



GOVERNMENT OF LAO PDR ASIAN DEVELOPMENT BANK

CUMULATIVE IMPACT ANALYSIS AND NAM THEUN 2 CONTRIBUTIONS



Annex 2: HYDROLOGY REPORT

Hydraulic simulations and hydrological analysis

Prepared by: Jean-Pierre Bramslev

November 2004

TABLE OF CONTENTS

1	INTRODUCTION.....	1
2	HYDROLOGICAL REFERENCE SERIES.....	2
2.1	Hydrological trends in the Reference period 1950-2000.....	2
2.2	Projected Reference Series	5
3	WATER BALANCE MODELLING.....	6
3.1.1	Baseline	6
3.1.2	NT2 Impacts.....	7
3.1.3	Cumulative Impacts	8
4	HYDRAULIC MODELLING	11
4.1	General Set-up	11
4.2	Input Data.....	12
4.3	Calibration	12
4.4	Baseline Simulations	14
4.5	Scenario Simulations.....	16
4.5.1	NT2 Impact Simulations.....	16
4.5.2	Cumulative Impacts 2010 and 2025.....	19
4.5.3	Impacts in the Delta	22
5	REFERENCES.....	35

LIST OF TABLES

Table 1	Hydrological Reference Series.....	2
Table 2	Deforestation History and Forecast in Lao PDR in terms Forest Cover (Percentage of the total Surface of Lao PDR).....	4
Table 3	Overview of planned reservoirs in the Mekong Basin, as input to hydrological simulations. Grouped by river sections.....	9
Table 4	Summary of key simulation results for impacts on Tonle Sap Lake: Wet Season	21
Table 5	Summary of key simulation results for impacts on Tonle Sap Lake: Dry Season	21
Table 6	Monthly Mean Sea Water Levels at the Mekong Delta (unit: cm).....	27
Table 7	Monthly Maximum Tidal Amplitude at the Mekong Delta in 1985 (Unit: cm)	27

LIST OF FIGURES

Figure 1	Trends in Mekong Discharges 1925-2000.	3
Figure 2	Detail of MikeBasin water balance model for hydrological simulations: The baseline setup simulates only TH hydropower. The little figure shows the entire model area.....	6
Figure 3	Detail of MikeBasin water balance model for hydrological simulations. Setup for simulation of NT2 operation. Compare with Figure 2.	7
Figure 4	Result of reservoir simulations of NT2: Reservoir inflow, turbine discharge and spills. Weekly average discharges 1950-2000.....	8
Figure 5	Simulated turbine discharge at Theun-Hinboun HP, pre-NT2 baseline (bold red) and post-NT2 (blue with markers).....	8
Figure 6	Input to MikeBasin water balance calculation: Regulation in Yunnan (2010 and 2025), as a result of hydropower simulations.....	10
Figure 7	Result output from MikeBasin water balance simulations: Mekong Discharge at Kratie – baseline and regulated (cumulative 2010 and 2025).	10
Figure 8	Schematic view of the hydraulic model of the Tonle Sap and Mekong Delta.....	11
Figure 9	Location of gauging stations used for calibration (triangles).....	14
Figure 10	Simulated daily water level in Tonle Sap Lake 1960-2001 (Baseline).	15
Figure 11	Simulated water level in Tonle Sap Lake (blue with markers) and at Mekong/Tonle Sap confluence at Phnom Penh (bold red). Baseline situation.	15
Figure 12	Longitudinal profile from Mekong upstream, through Tonle Sap river to the Lake. Simulated water level during rising floods (August): Water is filling into Tonle Sap.	16
Figure 13	Longitudinal profile from Tonle Sap Lake trough Tonle Sap river, Bassac to the Delta. Simulated water level during flood recession (December): Water is draining out of the Lake.	16
Figure 14	Input to hydraulic simulations, discharge at Kratie. Baseline and post-NT2.....	17
Figure 15	Daily Simulated Tonle Sap water level: Post-NT2.....	17
Figure 16	NT2 impact on Tonle Sap lake levels: Simulated change of lake level (post-NT2 minus baseline). Negative figures means reduced level. Should be related to Figure 15.	17
Figure 17	Summary of simulations 1950-2000 of NT2 impacts on Tonle Sap lake levels. Mean, 10% and 90% percentiles of 50 years of simulations.	18
Figure 18	Annual Maximum Water Level, Tonle Sap. Baseline and post-NT2.	18
Figure 19	Input to hydraulic simulations: Discharge at Kratie as a result of cumulative impacts 2010 and 2025.	19
Figure 20	Simulated Tonle Sap water levels: Cumulative Impacts 2010 and 2025.	19
Figure 21	Change of Tonle Sap water level. Average of entire 50 years simulation period, 2010 and 2025 Cumulative Impacts.....	20
Figure 22	Annual Maximum Water Level in Tonle Sap (September or October). Baseline, 2010 and 2025 Cumulative Impacts.....	20
Figure 23	Observed Mekong discharges under tidal influence. Stations Tan Chau at Cambodian/Vietnamse border and my Thuan 90km further downstream. Source:WUP-JICA 2003.....	22

Figure 24	Simulated tidal oscillations of discharge in the Mekong Delta. Two lines outline the “envelope” of negative flows for the two scenarios: pre- and post-NT2.	24
Figure 25	Flow Duration Curve (Discharge interval <6000 m ³ /s, i.e. dry season). Illustrates scenario impacts on flow duration: Duration of negative discharges is reduced due to regulation. The bold frame indicates the area that is zoomed to on Figure 26.	24
Figure 26	Flow Duration Curve (Discharge interval <2000 m ³ /s). Illustrates scenario impacts on flow duration: Duration of negative discharges is reduced due to regulation.	25
Figure 27	Storage Curve for Tonle Sap Lake. Established by Tes et al (1998).	27
Figure 28	Selected Example Cross Section Profiles.	28
Figure 29	Inundated areas on 30 th August 2001 (light blue). Figures are used as floodplain storage in Mike11. All figures in square km. Dark blue areas are permanently inundated.	29
Figure 30	Tidal effects in the Delta. Simulated water levels and discharges. Note negative discharges (reverse flow) in the dry season, i.e. saltwater intrusion. Reporting points located 10 - 170 km from river mouth (mouth = 212,000).	30
Figure 31	Calibration Result, Tonle Sap river at Prek Kdam: Comparison of observed and simulated water levels (above) and discharges (below).	31
Figure 32	Calibration Result: Comparison of observed and simulated discharges at Neak Luong (above) and water levels at Kompong Cham (below).	32
Figure 33	Result of reservoir simulations: Nam Kading discharges at Pakkading (Mekong Confluence). Baseline and post-NT2.	33
Figure 34	Result of reservoir simulations: Xe Bang Fai discharges at Mahaxai. Baseline and post-NT2.	33
Figure 35	Simulated NT2 impact on Tonle Sap lake levels: Difference between daily lake levels pre- and post-NT2 ($\Delta H = H_{NT2}$ minus $H_{baseline}$). Negative figures means reduced level.	34