The Mekong River Report Card on Water Quality (2000-2006)

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Mekong River Commission

Background

The water resources of the Mekong River support the livelihoods of most of the 60 million people who live in the Lower Mekong Basin. Good water quality and a healthy environment of the Mekong River and its tributary ecosystems form the basis for these livelihoods. Water quality is a key determinant of environmental health.

The condition of the river, which at present has a good/acceptable water quality, must be maintained if we are to promote sustainable development within the Mekong River Basin. Water quality monitoring helps the basin's stakeholders to recognise changes in environmental conditions in sufficient time to take preventive and remedial action.

This Mekong River Report Card on Water Quality provides an overview of water quality parameters and the changes of key environmental stressors that may affect the river's aquatic life. It provides a summary of the MRC water quality monitoring data during the period from 2000-2006. The data are taken from 22 sampling sites in the mainstream of the Mekong River from Northern Lao PDR to the Mekong Delta. Assesssment of water quality in the tributaries and the Mekong Delta is presented in MRC Technical Paper No 19 - An Assessment of Water Quality in the Lower Mekong River Basin.

Water Quality Monitoring Network

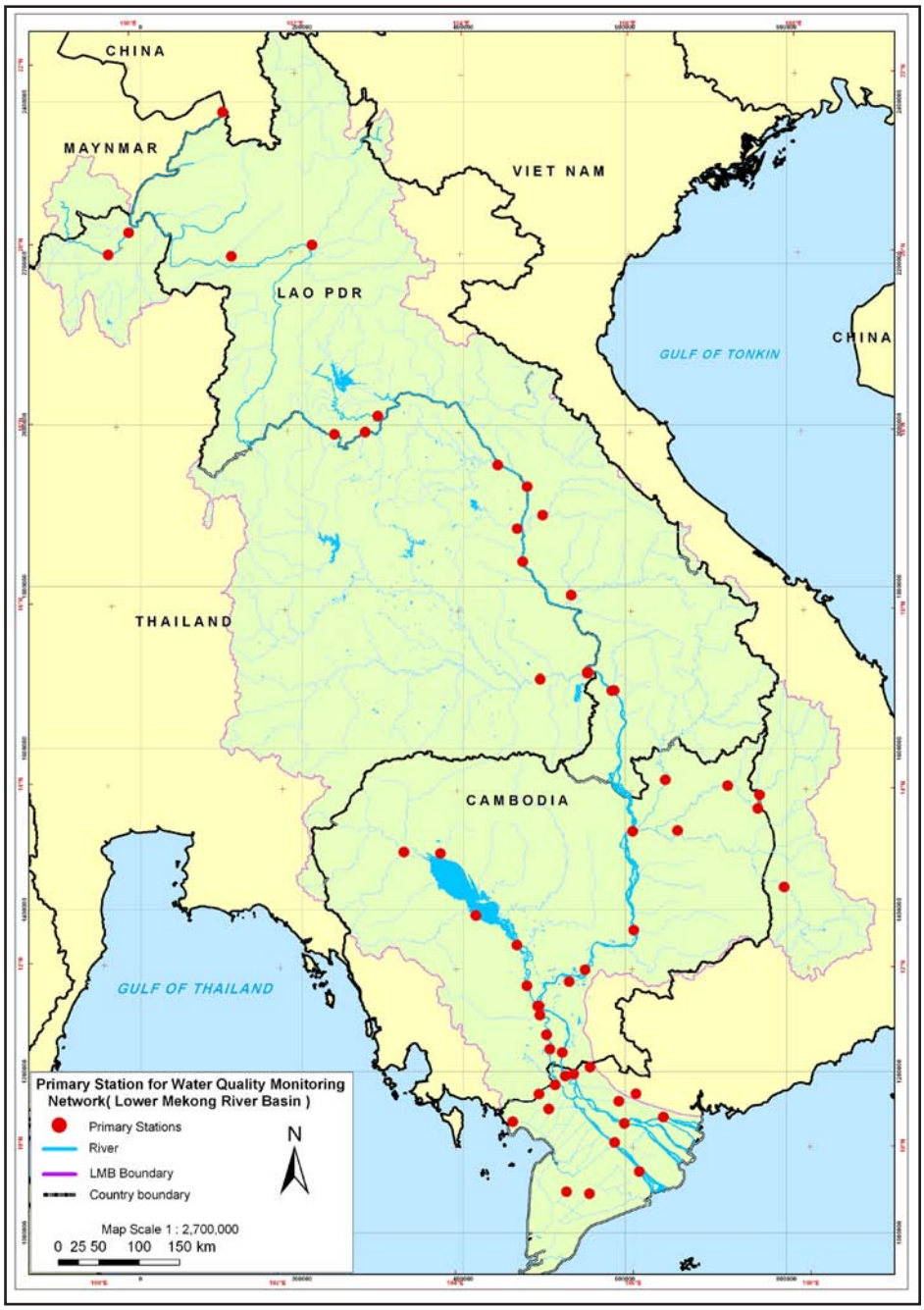
In 1985, the MRC's predecessor, in response to riparian concerns over potential water pollution and its trans-boundary implications, began a water quality monitoring programme in the Lao PDR, Thailand and Viet Nam. Cambodia later joined the programme in 1993. The member countries participate by carrying out water sampling at stations within their national territory and performing water quality analysis in designated laboratories. Overall programme coordination is provided by the MRC Secretariat in Vientiane.

The purpose of the MRC water quality monitoring programme is to provide timely data and information on the status and changes in water quality of the Mekong River Basin. This information can then be used by the relevant stakeholders.

The programme includes water quality monitoring for 87 permanent stations, of which 55 are primary stations (shown in the map) and 32 are secondary stations on the mainstream and important tributaries of the Mekong River. River water is sampled from the surface and the mid-stream on a monthly basis. As outlined in Table 1, 19 different parameters are measured.

Table 1: List of parameters measured in the MRC water quality monitoring programme

Temperature	Calcium	Total Nitrite and Nitrate
Conductivity	Magnesium	Total Phosphorous
Total Suspended Solids	Chloride	Chemical Oxygen demand
pH	Sulphate	Fecal Coliform
Dissolved Oxygen	Alkalinity	Chlorophyll - a
Sodium	Total Nitrogen	
Potassium	Ammonium	


CHINA
MAYNMAR
VIET NAM
LAO PDR
CHINA
GULF OF TONKIN
THAILAND
CAMBODIA
GULF OF THAILAND
Primary Station for Water Quality Monitoring Network(Lower Mekong River Basin)
Primary Stations
River
LMB Boundary
Country boundary
N
Map Scale 1 : 2,700,000
0 25 50 100 150 km

Mekong River Water Quality

Water quality for protection of aquatic life

Healthy aquatic life in the Mekong Basin depends on water of good quality, with acceptable concentrations of dissolved oxygen and low concentrations of toxic ammonia. It is also important that pH values are not too low. Balanced concentrations of nutrients are needed to support aquatic primary production.

Water quality indices

Based on a review of the scientific literature and statistical characteristics of available data at the MRC Secretariat database, six parameters and their guideline values were selected for assessing suitability of water quality for protection of aquatic life in the Mekong river (see Table 2).

Samples with a water quality within the range of the values in Table 2 were given a high rating as outlined in Table 3, while water samples with values outside the range of Table 2 were given a lower rating, depending on how far the values were from the given range. The Water Quality Indicator (WQI) for each station is calculated as a formula (1) and the WQI used in this assessment may require future adjustment.

$$WQI = \frac{\sum (p1 + p2 \ldots\ldots pn)}{M} \times 10 \quad \textbf{(1)}$$

Where:

- "p" is the number of points per sample day, (if DO, pH, NH_3 and Conductivity meet the guidelines in Table 2, two points are scored, otherwise zero points are scored; if NO_{2-3} and Total-P meet the guidelines, one point is scored, otherwise the score is zero).
- "n" is the number of sample dates in the year.
- "M" is the maximum possible number of points for the measured parameters in the year.

Note:

This classification system has been revised from that used in MRC Technical Paper No 19 in consultation with the member countries.

Table 2: Water quality parameters used in classification system for protection of aquatic life

Parameter	Units	Value	Parameter	Units	Value
pH value		6.0 - 8.5	Dissolved oxygen	mg/l	> 5
Conductivity	mS/m	< 70	Nitrite & Nitrate	mg/l	<0.7
Ammonia	mg/l	0.1	Total Phosphorous	mg/l	<0.13

Table 3: Rating system

Class	Rating Score	Characteristic feature
A Excellent	10 ≥ A ≥ 9	all aquatic life is protected with a virtual absence of threat or impairment
B Good	9 > B ≥ 8	all aquatic life is protected with only a minor degree of threat or impairment
C Moderate	8 >C ≥ 7	most aquatic life is protected but some species are threatened or impaired a few species may be temporarily interrupted
D Poor	D < 7	most aquatic lives are threatened or impaired several species may be temporarily interrupted conditions usually differ from natural or desirable levels

Assessing water quality for protection of aquatic life

Table 4 shows that the water quality at almost all the 22 mainstream stations is rated as 'excellent' for the protection of aquatic life. The few exceptions are My Tho station in 2002 and 2005, My Thuan station in 2006 and Chau Doc station in 2002. In these stations the water quality was rated as class B, indicating good/acceptable quality for the protection of aquatic life. A minor degree of impairment is caused by salinity intrusion and nutrient concentrations.

Table 4: Water quality class for protection of aquatic life 2000–2006

No	Station Name	Country	Class						
			2000	2001	2002	2003	2004	2005	2006
1	Houa Khong	Lao PDR	nd	nd	nd	nd	A	A	A
2	Chiang Saen	Thailand	A	A	A	A	A	A	A
3	Luang Prabang	Lao PDR	A	A	A	A	A	A	A
4	Vientiane	Lao PDR	A	A	A	A	A	A	A
5	Nakhon Phanom	Thailand	A	A	A	A	A	A	A
6	Savannakhet	Lao PDR	nd	A	A	A	A	A	A
7	Khong Chiam	Thailand	A	A	A	A	A	A	A
8	Pakse	Lao PDR	A	A	A	A	A	A	A
9	Stung Treng	Cambodia	A	A	A	A	A	A	A
10	Kratie	Cambodia	nd	nd	nd	A	A	A	A
11	Kampong Cham	Cambodia	A	A	A	A	A	A	A
12	Chroy Chanvar	Cambodia	A	A	A	A	A	A	A
13	Neak Loung	Cambodia	A	A	A	A	A	A	A
14	Krom Samnor	Cambodia	nd	nd	nd	nd	A	A	A
15	Tan Chau	Viet Nam	A	A	A	A	A	A	A
16	My Thuan	Viet Nam	A	A	A	A	A	A	B
17	My Tho	Viet Nam	A	A	B	A	A	B	A
18	Takhmao	Cambodia	A	A	A	A	A	A	A
19	Khos Khel	Cambodia	A	A	A	A	A	A	A
20	Khos Thom	Cambodia	nd	nd	nd	nd	A	A	A
21	Chau Doc	Viet Nam	A	A	B	A	A	A	A
22	Can Tho	Viet Nam	A	A	A	A	A	A	A

Note:

- nd: no data
- The number and station names in Table 4 are the same as those referred to in the WQI class map overleaf and in Figures 1a, 1b, 2a, 2b, 3a, 3b, 4a and 4b.

Status Ratings: overall water quality class for protection of aquatic life 2004-2006

Water Quality Trends

Routine water quality monitoring data from 22 stations in the Mekong mainstream were statistically analysed. Four parameters - Total Suspended Solids (TSS), Total Phosphorous, Nitrite-Nitrate and Chemical Oxygen Demand - were tested by using boxplots and linear regression to detect change over time and spatial differences between sites.

Total Suspended Solid trends

Total Suspended Solids in the Mekong River are influenced by natural and anthropogenic (human) activities in the Basin, such as natural or excessive soil erosion from agriculture, forestry or construction, urban runoff, industrial effluents, or excessive phytoplankton growth.

Water samples are taken just below the water surface, so measurements do not reflect the sediment concentration in the whole water column. Nevertheless, the measures give a reasonable indication of the amount of sediment in the water.

No clear trends have been identified in annual variations of TSS in the Mekong River. Figures 1a and 1b show that there were no significant differences in the median value of TSS between the years 2000–2006.

Chiang Saen has the highest median value of TSS, and there is a gradual decrease of TSS values towards the Mekong Delta, where the lowest values are found.

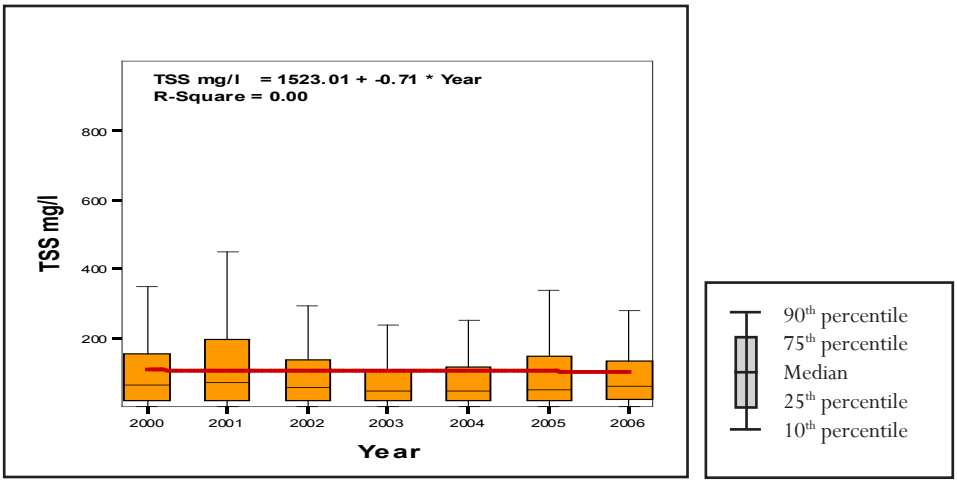


Figure 1a: The variation of TSS in the Mekong River 2000-2006

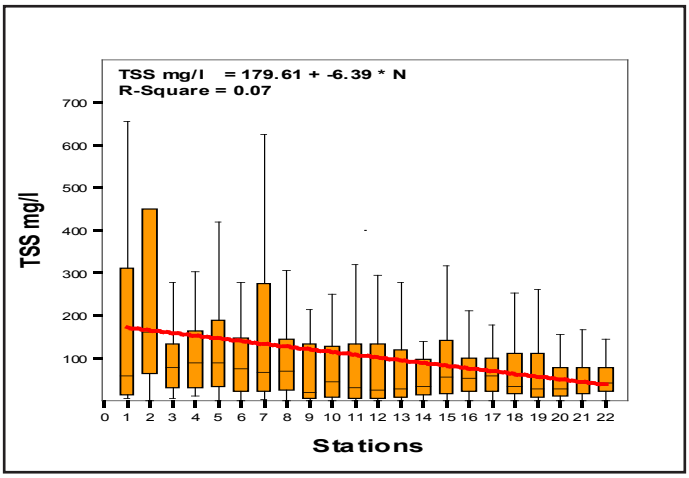


Figure 1b: Total Suspended Solids (TSS) at 22 stations along the Mekong River 2000-2006.

Nutrient trends

Nitrogen and phosphorous occur in water in a variety of inorganic and organic forms, and the concentration of each form is primarily mediated by biological activity. Phosphorus and nitrogen are considered to be the primary drivers of eutrophication in aquatic ecosystems, when increased nutrient concentrations lead to increased primary productivity. Some systems are naturally eutrophic, whereas others have become eutrophic as a result of human activities ('cultural eutrophication') through factors such as runoff from farmland and the discharge of municipal waste into rivers.

Overall, the concentrations of nutrients at all mainstream stations are low, and do not indicate eutrophic status on the river. The concentrations of total phosphorous are low at most stations with the exception of Tan Chau, My Thuan, My Tho, Chau Doc and Can Tho. The concentrations of nitrite and nitrate are slightly elevated at Houa Khong, Chiang Saen, Vientiane, Nakhon Phanom, Khong Chiam, Stung Treng, Tan Chau, My Thuan, My Tho, Chau Doc and Can Tho stations. The nitrate and nitrite concentrations did not chang significantly between 2000-2006 (Figures 2a and 2b) However, total phosphorous levels at the Mekong mainstream stations have varied to a great extent in recent years (Figures 3a and 3b).

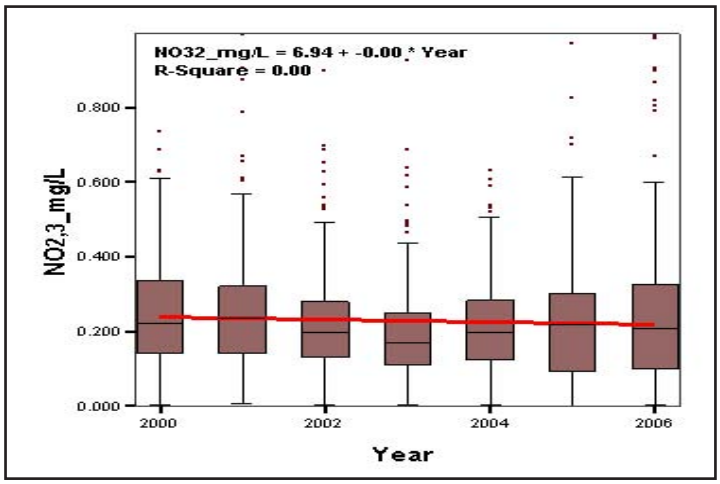


Figure 2a: The variation of nitrite and nitrate in the Mekong River 2000-2006

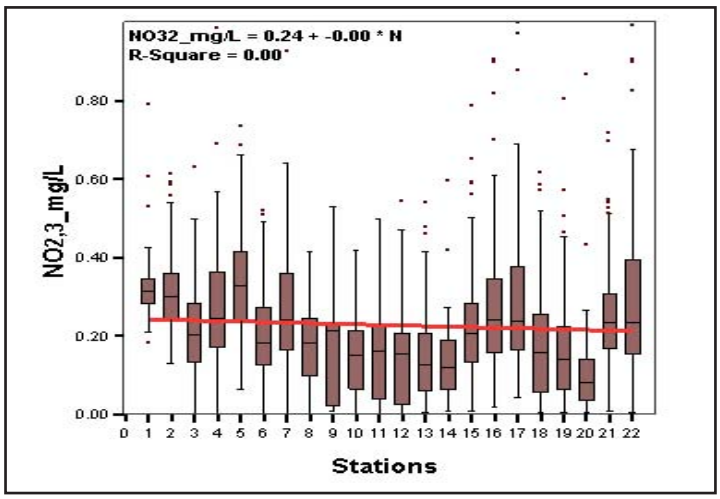


Figure 2b: Nitrite and nitrate (mg/l) at 22 stations along the Mekong River 2000-2006.

Organic matter trends

Organic matter is important in the recycling of nutrients, carbon and energy between producers and consumers in the aquatic environment. External supply of organic matter that enters aquatic ecosystems from a drainage basin through point sources such as effluent outfalls, or non-point sources such as runoff from agricultural areas, can enhance the production and respiration of aquatic organisms (including microorganisms), and be followed by an increased oxygen demand. The chemical oxygen demand (COD) is commonly used to indirectly measure the amount of organic matter in water.

The COD concentrations are lowest in the upper part of the Mekong River, with COD levels increasing as the river flows towards the Mekong Delta. This trend is consistent with the trend of total phosphorous. Figures 4a and 4b indicate that COD concentrations have increased slightly over the last seven years. Still, 75% of monitoring data show values which are lower than 5 mg/l (Figures 4a and 4 b).

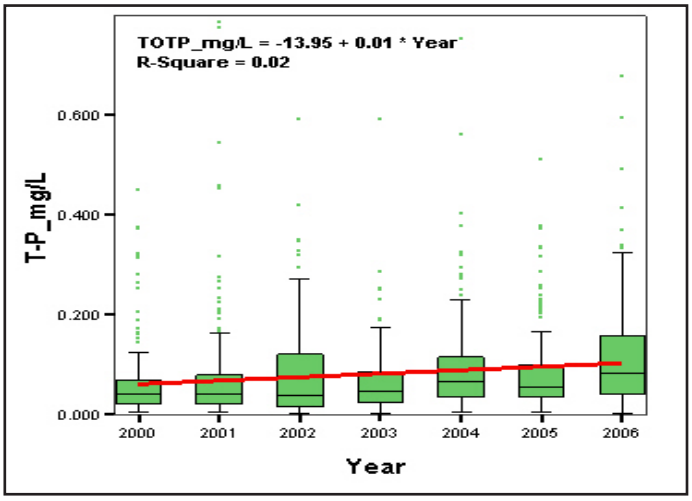


Figure 3a: The variation of total-phosphorous (mg/) in the Mekong River 2000-2006

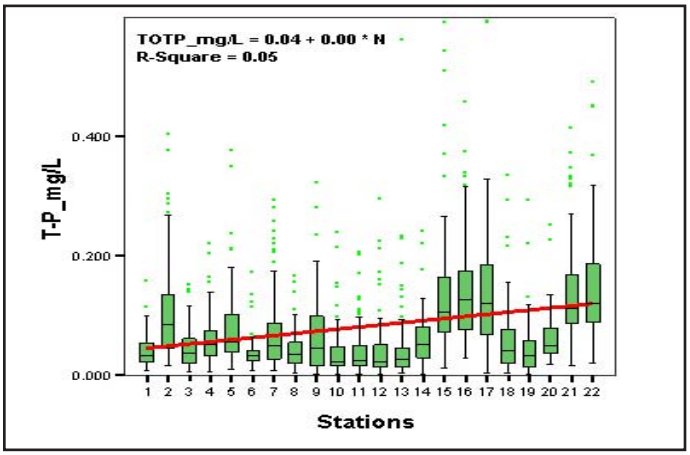


Figure 3b: Total phosphorous (mg/l) at 22 stations along the Mekong River 2000-2006.

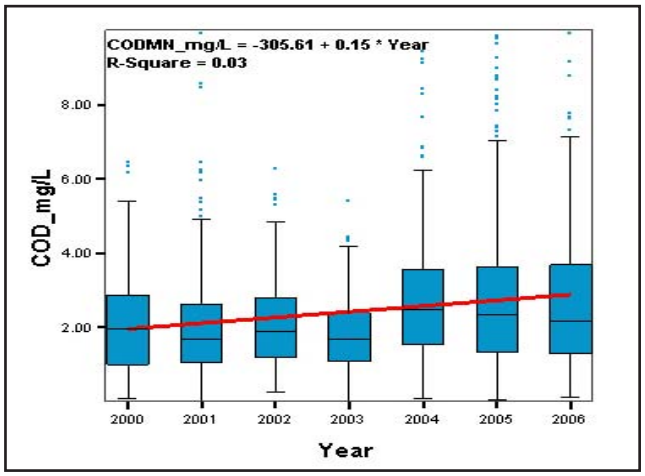


Figure 4a: Variation of chemical oxygen demand (mg/l) in the Mekong River 2000-2006

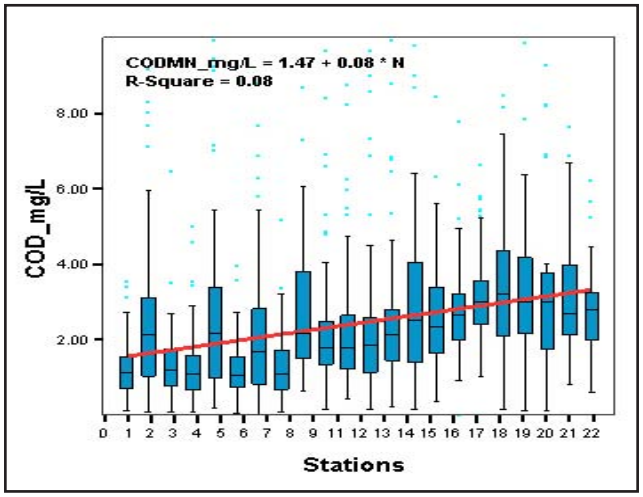


Figure 4: Chemical oxygen demand (mg/l) at 22 stations along the Mekong River 2000-2006

Toxic Contamination

Toxic chemicals in the environment include heavy metals and some organic compounds. These persistent pollutants cause specific problems in aquatic environments as they are often accumulated into the food chains. A diagnostic study of water quality in the Lower Mekong Basin conducted between 2003-2004 showed that the surface water of the Lower Mekong was relatively unpolluted by industrial organic pollutants, pesticides and heavy metals.

The results from bottom sediment analyses and bioassay, (where persistent pollutants can remain for many years), indicated that heavy metals mostly occurred at lower concentrations than their Threshold Effect Concentration. However, the bioassay tests indicated a few sites at the Lao-China border, Vientiane, Neak Loung, Tan Chau and Chau Doc, where toxicity was observed, and further studies are needed before any conclusions can be drawn.

Important notes and future needs for water quality monitoring

Water conservation for sustainable development

- Protecting and restoring a complex water resource like the Mekong River Basin alongside dynamic economic development is a permanent challenge.
- More than 60 million people rely on the resources of the basin for their livelihoods.
- Preserving a healthy Mekong River Basin is vital for the next generation.

Water quality threats

- Population growth, intensive agricultural and aquaculture, navigation and hydropower dams, all contribute to a changing environment, often with an increased input of chemicals, which ultimately may affect the aquatic ecosystem and human health in the Mekong River Basin.
- Industrial waste and oil spills are emerging threats which need to be addressed through common action plans and environmental management schemes.
- Climate change, in terms of changed precipitation patterns and rising sea levels, may occur over the next few decades and influence the Mekong River Basin's water quality.

Future monitoring needs

The primary objectives of MRC water quality monitoring are to:

- Provide timely data to assure good water quality for the protection of aquatic life and human health.
- Understand the relationships between water quality conditions and the natural landscape, and between hydrological processes and human activities within transboundary areas and across the whole Mekong River Basin.
- Evaluate water quality together with biological parameters and water quantity changes,
- Improve water quality risk assessment, information and communication.
- Create joint water quality monitoring and scientific assessments that build trust and support cooperation across the basin.

The Mekong River Report Card on Water Quality is published every two years by the Mekong River Commission Secretariat in Vientiane, Lao PDR and distributed to the MRC Member States. Free email subscriptions to the Mekong River Report Card on Water Quality are available through the MRC website, www.mrcmekong.org. For hard copy subscriptions, contact the MRC Documentation Centre by email: doc.center@mrcmekong.org .

Contributions to and comments on the Mekong River Report Card on Water Quality may be sent to mrcs@mrcmekong.org.

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