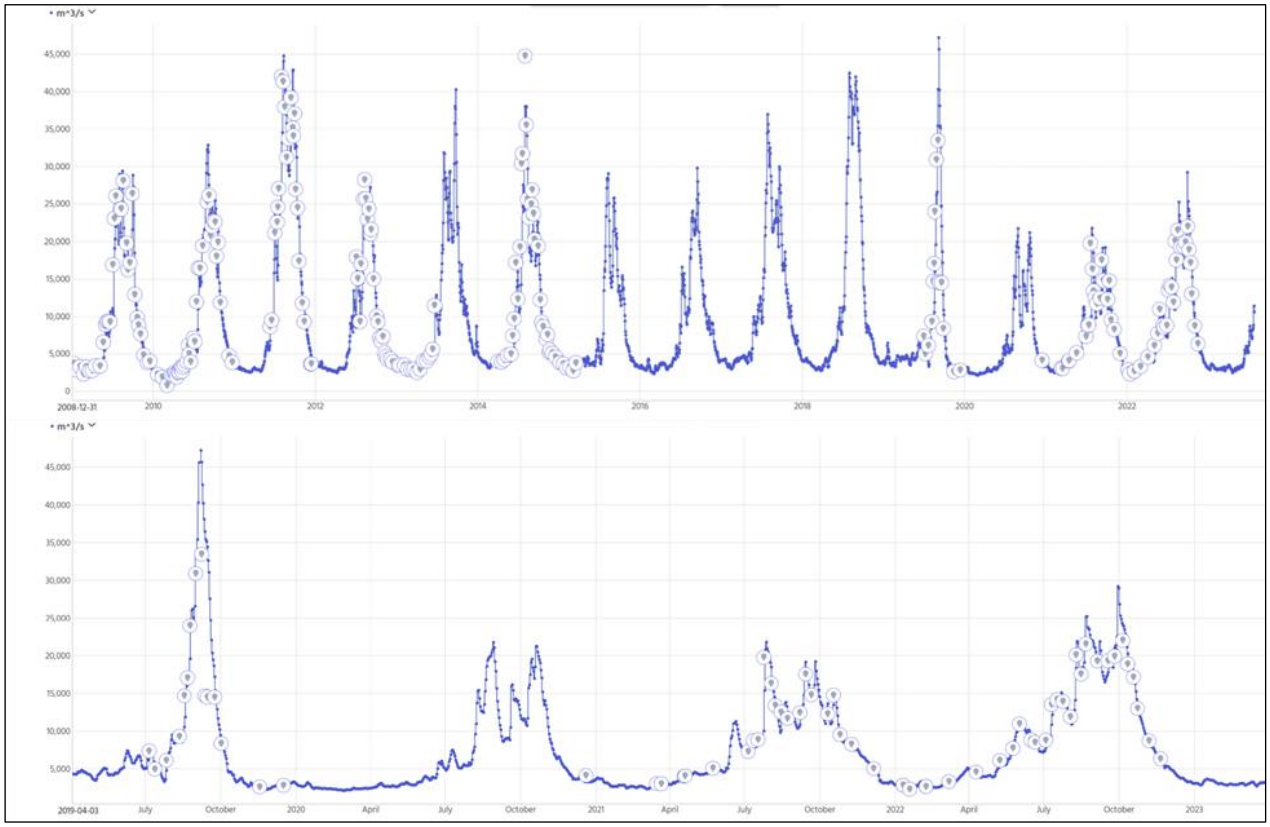


Figure G.3. The data pairs/points observed water level and discharge (dots) plotted against the derived discharge (blue line) from new rating curve at Pakse station

Table H. Water level and discharge observation of Mekong mainstream at Stung Treng (continued)

WL-Q Observation					Mekong-HYCOS			QA/QC		
No	Date	WL1[a] (m)	Q (m3/s)		Start time	End time	WL2[b] (m)	1[c]	2[d]	3[e]
1	15-01-2012	2.90	4182.51		-	-	-	1	0	-1
2	25-01-2012	2.80	3936.35		7:00	12:00	2.799	1	1	1
3	11-02-2012	2.63	3212.92		7:00	12:00	2.622	1	1	1
4	22-02-2012	2.56	3135.39		7:00	12:00	2.557	1	1	1
5	14-03-2012	2.59	3258.00		7:00	12:00	2.59	1	1	1
6	23-03-2012	2.50	3043.00		7:00	12:00	2.512	1	1	1
7	19-04-2012	2.69	3560.00		7:00	12:00	2.705	1	1	1
8	29-04-2012	2.66	3440.00		7:00	12:00	2.676	1	1	1
9	16-05-2012	2.78	3861.00		7:00	12:00	2.795	1	1	1
10	24-05-2012	3.21	5677.00		7:00	12:00	3.252	1	1	1
11	11-08-2012	7.45	26418.00		7:00	12:00	7.421	1	1	1
12	17-08-2012	7.70	27802.00		7:00	12:00	7.679	1	1	1
13	23-08-2012	7.23	25107.00		7:00	12:00	7.218	1	1	1
14	30-08-2012	8.63	33502.00		7:00	12:00	8.591	1	1	1
15	01-09-2012	8.25	31129.00		7:00	12:00	8.215	1	1	1
16	13-09-2012	7.89	29362.00		7:00	12:00	7.897	1	1	1
17	20-09-2012	7.11	24588.00		7:00	12:00	7.08	1	1	1
18	29-09-2012	6.44	20863.99		7:00	12:00	6.48	1	1	1
19	10-10-2012	6.18	19247.00		7:00	12:00	6.155	1	1	1
20	21-10-2012	4.49	10800.00		7:00	12:00	4.469	1	1	1
21	25-10-2012	4.19	9554.00		7:00	12:00	4.191	1	1	1
22	29-10-2012	4.09	9554.00		7:00	12:00	4.083	1	1	1
23	07-11-2012	3.81	8113.00		7:00	12:00	3.821	1	1	1
24	21-11-2012	3.36	6259.00		7:00	12:00	3.385	1	1	1
25	10-12-2012	3.02	4989.00		-	-	-	1	0	-1
26	23-12-2012	2.91	4329.23		-	-	-	1	0	-1
27	10-01-2013	2.65	3444.44		7:00	12:00	2.667	1	1	1
28	20-01-2013	2.62	3362.02		7:00	12:00	2.644	1	1	1
29	08-02-2013	2.52	3031.86		7:00	12:00	2.535	1	1	1
30	21-02-2013	2.58	3117.39		7:00	12:00	2.591	1	1	1
31	06-03-2013	2.49	3011.55		7:00	12:00	2.51	1	1	1
32	21-03-2013	2.58	3248.06		7:00	12:00	2.597	1	1	1
33	10-04-2013	2.43	2791.65		7:00	12:00	2.442	1	1	1
34	24-04-2013	2.54	3205.78		7:00	12:00	2.565	1	1	1
35	10-05-2013	2.87	4269.63		7:00	12:00	2.884	1	1	1
36	23-05-2013	3.05	4977.76		7:00	12:00	3.067	1	1	1
37	06-06-2013	3.20	5509.22		7:00	12:00	3.204	1	1	1
38	22-06-2013	3.49	6892.88		7:00	12:00	3.533	1	1	1
39	03-07-2013	4.94	12839.55		7:00	12:00	4.903	1	1	1
40	12-07-2013	4.38	10372.26		7:00	12:00	4.365	1	1	1
41	18-07-2013	5.15	13938.09		7:00	12:00	5.125	1	1	1
42	21-07-2013	6.50	21845.73		7:00	12:00	6.596	1	1	1
43	08-04-2014	2.91	4375.35		7:00	12:00	2.935	1	1	1
44	21-04-2014	2.92	4490.03		7:00	12:00	2.954	1	1	1

Table H. Water level and discharge observation of Mekong mainstream at Stung Treng (continued)

WL-Q Observation					Mekong-HYCOS			QA/QC		
No	Date	WL1[a] (m)	Q (m3/s)		Start time	End time	WL2[b] (m)	1[c]	2[d]	3[e]
45	08-05-2014	3.01	4844.60		7:00	12:00	3.041	1	1	1
46	22-05-2014	3.11	5200.69		7:00	12:00	3.141	1	1	1
47	05-06-2014	3.24	5818.77		7:00	12:00	3.261	1	1	1
48	12-06-2014	3.66	7636.34		7:00	12:00	3.712	1	1	1
49	17-06-2014	4.37	10375.94		7:00	12:00	4.362	1	1	1
50	27-06-2014	6.00	18549.17		7:00	12:00	6	1	1	-1
51	05-07-2014	5.51	15511.67		7:00	12:00	5.471	1	1	1
52	12-07-2014	6.90	23318.36		7:00	12:00	6.874	1	1	1
53	18-07-2014	7.30	25205.22		7:00	12:00	7.259	1	1	1
54	24-07-2014	9.17	37628.18		7:00	12:00	9.159	1	1	1
55	07-08-2014	11.55	52396.09		7:00	12:00	11.447	1	-1	-1
56	15-08-2014	8.51	32400.11		7:00	12:00	8.439	1	1	1
57	24-08-2014	6.75	22373.90		7:00	12:00	6.728	1	1	1
58	30-08-2014	6.93	23497.19		7:00	12:00	6.911	1	1	1
59	05-09-2014	7.94	29260.12		7:00	12:00	7.925	1	1	1
60	15-09-2014	7.47	26562.35		7:00	12:00	7.463	1	1	1
61	18-09-2014	7.63	26968.78		7:00	12:00	7.623	1	1	1
62	30-09-2014	7.61	27274.53		7:00	12:00	7.593	1	1	1
63	08-10-2014	6.62	20971.15		7:00	12:00	6.601	1	1	1
64	16-10-2014	5.04	13303.31		7:00	12:00	5.01	1	1	1
65	19-10-2014	4.65	11407.78		7:00	12:00	4.64	1	1	1
66	31-10-2014	4.40	10557.49		7:00	12:00	4.401	1	1	1
67	15-11-2014	3.81	7920.66		7:00	12:00	3.826	1	1	1
68	18-11-2014	3.88	7992.87		7:00	12:00	3.897	1	1	1
69	25-11-2014	3.38	6129.79		7:00	12:00	3.385	1	1	1
70	30-11-2014	3.36	6037.86		7:00	12:00	3.391	1	1	1
71	14-12-2014	3.19	5427.67		7:00	12:00	3.214	1	1	1
72	24-12-2014	3.07	5010.73		7:00	12:00	3.103	1	1	1
73	08-01-2015	2.93	4362.77		7:00	12:00	2.958	1	1	1
74	22-01-2015	2.74	3771.48		7:00	12:00	2.778	1	1	1
75	11-02-2015	2.58	3250.58		7:00	12:00	2.612	1	1	1
76	27-02-2015	2.61	3278.41		7:00	12:00	2.664	1	1	1
77	15-03-2015	2.50	2990.17		7:00	12:00	2.537	1	1	1
78	19-03-2015	2.60	3414.59		7:00	12:00	2.652	1	1	1
79	08-04-2015	2.93	4589.07		7:00	12:00	2.971	1	1	1
80	24-04-2015	2.98	4850.87		7:00	12:00	3.028	1	1	1
81	10-05-2015	3.04	5030.66		7:00	12:00	3.08	1	1	1
82	26-05-2015	2.87	4296.62		7:00	12:00	2.9	1	1	1
83	09-06-2015	2.86	3318.94		7:00	12:00	2.913	1	1	1
84	16-06-2015	2.93	4766.07		7:00	12:00	2.995	1	1	1
85	21-06-2015	3.43	5064.40		7:00	12:00	3.485	1	1	1
86	30-06-2015	3.92	8403.79		7:00	12:00	3.923	1	1	1
87	03-07-2015	3.46	7587.65		7:00	12:00	3.466	1	1	1
88	14-07-2015	4.44	11122.48		7:00	12:00	4.467	1	1	1

Table H. Water level and discharge observation of Mekong mainstream at Stung Treng (continued)

WL-Q Observation					Mekong-HYCOS			QA/QC		
No	Date	WL1[a] (m)	Q (m3/s)		Start time	End time	WL2[b] (m)	1[c]	2[d]	3[e]
89	22-07-2015	5.31	15495.24		7:00	12:00	5.361	1	1	1
90	29-07-2015	6.04	17571.49		7:00	12:00	6.135	1	1	1
91	07-08-2015	8.00	29133.53		7:00	12:00	7.969	1	1	1
92	14-08-2015	8.20	29959.28		7:00	12:00	8.14	1	1	1
93	21-08-2015	5.99	18281.96		7:00	12:00	5.976	1	1	1
94	29-08-2015	6.45	17315.19		7:00	12:00	6.418	1	1	1
95	08-09-2015	7.65	27383.53		7:00	12:00	7.61	1	1	1
96	15-09-2015	7.13	24371.56		7:00	12:00	7.104	1	1	1
97	21-09-2015	6.43	20294.58		7:00	12:00	6.39	1	1	1
98	27-09-2015	5.55	19415.66		7:00	12:00	5.525	1	1	1
99	09-10-2015	5.89	17850.57		7:00	12:00	5.87	1	1	1
100	18-10-2015	5.79	17302.74		7:00	12:00	5.767	1	1	1
101	24-10-2015	5.01	13234.98		7:00	12:00	4.982	1	1	1
102	30-10-2015	4.03	12396.62		7:00	12:00	4.031	-1	1	-1
103	06-11-2015	3.73	7658.06		7:00	12:00	3.749	1	1	1
104	14-11-2015	3.48	6588.65		7:00	12:00	3.496	1	1	1
105	20-11-2015	3.18	5414.69		7:00	12:00	3.195	1	1	1
106	28-11-2015	3.15	5286.79		7:00	12:00	3.168	1	1	1
107	10-12-2015	2.78	3899.16		7:00	12:00	2.8	1	1	1
108	26-12-2015	2.68	3909.68		7:00	12:00	2.711	1	1	1
109	17-06-2018	4.99	14630.12		7:00	12:00	4.966	1	1	1
110	30-06-2018	4.83	13756.19		7:00	12:00	4.834	1	1	1
111	10-07-2018	6.08	20229.40		7:00	12:00	6.11	1	1	1
112	17-07-2018	8.18	33209.24		7:00	12:00	8.154	1	1	1
113	25-07-2018	9.63	44207.91		7:00	12:00	9.595	1	1	1
114	07-08-2018	10.64	51546.09		7:00	12:00	10.567	1	1	1
115	15-08-2018	9.79	45778.66		7:00	12:00	9.774	-1	1	-1
116	21-08-2018	10.94	54573.44		7:00	12:00	10.881	-1	1	-1
117	28-08-2018	10.81	54258.96		7:00	12:00	10.767	-1	1	1
118	10-09-2018	9.46	43219.65		7:00	12:00	9.494	-1	1	-1
119	24-09-2018	8.14	33488.51		7:00	12:00	8.146	1	1	1
120	29-09-2018	7.12	31046.96		7:00	12:00	7.119	-1	1	-1
121	06-10-2018	5.96	18864.10		7:00	12:00	5.999	1	1	1
122	26-10-2018	4.51	11842.87		7:00	12:00	4.561	1	1	1
123	10-11-2018	4.02	9340.83		7:00	12:00	4.094	1	1	1
124	21-11-2018	3.55	9384.29		-	-	-	1	0	-1
125	08-12-2018	3.24	6575.85		7:00	12:00	3.303	1	1	1
126	23-12-2018	3.00	6495.71		7:00	12:00	3.078	1	1	1
127	20-06-2019	3.90	7916.38		7:00	12:00	3.95	1	1	1
128	25-06-2019	3.70	7678.41		7:00	12:00	3.785	1	1	1
129	29-06-2019	3.40	7584.00		7:00	12:00	3.425	1	1	1
130	07-07-2019	4.44	10656.00		7:00	12:00	4.416	1	1	1
131	14-07-2019	3.61	7054.00		7:00	12:00	3.618	1	1	1
132	21-07-2019	3.29	5413.00		7:00	12:00	3.206	1	1	1

Table H. Water level and discharge observation of Mekong mainstream at Stung Treng (continued)

WL-Q Observation					Mekong-HYCOS			QA/QC		
No	Date	WL1[a] (m)	Q (m3/s)		Start time	End time	WL2[b] (m)	1[c]	2[d]	3[e]
133	28-07-2019	3.69	7576.00		7:00	12:00	3.716	1	1	1
134	04-08-2019	5.36	14822.00		7:00	12:00	5.337	1	1	1
135	10-08-2019	6.09	18811.00		7:00	12:00	6.076	1	1	1
136	18-08-2019	5.38	15348.00		7:00	12:00	5.379	1	1	1
137	25-08-2019	7.49	27384.00		7:00	12:00	7.519	1	1	1
138	06-09-2019	12.01	57349.00		7:00	12:00	11.94	1	1	1
139	14-09-2019	10.30	44504.00		7:00	12:00	10.258	1	1	1
140	22-09-2019	8.09	34084.00		7:00	12:00	8.203	1	1	1
141	02-10-2019	5.13	13887.00		7:00	12:00	5.135	1	1	1
142	12-10-2019	3.84	8096.00		7:00	12:00	3.893	1	1	1
143	31-10-2019	3.13	4870.00		7:00	12:00	3.15	1	1	1
144	21-11-2019	2.76	3666.00		7:00	12:00	2.783	1	1	1
145	20-12-2019	2.91	4210.00		7:00	12:00	3.038	1	-1	-1
146	29-04-2020	2.54	3175.00		7:00	12:00	2.548	1	1	1
147	15-05-2020	2.70	3175.00		7:00	12:00	2.715	1	1	1
148	29-05-2020	2.85	4008.00		7:00	12:00	2.822	1	1	1
149	05-06-2020	2.99	4523.00		7:00	12:00	2.981	1	1	1
150	12-06-2020	2.92	4386.00		7:00	12:00	2.939	1	1	1
151	18-06-2020	3.11	4972.00		7:00	12:00	3.097	1	1	1
152	29-06-2020	3.38	6544.00		7:00	12:00	3.42	1	1	1
153	04-07-2020	3.53	6832.00		7:00	12:00	3.556	1	1	1
154	13-07-2020	3.85	8012.00		7:00	12:00	3.858	1	1	1
155	22-07-2020	3.39	6271.00		7:00	12:00	3.422	1	1	1
156	30-07-2020	3.57	6888.00		7:00	12:00	3.581	1	1	1
157	06-08-2020	4.67	11878.00		7:00	12:00	4.68	1	1	1
158	15-08-2020	6.18	19088.00		7:00	12:00	6.17	1	1	1
159	22-08-2020	6.96	23472.00		7:00	12:00	6.964	1	1	1
160	28-08-2020	7.03	24040.00		7:00	12:00	7.058	1	1	1
161	05-09-2020	5.60	16037.00		7:00	12:00	5.592	1	1	1
162	10-09-2020	4.75	12096.00		7:00	12:00	4.766	1	1	1
163	23-09-2020	6.27	19701.00		7:00	12:00	6.275	1	1	1
164	29-09-2020	6.05	16705.00		7:00	12:00	6.053	1	1	1
165	10-10-2020	6.31	19946.00		7:00	12:00	6.354	1	1	1
166	19-10-2020	8.22	31965.00		7:00	12:00	8.239	1	1	1
167	27-10-2020	6.66	20004.00		7:00	12:00	6.563	1	1	1
168	31-10-2020	7.12	22174.00		7:00	12:00	7.238	1	-1	-1
169	13-11-2020	5.10	14363.00		7:00	12:00	5.166	1	1	1
170	28-11-2020	3.53	6634.00		7:00	12:00	3.539	1	1	1
171	11-12-2020	3.30	5680.00		7:00	12:00	3.302	1	1	1
172	25-05-2021	3.24	5737.00		7:00	12:00	3.272	1	1	1
173	30-05-2021	3.47	6210.00		7:00	12:00	3.452	1	1	1
174	05-06-2021	3.25	5647.00		7:00	12:00	3.239	1	1	1
175	16-06-2021	4.87	12585.00		7:00	12:00	4.818	1	1	1
176	23-06-2021	4.81	12997.00		7:00	12:00	4.774	1	1	1

Table H. Water level and discharge observation of Mekong mainstream at Stung Treng (continued)

WL-Q Observation					Mekong-HYCOS			QA/QC		
No	Date	WL1[a] (m)	Q (m3/s)		Start time	End time	WL2[b] (m)	1[c]	2[d]	3[e]
177	30-06-2021	4.02	12954.00		7:00	12:00	3.965	-1	1	-1
178	07-07-2021	3.99	9330.00		7:00	12:00	3.989	1	1	1
179	14-07-2021	4.27	9252.00		7:00	12:00	4.202	1	1	1
180	21-07-2021	5.35	15586.00		7:00	12:00	5.357	1	1	1
181	28-07-2021	7.57	27410.00		7:00	12:00	7.523	1	1	1
182	04-08-2021	6.71	26819.00		7:00	12:00	6.651	-1	1	-1
183	11-08-2021	5.53	15797.00		7:00	12:00	5.483	1	1	1
184	08-09-2021	6.12	19158.00		7:00	12:00	6.13	1	1	1
185	10-09-2021	6.32	19894.00		7:00	12:00	6.289	1	1	1
186	17-09-2021	7.18	24936.00		7:00	12:00	7.145	1	1	1
187	24-09-2021	6.42	21167.00		7:00	12:00	6.445	1	1	1
188	02-10-2021	6.18	19026.00		7:00	12:00	6.163	1	1	1
189	12-10-2021	6.27	19060.00		7:00	12:00	6.152	1	1	1
190	15-10-2021	6.29	19452.00		7:00	12:00	6.314	1	1	1
191	19-10-2021	7.94	29542.00		7:00	12:00	7.92	1	1	1
192	28-10-2021	5.42	15150.00		7:00	12:00	5.394	1	1	1
193	31-10-2021	5.50	15761.00		7:00	12:00	5.447	1	1	1
194	09-11-2021	4.67	11562.00		7:00	12:00	4.649	1	1	1
195	17-11-2021	4.55	10743.00		7:00	12:00	4.485	1	1	1
196	24-11-2021	4.16	9167.00		7:00	12:00	4.116	1	1	1
197	04-12-2021	3.96	8389.00		7:00	12:00	3.939	1	1	1
198	23-12-2021	2.92	4217.00		7:00	12:00	2.919	1	1	1
199	20-01-2022	2.65	3473.00		7:00	12:00	2.67	1	1	1
200	20-02-2022	2.60	3171.00		7:00	12:00	2.63	1	1	1
201	13-03-2022	2.74	3813.00		7:00	12:00	2.80	1	1	1
202	10-04-2022	3.15	5335.00		7:00	12:00	3.21	1	1	1
203	13-05-2022	3.54	6919.00		7:00	12:00	3.55	1	1	1
204	30-05-2022	5.12	13793.00		7:00	12:00	5.07	1	1	1
205	11-06-2022	4.82	12125.00		7:00	12:00	4.71	1	-1	-1
206	13-06-2022	4.76	12831.00		7:00	12:00	4.74	1	1	1
207	24-06-2022	4.38	9976.00		7:00	12:00	4.21	1	-1	-1
208	28-06-2022	4.26	10156.00		7:00	12:00	4.20	1	1	1
209	13-07-2022	6.24	19382.00		7:00	12:00	6.13	1	-1	-1
210	15-07-2022	6.29	19994.00		7:00	12:00	6.23	1	1	1
211	27-07-2022	5.77	16757.00		7:00	12:00	5.66	1	-1	-1
212	31-07-2022	5.75	17372.00		7:00	12:00	5.63	1	-1	-1
213	10-08-2022	8.20	31442.00		7:00	12:00	8.20	1	1	1
214	12-08-2022	8.85	33650.00		7:00	12:00	8.73	1	-1	-1
215	24-08-2022	8.25	30331.00		7:00	12:00	8.15	1	-1	-1
216	28-08-2022	7.84	30512.00		7:00	12:00	7.73	1	-1	-1
217	13-09-2022	6.99	23315.00		7:00	12:00	6.90	1	1	1
218	17-09-2022	7.22	24606.00		7:00	12:00	7.14	1	1	1
219	29-09-2022	9.19	34803.00		7:00	12:00	8.86	1	-1	-1
220	01-10-2022	9.85	40179.00		7:00	12:00	9.73	1	-1	-1

Table H. Water level and discharge observation of Mekong mainstream at Stung Treng (continued)

WL-Q Observation					Mekong-HYCOS			QA/QC		
No	Date	WL1[a] (m)	Q (m3/s)		Start time	End time	WL2[b] (m)	1[c]	2[d]	3[e]
221	14-10-2022	7.13	24369.00		7:00	12:00	7.04	1	1	1
222	17-10-2022	7.35	22999.00		7:00	12:00	7.37	1	1	1
223	28-10-2022	5.43	15285.00		7:00	12:00	5.35	1	1	1
224	31-10-2022	5.16	14610.00		7:00	12:00	5.11	1	1	1
225	18-11-2022	3.91	8038.00		7:00	12:00	3.78	1	-1	-1
226	30-11-2022	3.68	7291.00		7:00	12:00	3.42	1	-1	-1

[a] WL1 is manually observed water level from staff gauges.
[b] WL2 is near real-time water level from the Mekong-HYCOS network.
[c] QA/QC1: Rating curves analysis for manually observed water level and discharge; "-1" outliers detected outside ±10 % of the rating curves; "1" pairs/points were in range of ±10 % of the rating curves.
[d] QA/QC2: validation analysis for near real-time water level from the Mekong-HYCOS network; "0" no data for near real-time water level from the Mekong-HYCOS network; "-1" difference between manually observed and near real-time water level is outside the range of ±10 cm; "1" difference between manually observed and near real-time water level is within the range of ±10 cm, therefore, near real-time water level is considered reliable.
[e] QA/QC3: Validation of rating curves developed for manually observed water level for near real-time water level; "-1" invalidated for near real-time water level; "1" validated for near real-time water level.

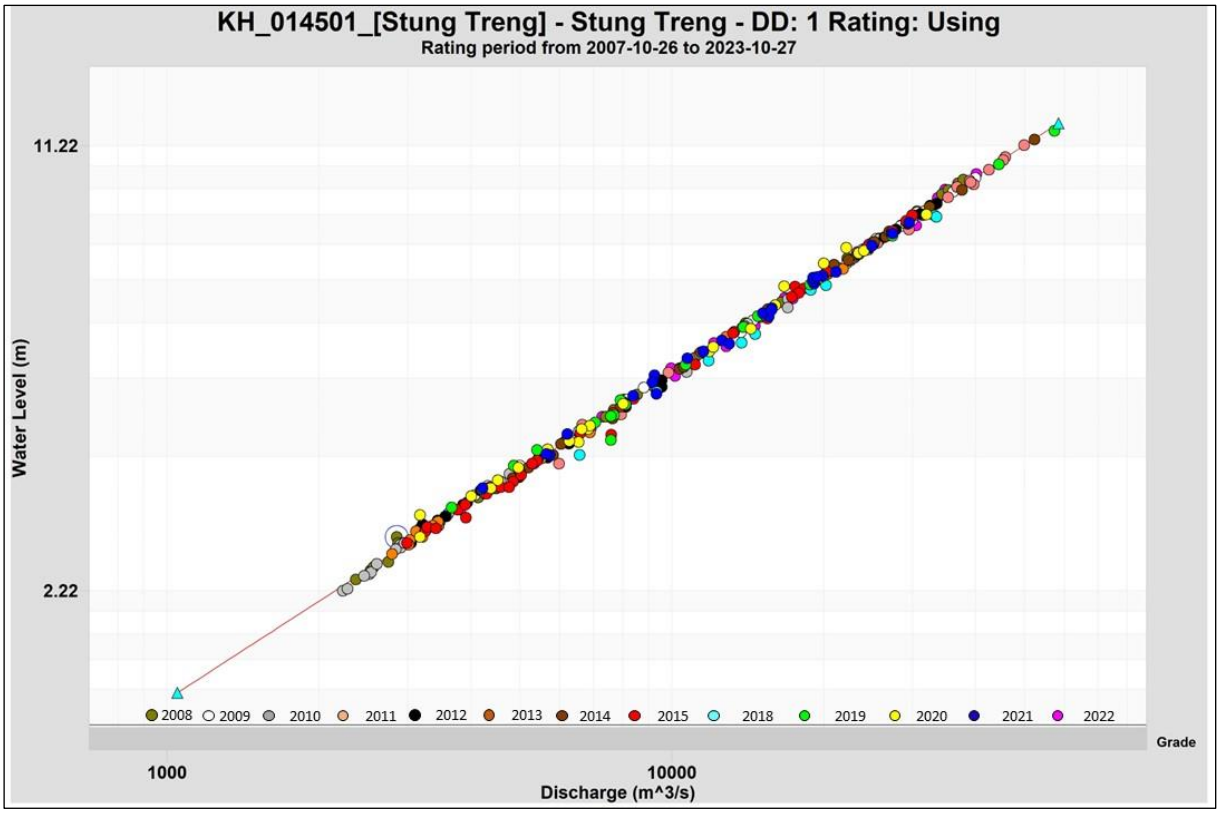


Figure H.1. Rating curve and rating equations of the Mekong mainstream at Stung Treng for the dataset after applying ±10 % in discharge off the curve. Solid line is proposed rating curves

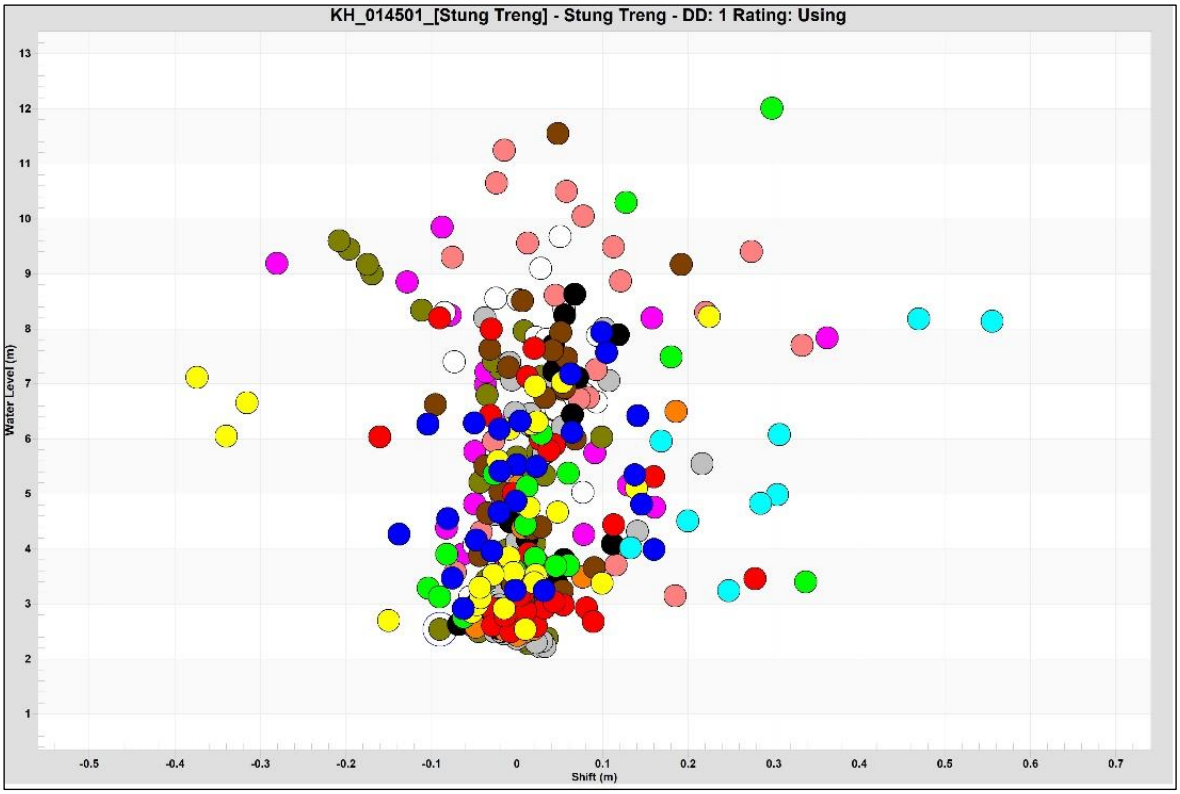


Figure H.2. The shift diagram was displayed data pairs/points observed water level and discharge scattering points around the rating curves of the Mekong mainstream at Stung Treng for the dataset after applying ±10 % in discharge off the curve

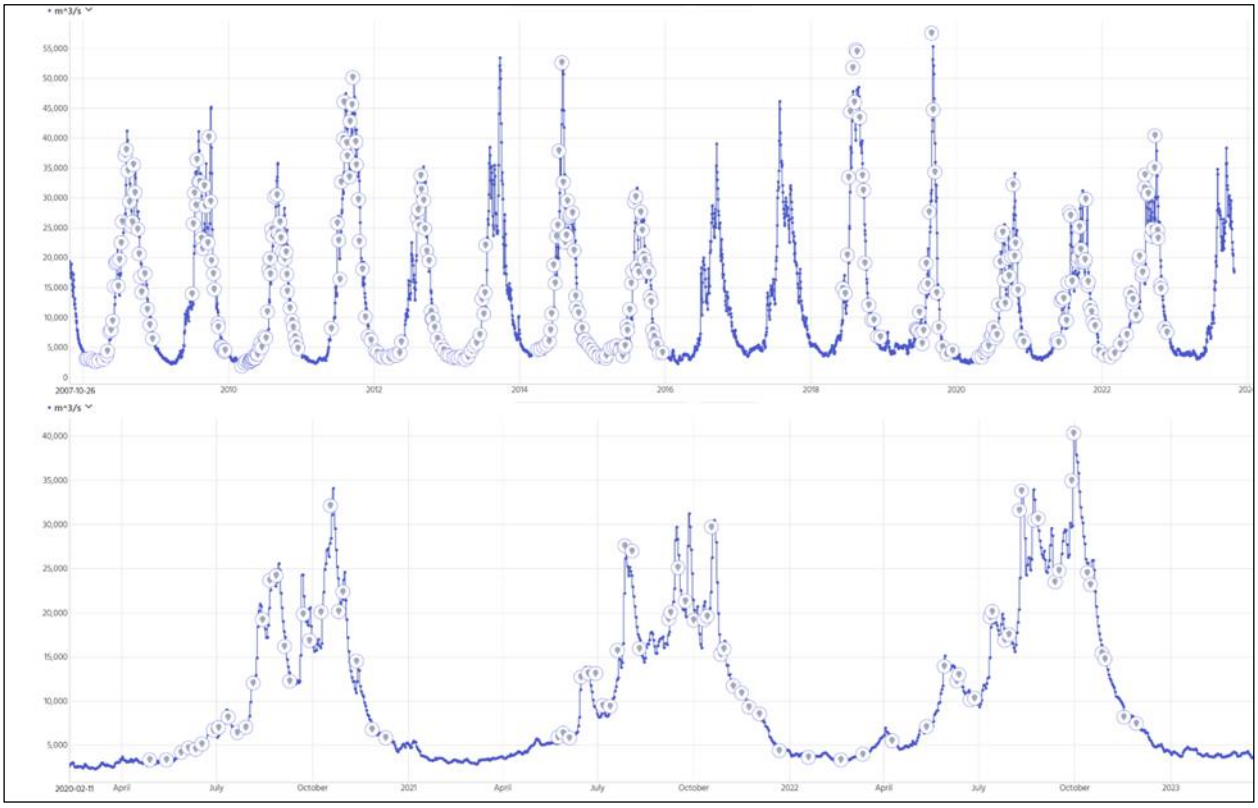


Figure H.3. The data pairs/points observed water level and discharge (dots) plotted against the derived discharge (blue line) from new rating curve at Stung Treng station

Table J. Water level and discharge observation of Mekong mainstream at Kratie station

WL-Q Observation					Mekong-HYCOS			QA/QC		
No	Date	WL1[a] (m)	Q (m3/s)		Start time	End time	WL2[b] (m)	1[c]	2[d]	3[e]
1	10-08-2012	17.33	27722.36		7:00	12:00	17.27	1	1	1
2	16-08-2012	17.36	27974.38		7:00	12:00	17.38	1	1	1
3	22-08-2012	16.80	25520.38		-	-	-	1	0	-1
4	29-08-2012	18.19	31195.92		7:00	12:00	18.25	1	1	1
5	02-09-2012	18.31	30351.02		7:00	12:00	18.25	1	1	1
6	12-09-2012	18.15	30001.23		7:00	12:00	18.31	1	-1	-1
7	19-09-2012	17.75	27332.57		7:00	12:00	17.69	1	1	1
8	25-09-2012	17.12	25870.10		7:00	12:00	17.20	1	1	1
9	09-10-2012	15.88	21228.27		7:00	12:00	15.83	1	1	1
10	20-10-2012	12.02	11563.99		7:00	12:00	12.01	1	1	1
11	26-10-2012	10.96	9608.69		7:00	12:00	10.98	1	1	1
12	30-10-2012	10.65	9176.55		7:00	12:00	10.69	1	1	1
13	06-11-2012	10.22	8318.08		7:00	12:00	10.25	1	1	1
14	22-11-2012	9.04	6189.46		7:00	12:00	9.11	1	1	1
15	09-12-2012	8.20	4715.75		-	-	-	1	0	-1
16	22-12-2012	8.06	4682.23		-	-	-	1	0	-1
17	09-01-2013	7.35	3458.49		7:00	12:00	7.38	1	1	1
18	19-01-2013	7.21	3343.41		7:00	12:00	7.26	1	1	1
19	07-02-2013	7.02	3033.80		7:00	12:00	7.02	1	1	1
20	20-02-2013	7.22	3393.51		7:00	12:00	7.23	1	1	1
21	05-03-2013	6.86	2890.19		7:00	12:00	6.87	1	1	1
22	20-03-2013	7.12	3250.06		7:00	12:00	7.12	1	1	1
23	09-04-2013	6.84	2881.22		7:00	12:00	6.85	1	1	1
24	23-04-2013	6.74	2758.55		7:00	12:00	6.76	1	1	1
25	13-05-2013	7.78	4312.05		7:00	12:00	7.78	1	1	1
26	22-05-2013	8.42	5409.05		7:00	12:00	8.42	1	1	1
27	05-06-2013	8.73	6045.84		7:00	12:00	8.74	1	1	1
28	23-06-2013	9.48	7202.12		7:00	12:00	9.50	1	1	1
29	02-07-2013	12.48	13699.06		7:00	12:00	12.49	1	1	1
30	11-07-2013	11.17	10791.68		7:00	12:00	11.17	1	1	1
31	17-07-2013	12.06	13765.68		-	-	-	1	0	-1
32	22-07-2013	15.62	23894.74		7:00	12:00	15.76	1	-1	-1
33	07-04-2014	7.85	4368.97		7:00	12:00	7.86	1	1	1
34	20-04-2014	7.96	4532.67		7:00	12:00	7.95	1	1	1
35	07-05-2014	8.14	4901.80		7:00	12:00	8.15	1	1	1
36	21-05-2014	8.63	5566.32		7:00	12:00	8.59	1	1	1
37	04-06-2014	8.57	5684.63		7:00	12:00	8.56	1	1	1
38	11-06-2014	8.62	5894.73		7:00	12:00	8.64	1	1	1
39	18-06-2014	10.90	10803.57		7:00	12:00	10.94	1	1	1
40	26-06-2014	14.03	17952.20		7:00	12:00	13.99	1	1	1
41	04-07-2014	15.02	19411.44		7:00	12:00	14.85	1	-1	-1
42	11-07-2014	15.43	22214.86		7:00	12:00	15.48	1	1	1
43	17-07-2014	15.71	23530.58		7:00	12:00	15.83	1	-1	-1
44	23-07-2014	18.82	34937.74		7:00	12:00	18.91	1	1	1

Table J. Water level and discharge observation of Mekong mainstream at Kratie (Continued)

WL-Q Observation				Mekong-HYCOS			QA/QC		
No	Date	WL1[a] (m)	Q (m3/s)	Start time	End time	WL2[b] (m)	1[c]	2[d]	3[e]
45	06-08-2014	22.77	52321.19	-	-	-	1	0	-1
46	14-08-2014	20.38	37244.95	7:00	12:00	20.31	-1	1	-1
47	23-08-2014	16.16	22944.98	7:00	12:00	16.20	1	1	1
48	29-08-2014	16.30	23549.55	7:00	12:00	16.33	1	1	1
49	04-09-2014	17.77	29457.09	7:00	12:00	17.85	1	1	1
50	14-09-2014	17.82	28592.67	7:00	12:00	17.80	1	1	1
51	19-09-2014	17.60	27625.09	7:00	12:00	17.58	1	1	1
52	29-09-2014	17.74	28274.48	7:00	12:00	17.74	1	1	1
53	07-10-2014	16.44	24497.16	7:00	12:00	16.57	1	1	1
54	15-10-2014	13.44	14878.99	7:00	12:00	13.41	1	1	1
55	18-10-2014	12.40	12576.06	7:00	12:00	12.41	1	1	1
56	30-10-2014	12.19	11895.39	7:00	12:00	12.16	1	1	1
57	14-11-2014	10.13	8205.32	7:00	12:00	10.17	1	1	1
58	17-11-2014	10.03	8137.38	7:00	12:00	10.08	1	1	1
59	24-11-2014	9.40	6111.53	7:00	12:00	9.46	1	1	1
60	29-11-2014	9.04	6108.34	7:00	12:00	9.11	1	1	1
61	13-12-2014	8.75	5733.25	7:00	12:00	8.80	1	1	1
62	23-12-2014	8.42	5213.48	7:00	12:00	8.43	1	1	1
63	05-01-2015	8.02	4492.18	7:00	12:00	8.02	1	1	1
64	21-01-2015	7.58	3758.79	7:00	12:00	7.59	1	1	1
65	11-02-2015	7.24	3345.90	7:00	12:00	7.24	1	1	1
66	26-02-2015	7.19	3295.57	7:00	12:00	7.20	1	1	1
67	16-03-2015	6.98	2951.44	7:00	12:00	6.98	1	1	1
68	21-03-2015	7.32	3632.22	7:00	12:00	7.36	1	1	1
69	07-04-2015	7.88	4495.29	7:00	12:00	7.88	1	1	1
70	23-04-2015	7.99	4759.86	7:00	12:00	8.01	1	1	1
71	09-05-2015	7.99	4744.34	7:00	12:00	8.01	1	1	1
72	25-05-2015	7.92	4539.55	7:00	12:00	7.92	1	1	1
73	08-06-2015	7.84	4468.24	7:00	12:00	7.85	1	1	1
74	15-06-2015	7.72	4430.10	7:00	12:00	7.74	1	1	1
75	20-06-2015	8.38	4998.01	7:00	12:00	8.44	1	1	1
76	29-06-2015	10.70	9834.68	7:00	12:00	10.68	1	1	1
77	02-07-2015	9.69	7672.63	7:00	12:00	9.68	1	1	1
78	13-07-2015	10.56	10409.82	7:00	12:00	10.77	1	-1	-1
79	21-07-2015	11.14	11406.28	7:00	12:00	11.22	1	1	1
80	28-07-2015	13.87	17718.04	7:00	12:00	13.84	1	1	1
81	06-08-2015	17.05	27958.71	7:00	12:00	17.04	1	1	1
82	13-08-2015	18.18	32680.15	7:00	12:00	18.26	1	1	1
83	20-08-2015	15.00	20148.76	7:00	12:00	14.98	1	1	1
84	28-08-2015	14.76	21580.12	7:00	12:00	14.92	1	-1	-1
85	04-09-2015	16.77	23995.95	7:00	12:00	16.89	1	-1	-1
86	07-09-2015	17.29	27339.99	7:00	12:00	17.29	1	1	1
87	20-09-2015	16.39	23717.17	7:00	12:00	16.32	1	1	1
88	26-09-2015	14.06	17445.54	7:00	12:00	14.02	1	1	1

Table J. Water level and discharge observation of Mekong mainstream at Kratie (Continued)

WL-Q Observation					Mekong-HYCOS			QA/QC		
No	Date	WL1[a] (m)	Q (m3/s)		Start time	End time	WL2[b] (m)	1[c]	2[d]	3[e]
89	08-10-2015	14.95	19505.09		7:00	12:00	14.84	1	-1	-1
90	17-10-2015	14.55	18533.90		7:00	12:00	14.56	1	1	1
91	23-10-2015	13.08	14759.90		7:00	12:00	13.05	1	1	1
92	29-10-2015	11.06	9938.28		7:00	12:00	11.02	1	1	1
93	05-11-2015	9.72	7473.01		7:00	12:00	9.78	1	1	1
94	13-11-2015	9.42	7068.51		7:00	12:00	9.53	1	-1	-1
95	19-11-2015	8.76	5852.96		7:00	12:00	8.82	1	1	1
96	27-11-2015	8.30	5259.19		7:00	12:00	8.40	1	1	1
97	09-12-2015	7.85	4339.77		7:00	12:00	7.88	1	1	1
98	25-12-2015	7.34	3619.19		7:00	12:00	7.40	1	1	1
99	16-06-2018	12.53	14016.81		7:00	12:00	12.39	1	-1	-1
100	29-06-2018	11.67	12600.52		7:00	12:00	11.67	1	1	1
101	09-07-2018	12.87	13229.80		7:00	12:00	12.92	1	1	1
102	16-07-2018	16.95	28443.28		7:00	12:00	16.96	1	1	1
103	24-07-2018	19.46	37790.21		7:00	12:00	19.50	1	1	1
104	06-08-2018	21.74	46112.20		-	-	-	1	0	-1
105	14-08-2018	21.33	42824.61		-	-	-	1	0	-1
106	20-08-2018	22.02	49912.73		-	-	-	1	0	-1
107	27-08-2018	21.91	48075.47		-	-	-	1	0	-1
108	09-09-2018	20.79	41115.30		-	-	-	1	0	-1
109	23-09-2018	19.32	33822.53		-	-	-	1	0	-1
110	28-09-2018	17.94	30294.85		-	-	-	1	0	-1
111	05-10-2018	15.69	20781.05		7:00	12:00	15.63	1	1	1
112	25-10-2018	11.78	11615.09		7:00	12:00	11.76	1	1	1
113	09-11-2018	10.62	9320.59		7:00	12:00	10.63	1	1	1
114	20-11-2018	9.68	7267.87		7:00	12:00	9.66	1	1	1
115	07-12-2018	8.89	5812.42		7:00	12:00	8.89	1	1	1
116	22-12-2018	8.22	4674.75		7:00	12:00	8.26	1	1	1
117	19-06-2019	9.32	8147.00		7:00	12:00	9.34	1	1	1
118	24-06-2019	9.69	7686.00		7:00	12:00	9.69	1	1	1
119	28-06-2019	9.16	7065.00		7:00	12:00	9.13	1	1	1
120	06-07-2019	10.84	10851.00		7:00	12:00	10.87	1	1	1
121	13-07-2019	10.27	9052.00		7:00	12:00	10.25	1	1	1
122	20-07-2019	9.47	7486.00		7:00	12:00	9.48	1	1	1
123	27-07-2019	9.74	8301.00		7:00	12:00	9.79	1	1	1
124	03-08-2019	12.94	16040.00		7:00	12:00	13.00	1	1	1
125	09-08-2019	13.00	16160.00		7:00	12:00	13.09	1	1	1
126	17-08-2019	12.52	14411.00		7:00	12:00	12.56	1	1	1
127	24-08-2019	16.22	25468.00		7:00	12:00	16.26	1	1	1
128	05-09-2019	21.80	52628.00		7:00	12:00	21.66	1	-1	-1
129	13-09-2019	22.10	47355.00		7:00	12:00	21.95	1	-1	-1
130	21-09-2019	19.48	33189.00		7:00	12:00	19.67	-1	-1	-1
131	01-10-2019	13.78	8853.00		7:00	12:00	13.76	-1	1	-1
132	11-10-2019	10.69	8853.00		7:00	12:00	10.61	1	1	1

Table J. Water level and discharge observation of Mekong mainstream at Kratie (Continued)

WL-Q Observation					Mekong-HYCOS			QA/QC		
No	Date	WL1[a] (m)	Q (m3/s)		Start time	End time	WL2[b] (m)	1[c]	2[d]	3[e]
133	30-10-2019	8.53	5188.00		7:00	12:00	8.51	1	1	1
134	22-11-2019	7.76	4060.00		7:00	12:00	7.72	1	1	1
135	19-12-2019	7.45	3724.00		7:00	12:00	7.46	1	1	1
136	28-04-2020	6.85	2976.00		-	-	-	1	0	-1
137	14-05-2020	7.17	3463.00		-	-	-	1	0	-1
138	28-05-2020	7.65	4122.00		-	-	-	1	0	-1
139	04-06-2020	7.82	4521.00		-	-	-	1	0	-1
140	11-06-2020	7.98	4823.00		-	-	-	1	0	-1
141	17-06-2020	8.10	5179.00		-	-	-	1	0	-1
142	28-06-2020	8.81	6370.00		-	-	-	1	0	-1
143	03-07-2020	8.91	6454.00		-	-	-	1	0	-1
144	12-07-2020	10.09	8981.00		-	-	-	1	0	-1
145	21-07-2020	8.93	6596.00		-	-	-	1	0	-1
146	29-07-2020	9.27	7218.00		-	-	-	1	0	-1
147	05-08-2020	11.32	11741.00		-	-	-	1	0	-1
148	14-08-2020	14.74	19940.00		7:00	12:00	14.72	1	1	1
149	21-08-2020	14.90	21530.00		7:00	12:00	14.94	1	1	1
150	27-08-2020	15.63	22781.00		7:00	12:00	15.61	1	1	1
151	04-09-2020	14.81	18077.00		7:00	12:00	14.17	1	1	1
152	09-09-2020	12.33	13111.00		7:00	12:00	12.20	1	1	1
153	22-09-2020	16.02	23707.00		7:00	12:00	15.99	1	1	1
154	28-09-2020	15.05	20124.00		7:00	12:00	14.90	1	-1	-1
155	12-10-2020	15.53	22060.00		7:00	12:00	15.99	1	-1	-1
156	18-10-2020	17.74	29445.00		7:00	12:00	17.69	1	1	1
157	26-10-2020	16.30	22380.00		7:00	12:00	16.37	1	1	1
158	30-10-2020	15.62	22582.00		7:00	12:00	15.63	1	1	1
159	12-11-2020	11.44	11385.00		7:00	12:00	11.46	1	1	1
160	27-11-2020	9.60	7459.00		7:00	12:00	9.59	1	1	1
161	10-12-2020	8.72	6033.00		7:00	12:00	8.71	1	1	1
162	24-05-2021	8.27	5471.00		7:00	12:00	8.28	1	1	1
163	29-05-2021	9.02	6562.00		7:00	12:00	9.01	1	1	1
164	04-06-2021	8.72	6105.00		7:00	12:00	8.71	1	1	1
165	15-06-2021	10.77	11611.00		7:00	12:00	10.84	1	1	1
166	22-06-2021	12.14	13808.00		7:00	12:00	12.11	1	1	1
167	29-06-2021	10.36	9713.00		7:00	12:00	10.35	1	1	1
168	06-07-2021	10.05	9101.00		7:00	12:00	10.06	1	1	1
169	13-07-2021	10.25	9528.00		7:00	12:00	10.26	1	1	1
170	20-07-2021	12.00	13312.00		7:00	12:00	11.99	1	1	1
171	27-07-2021	15.13	23464.00		7:00	12:00	15.19	1	1	1
172	03-08-2021	16.09	23764.00		7:00	12:00	16.08	1	1	1
173	10-08-2021	13.78	17635.00		7:00	12:00	13.80	1	1	1
174	17-08-2021	13.30	16434.00		7:00	12:00	13.35	1	1	1
175	07-09-2021	14.24	17750.00		7:00	12:00	14.26	1	1	1
176	11-09-2021	15.27	18729.00		7:00	12:00	15.19	1	1	1

Table J. Water level and discharge observation of Mekong mainstream at Kratie (Continued)

WL-Q Observation					Mekong-HYCOS			QA/QC		
No	Date	WL1[a] (m)	Q (m3/s)		Start time	End time	WL2[b] (m)	1[c]	2[d]	3[e]
177	16-09-2021	17.50	21606.00		7:00	12:00	17.47	-1	1	1
178	23-09-2021	15.17	20675.00		7:00	12:00	15.16	1	1	1
179	01-10-2021	15.82	21774.00		7:00	12:00	15.76	1	1	1
180	11-10-2021	15.30	21249.00		7:00	12:00	15.34	1	1	1
181	18-10-2021	16.40	25195.00		7:00	12:00	16.49	1	1	1
182	27-10-2021	14.04	16825.00		7:00	12:00	14.06	1	1	1
183	30-10-2021	14.00	17006.00		7:00	12:00	14.03	1	1	1
184	08-11-2021	11.86	11830.00		7:00	12:00	11.87	1	1	1
185	16-11-2021	11.20	10759.00		7:00	12:00	11.20	1	1	1
186	23-11-2021	10.80	9883.00		7:00	12:00	10.75	1	1	1
187	03-12-2021	9.97	8420.00		7:00	12:00	9.92	1	1	1
188	21-12-2021	7.98	4305.00		7:00	12:00	7.94	1	1	1
189	19-01-2022	7.31	3451.00		7:00	12:00	7.28	1	1	1
190	19-02-2022	7.05	3247.00		7:00	12:00	7.09	1	1	1
191	12-03-2022	7.34	3839.00		7:00	12:00	7.41	1	1	1
192	09-04-2022	8.59	5787.00		7:00	12:00	8.59	1	1	1
193	12-05-2022	9.04	6577.00		7:00	12:00	9.02	1	1	1
194	29-05-2022	12.60	15173.00		7:00	12:00	12.32	1	-1	1
195	10-06-2022	12.13	13132.00		7:00	12:00	12.05	1	1	1
196	14-06-2022	11.79	12820.00		7:00	12:00	11.79	1	1	1
197	23-06-2022	10.87	10191.00		7:00	12:00	11.10	1	-1	1
198	27-06-2022	10.90	10550.00		7:00	12:00	10.86	1	1	1
199	12-07-2022	13.27	17259.00		7:00	12:00	13.34	1	1	1
200	14-07-2022	14.90	20498.00		7:00	12:00	14.83	1	1	1
201	26-07-2022	14.54	18615.00		7:00	12:00	14.44	1	1	1
202	30-07-2022	14.02	17407.00		7:00	12:00	13.97	1	1	1
203	09-08-2022	15.69	23127.00		7:00	12:00	15.77	1	1	1
204	11-08-2022	18.54	33578.00		7:00	12:00	18.59	1	1	1
205	23-08-2022	19.13	34354.00		7:00	12:00	19.10	1	1	1
206	27-08-2022	18.52	31323.00		7:00	12:00	18.45	1	1	1
207	12-09-2022	16.78	24552.00		7:00	12:00	16.76	1	1	1
208	16-09-2022	17.14	23664.00		7:00	12:00	17.13	1	1	1
209	28-09-2022	18.44	30324.00		7:00	12:00	18.41	1	1	1
210	30-09-2022	20.05	38495.00		7:00	12:00	19.97	1	1	1
211	13-10-2022	17.53	26589.00		7:00	12:00	17.52	1	1	1
212	16-10-2022	16.83	24547.00		7:00	12:00	16.69	1	-1	1
213	27-10-2022	13.94	16171.00		7:00	12:00	13.91	1	1	1
214	30-10-2022	13.31	15393.00		7:00	12:00	13.30	1	1	1
215	17-11-2022	10.57	8882.00		7:00	12:00	10.63	1	1	1
216	29-11-2022	9.61	7186.00		7:00	12:00	9.66	1	1	1

[a] WL1 is manually observed water level from staff gauges.
[b] WL2 is near real-time water level from the Mekong-HYCOS network.
[c] QA/QC1: Rating curves analysis for manually observed water level and discharge; "-1" outliers detected outside ±10 % of the rating curves; "1" pairs/points were in range of ±10 % of the rating curves.
[d] QA/QC2: validation analysis for near real-time water level from the Mekong-HYCOS network; "0" no data for near real-time water level from the Mekong-HYCOS network; "-1" difference between manually observed and near real-time water level is outside the range of ±10 cm; "1" difference between manually observed and near real-time water level is within the range of ±10 cm, therefore, near real-time water level is considered reliable.
[e] QA/QC3: Validation of rating curves developed for manually observed water level for near real-time water level; "-1" invalidated for near real-time water level; "1" validated for near real-time water level.

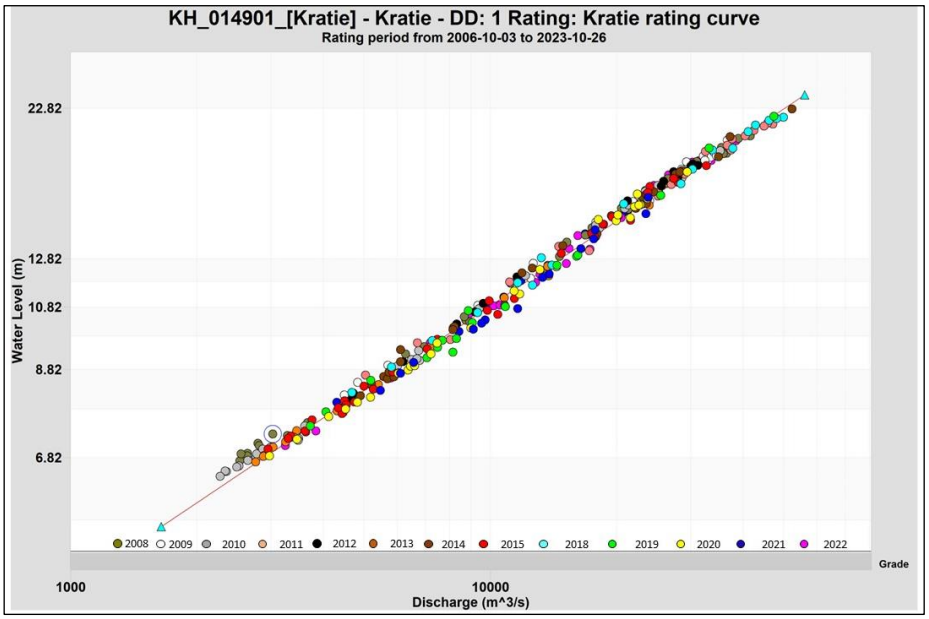


Figure J.1. Rating curve and rating equations of the Mekong mainstream at Kratie for the dataset after applying ±10 % in discharge off the curve. Solid line is proposed rating curves

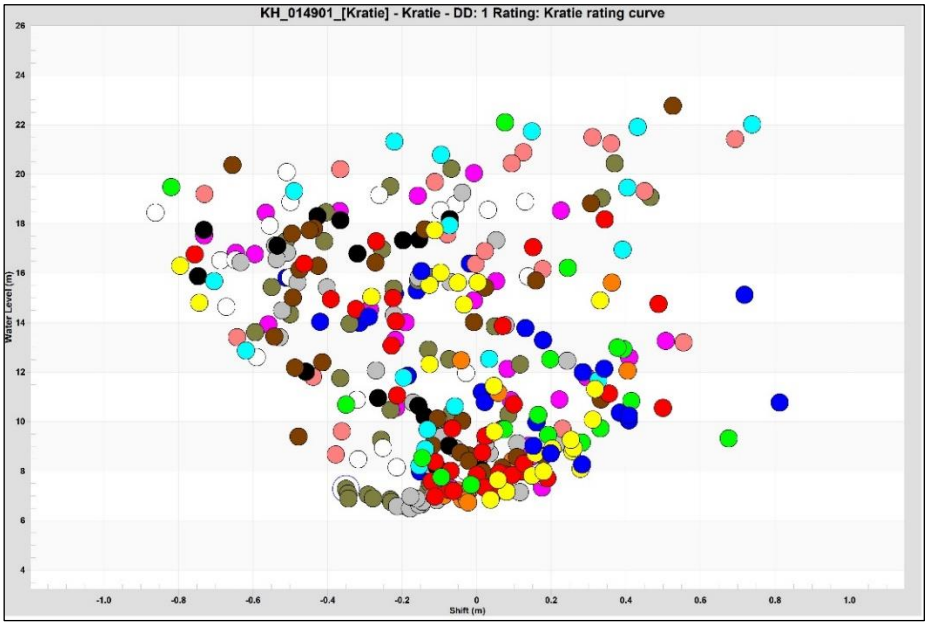


Figure J.2. The shift diagram was displayed data pairs/points observed water level and discharge scattering points around the rating curves of the Mekong mainstream at Kratie for the dataset after applying ±10 % in discharge off the curve

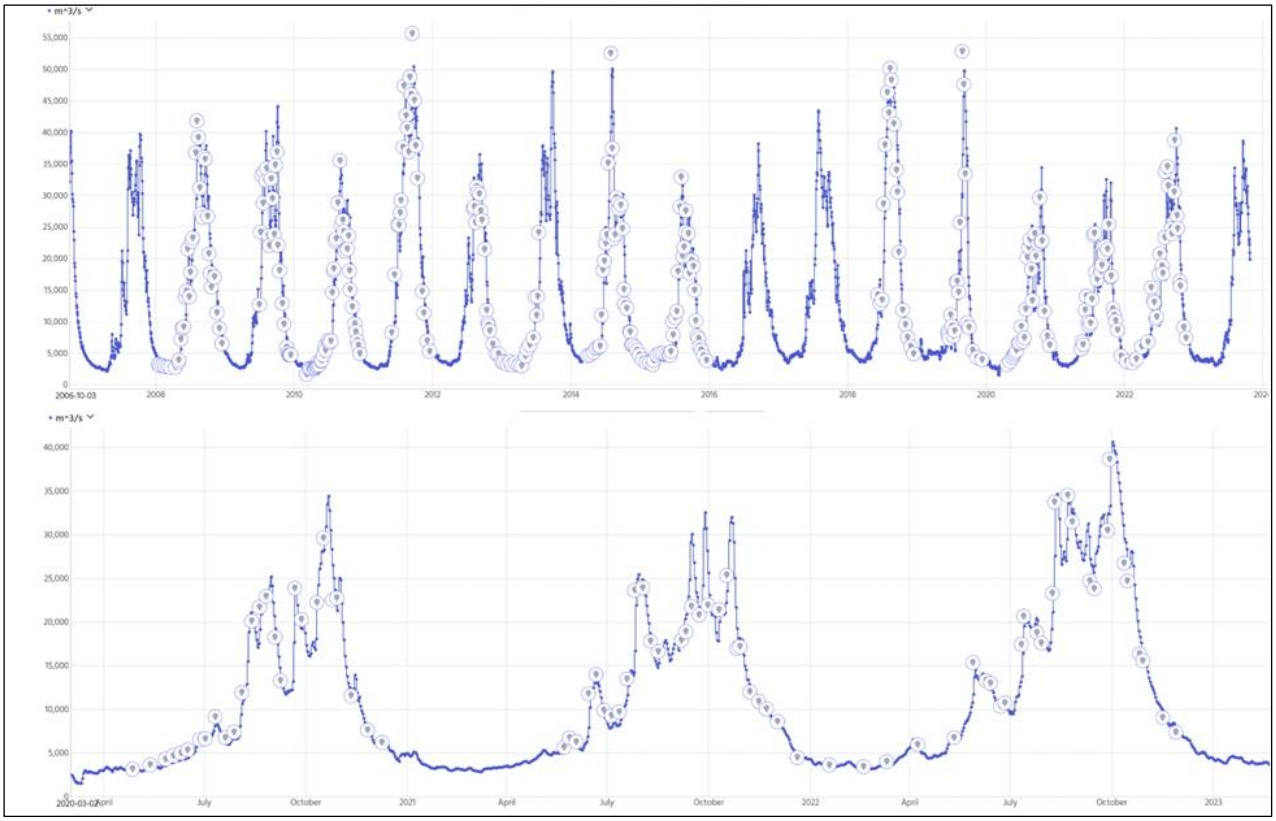


Figure J.3. The data pairs/points observed water level and discharge (dots) plotted against the derived discharge (blue line) from new rating curve at Kratie station

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