Hydraulic design conditions for Kratie river bank protection

Appendix 5 to the Annex 1 to the
Draft Stage 2 Evaluation Report

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Draft Report

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1 Introduction

The CNMC has selected Kratie Province along the Mekong River as focal area for river training works to protect the river banks. This includes the following locations along the river (chainage according to hydrographic atlas of MRC):

- Ph. Sambok at rkm 573.4
- Ph. Thmar Krae Kroam at rkm 568.7
- Ph. Peam Te at rkm 557.2

The locations are shown in Figure 1.1. For the design water levels and flow velocities of selected frequencies are required. These data are elaborated in this report.

Figure 1.1 Layout of bank protection sites on Mekong near Kratie

2 Design water levels

2.1 Requirements

The following water level information is required to support the design:

- MHWL = maximum high water level
- AHWL = 95% not-exceeded water level
- MWL = median water level
- SLWL = 5% not-exceeded water level
- MLWL = minimum low water level

These water levels for the 3 sections/location defined in Chapter 1 are derived below.

2.2 Computational procedure

2.2.1 Available data

At Kratie in 1933 a gauging station was established on Mekong River at rkm 560.3, with a gauge zero level of 0.4822 masl. The location of the station is seen to be between the Thmar Krae Kraom and the Peam Te sites. Water level and discharge data for Kratie is available from 1933 till to date with a major gap between 1974 and 1980. For a detailed description of the available data reference is made to Appendix 8 of Annex 1. The historical water level record of Kratie is not homogeneous as the conditions downstream of Kratie have changed considerably in the course of time. The trend in the water levels is upward: for a particular discharge at Kratie the water levels are gradually increasing.

Upstream of Kratie river stages and flows are gauged at Stung Treng and downstream of Kratie at Kampong Cham. At Stung Treng a stage record is available since 1910. The gaps in the water level record in the seventies and eighties have been completed via regression equations on Pakse and Kratie (see Appendix 8 of Annex 1). By making use of a stage relation curve with station Stung Treng, which is a stable site, the water level record of Kratie can be adjusted to the 2000-2006 conditions.

The water levels at the bank protection sites have been derived from the levels at Kratie using a slope around Kratie derived from the level difference with Kampong Cham, which is located at 113 km downstream of Kratie (gauge zero = -0.93 masl). The slope of the water table varies from 4.5×10^{-5} for the low and medium flows till 7.0×10^{-5} for the high flows. Interpolation between Stung Treng and Kratie is cumbersome as the behaviour of the Sambor Rapids is unknown.

2.2.2 Water level series

The water level series of Kratie prior to 2000 has been derived from Stung Treng based on the stage relation curve for 2000-2006 between the locations. Separate curves apply for rising and falling stages, due to the backwater from the Tonle Sap. A polynomial with a time shift of 1 day ($h_{Kratie}(t)=f(h_{Stung\ Treng}\ (t-1))$ has been used. The coefficients of the polynomial are presented in Table 2.1.

Table 2.1 Kratie-Stung Treng stage-relation parameters of equation (3.1) for rising and falling stages.

Period	Stage	Range (m)	a	b	c	d
2000-2006	rising	2.00 – 12.00	2.585	1.597	0.1099	-0.0085
	falling	1.40 – 6.00	1.322	2.410	-0.0280	-
		6.01 – 10.20	-4.826	4.260	-0.1669	-

The resulting water level frequency curves and minimum and maximum levels are shown in Figure 2.1. It is observed that the lowest water levels occur in the months April-May and the highest in August, September till early October.

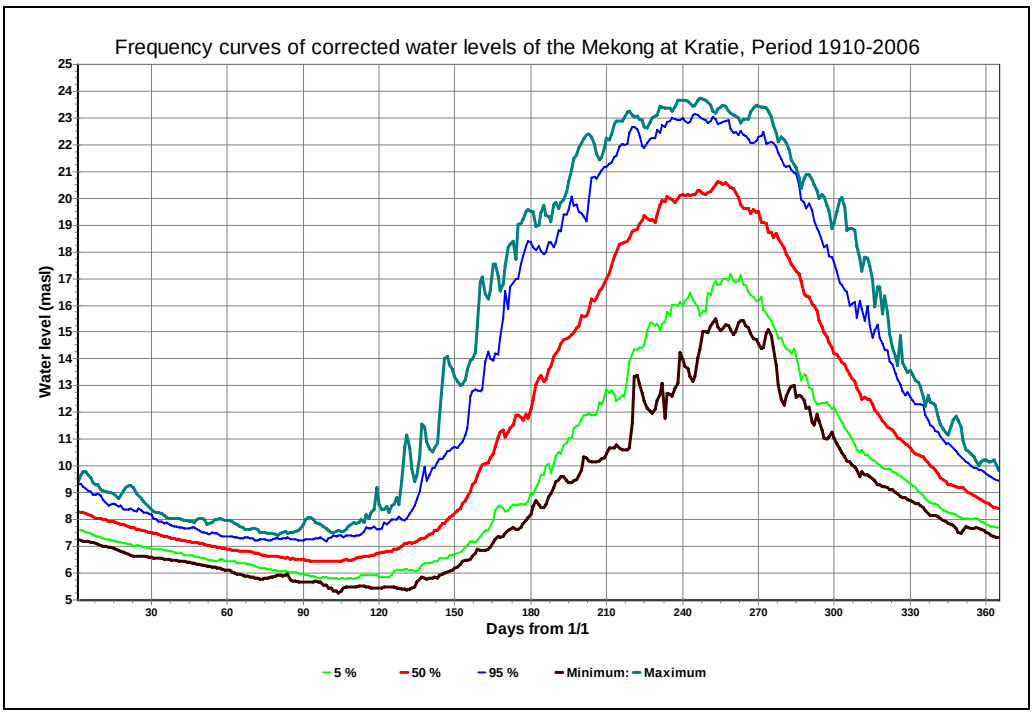

Figure 2.1 Frequency and minimum and maximum water level curves for the Mekong at Kratie, period 1910-2006 homogenized to the present day conditions

2.2.3 Design water levels

The design water levels as defined in Sub-section 2.1 have been derived from the average duration curve of the homogenized water levels at Kratie. The values are displayed in Table 2.2.

Table 2.2 Design water levels and flow area and velocities at MHWL for a discharge of 64,200 m^3/s at Kratie

Location	Design water levels (masl)					Area (MHWL) (m^2)	Velocity m/s
Rkm	MinWL	SLWL	MWL	AHWL	MHWL		
573.4	5.84	6.86	10.24	21.93	24.66	13,640	4.7
568.7	5.63	6.65	10.00	21.60	24.33	17,000	3.8
560.3	5.25	6.27	9.58	21.01	23.74	gauging station	
557.2	5.11	6.13	9.43	20.79	23.52	19,200	3.3

The design levels for the bank protection sites have been derived from the levels at Kratie by interpolation and extrapolation based on the water surface slope between Kratie and Kampong Cham.

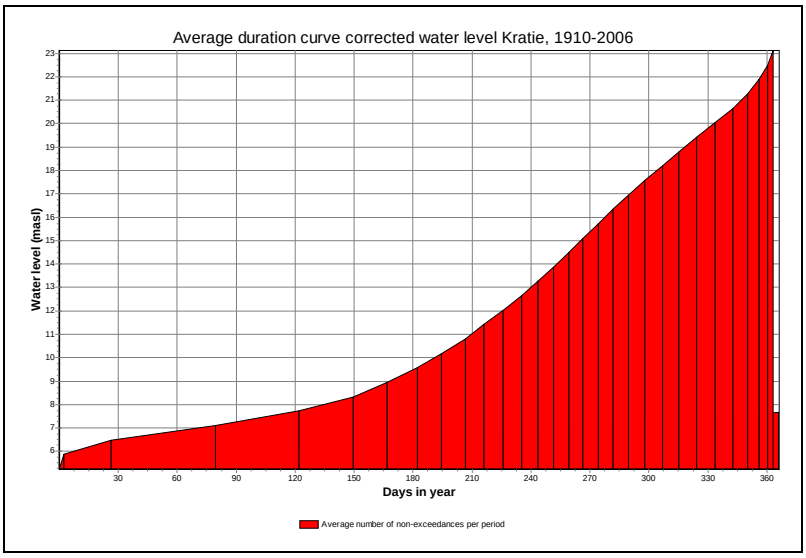

Figure 2.2 Average duration curve of water level in the Mekong at Kratie

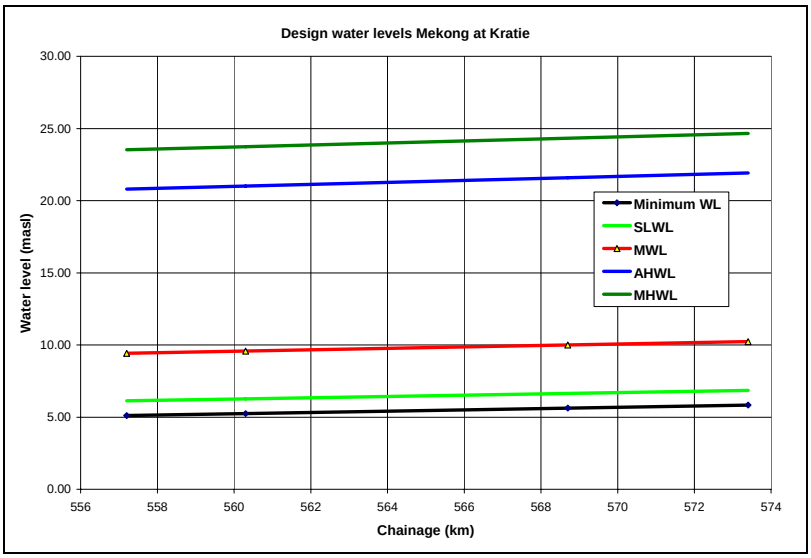

Figure 2.3 Design water levels around Kratie

2.2.4 Flow velocities

Based on the cross-sectional profiles presented in Sub-section 2.2.5 and the maximum water level the wetted cross-sectional area has been determined and has been compared with the discharge at Kratie derived from the latest discharge rating curve (see Appendix 8 of Annex 1). At a water level of 23.74 (masl), the discharge at Kratie is estimated at 64,200 m^3/s. This discharge has been used to determine the maximum average velocity at the selected sections, see Table 2.2, last column.

The average flow velocities in the reaches appear to vary from 3.3 to 4.7 m/s. These are unrealistically high values, probably due to wrong referencing of the bathymetry to the LLWL. To properly estimate the flow velocities in this case the use of 2D or 3D models is recommended.

2.2.5 Cross-section at design locations

The cross-sections of the Mekong at the bank protection locations are presented in Figure 2.4 to Figure 2.6. The cross-sections were taken from the Hydrographic Atlas of the Mekong River (Mekong River Commission, 1999, sheets 3-046, 3-045, 3-044 and 3-043). In the atlas it is mentioned that "*the depths of the river marked on the charts are expressed in decimetres and reduced from soundings to Chart Datum (LLW, Lowest Low Water Level). Stage measurements and water level observations to establish the Chart Datum have been based on bench mark elevation linked to second and third order levelling from Ha Tien datum (MSL, Mean Sea Level). To be consistent with the 1960's Hydrgraphic Atlas, reference was made to the same Chart Data, which levels at that time were very low. Therefore caution is to be taken when reading the soundings on the maps: even during very dry seasons, the actual water level will be higher than Chart Datum*."

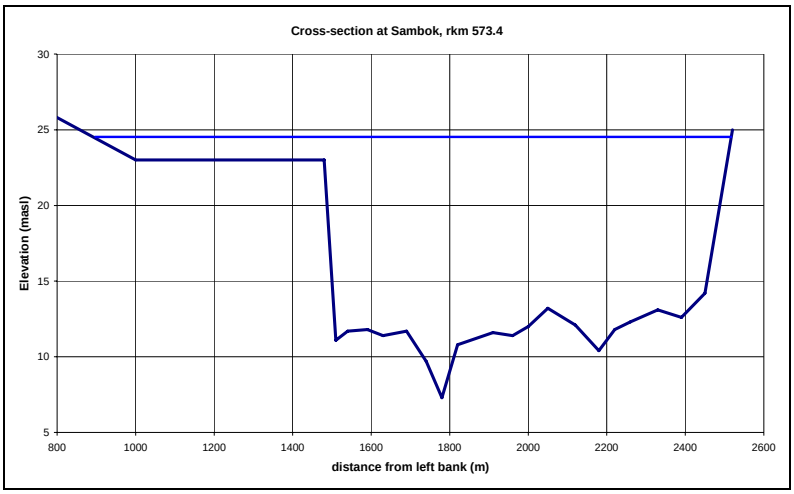

Figure 2.4 Cross-section of Mekong at Sambok, rkm 573.4

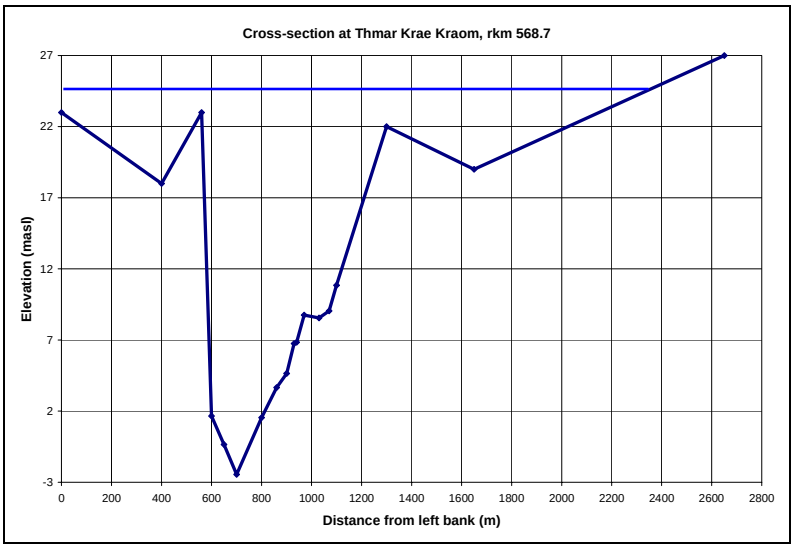

Figure 2.5 Cross-section of Mekong at Thmar Krae Kraom, rkm 568.7

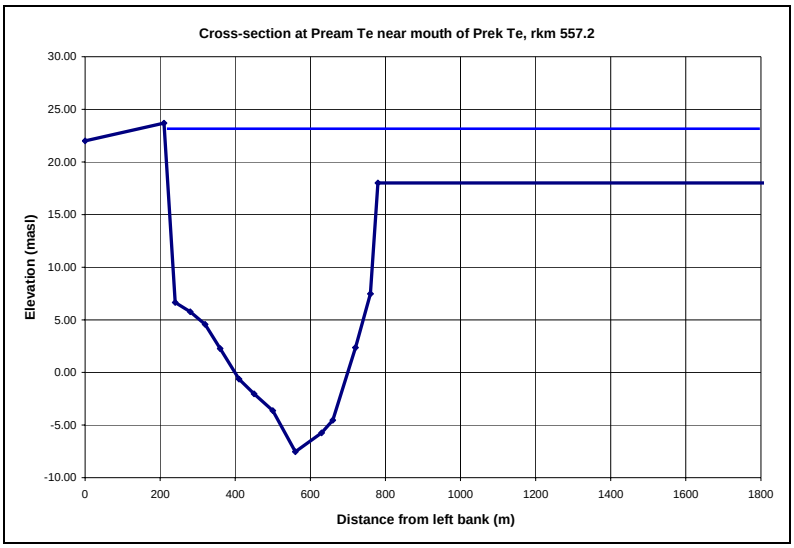

Figure 2.6 Cross-section of Mekong at Peam Te, rkm 557.2

3 Literature

Mekong River Commission (1999)
Hydrographic Atlas Mekong River in Cambodia, Mekong River from Phnom Penh to Cambodia/Lao PDR Border", Kingdom of Cambodia, Ministry of Public Works and Transport, Waterways Department , Scale 1/20,000, Volume 2, 1999.

Mekong Secretariat/Mekong River Commission (1960-1997)
Mekong Hydrological Yearbook, of the years 1960, …., 1997.

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