Managing the ecological health of the Mekong River: evaluating threats and formulating responses.

Ian C. Campbell, Christopher G. Barlow and Pham Gian Hien.

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Introduction

The Mekong River is a largely undeveloped river in a region which is poor and generally considered underdeveloped. The river is one of the largest in the world, with a mean annual discharge estimated at 475 x 10^9 m^3, and a catchment encompassing parts of China, Myanmar, Lao PDR, Thailand, Cambodia and Viet Nam (MRC 2003). There are relatively high levels of poverty in many parts of the basin (HOOK ET AL. 2003), which in part reflect their turbulent recent history. Even in Thailand, the wealthiest and most developed of the four lower Mekong countries, the provinces in the northeast which are situated in the Mekong basin contain about 60% of the country's poor (NESB cited by HOOK ET AL. 2003). Until recently there have been no dams on the mainstream of the Mekong, and relatively little of the water is used for either off stream (e.g. domestic or irrigation water) or instream (e.g. hydropower) purposes (MRC 2003)

The present ecological condition of the river has been a matter of some discussion. BARLOW AND CLARKE (2002) described the river as "choking with industrial and human waste". MRC (1997) identified "deteriorating water quality threatens resources and sustainability"as the top priority physical resources issue in the basin. Workshops held with staff from government agencies in each of the four lower Mekong countries in 1992 identified water quality, sedimentation, dams and reduced dry season flows, flooding and fisheries decline as the major transboundary issues of concern (MRC unpublished data). More recently concern has been raised in the media about the impact of dams in China on the lower Mekong (e.g. CROPLEY 2004, VIDAL 2004).

This paper collates and analyses some data from the basin in an attempt to clarify present conditions and current threats to the Mekong. In particular we focused on data that could be used to test whether the five issues identified by staff from government agencies in the region are significant problems at present or are likely to become so in the immediate future.

Methods

Data on water quality were obtained from the MRC water quality database which includes sample data collected monthly at approximately one hundred sites throughout the lower basin since 1985. Approximately 20 chemical and physical parameters are included. Data on total phosphorus and nitrate nitrogen were primarily used as an indicator of pollution. Preliminary data from a survey of toxicants in the lower basin are also available. Sedimentation was assessed based on data on total suspended solids in surface water samples collected as part of the water quality monitoring programme and an investigation of channel cross-section changes conducted by BOUNTIENG (2003). The present and potential future impact of dams, including those in China was assessed using hydrological data from the MRC database and modeling conducted with a basinwide hydrological model developed specifically for the purpose of evaluating impacts of future changes in water resource use in the basin (HALCROW 2004)

Flood frequency and intensity data have been analysed by SOK & THANONGDETH (2003) and we accepted their analysis of changes in flood frequency and intensity. Fish catch data is extremely difficult to collect in a basin such as the Mekong where millions of people are involved in harvesting the resource and much of the product is consumed by the catcher or traded locally. However the Department of Fisheries in Cambodia collect data on the Dai fishery in Tonle Sap River. This is a large fishery based on 13 sets of large nets that are operated in January and February each year as fish migrate downstream. We assume that the fish catch in the Tonle Sap River reflects the wider fishery.

Results

Concentrations of total nitrogen and phosphorus were generally low except in the delta (Figs 1 & 2). Median concentrations of phosphorus for all sites outside the delta were below 0.05 mg/L, and for total nitrogen were below 0.5 mg/L. Furthermore 6 sites outside the delta showed statistically significant negative regressions over time in phosphorus concentrations and 5 for nitrogen concentrations, compared with 3 sites showing an increase in phosphorus and 2 showing an increase in nitrogen. Most sites showed no statistically significant trend (MRC 2003). Surveys for toxic materials including pesticides, metals and persistent organic contaminants in water and sediments has so far failed to find concentrations of concern at any locations in the lower basin although there are indications of some toxicity in sediments at several locations (MRC unpublished data).

Suspended sediment concentrations decrease downstream with median values below 200 mg/L for all sites except Chiang Saen, which is slightly higher (HART ET AL. 2001). Over time concentrations at main stream from Chiang Saen to Pakse have also decreased in the period since 1985 (MRC 2003). Some of the decrease is due to sediment trapping from Manwan dam in China, and the reductions on tributary streams may be due to the construction of small diversion structures (MRC 2003). BOUNTIENG (2003) investigated whether there had been any changes in channel cross-sectional area at the site of the Nong Khai bridge between 1995 and 2002 and found no significant difference.

MRC (2003) found that along the mainstream there has been a tendency towards an increase in monthly discharges in the dry season over the past 15 years, and a decrease in wet season monthly discharges. In both cases the changes were relatively small but was more pronounced at the downstream site (Pakse) than the upstream site (Chiang Saen), indicating that this is not a phenomenon arising from activities in China. Preliminary modeling of the impacts of dams currently under construction in China indicate that at sites downstream as far as Pakse in Cambodia there is the possibility of a slight decrease in wet season flows (~3%) and a much more pronounced increase in dry season flows (~20%) once these dams begin operation (Richard Beecham personal communication).

Comparison of the flood return periods for the period of hydrological records up to 2001 with the period from 1970 to the present for 7 sites on the Mekong main stream indicates an inconsistent pattern (SOK & THANONGDETH 2003). At 3 sites the size of the 100 year return flood had deceased and at 4 sites it had increased. Similar inconsistent patterns were found for other flood return periods. This does not support suggestions of an increase in flood size or frequency, although the impact of floods may be increasing as population and infrastructure on the flood plains increases.

Fish catches in the Tonle Sap river generally correlate with the previous year's flood. However there has been a decline in the catch between 2002-2004 which seems greater than would be expected based on flood height alone (HORTLE ET AL. 2004). This may be an indication of the beginnings of a catch decline, or it may be due to some other feature of the flood in 2003, such as the timing or duration.

Discussion

Nutrient levels in the Mekong compare favourably with world values (FRASER ET AL. 1995), and there appears to be no evidence of significant water quality problems in the Mekong mainstream upstream of the delta. However there does appear to be a significant nutrient contamination in the delta probably associated with higher population densities, more intensive agriculture and in-stream aquaculture activities. None of the data we have seen supports the statement by BARLOW AND CLARKE (2002) cited earlier.

The available data on sediment are less extensive, including no data based on depth integrated sampling for example. However, based on the data we have there does not appear to be a problem with excessive sediment within the river. Problems of erosion caused by legal and illegal timber harvesting have often been referred to in the basin, and MRC (1997) identified as a key issue that "Sedimentation is critical and intensifying" but presented no supporting data. Suggestions that the Great Lake at Tonle Sap would fill with sediment with a few decades (CSAVAS ET AL 1994) are not supported by any data.

Our hydrological analysis identified changes in flow patterns but not the decrease in dry season flows that those in the workshops had identified as a concern. The present trend has seen an increase in dry season flows, and modeling suggests that this pattern will become stronger after completion of the dams under construction in China. While many in the basin see this as a good thing it is possible that it may have unintended consequences for the lower Mekong fishery, and also contribute to sediment "starvation" of the lower river.

Floods and droughts do not appear to be increasing in frequency or severity in the lower Mekong basin as a whole. However this data is based on a relatively short time span. There have been a number of analyses of possible consequences of climate change on the basin (e.g. see PEARCE 2004) some of them contradictory so it is not possible at present to make predictions about future changes. What is certain is that future development in the basin will make the consequences of flooding more severe.

Large fish now comprise only a small proportion of the fish the catch in the lower Mekong whereas they formerly comprised the bulk of the catch (MRC2003) an indication that the fishery is under pressure. The data on the dai catch may also be an indication of a decline in the total catch of small, short life cycle species. If so, the consequences for the human population will be severe. The catch in January and February 2005 will provide an important indication of the future of the fishery. Early indications are that the wet season in 2004 is closer to normal, so that if the lower catch in early 2004 was due to the drought in 2003 the catch in 2005 should be close to normal.

Overall the condition of the lower Mekong basin is relatively good. Analysis of existing data indicates that there are several emerging problems. Water quality in the Mekong delta is deteriorating and, if present trends continue, the passage of anadromous fish species such as the silver toned catfish (*Pangasius krempfi*) (HOGAN ET AL 2004) may eventually be blocked. The impact of floods will continue to increase unless greater care is given to design and siting of infrastructure development and managing human population on the flood plain.

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Authors'Addresses:
Mekong River Commission, P.O. Box 6101, Vientiane, Lao PDR.
Email: Campbell@mrcmekong.org

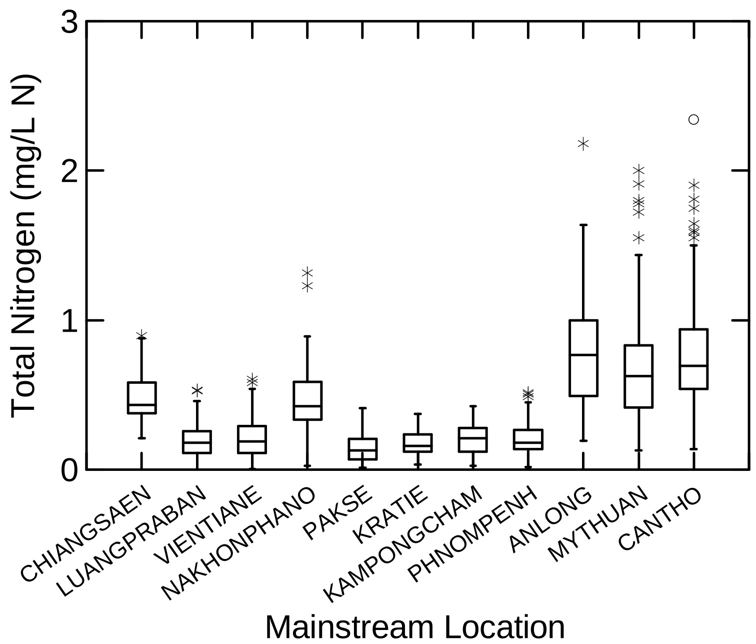

Figure 1. Median values and 25% quartile ranges for total Nitrogen values in the Mekong River based on water quality data collected from 1985 in Thailand, Lao and Viet Nam and since 1992 in Cambodia.

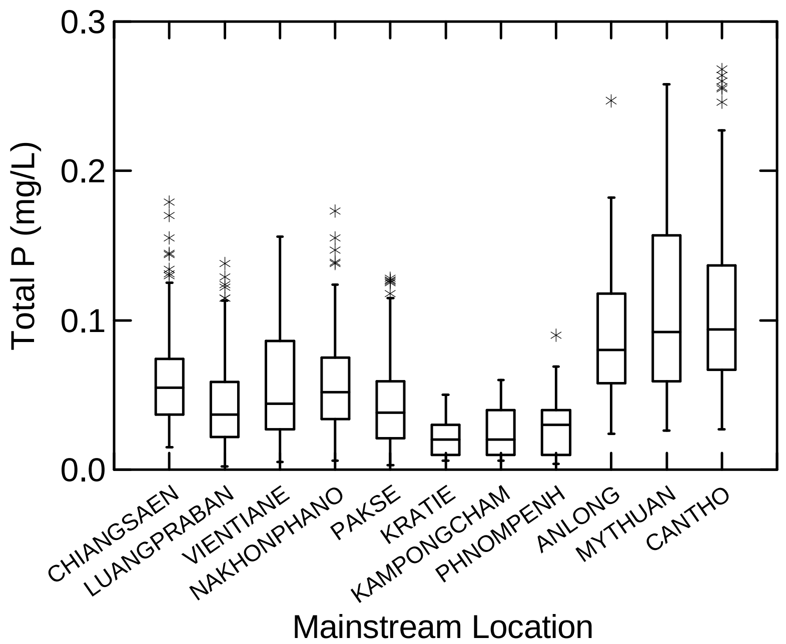

Fig. 2. Median total phosphorus concentrations from Mekong mainstream stations derived from the same data base as Fig. 1.