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The Council Study

Study on the sustainable management and development of the Mekong River, including impacts of mainstream hydropower projects

Note for information for the technical meeting on the baseline to be used in the Council Study

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Document history

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1	0	Draft based on review of relevant MRC documents	19 March 2015	AK
2	0	Draft based on communications with MRC/IKMP	24 March 2015	AK

1. Introduction

The 4th RTWG meeting (10 March 2015) discussed the concept note on the scoping of the formulation and assessment of development scenarios under the Council Study", dated 3 March 2015.

The meeting agreed on the scenarios, starting with the formulation and assessment of the Early Development Situation (2008), the Definite Future Scenario (2020) and the Planned Development Scenario (2040) and continuing with a few Exploratory Scenarios (2060) and Alternative Plan Scenarios (2040). But the countries would like to discuss further the proposed baseline against which these scenarios will be assessed.

The proposed baseline in the concept note has two elements: (i) the development element that would represent a situation in the past whereby there is no significant water resources development in the Mekong Basin (the 'pre significant development situation') and (ii) the DFF hydrological element that still represents historical natural mainstream flow conditions. The DSF hydrological element is available for the periods 1985-2000 and 1985-2008.

All scenarios will be assessed against the pre significant development situation/baseline, using indicators of the MRC Indicator Framework. The DSF hydrological baseline is needed to help quantify the majority of the assessment indicators. The DSF hydrological baseline for the period 1985-2000 (or 1985-2008, see below) can be used for assessment of the scenarios because the flow regime in this period is still representative of the natural flow regime at the time of the pre significant development situation.

The 4th RTWG meeting agreed to organize a small, technical meeting to discuss and make recommendations to the 5th RTWG meeting for the DSF hydrological baseline to be used in the Council Study. This note is prepared in support of the technical meeting.

2. Hydrological baseline

Two available baselines

Hydrological baseline 1985-2000. The existing hydrological baseline 1985-2000 (as simulated by the DSF) has been used during the last 10 years for the implementation of MRC Procedures (particularly PNPCA, PMFM) and for planning studies, such as the MRC/BDP 2008-2010 scenario assessments.

The 2nd Technical Review Group (TRG) meeting on PMFM (May 2004) agreed that the DSF is adequate for flow assessments. The 3rd TRG meeting (August 2004) agreed that the 16-year period (1985-2000) is representative of the longer data sets for low flow assessments, and thus represents natural flow conditions in the Mekong mainstream.

The period 1985-2000 was chosen because: (i) before 1985, less meteorological data are available for calibrating and validating the baseline and (ii) the expectation that after 2000, new water resources developments in the Upper Mekong Basin and elsewhere would increasingly modify the natural flow regime.

Hydrological baseline 1985-2008. The hydrological baseline 1985-2000 has been extended to 2008 and calibrated during the last few years. The extended baseline is being used in the Mekong Delta Study. At the basin-wide scale, the 1985-2008 baseline may still represent natural flow conditions in the Mekong mainstream since the two large storage dams in the Upper Mekong Basin had not become operational and, by 2008, total operational storage in the basin was limited to about 5% of the Mekong basin's mean annual runoff.

A choice has to be made

For the Council Study, a choice needs to be made between the DSF hydrological baseline 1985-2000 and the DSF hydrological baseline 1985-2008. There is little point in choosing a baseline that is in between these two options, given the relatively likely limited difference in the results and the need for calibration and validation of any new options.

The following considerations are offered to select the hydrological baseline for the Council Study.

Influence of hydrological data by human-induced interventions

Section 6 of the hydrological report to the 33rd JC Meeting in March 2011 (attached as Appendix 1) shows evidence since 1993 of high frequency water level and discharge fluctuations from Chiang Saen up to Luang Prabang. These fluctuations, which occurred mainly in the dry season, cannot be attributed to changes in rainfall, which would result in a much smoother hydrograph. Therefore, the observed discharge fluctuations are attributed to the operation of the first dam of the Lancang cascade in China: the Manwan dam (commissioned in 1993) and the Jinghong dam (commissioned in 2003).

According to the 2011 hydrological report to the JC, the principal emerging impact of mainstream hydropower is unmistakable but local to the LMB between Chiang Saen and Luang Prabang. The report further describes that, by 2010/2011, there is no evidence of significant "regulation", i.e. the reallocation of water from the wet to the dry season. This would require the commissioning of the first storage dam on the Lancang cascade, the Xiaowan hydropower dam.

The filling of the Xiaowan hydropower dam, with a net storage capacity of 9,800 million m^3, started towards the end of 2008. The Xiaowan dam was commissioned in 2010. Inter-seasonal regulation increased in 2011 with the commencement of filling the second storage dam on the Lancang cascade: the Nuozhadu hydropower dam of 12,400 million m^3. This dam will be commissioned in 2015. Thus, regulation of water flows in the Lancang may have started in 2008/2009.

Since 2012, water level observations in the Mekong mainstream indicate a significant reallocation of water from the wet to dry season. In the dry season of 2012/2013 and 2013/2014, water levels between Chiang Saen and Kratie were above long-term average levels for a major part of the dry season. At several stations, the water levels were above the highest level on record for part of the dry season (see the PMFM webpage: http://pmfm.mrcmekong.org/). In the beginning of the wet season, water levels were significantly lower than average.

These water level observations are in line with the flow changes predicted in 2008-2009 for the Definite Future Scenario. The main reason is the reallocation of water from the wet to dry season by the above two large storage dams on the Lancang cascade, and the filling of the reservoirs in the beginning of the wet season to maximize energy production.

Representativeness of the baseline of historical long-term natural flow data

The period 1985-2000 was on average dryer than the long term average[1]. There are insufficient basin-wide hydrometeorological data prior to 1985 to support reliable flow changes. Thus the hydrological baseline period can only be extended beyond 2000 but not further than 2007 or perhaps 2008, since the filling of the first storage dam in the Upper Mekong Basin started in 2008.

A check could be made if the DSF hydrological baseline 1985-2008 represents the average natural flow regime better than the DSF hydrological baseline 1985-2000. This would include tests of mean and variability of dry season and wet season flows, annual flow volumes, Tonle Sap reverse flow dates/volume, wet season onset etc. for the statistics of each baseline time series compared to long term statistics at each of the agreed mainstream monitoring stations.

Other considerations

The hydrological baseline 1985-2000 has been accepted before and its continued use allows ready comparison with earlier studies. In this connection, the question arises as to what extent the MRC committed to using the 1985-2008 by resetting up, recalibrating and revalidating the models around this extended period, and if there would be major issues to revert to 1985-2000.

In conclusion, either of the two existing hydrological baselines can be used under the Council Study. But it may be sensible to use the original hydrological baseline 1985-2000 as previously agreed and used unless it can be demonstrated that a longer period (1985-2008) would provide significantly better results.

Appendices

1. Appendix 1 – Section 6 of attachment to Agenda D.1.2; report on the hydrological conditions in the Lower Mekong Basin for the thirty-third meeting of the MRC Joint Committee, 25-26 March 2011.

[1] Section 7.6 and 9.2 of the PMFM Comprehensive Information Report.

Appendix 1

Section 6 of attachment to Agenda D.1.2
Report on the hydrological conditions in the Lower Mekong Basin
for the thirty-third meeting of the MRC Joint Committee
25-26 March 2011

6. THE CONTINUING IMPACT OF THE DAMS IN CHINA ON MAINSTREAM HYDROLOGY.

Being significantly below the long term average, the 2009 (Figure 14) and the 2010 (Figure 5) daily discharge hydrographs at Chiang Saen reveal considerable ‘noise’ in the data both during the low flow and flood seasons. There are a great number of short term fluctuations in discharge with a frequency and pattern that appears to be inconsistent with the hydrological response to rainfall that might be expected over the upstream drainage area which amounts to almost 200 000 km^2. At this scale a much ‘smoother’ hydrograph would be the expectation. The oscillations also occur during the low flow season when, while most are quite small, there is little if any rainfall to explain them.

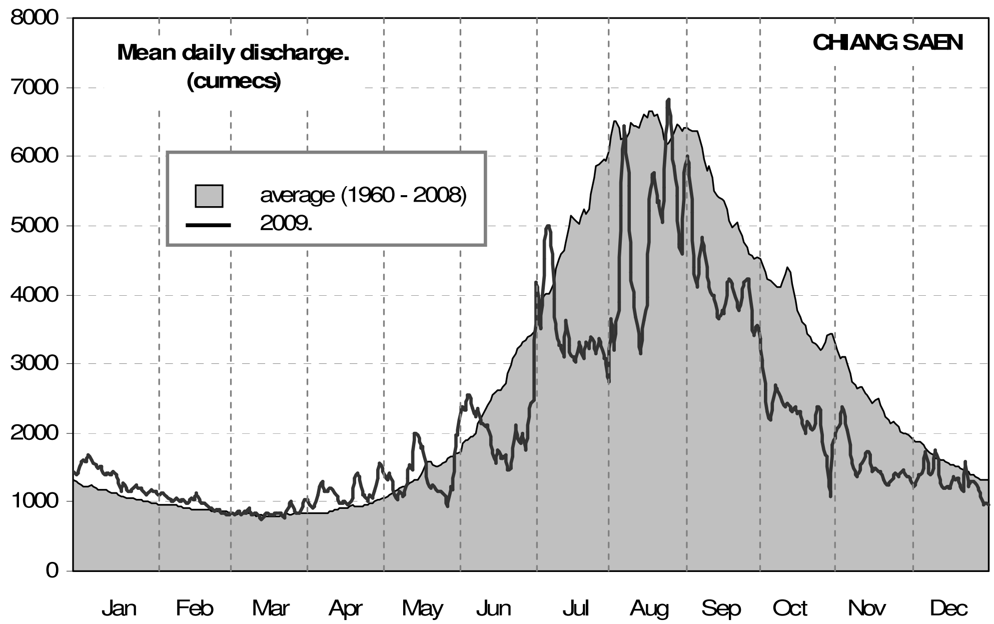

Figure 14: Chiang Saen: the 2009 daily discharge hydrograph compared to the long term average showing the high frequency day to day fluctuations which continued into 2010..

A simple definition of these fluctuations might be that they occur in the time series when the discharge on day ‘t-1’ and ‘t+1’ are both greater than (less than) that on day ‘t’ (t=1,365), or when q(t-1) < q (t) > q(t+1) or q(t-1) > q (t) < q(t+1). These fluctuations we might term ‘discharge reversals’. Figure 15 below shows the annual count of these reversals over the 51 years between 1960 and 2010, the analysis being extended to include the Mekong daily discharge time series at Luang Prabang and Vientiane over the same time period.

There is a clear change point in their frequency around 1993 and the commissioning of Manwan dam. Post 1993 the mean annual rate doubles at Chiang Saen. At Luang Prabang the increased rate remains significant, while at Vientiane the change is much more modest. Clearly the short term hydrological impacts of reservoir operation are modulated downstream as tributary inflows exert an effect and 'damp' them out, but the picture that emerges from this simple analysis is that the operational impacts of the dams in China on the flow regime of the Mekong are already manifest upstream of Vientiane.

The impacts are not only be detectable during the low flow season, as expected, but also during flood seasons such as those of 2009 and 2010 when discharges were considerably below average throughout. Also revealed is the effect of basin scale on the short term variance of the annual flood hydrograph. Pre 1993 the hydrology may be considered to have been 'natural' and indicates that the mean annual frequency of discharge reversals decreases downstream as drainage area increases and the hydrograph becomes more coherent from day to day.

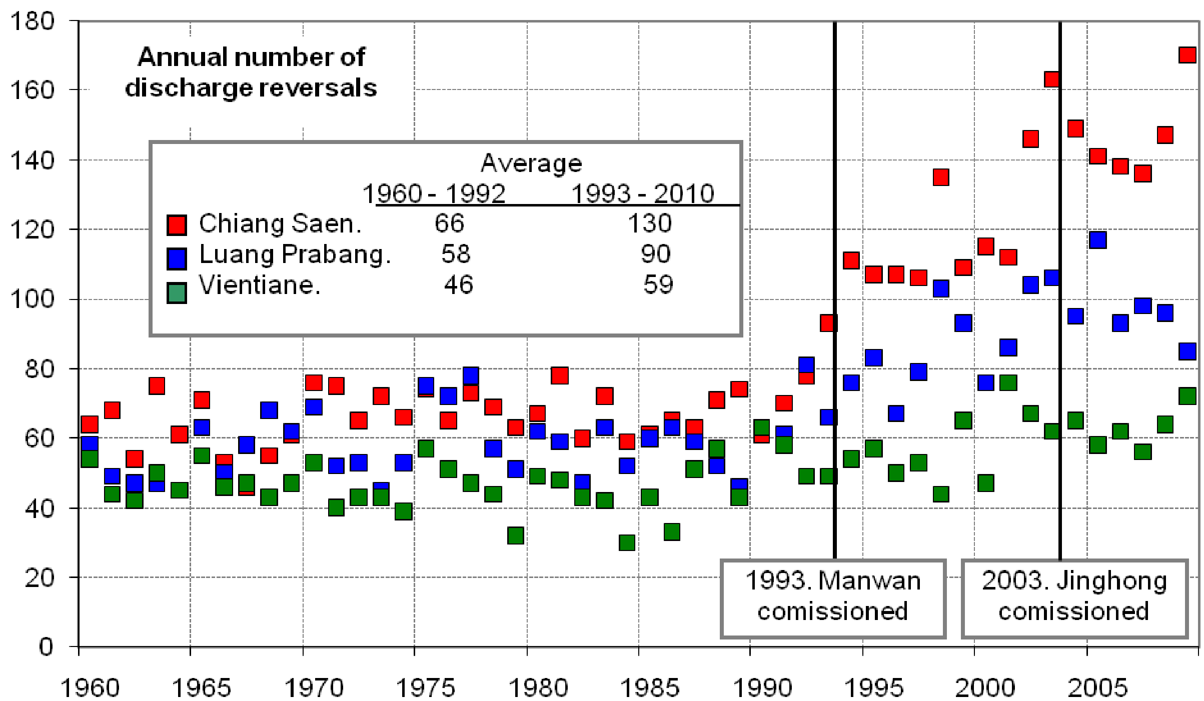

Figure 15: The annual number of discharge reversals at Chiang Saen, Luang Prabang and Vientiane, 1960 – 2010.