Ecological Health Monitoring 2015 in Thailand Report

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1. INTRODUCTION

The aquatic resources of the Mekong River and its tributaries are essential to the livelihoods of a large portion of the 60 million or more people who live in the Lower Mekong Basin. Maintaining the ecological health of the river is the basis of the sustainable management of natural resources, The Environment Programme of the Mekong River Commission (MRC) has monitored the ecological health of the Mekong river-system by using biological indices since 2003. This report describes the biomonitoring activities field surveys in 2015. In this year, the Mekong River Commission (MRC) has monitored the systems in place for hydrology and water quality. Normally, the activities have been based on measurement of physical-chemical parameters but from year 2003, the MRC has planned for the eventual integration of this system into the activities of the National Mekong Committees (NMCs) and their line agencies. The representatives of the NMCs and line agencies together with national experts and international consultants developed a program and selected appropriate methods and procedures for EHM (Ecological Health Monitoring). However, this report will described only the field trip and some physical and biological activities.

The objectives of this report are to

(i) Conduct the biomonitoring collecting samples by using the methodologies and protocols which are derived from the Biomonitoring Handbook published in 2010.

(ii) Determine the physical and chemical parameters as the ecological health condition at the selected sampling sites in Thailand.

2. SAMPLING SITES, ACTIVTIES AND METHODS

2.1 Sampling Sites

The sampling sites were selected by the previous sites which has been done from year 2004-2007, 2008, 2011and 2013 and new sites in North-eastern Thailand follow the 2008, 2011 and 2013 collection. The sites include localities on the Mekong and its major tributaries which focused on northern and north-eastern part of Thailand. The sites were exhibited various disturbance from low to high human activity impact. There are a few study sites located in or close by villages or towns, some are next to fields where crops are grown and livestock graze, some are upstream or downstream of dams and weirs, and some are moderate to heavy river navigate route. The sampling distributes two sites in the North and six sites in the North-Eastern. All eight sites were sampled during 31 March - 9 April 2015.

Site TNP (Thailand Nakorn Panom)**,** Mekong River at Nakorn Panom Province

This site is the border between Thailand and Lao PDR. It is located about 1.5 km upstream of the Nakorn Panom downtown. This site was surrounded by small villages, which has about 200 inhabitants. The left bank was steep, at a 30° angle (Laos PDR. side); the right bank lay at 35° (Thailand side). The riparian area consisted of a few temporary agriculture, floating fish cage. The human impacts were appeared as waste creek, rubbish disposal, agriculture runoff, fish farming and bank erosion.

Site TSM (Thailand Songkarm Mount)**,** Mekong River at the connection between Songkram River and Mekong River.

This site is also the border between Thailand and Lao PDR. It is located on the connection between Songkram River and Mekong River. This site was also sampled in March 2007, 2008, 2011 and 2013. The both side of the bank had a 40° slope. The riparian vegetation was bamboo, grass and tree. TSM site was surrounded by medium villages, which has about 500 inhabitants. The riparian zone consisted some forest, land slide, few houses, small scale agriculture and floating fish cages. This site was the pier for boat transportation between Thailand and Lao PDR. The most substrate types were sand and clay, then firm mud and firm sand. The human impacts were appeared on this site include restaurant, fish cage, disposal of human and animal wastes, agriculture runoff and livestock damage to bank.

Site TNK, (Thailand Nam Kham River)**,** Nam Kham River at the Mukdaharn Province.

This site is located about 5 km downstream from water supply dam and it was shallow (<0.5-1.5 m depth), and the slope was 40-50° angle on both banks. The vegetation on the right bank was paddy field and bamboo. The substrate types were a wood and leaf debris, sand, clay, gravel, and mud. This site had a saviour bank erosion and landslide. A few impacts from human were appeared in this sampling area but there had some evidences of human wastes such as rubbish disposal from upstream.

Site TMU, (Thailand Mun River)**,** Mun River at the Kong Chiam District, Ubonrachathani Province.

TMU site located about 3 km above the connection between Mun River and Mekong River. It was also sampled in March 2004, 2008, 2011 and 2013. This site was surrounded by

small communities, which has about 180 inhabitants and most of them are fisher man. The fishermen village was the temporary house. They always migrate depending on the level of the river. The left bank was a 30° angle and the right bank lay at 30°. The riparian area were consisted of grass fields, temporary agriculture, house and floating houses. There were some soil erosion, cattle grazing, fish farm and floating fish house. The substrate types were sand and gravel and some bedrock. The human impact appeared as the disposal of human and animal wastes, agriculture runoff, and urban runoff.

Site TKC, (Thailand Kong Chiam)**,** Mekong River at the Kong Chiam District, Ubonrachathani Province.

TKC site is also the border between Thailand and Lao PDR. It is located on connection between Mun River and Mekong River. There was steep slope as 30° angle on the left side; it was a flat sand bar. The left bank was steep, at a 30°-40° angle (Laos PDR. side); the right bank lay at 45° (Thailand side). Some part of both site were constructing for the embankment. The riparian vegetation was bamboo forest. This site was surrounded by fishermen villages, which has about 800 inhabitants. The riparian zone consisted of concreate construction especially for right side. On the other hands, the reeds, land slide, tourist place, pear and floating house and fish cages were presented. This site had a large pier for boat shipping and transportation between Thailand and Lao PDR. The substrate types of this site were bed rock, sand and clay, firm mud and firm sand. The human impact appeared on this site is restaurant, fish cage, disposal of human and animal wastes.

Site TUN, (Thailand Ubon New)**,** Mun River at the Ubonrachathani Province.

This site located on about 10 km from Ubonrachathani downtown and it was surrounded by few houses and all of them is the single fisherman house. The left bank was a 15° angle and the right bank lay at 15° angle. The riparian zone consisted of cattle grazing area, soil erosion, algae and aquatic plant. The substrate types were mud, aquatic plant, sand and clay, firm sand and gravel. The human impacts were appeared as disposal of human and animal wastes, navigation and agriculture**.**

Site TCS, (Thailand Chiang San)**,** Mekong River at the Chiang San District, Chiang Rai Province.

TCS site is located on the Chiang San Downtown and also the border between Thailand and Lao PDR. This site was also sampled in 2008 and 2011 and located on the Chiang San Downtown. Not only the inner city site but also the most important docks for navigation, import and export transportation between China, Myanmar, Thailand and Lao PDR. There was sand and gravel bars on the left side (Lao PDR.) and the right bank had an artificial bank such as a concrete embankment, stair and hard barrier. This site was surrounding by huge communities, which has about 10,000 inhabitants especially in Thailand side. The riparian zone consisted of some forest, land slide, cattle such as water buffalo mainly on the left side. In addition, on the right side were soil erosion, algae and aquatic plant and local market. The substrate was sand, clay, mud and gravel. The human impacts were appeared on this site including road construction (In left side, Loa PDR.) boat navigation, construction, domestic waste, disposal from human and trading activities.

Site TKO, (Thailand Kok River)**,** Kok River at the Chiang, Chiang Rai Province.

This site was also sampled in year 2004, 2005, 2008, 2011 and 2013. The left bank had a 30° slope and the right bank was flat. Both banks were eroded and riparian areas consist of forest, with agricultural development on the left bank but the right were changed to a resort and tourist recreation area. There was a cobble and gravel area in the centre of the river. Human influences were included agriculture runoff, navigation as a tourist boats created wave action along the banks. The substrate types were sand, cobble and gravel.

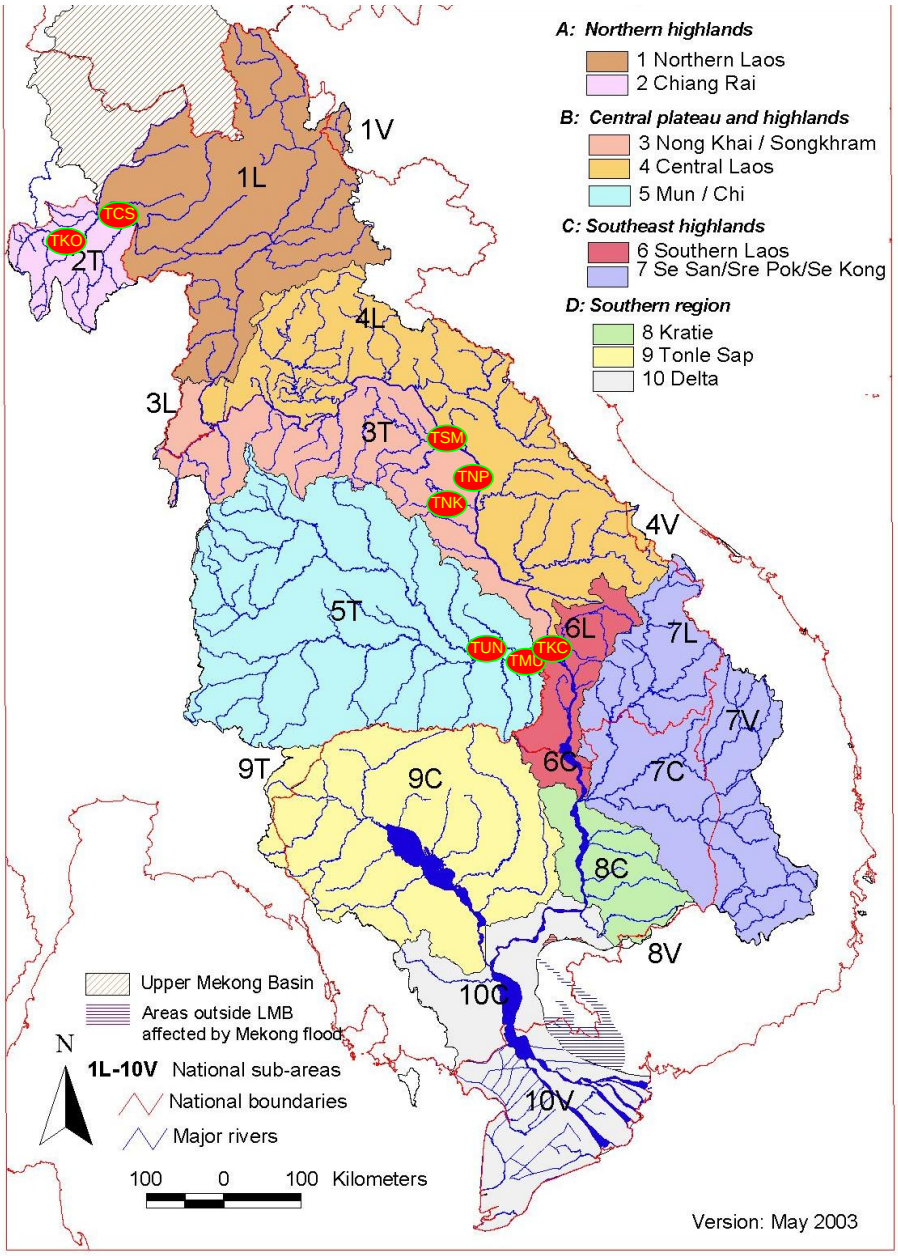

Figure 1. Sampling stations for Ecological Health Monitoring program in the 2015

TNP : Thailand Nakorn Panom, Mekong River at Nakorn Panom Province
TSM : Thailand Songkarm Mount, Mekong River at the connection between Songkram River and Mekong River
TNK : Thailand Nam Kham River, Nam Kham River at the Mukdaharn Province.
TMU : Thailand Mun River, Mun River at the Kong Chiam District, Ubonrachathani Province.
TKC: Thailand Mekong River , Mekong River at the Kong Chiam District, Ubonrachathani Province.
TUN: Thailand Ubon New, Mun River at the Ubonrachathani Province.
TCS : Thailand Chiang San, Mekong River at the Chiang San District, Chiang Rai Province.
TKO: Thailand Kok River, Kok River at the Chiang, Chiang Rai Province.

	
TNP, Thailand Nakorn Panom	TSM, Thailand Songkarm Mount
	
TNK, Thailand Nam Kham River	TUN, Thailand Ubon New
	
TKC, Thailand Mekong River	TMU, Thailand Mun River
	
TCS, Thailand Chiang San	TKO, Thailand Kok River

Figure 2. The sampling stations for Ecological Health Monitoring program in the 2015

2.2 The schedule for 2015 EHM Sampling Activities

The sample collection and travelling were spending up to 10 days the description of activities and transportation and the list of team member are as Table 1 and Table 2.

Table 1. The description of activities and transportation.

Date	Description of activities	Site name	Accommodation and trasportation	Remark
31 Mar 15	Team member -First meeting and team preparation		- Stay at Nakon Phanom - 1 van	
1 Apr 15	Sampling at Nakonphanom	Thailand Nakorn Panom (TNP)	- Stay at Nakon Phanom - 1 van - 2 boats	
2 Apr 15	Sampling at Song Kram River and traveling to Mukdaharn	Thailand Songkarm River mount (TSM)	- Stay at Mukdaharn - 1 van - 2 boats	
3 Apr 15	Sampling at Nam Kam River and traveling to Ubonrachatani	Thailand Nam Kham (TNK)	- Stay at Ubonrachatani - 1 van - 2 boats	
4 Apr 15	Sampling at Mun River, Ubonrachatani Sampling at Mekong River, Khong Chaim	Thailand Mun River (TMU) Thailand Khong Chaim (TKC)	- Stay at Ubonrachatani - 1 van - 2 boats	
5 Apr 15	Sampling at Mun River, near Ubonrachathani city	Thailand Ubon New (TUN)	- Stay at Ubonrachatani - 1 van - 2 boats	
6 Apr 15	Traveling from Ubonrachatani – Bangkok-Chiang Rai		- Stay at Chiang Rai - 1 van	
7 Apr 15	Sampling at Mekong River, Chiang San(site TCH)	Thailand Chiang San (TCH)	- Stay at Chiang Rai - 1 van - 2 boats	
8 Apr 15	Sampling at Kok River, Chiang Rai (site TKO) Team member -Revise data and conclude site disturbance score - final meeting and recheck the samples	Thailand Kok River (TKO)	- Stay at Chiang Rai - 1 van - 2 boats	
9 Apr 15	-Traveling back to Chiang Mai, Khonkane and Bangkok		- 1 van	

Table 2. The list of team member

No.	Name - Lastname	Position	Office
1	Mr. Tatporn Kunpradid	EHM National Expert, Team leader	Rajabhat Chiang Mai University
2	Mr. Songyot Kullasoot	National Expert	Chiang Mai University
3	Mr. Nirut Tengpongsathorn	National Expert	Rajabhat Chiang Mai University
4	Mr. Atinut Joradol	National Expert	Chiang Mai University
5	Ms. Sujeephon Atibai	National Expert	Khon Kaen University
6	Ms. Benjamas Suksai	National Expert	Khon Kaen University
7	Ms. Em-on Sriariyanawath	National Expert	Khon Kaen University
8	Ms. Thitima Phuavong	EP Coordinator,	TNMCS, Dept. of Water Resources
9	Mr. Rathaphum Nakhamphan	EP Coordinator,	TNMCS, Dept. of Water Resources

2.3 The activities

Respective roles and responsibilities of team member and duties are as follows

- The site descriptions such as the coordinate, elevation and some physical and chemical will be measured environment parameters include DO, pH, Conductivity and water transparency as required at the eight selected sites.
- The biota samples of four organism including Zooplankton, benthic Diatoms, benthic macroinvertebrates and littoral macroinvertebrates at the eight selected sites were collected by team members.
- Habitat Assessment (HA) and Site Disturbance Score (SDS) based on the experts' visual assessment and scoring of the surrounding landscape at each selected site according to sampling method that described in Biomonitoring Handbook.
- Preserve and transport the biota samples follow the guideline that described in the Biomonitoring Handbook.

2.4 The field methodology

Physical and chemical measurement

The variables describing the physical and chemical environments provide essential information for characterising aquatic ecosystems, because these factors directly influence the structure and function of an ecosystem's biological components. Physical and chemical variables are widely used to set water-quality standards and can be used to assist in interpreting biological trends and patterns. The sampling methods in the 2015 survey generally followed those used in the previous study (2011, 2011, 2008 and 2004-2007). The map coordinates and altitudes of the sampling sites were determined with a Garmin GPS 12xL, and stream width was collected by the secondary data for the hydrology station. At each site, water-quality measurements were made in three sections of the river: near the left bank, near the right bank, and in the centre of the river.

A Secchi disc was used to determine water transparency. The disc was slowly lowered into the water, and the depth at which it could no longer be seen was recorded. The disc was then lowered another metre and slowly pulled up until it reappeared. If it reappeared at a

depth more than 0.05 m different from the depth at which it disappeared, the procedure was repeated.

Water turbidity was measured at the water surface with a Hach 2100P turbidity meter. Temperature, DO, EC, and pH were measured with YSI 556MP5 meter, calibrated according to the manufacturer's instructions. Readings were taken at the surface of the river, whichever was less.

Benthic diatoms

Ten points were sampled at intervals of about 10 m. At each point a single stone was selected that appeared to contain a thin brownish film or a slippery feel, which are often signs of a coating of abundant benthic diatoms. For each point that had no stones, the nearest hard substratum was sampled. To sample the diatoms, a plastic sheet with a 10 cm^2 square cut-out was placed on the upper surface of the selected stone or other substratum, and benthic diatoms were brushed and washed off into a plastic bowl until the cut-off area was completely clear. Each sample was transferred to a plastic container and labelled with the site name, location code, date, and replicate number. The collector's name and substratum type were also recorded. Samples were preserved with Lugol's solution.

Zooplankton

Three samples were collected at each site. One was taken near the left bank of the river, at a distance of about 4–5 m from the water's edge. A separate sample was taken at a similar distance from the right bank, and another in the middle of the river. The samples were taken at least 1 m from potentially contaminating substances such as debris and aquatic plants, and at least 2 m from vertical banks. At sites where the water current was too fast to sample exactly in the mid-stream, samples were collected closer to the left or the right bank, but not as close to the bank as where the 'side samples' were taken. Quantitative samples were collected at a depth of 0 to 0.5 m in a bucket having a volume of 10 L. The 10 L of river water collected was filtered slowly through a plankton net (mesh size of 20 μm) to avoid any overflow. When the water volume remaining in the net was about 150 mL, the water was transferred to a plastic jar (250 mL volume). The samples were immediately fixed in the field with 4% formaldehyde. The sample jars were labelled with the site name, site code, sampling position, sampling date, and the sample number.

Literal macroinvertebrates

At each site littoral macroinvertebrate samples usually were taken on only one side of the river. In most instances this was the depositional side where sampling was easier because of the gradual shelving of the bottom that occurs in this setting in contrast to the steeper bottom that is characteristic of the erosion side. In addition, the depositional side tends to support more aquatic vegetation, which also provides more habitats suitable for invertebrates. Because the study area was large, a wide range of littoral habitat types was sampled. As far as possible, similar habitats were selected at each site to facilitate comparisons among sites. A D-frame net with 30 cm x 20 cm opening and mesh size of 475μm was used. Sweep samples were taken along the shore at intervals of about 20 m. To obtain each sweep sample, the collector stood in the river about 1.5 m from the water's edge and swept the net toward the bank 10 times near the substrate surface. Each sweep was done for about 1 m at right angles to the bank, in water no deeper 1.5 m, and did not overlap the previous sweep. Ten sweep samples were taken per site, unless there was no suitable habitat for kick sampling, in which case ten sweep samples were taken.

After sample collection, the net contents were washed to the bottom of the net. The net was inverted and its contents were emptied into a metal sorting tray, with any material adhering to the net being washed off with clean water. Invertebrates were picked from the tray with forceps and placed in a jar of 90% ethanol. Small samples were kept in 30 mL jars and large samples were kept in 150 ml. jars. During the picking process, the tray was shaken from

time to time to redistribute the contents, and tilted occasionally to look for animals adhering to it. Sorting proceeded by working back and forth across the tray until no more animals were found. A second person then checked the tray to be sure that no animals remained. The sample jars were labelled with the site location code, date, and sample replicate number. The collector's name, the sampling site, and replicate characteristics (including substrate types sampled) were recorded in a field notebook.

Benthic macroinvertebrates

At each sampling location, a composite of four samples was taken with a Petersen grab sampler, covering a total area of 0.1 m^2. Grab contents were discarded if the grab did not close properly because material such as wood, bamboo, large water-plants, or stones jammed the grab's jaws. In these cases the sample was retaken. The sample will be washed through a sieve (0.3 mm) with care taken to ensure that macroinvertebrates did not escape. The contents of the sieve were then placed in a white sorting tray and dispersed in water. All the animals in the tray were picked out with forceps and pipettes, placed in jars, and fixed with formaldehyde. Samples of less experienced sorters were checked by an experienced sorter. The sample jar was labelled with site name, location code, date, position within the river, and replicate number. The sampling location conditions, collector's name and sorter's name were recorded on a field sheet. Sometimes, samples could not be sorted on because a very large number of animals were collected, because there was insufficient time at a site, or because the presence of lumps of clay caused the samples to cloud continually. In these cases, samples were sorted in the laboratory.

Table 3. The sampling station data of 2015 Ecological Health Monitoring in Thailand.

Site name	Code	Date	Coordinate (Lat-Long)				GPS elevation (m)	Width (m)	Depth (m)		
			RB (E)	RB (N)	LB (E)	LB (N)			Left	Middle	Right
Thailand Nakorn Panom	TNP	1.04.2015	E104^{0}46'492"	N17^{0}25'513"	-	-	135	950	2.45	3.07	1.90
Thailand Songkarm Mount	TSM	2.04.2015	E104^{0}28'191"	N17^{0}39'067"	E104^{0}28'089"	N17^{0}39'027"	135	1,100	0.34	0.83	1.53
Thailand Nam Kham	TNK	3.04.2015	E104^{0}32'099"	N16^{0}57'217"	-	-	140	38	0.50	1.67	1.27
Thailand Mun River	TMU	4.04.2015	E105^{0}29'125"	N15^{0}18'100"	E105^{0}29'062"	N15^{0}18'098"	85	350	2.10	6.00	2.90
Thailand Khong Chaim	TKC	4.04.2015	E105^{0}29'303"	N15^{0}19'693"	-	-	90	1,250	3.88	6.00	3.00
Thailand Ubon New	TUN	5.04.2015	E104^{0}46'492"	N15^{0}14'573"	E104^{0}57'225"	N15^{0}14'490"	109	135	3.35	5.60	1.71
Thailand Chiang San	TCS	7.04.2015	E100^{0}05'914"	N20^{0}15'414"	E100^{0}05'771"	N20^{0}15'783"	360	750	0.98	3.42	1.50
Thailand Kok River	TKO	8.04.2015	E99^{0}47'125"	N19^{0}54'740"	E99^{0}47'104"	N19^{0}54'773"	395	90	0.40	1.00	0.42

Table 3. (Continue)

Site Name	Land use and cover		Substratum		Potential human impacts
	Left bank	Right bank	Littoral	Channel	
Thailand Nakorn Panom	Agriculture, few house, shoreline agriculture, artificial bank and pier	Agriculture, some trees on bank, many fish farms	Clay and Mud, Bed rock Wood debris,	R- mud and clay C- Bed rock and Cobble L-mud and clay	Rubbish disposal, Agriculture runoff, fish farming, bank erosion and aquaculture
Thailand Songkarm Mount	Forest , land slide, few houses, cattle grazing, aquatic plant and algae,	Small scale agriculture, pier, floating fish cages and fish trap	Sand and clay, Firm mud and firm sand	R-sand, mud C-sand, mud L-clay and sand	Restaurant, fish cage, disposal of human wastes, agriculture runoff and livestock waste
Thailand Nam Kham	Soil erosion, few house, wood and leaf debris	Soil erosion and land slide, bamboo range, wood and leaf debris	Sand and clay Gravel, mud, leaf and wood debris,	R-gravel and sand C- sand and leaf debris L-sand and mud	Human wastes and rubbish disposal from upstream, Bank erosion and fishing
Thailand Mun River	Grass fields, temporary agriculture, house and floating houses, soil erosion, cattle grazing	Fish farm, vegetation house and floating house	Sand and gravel, leaf and wood debris	R- sand and bed rock C- clay and sand L- sand and gravel	disposal of human and animal wastes, agriculture runoff, urban runoff
Thailand Khong Chaim	Village, agriculture, cattle grazing, fish farm	Bed rock and cobble, with many small channels and soil erosion	Bed rock, leaf and wood debris, sand, silt and mud	R-Mud and sand C-sand and clay L-sand and firm mud	Agriculture runoff, livestock damage to banks, urban runoff
Thailand Ubon New	Few house, small scale agriculture, aquatic plants	Aquatic plant and few house	Sand and silt, leaf and wood debris	R- sand and firm mud C-sand and clay L-sand and firm mud	Navigation, agriculture runoff and fishing
Thailand Chiang San	Road and embankment construction, soil erosion, algae, weed and aquatic plant	Mud, aquatic plant and few house, pier and docks, market and large community	Cobble and gravel, sand and clay, firm sand gravel	L- sand and gravel M- firm sand R- bed rock and cobble	Navigation, construction, domestic waste, disposal from human and market
Thailand Kok River	Gravel and sand, algae, weed and aquatic plant	Resort and tourist activities, temporary pier	Cobble and gravel, sand	L-gravel and sand M- sand and silt R- grave	Tourist area, community waste, agriculture runoff, navigation, market and tourist activities

3. THE RESULT

3.1 Environnemental Variables

The environmental variables had broad ranges across the widely dispersed at all study sites. The water temperature was slightly different from site to site, with an about of 21.03°C – 32.63°C. Low temperatures were recorded at most of the upstream main channel; TCS was same as year 2013 and 2011 sampling, with the lowest value of 21.03 °C recorded. Higher temperatures were recorded in TNK and TUN, with the highest values of 32.0 °C in the Nam Kham River and Mun River. The average dissolved oxygen (DO) concentrations in all sampling sites were slightly higher than the previous investigation. The DO were generally moderate to high compared to those typically reported for tropical running waters, with an average of 6.33 – 8.95 mg/L. Highest DO values were recorded at the value of 8.95 mg/L at Mekong River at Chiang San. The lowest DO values were found at sites at Mun River, TMU with the value 6.33 mg/L. The water was neutral range at most of the sites, with pH value varying between 7.36 and 8.93. The highest pH and lowest pH values were similar with previous study in 2011 and 2013. The highest pH recorded as 8.53 at Kok River (TKO), and the lowest at Mekong River at Nam Kam River (TNK) with the value 7.36. The electrical conductivity was the widely range from 87.57 to 424.10 μS/cm. The highest conductivities were found at the TUN sites (424.10 μS/cm) while, the lower conductivity was found at sites in the Mun River, TMU (87.57 μS/cm).

The environmental variables at the sampling sites were mostly within the natural ranges expected for surface waters in this region. Some parameters were slightly higher than the previous study such as DO. The average of DO was slightly increased compare to the previous study in 2011 and 2013. Both surveys have been done in mid-summer (March and May) as well as this year sampling. However, some parameter was different result such as Secchi depth. The Secchi depth in this year investigation shows the lower value that represents the higher turbidity. On the other hand, the water level in the Mekong main channel slightly increasing compare to the normal level in dry season. The water body also showed the high turbidity and low temperature especially in the site TCH, the upstream Mekong main channel. For overall results, the parameters were within the ranges defined for aquatic ecosystems according to the standards for surface water quality set by Thailand, Vietnam, and Cambodia and could be classified to the 2-3 categories when compared to the Water Quality Standards of Thailand. (MRC, 2005; PCD, 2000).

Table 4 Environmental variable collected in 2015 EHM Thailand

		Depth (m.)	Secchi depth (m.)	Temp. (C^0)	DO (mg/L)	pH	Conduct. (µs/cm)
TNP	Left	2.45	0.31	27.83	6.95	7.72	259.33
	Middle	3.07	0.28	28.03	7.28	7.77	252.67
	Right	1.90	0.30	27.50	7.04	7.55	271.40
TSM	Left	0.34	0.33	27.87	7.70	8.18	259.83
	Middle	0.83	0.35	27.80	7.32	8.03	245.93
	Right	1.53	0.39	28.07	6.98	8.16	288.03
TNK	Left	0.50	0.50	31.43	6.93	7.47	297.53
	Middle	1.60	1.53	31.77	6.91	7.48	296.93
	Right	1.27	1.27	32.10	7.17	7.36	296.03
TMU	Left	2.10	1.92	31.10	6.47	7.50	87.99
	Middle	6.00	2.43	31.00	6.33	7.45	87.57
	Right	2.90	1.90	31.47	6.70	7.67	87.57
TKC	Left	3.88	0.68	28.83	7.06	8.42	248.27
	Middle	6.00	0.87	28.73	7.11	8.16	241.97
	Right	9.00	0.74	28.33	7.08	8.53	241.60
TUN	Left	3.35	1.20	31.77	7.75	7.78	420.77
	Middle	5.60	1.42	31.83	7.88	7.99	424.10
	Right	1.71	1.21	32.63	8.95	8.49	418.10
TCS	Left	0.98	0.61	21.03	8.31	8.27	312.70
	Middle	3.42	0.88	21.10	8.11	7.62	311.17
	Right	1.50	0.90	21.83	7.57	8.24	295.60
TKO	Left	0.40	0.40	26.47	7.31	7.73	140.63
	Middle	1.00	0.97	27.07	7.21	7.76	116.40
	Right	0.42	0.42	26.60	7.08	7.49	123.73

3.2 Biota collected

Benthic Diatoms

The 8 sites were sampled in 2015, yielded a total of 116 species of benthic diatoms out of the 254,986 cell count from benthic diatom samples collected. The most common species were found in order Naviculales as well as 2013 studied (Appendix 1, Table 5 and Table 7). *Cymbella turgidula*, *Cyclotella* spp. and *Gomphonema* spp. were the highest amount and distribution at all sites sampled.

Richness (number of taxa)

Species richness per site ranged from 9.5 to 19.6 at the Thailand sampling sites (Appendix 1). The highest richness was found at sites in Mun River as TMU (19.6), while the lowest richness was found at the sites TNP (9.2).

Abundance

The average density of diatoms ranged from 404 to 3,830 cells/cm^2 at the sampling sites (Table 5). The highest abundance was found at site TKO (3,830 cells/cm^2), while the lowest abundance was found at the Mun River sites at Ubonrachatani (404 cells/cm^2) whereas, almost of substrate are firm mud and sand.

Zooplankton

The 8 sites sampled in 2015 yielded a total of 30 species of zooplankton out of the 1,126 individuals collected (Appendix 1, Table 5 and Table 8). The zooplankton number and richness were significantly decreasing compared to the 2011 and 2013 studied. *Keratella* spp. and *Copepoda* (nauplius and copepodate) had the highest amount and distribution from the sampled.

Richness (number of taxa)

Species richness per site ranged from 1.3 to 14.7 at the 2015 sites (Appendix 5 and Table 8). The highest richness occurred at sites TUN (14.7), while the zooplankton was lowest richness at the Mekong River at Songkram Mount (TSM, 1.3) The unappropriated environmental condition such as the high turbidity at the Mekong River main channel may impact to the distribution of Zooplankton, such as TNP, TSM, TKC and TCS. The zooplankton richness was significantly decreasing from the year 2013 study.

Abundance

The average abundance of zooplankton was ranged from 3 to 166 individuals from 8 study sites (Appendix 1). The highest abundance occurred at site TMU (166 individuals), while the lowest abundance was found at the Mekong River at TSM and TKC. The zooplankton abundance was significantly decreasing from the year 2013 study.

Littoral macroinvertebrates

The 8 sites sampled in 2015 sampling yielded a total of 173 species of littoral macroinvertebrates out of the 15,041 individuals collected (Appendix 1, Table 5 and Table 9). *Cloeon* sp and *Caridina* sp. were a common distribution at all sites sampled as 2013 studied.

Richness (number of taxa)

Species richness per site ranged from 3.9 to 23.4 at the 2015 sampling sites (Table 5). The highest richness occurred at sites TNK (23.4), while the lowest richness was found at the TCS (3.6) as well as 2013 investigation. However, the overall richness increased comparing with the previous study especially, 2013 investigation.

Abundance

The average abundance ranged from 7 to 662 individuals (Appendix 1 and Table 5). The highest abundance occurred at site TUN (662 individuals), while the lowest abundance was found at the Mekong River at Chiang San (TCS). The TCS had lowest abundance of littoral macro invertebrate since 2011 study. This study site had high velocity and turbidity. However, the overall abundance in this year study was slightly increasing when compared to the pervious study.

Benthic Macronivertebrates

The 8 sites sampled in 2015 yielded a total of 109 species of benthic macroinvertebrates out of the 6,368 individuals collected ((Appendix 1, Table 5 and Table 10). *Anagenisia* sp. was the highest amount 1,151 individuals. *Melanoides* sp., *Stenothyra* sp., *Polypedilum* sp. and *Corbicula* sp. was a common distributed species at all sites sampled.

Richness (number of taxa)

Species richness per site ranged from 10.3to 27.4 at the 2015 sites (Appendix 1 and Table 5). The highest richness occurred at sites TKO (24.7), while the TCS was found lowest benthic macronivertebrates richness (10.3). This site had the lowest benthic macroinvertebrate since 2011 study. This site were contains a sandy and muddy substrata and fast flowing current.

Abundance

The average abundance of benthos ranged from 65 to 545 individuals at the 2015 study (Appendix 1 and Table 5). The highest abundance occurred at site TNP (545 individuals), that had a soft and suitable substrate to this organism such as mud, sandy and gravel. On the other hands, lowest abundance was found at the Mekong River at Chiang San (TCS) that had high velocity. However, the distributions of benthos were significantly increasing compared to the previous study.

Table 5 The biological metric from 2015 Thailand EHM activities

Site Code	Sampling date	Summary of biological metric values											
		Diatom			Zooplankton			Littoral Macroinvertebrate			Benthos		
		Abundance	Average richness	ATSPT	Abundance	Average richness	ATSPT	Abundance	Average richness	ATSPT	Abundance	Average richness	ATSPT
TNP	01-04-15	1,518	14.2	44.9	9	3.0	40.5	96	11.6	40.3	545	18.3	40.4
TSM	02-04-15	1,909	16.0	43.0	3	1.3	43.0	57	7.4	41.9	235	14.7	42.0
TNK	03-04-15	1,047	19.0	34.7	18	6.0	36.5	430	23.4	34.4	471	20.7	36.7
TMU	04-04-15	404	11.7	38.0	166	13.0	38.0	91	10.1	40.6	269	19.0	39.9
TKC	04-04-15	1,325	18.3	41.7	3	2.3	41.8	78	8.9	40.2	115	12.0	40.8
TUN	05-04-15	897	13.3	40.2	171	14.7	39.9	662	21.5	31.7	215	15.3	38.4
TCS	07-04-15	1,913	19.6	42.8	4	3.3	42.2	7	3.9	43.2	65	10.3	43.4
TKO	08-04-15	3,830	9.5	41.1	6	2.0	44.9	83	17.5	35.1	208	24.7	37.4

3.3 The site assessment

The site assessments of eight sampled sites in Thailand from 2015 activity were compared to the guideline of EHM Bio-monitoring Handbook. The sites were classified and

grouped according to the number of 12 indicators that meet the guidelines (MRC 2008). The sites from this year investigation were classified into only top two classes, class A and Class B. The class A is site TSM, TMU, TKC and TUN. The class B is sites TNP, TNK, TCS, and TKO. The site classification revealed that the sampling sites in Thailand for 2015 investigation were good ecological health and good to moderate impacted from human activities. The distribution of organisms almost meets the guideline criteria. The factors that made a high classification were the distributions of the four biological groups and the three metrics to assess of the site (average abundance, average richness, and ATSPT). The abundance and richness were increased in abundance for benthic diatom, lateral and benthic macro invertebrate but decreasing for Zooplankton. The richness is slightly different from the previous study. The overall richness is increasing except the zooplankton. In this year, the result from guideline shown changing category position as TKC and TSM were better (Class B to A) whereas, TNP and TNK changed from A to B. However, the overall classification was similar when compared to the previous study. The impacts in some sites have been continued such as a construction, river bank development, tourist activities and navigation and fish farming as site TCS, TKO and TNP. Moreover, the erosion and riverbank collapse were found in site TNK On the other hand, the sites that have not changing of the classification were slightly better even though the class is similar with previous study as TCS and TKO. Those sites were classified in class B but the numbers of the meeting of the guideline were higher.

Table 6 The site assessment and classification from 2015 Thailand EHM activities that compared to the guideline of EHM 2004-2007, 2008, 2011 and 2013

Site code	Sampling date	Diatom			Zooplankton			Littoral sweep			Benthos			No. meeting guideline	Class
		Abundance	Average richness	ATSPT	Abundance	Average richness	ATSPT	Abundance	Average richness	ATSPT	Abundance	Average richness	ATSPT		
TNP	05-Mar-2008	Y	N	N	Y	N	Y	N	N	Y	Y	Y	Y	7	B
TNP	31-Mar-2011	Y	Y	N	N	N	N	Y	Y	Y	Y	Y	Y	8	B
TNP	15-Jun-2013	Y	Y	N	Y	Y	Y	Y	Y	N	Y	Y	Y	10	A
TNP	**1-Apr-2015**	**Y**	**Y**	**Y**	**N**	**N**	**N**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**9**	**B**
TSM	26-Mar-2007	N	N	N	Y	Y	Y	N	Y	Y	Y	Y	Y	8	B
TSM	06-Mar-2008	Y	Y	N	Y	N	Y	Y	Y	Y	Y	Y	Y	10	A
TSM	01-Apr-2011	Y	Y	N	N	N	N	Y	Y	Y	N	N	N	5	C
TSM	16-Jun-2013	Y	Y	N	Y	Y	Y	N	Y	N	Y	Y	Y	9	B
TSM	**2-Apr-2015**	**Y**	**Y**	**Y**	**N**	**N**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**10**	**A**
TNK	24-Mar-2007	N	Y	N	Y	Y	Y	N	Y	Y	N	Y	N	7	B
TNK	07-Mar-2008	Y	Y	N	Y	N	Y	N	Y	Y	Y	Y	Y	9	B
TNK	02-Apr-2011	N	Y	Y	N	N	N	Y	Y	Y	Y	Y	Y	8	B
TNK	17-Jun-2013	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	11	A
TNK	**3-Apr-2015**	**Y**	**Y**	**N**	**N**	**N**	**N**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**8**	**B**
TMU	26-Jun-2004	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	N	10	A
TMU	08-Mar-2008	Y	N	N	Y	Y	Y	N	Y	Y	Y	Y	Y	9	B
TMU	03-Apr-2011	Y	Y	N	N	N	N	Y	Y	N	Y	Y	Y	7	C
TMU	18-Jun-2013	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	11	A
TMU	**4-Apr-2015**	**Y**	**Y**	**N**	**Y**	**Y**	**N**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**10**	**A**
TKC	09-Mar-2008	Y	Y	N	Y	N	Y	N	N	Y	Y	Y	Y	8	B
TKC	05-Apr-2011	Y	Y	N	N	N	N	Y	Y	N	Y	Y	Y	7	C
TKC	18-May-2013	Y	Y	N	Y	Y	Y	N	N	N	Y	Y	Y	8	B
TKC	**4-Apr-2015**	**Y**	**Y**	**Y**	**N**	**N**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**10**	**A**
TUN	10-Mar-2008	N	Y	N	Y	N	Y	Y	Y	Y	Y	Y	Y	9	B
TUN	04-Apr-2011	Y	Y	Y	Y	N	N	Y	Y	Y	Y	Y	Y	10	A
TUN	19-May-2013	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	11	A
TUN	**5-Apr-2015**	**Y**	**Y**	**Y**	**Y**	**Y**	**N**	**Y**	**Y**	**N**	**Y**	**Y**	**Y**	**10**	**A**
TCS	11-Mar-2008	Y	Y	N	N	N	Y	N	N	Y	Y	Y	Y	7	B
TCS	07-Apr-2011	Y	Y	N	N	N	N	Y	Y	N	Y	Y	Y	8	B
TCS	21-May-2013	Y	Y	N	N	N	Y	N	N	Y	Y	Y	Y	7	B
TCS	**7-Apr-2015**	**Y**	**Y**	**Y**	**N**	**N**	**Y**	**N**	**N**	**Y**	**Y**	**Y**	**Y**	**8**	**B**
TKO	17-Mar-2005	Y	Y	N	Y	Y	N	Y	Y	Y	Y	Y	Y	10	A

TKO	12-Mar-2008	Y	Y	N	Y	N	N	N	Y	Y	Y	Y	Y	8	B
TKO	08-Apr-2011	Y	Y	N	N	N	Y	Y	Y	N	Y	Y	Y	8	B
TKO	22-May-2013	Y	Y	Y	Y	N	Y	N	N	N	Y	Y	Y	8	B
TKO	**8-Apr-2015**	**Y**	**Y**	**Y**	**N**	**N**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**N**	**9**	**B**

4. GENERAL CONCLUSIONS

The 2015 Ecological Health Monitoring sampling was conducted at eight sites in Thailand (two in northern and six in north-eastern). This report summarized the establish site assessment scores for the freshwater fauna and flora and corroborate with the chemical and physical parameter measurements. The biological assemblage of the diatoms, the zooplankton, the littoral and benthic macroinvertebrates (benthos) were studied.

A main aim of the 2015 program was investigated of abundance, richness and ATSPT for each group of organisms to evaluate their potential in the assessment of the ecological health of the Lower Mekong River in Thailand part. The results will describe the floral and faunal components of the assemblages in the samples collection in Thailand, then use this information to derive indicators of the ecological health of the sites examined in 2011 and 2013 Thailand EHM activities.

Flora and Fauna distribution

The 116 species of benthic diatoms out of the 254,986 cell count from benthic diatom samples were identified from samples collected. The most common species were *Cymbella turgidula*, *Cyclotella* spp. and *Gomphonema* spp. A total of 1,126 inividuals zooplankton, representing 30 species were identified from sample collected. The *Kelatella* spp. and *Copepoda* (nauplius and copepodate) were the highest amount and distribution at all sites sampled. The 173 species of littoral macroinvertebrates out of the 15,041 individuals were identified. Among the littoral macroinvertebrate, the *Cloeon* sp and *Caridina* sp. had a common distribution at all sites sampled. The 109 species of benthic macroinvertebrates out of the 6,368 individuals were identified. *Melanoides* sp., *Stenothyra* sp., *Polypedilum* sp. and *Corbicula* sp. were a common distribution species at all sites sampled.

Richness

Species richness per site of benthic diatom ranged from 9.5 to 19.6 at the Thailand sites. The highest richness was found at sites in Mekong tributary as the Mun River (TMU) as well as 2013 studied, while the lowest richness was found at the Kok River TKO. The zooplankton richness was ranged from 1.3 to 14.7. The highest richness occurred at sites TUN (14.7), while the lowest zooplankton was found at the shallow canal, high turbidity and fast currents at Mekong River main channel at Songkram mount, TSM. The zooplankton richness was significantly decreasing from the previous study, especially 2013 investigation. The species richness of littoral macroinvertebrate and benthos were ranged from 3.9 to 23.4 and 10.3 to 24.7 respectively. The lowest richness of both organism occurred at sites TCS, while the highest richness was found at Mekong tributaries as Kok River (TKO) and Namkam River (TNK). The highest richness of littoral macroinvertebrate was occurred at TNK, the small tributary contained with sandy sediment and soft substratum. The highest richness of benthic macroinvertebrate was occurred at TKO, the tributary that contained with gravel and cobble

substrate. However, the overall richness of 2015 studied were higher compared to the previous study, accept the zooplankton richness that decreased in all sampling site.

Abundance

The average density of diatoms ranged from 404 to 3,830 cells/cm^2 at the EHM 2015 sites. The lowest abundance was found at the Mun River sites at Ubonrachatani (404 cells/cm^2) due to the substrates in this area are firm mud and sand whereas the highest abundance occurred at site Kok River (TKO, 3,830 cells/ cm^2).

However, these samplings were lowest richness in this year study. The average abundance of zooplankton was ranged from 3 to 166 individuals. The highest abundance occurred at site TMU (166 individuals), while lowest abundance was found at the Mekong River at Songkram mount and Khong Chaim sites (TSM and TKC). However, the abundance of this year studied was very low compared to the previous studied especially, 2011 and 2013.

The zooplankton abundance were found only 10 individuals from half of sampling site in this year. The average abundance of littoral macro invertebrate ranged from 7 to 662 individuals. The highest abundance occurred at site TUN (662 individuals), while the lowest abundance was found at Mekong Main Channal at Chiang San (TCS) as same as 2013 studied. The average abundance of benthos ranged from 65 to 545 individuals. The highest abundance occurred at Mekong River at Nakon Phanom (TNK). This site had a suitable substrate for this organism such as mud and sand, cobble and gravel. On the other hands, the lowest distribution was a strong current site in the Mekong River at Chiang San (TCS). However, the distributions of benthos were increasing compared to the previous study.

ATSPT

The Average Tolerance Score Per Taxon (ATSPT) of Benthic Diatoms samples were taken in 2015 and ranged from 34.7 to 44.9. The ATSPT within the site in this yeas has done by using benthic diatom is slightly higher from the previous investigate. The ATSPT of zooplankton was ranged from 36.5 to 44.9 and the scores are higher compared to the previous study. The ATSPT of Literal Macroinvertebrate was ranged from 31.7 to 43.2 and the score was wider range and slightly increasing compare to the previous investigates. The ATSPT of benthic macroinvertebrate in this year were higher than previous studied. It was wider and ranged from 36.7 to 43.4.

The overall ATSPT in this yeas study were slightly increasing compared to the previous study. In terms of the sites sampled throughout the entire Lower Mekong basin, a trend of decreasing ATSPT values is evident for the four biological groups examined. At all sampling sites including the main channel and tributaries showed scores that indicate of lower stress at the tributaries than the mainstream of the Lower Mekong (Table 5). However, the ATSPT were shown the various impacted to the study sites sampling over multiple years. The comparison between the Sites Disturbance Scores and the ATSPT scores could be more accurate and precise if continue for each biological assemblages and study sites in previous study.

In contrast, the metrics and the tolerance values obtained show much promise. All four organisms have a similar proportion of sensitive and tolerance species. In this report, the same tolerance scale was used for each of the groups of organisms examined. However the source score had to more develop. The added information may use to derive the ATSPT such as the Average Human Impact Score of Chemical and Physical Properties Score. The physical and chemical factors were investigated as the environmental variables. All conditions were mostly within the natural ranges expected for surface waters in this region. However, some parameters were slightly higher compared to the previous study. The turbidity (Secchi depth.)

was also high as well as the previous study. This may represent the characteristic of the Mekong River that had a high turbidity throughout the year. Another investigation was a score within the sites. The site assessment score was analysed by comment from the team member and the secondary data from the sites. The Site Disturbance Score (SDS) ware range from 1.45-2.34. It reveals that all sites were the riparian zone consisted of moderate disturbance of the human impact such as navigation, mining, construction and trading activities. In some site was classified in moderate to high score since 2011 studied such as TCS (Thailand, Chiang San, Mekong River). This site was disturbed by a bank construction, navigation and soil erosion. However, the most disturbances found in every sampling sites were human activities included the agricultural, human wastes and rubbish disposal, and the river bank modification.

Site assessment

The site assessments of eight sampled sites in Thailand from 2015 sampling activity were compared to the data of EHM 2004-2007, 2008, 2011 and 2013. The sites were classified and grouped according to the number of 12 indicators that meet guidelines (MRC 2010a). The sites in this year investigation were classified to two classes. The class A is site TNP, TNK, TMU and TUN. The class B is sites TSM, TKC, TCS, and TKO. The site classification revealed that the sampling sites in this year investigation were good ecological health and slightly to moderate impacted from human activities. The overall results shown that almost the sites were similar classification compare to the previous study although some sites were classified better or worse category such as site TSM. The main factors that influence to the classified could be the richness in some organisms such as zooplankton and the ATSPT in some sampling sites.

In this year investigation, the biological distribution including richness and abundance of all organisms were slightly increasing. Not only the better appropriate habitat of mid dry season but the physical and chemical properties also corroborated. The number of richness and abundance in this year and two previous studied (2011 and 2013) reveal that the standard of identification that change from the national team to the riparian country and recently identification documents. However, this investigation is sampling in the same sites after several year collected. From the several year collections, the data showed the trend of environmental changing and the trend of biological distribution. The distribution not only revealed the changing from the riparian development but would response the impact from the global warming and atmospheric changes. This is the usefulness data for the biological indicator application in EHM of lower Mekong Basin.

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