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The 4th Cambodian Water Conference & Exhibition

INSTITUTE OF TECHNOLOGY OF CAMBODIA

GRADUATED SCHOOL
OF
WATER AND ENVIRONMENTAL ENGINEERING

WATER QUALITY ASSESSMENT OF TONLE SAP LAKE, CHNUK TRU COMMUNE, CAMBODIA AS ALTERNATIVE WATER SUPPLY

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Dr. HEU Rina

Presenter:
Ms. VAT Nimol

Content of the Presentation

01 INTRODUCTION

02 METHODOLOGY

03 RESULTS AND DISCUSSION

04 CONCLUSION AND RECOMMENDATION

INTRODUCTION

Overview of Tonle Sap Lake

- Cover area:
  - 3,000 km2 (Dry)
  - 15,000 km2 (Rainy) (Uk et al., 2018)
- Lake receive water: Mekong (53.5%), tributaries (34%), precipitation(12.5%) (Kummu et al., 2014)
- Village: 1037 ; water-based village: 53 ; land-based village: 948; water-land based village: 36 (Shivakoti et al., 2020)
- Chnok Tru Commune: 3 villages
- TSL Population: 5 millions (Ministry of Planning, 2013)
- Biodiversity: Fish (215), Bird (225), plant (370) (MRC 2010)

INTRODUCTION

LAKE WATER USAGE AND WATER POLLUTION

- People at TSL use lake water for domestic use, irrigation, fish production, aquaculture, transportation and tourism etc. tourism (Uk et al., 2018)
- Resident use lake water for drinking, cooking food, washing clothes, bathing, disposing of waste (Shivakoti et al., 2020)
- TSL water was polluted by anthropogenic activities (agriculture, aquaculture and human activities) (Uk et al., 2018)

INTRODUCTION

PREVIOUS STUDY

Techno-Science Research Journal 8 (2020) 8-15

Content list available at ITC

I.T.C

Techno-Science Research Journal

Journal Homepage: www.ric.itc.edu.kh

Assessment of Pesticide Residues in Surface Water, Sediment, and Fish from Chhnok Tru, Kampong Chhnang

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Abstract: *Pesticide residues in surface water, sediment and fish samples from Chnok Tru Floating Community of Tonle Sap Lake (TSL) was determined. Surface water and sediments from 18 sites were collected while 10 fish species were sampled from different locations of Chhnok Tru Floating Village. Samples were extracted by solid-phase extraction method using PLS3-AC2 cartridge and were subjected to analysis by GC-MS with an automated identification and quantification system. The results showed that 67% of water samples, 44% of sediment samples, and 70% of fish samples were contaminated with at least one pesticide compound. Among the 23 pesticide quantified, o,p'-DDT was the predominant pesticide commonly detected in all sample types. The highest concentration of o,p'-DDT was 2.32 µg/L in water, 18.3 ng/g dry weight in sediment, and 35.8 ng/g dry weight in fish samples. The presence of these pesticides in water, sediments and fish muscle brought about the great concern on not only ecosystem health but also public awareness. Therefore, spatial distribution and seasonal monitoring of these toxic chemicals should be further investigated to ensure the safety of aqua organism as well as human who dependent on this lake.*

Keywords:: Pesticide analysis, Chhnok Tru, Tonle Sap Lake

1. INTRODUCTION

The Tonle Sap Lake (TSL), also known as the Great Lake, is situated in the central plains of Cambodia. The Tonle Sap River, 120 km long, links the lake with the Mekong River. The lake is known for its rich biodiversity and exceptional water regime, with vast seasonal fluctuations in water level and volume (Keskinen, 2006). Fishing and crop cultivation in the TSL basin benefited from ample freshwater, nutrients and rich soils generated by seasonal flood pulse and rainfall; together these ecosystem services have sustained the region's livelihoods for centuries (Lin & Qi, 2017).

Agriculture is the economic backbone of Cambodia in which more than 70% of population use to be involved in agricultural activities (FAO, 2014; Jansen et al., 2011a). However, agriculture sectors face some constrain such as crop losses due to pest infestation. It is reported that global crop losses due to weeds accounted for 33 percent, 26 percent due to plant diseases, 20 percent to insect pests, and 21 percent to pests (Kimkhuy & Chhay, 2014). A number of global monitoring studies have shown the ability of pesticides to contaminate surface and ground water due to runoff, groundwater leaching and spray drift (Jansen et al., 2011b; Kapsi et al., 2019; Papadakis et al., 2015). In Cambodia, pesticides are applied to prevent pests and increase crop yields. However, farmers are not aware of proper pest management particularly in pesticide application (Matsukawa et al., 2015). Cambodia do not produce pesticides; therefore, pesticides are imported from other countries thus labelled in foreign languages which is incomprehensible to local farmers. Heavy uses of highly toxic compounds and improper management of pesticide application cause significant health issues to agricultural workers in low-income countries (Jansen et al., 2011a).

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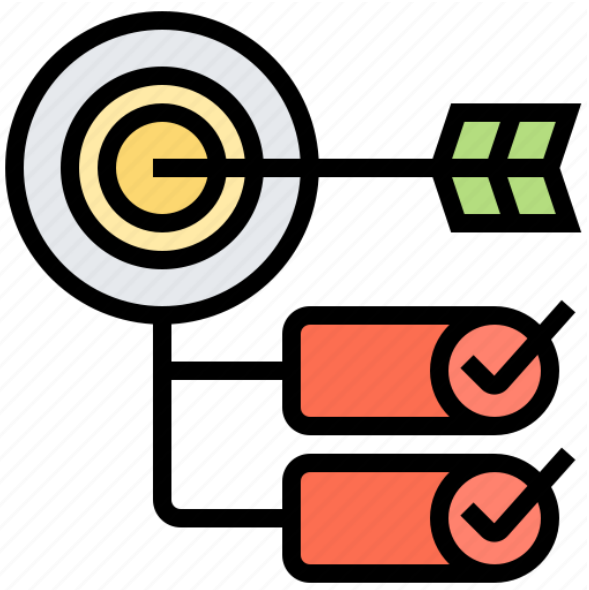
- Phat et al. 2020 confirmed occurrence of pesticides:
  - Fungicides, Herbicides, Insecticides
  - in water, fish and sediment at TSL, Chnok Tru area
- Yoshikawa et al., 2020, confirmed the occurrence and concentration of seven highest and some important heavy metals
  - Ca, Mg, Na, K, Si, Al, Fe, Mn, As, Mo and Sb in TSL.

OBJECTIVE



1. Temporal distribution assessment of water quality of Tonle Sap Lake.
2. Spatial distribution assessment of the water quality of TSL.
3. Evaluate water quality by Water Quality Index (WQI).
4. Health risk assessment.

Study area and sample collection

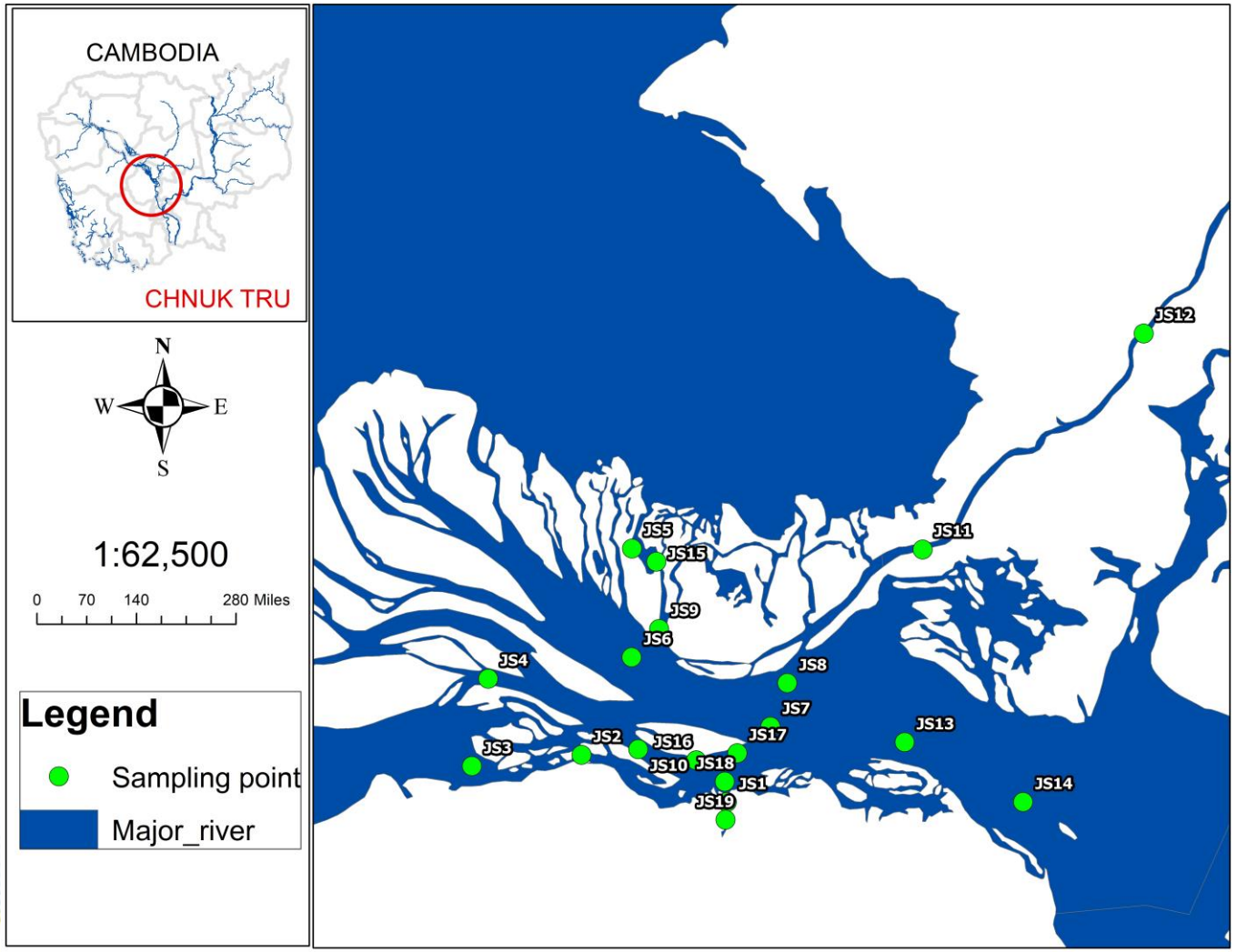


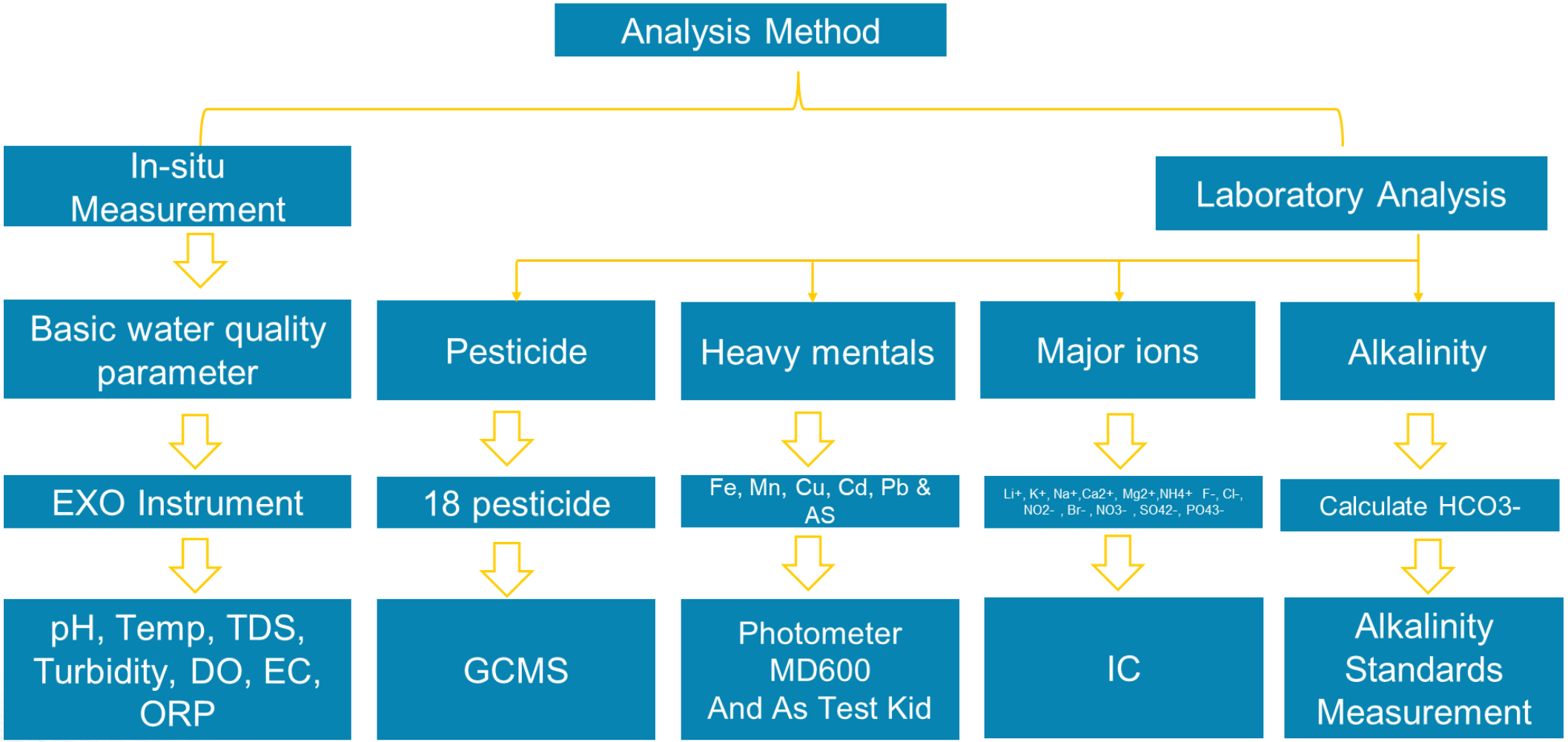
Fig: Map of sampling collection

- This study was conduct in Tonle Sap lake in Chnok Tru commune.
- Rainy and dry season
- 19 sampling site (surface water)
- 2.5L per each site
- Store in ice box

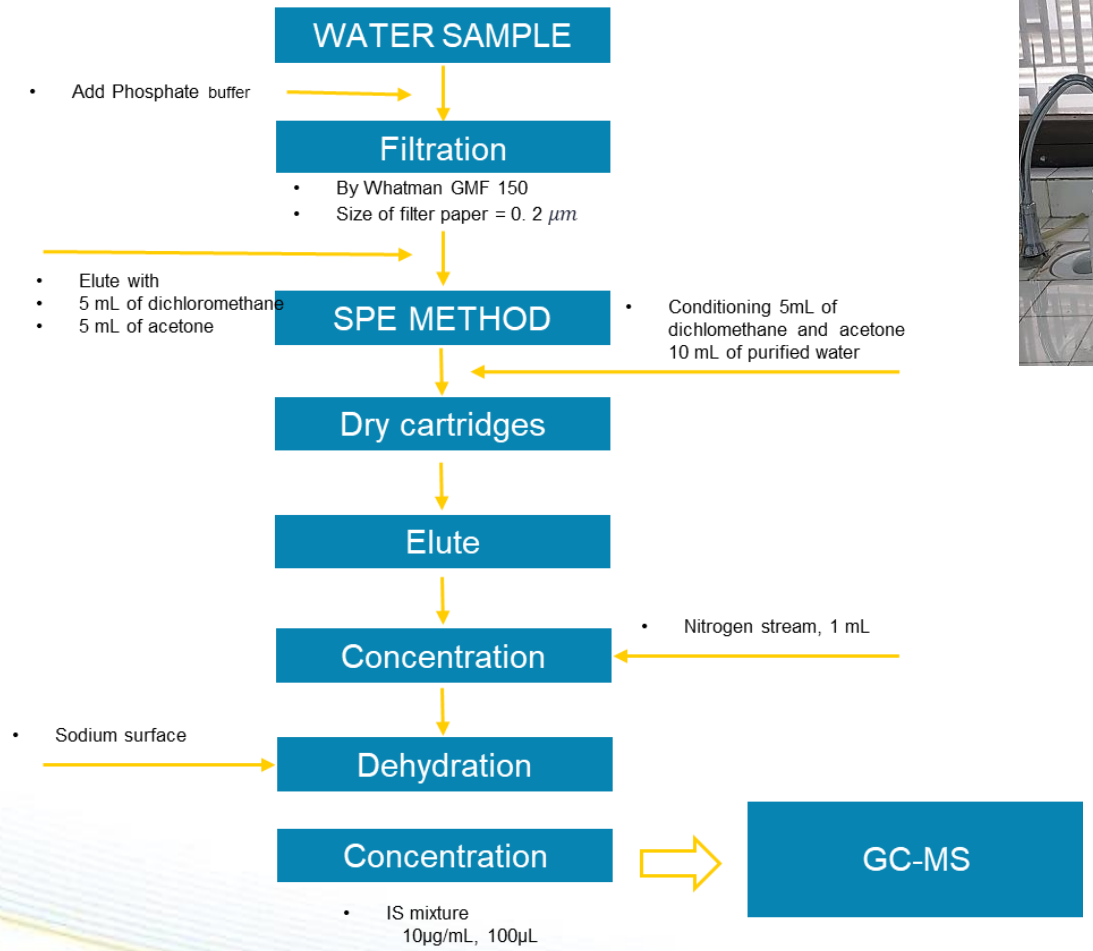
Basic Water Quality Parameter

- YSI EXO Water Quality Sonders
- Temperature, pH, DO, EC, TDS, Turbidity, ORP
- Results will show automatically to excel file.

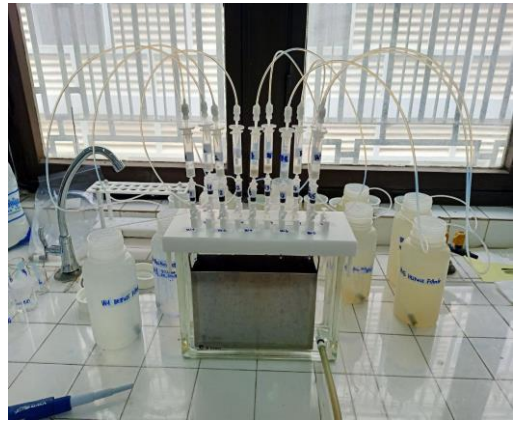
STRUCTURE OF RESEARCH



PESTICIDE ANALYSIS



Filtration Process



Extraction process

GCMS analysis

HEAVY MENTAL ANALYSIS

Parameter	Range	Reagent/Accessories	Form of reagent or accessories/ Quantity	Order-No	Brand and country
Mn	0.2 – 4 mg/l Mn	Manganese LR No.1	Tablet/100	516080BT	Lovibond®, Germany
		Manganese LR No. 2	Tablet/100	516090BT	Lovibond®, Germany
Cu	0.05 – 5 mg/l Cu	Copper No. 1	Tablet / 100	513550BT	Lovibond®, Germany
		Copper No. 2	Tablet / 100	513560BT	Lovibond®, Germany
		Copper / Zinc LR	Tablet / 100	512620BT	Lovibond®, Germany
Zn	0.02 – 0.9 mg/l Zn	EDTA	Tablet / 100	512390BT	Lovibond®, Germany
		Dechlor	Tablet / 100	512350BT	Lovibond®, Germany
Fe	0.02 – 1.8 mg/l Fe	Vario Iron TPTZ F10	Powder Pack / 100	530550	Lovibond®, Germany
As	0-0.50 mg/l As	Arsenic test strip	Tube/100 tests	117927	MQuant®, Germany
	-	As-1	Bottle/11ml	117927/1	Merck, Germany
	-	As-2	Botlle/154g	117927/2	Merck, Germany
	-	As-3	Bottle/121g	117927/3	Merck, Germany

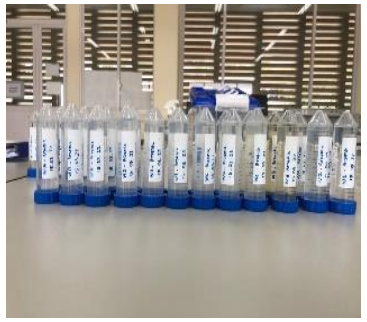
Filtration process

Sample after filtration

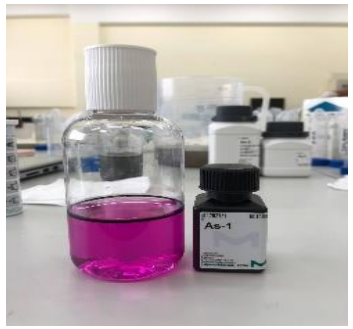
Photometer MD 600

ARSENIC ANALYSIS

Arsenic test kit set for testing



Preparing the water sample 60ml for testing



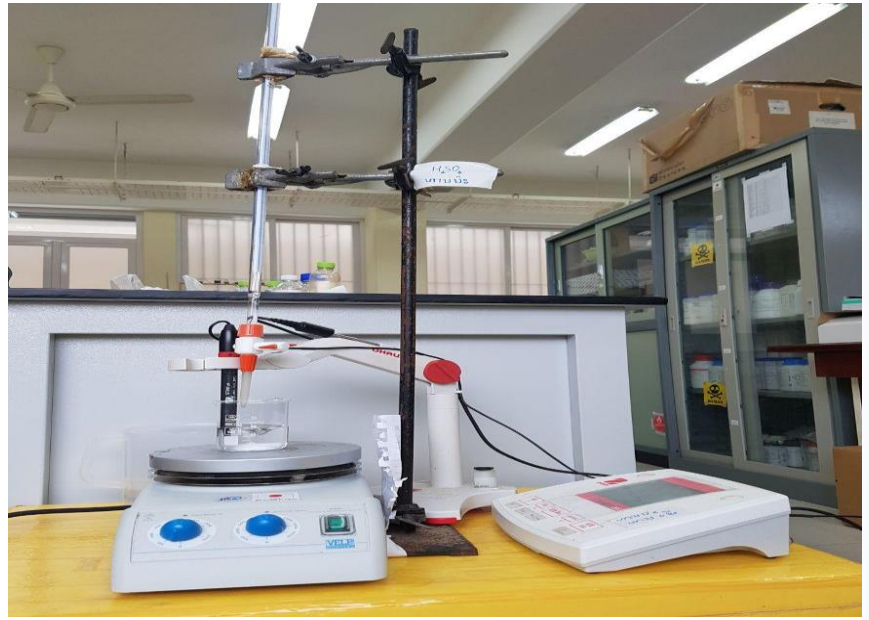
Put As 1 two points into water sample and shake it slightly

Put As 2 one red spoon and shake it slightly

Put As 3 one green spoon and shake it slightly

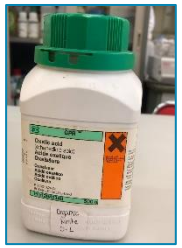
After waiting 20 minutes take out testing paper and Compare it with the result

ALKALINITY MEASUREMENT



Alkalinity measured by titration method with **0.01M H_2SO_4** until end point **pH = 4.5.**

MAJOR ION ANALYSIS



Oxalic acid (2mM)

1. Weight the amount of Oxalic acid powder for solution preparation.

2. Put Oxalic acid powder into Ultrapure water 1L.

3. Stir solution until reagent is dissolved.

4. Filtrate solution obtained.

5. take mobile phase of cation to do ultrasonic.

Preparation of mobile phase of cation

1. Weight the amount of 3 reagent powders for solution preparation.

2. Put reagent powders into Ultrapure water 1L.

3. Stir solution until reagent is dissolved.

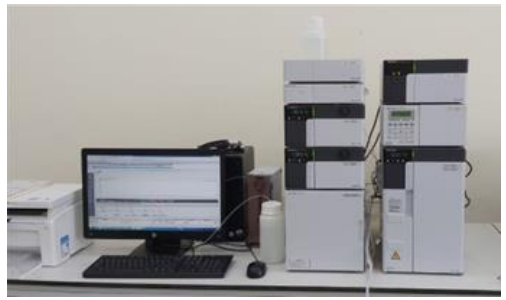
4. Filtrate solution obtained.

5. take mobile phase of cation to do ultrasonic.

Preparation of mobile phase of anion

Condition	Cation	Anion
Column	Shim-pack IC-C4	Shim-pack IC-A3
Flow rate	1ml/min	1.2mL
Column Temperature	40C	40C
Pressure	3.1Mpa	6.4Mpa
Detection wavelength	254nm	254nm
Detector	Conductivity	Conductivity
Inject volume	50uL	50uL

Major ion (cation and anion) analyze by using IC



Ion Chromatography machine

TEMPORAL AND SPATIAL ANALYSIS

Data Analyze :

fieldwork

RESULTS

Excel

ArcGIS ArcMap 10.8

ORIGIN® 2018
Graphing & Analysis

WATER QUALITY INDEX

- $W_i = \frac{w_i}{\sum w_i}$
- $q_i = \frac{C_i}{S_i} \times 100$

- $SI = W_i \times q_i \quad => \quad WQI = \sum_{n=1}^{n} SI$

WATER QUALITY INDEX

C_i :Concentration of each parameters

SI :Objective to be meet

W_i :Relative weights

q_i :Quality Rating Scale

WQI Rating	Category
<25	Excellent
26-50	Good
51-75	Poor
76-100	Very Poor
>100	Unsuitable

❑ **Drinking Water Quality Standard**

Paramters	Unit	Weight	Relative weight	Standard
		wi	Wi	Si
pH	_	4	0.114286	6.5-8.5
TDS	mg/l	5	0.142857	500
Fe	mg/l	3	0.085714	0.3
Mn	mg/l	3	0.085714	0.1
Na	mg/l	3	0.085714	200
NO3	mg/l	5	0.142857	12
Ca	mg/l	2	0.057143	200
Mg	mg/l	2	0.057143	150
Cl	mg/l	3	0.085714	250
HCO3	mg/l	2	0.057143	600
SO4	mg/l	3	0.085714	250
Total		35	1	

HEALTH RISK ASSESSMENT

❑ Noncancer Risk

- $ADD_{dermal} = C.K_p.S_A.\frac{ED.EF.ET.CF}{BW.AT}$
- $ADD_{ingestion} = \frac{C.IR.ED.EF}{BW.AT}$

$$HQ = \frac{ADD}{RfD} \Rightarrow HI = \sum_{i=1}^{n} HQ$$

HI : Hazard Index

HQ : Hazard Quotient

ADD : the average daily dose during the exposure through dermal contact and ingestion of water (mg/kg-day),

RfD : Oral reference dose (mg/kg-day)

Input Data to calculate noncarcinogenic human health risk

Indicators	Unit	Adults (>65 Years)	Children (6-11 Years)	Infants (6-12 Months)
Body surface area (S_A)	(cm^2)	19,800*	10,800	4,500
Average Ingestion of Water (IR)	(L/d)	1.046	0.414	0.36
Exposure Duration (ED)	(years)	65	11	1
Average body weight (BW)	(Kg)	80	31.8	9.2
Average lifetime (AT)	(days)	23,725	4,015	365

❑ Cancer Risk

$$ELCR = CDI.CSF$$

ELCR : Excess lifetime for cancer risk

CSF : The cancer slope factor

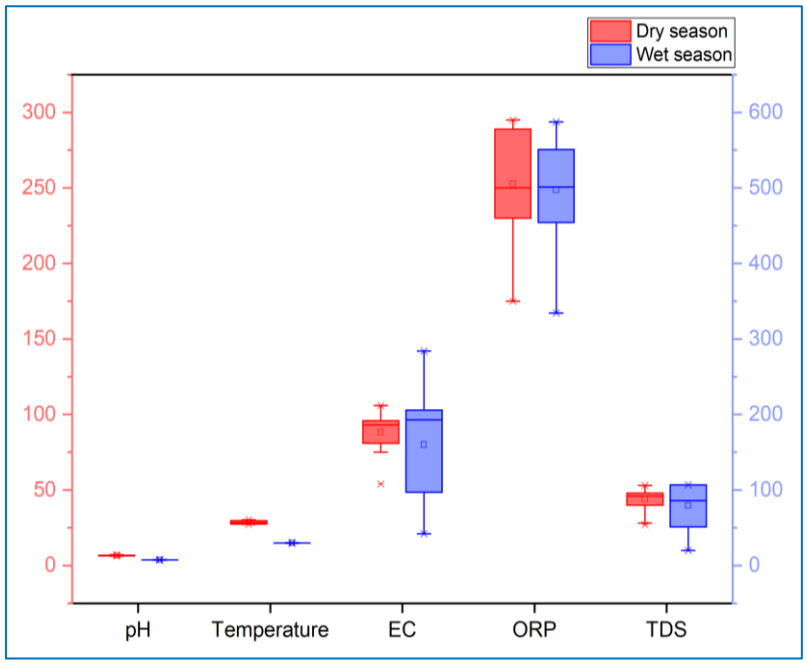
CDI : The average daily dose of elements through dermal contact and ingestion pathways,

Dermal and oral reference doses (RfD) and cancer slop factor (CSF)

Chemical	RfD Dermal (µg/kg-day)	RfD Ingestion (µg/kg-day)	Cancer Slope Factor (µg/kg-day)
As	0.123	0.3	0.0015
Cu	12	40	NE
Fe	45	300	NE
Mn	0.8	20	NE
Zn	60	300	NE

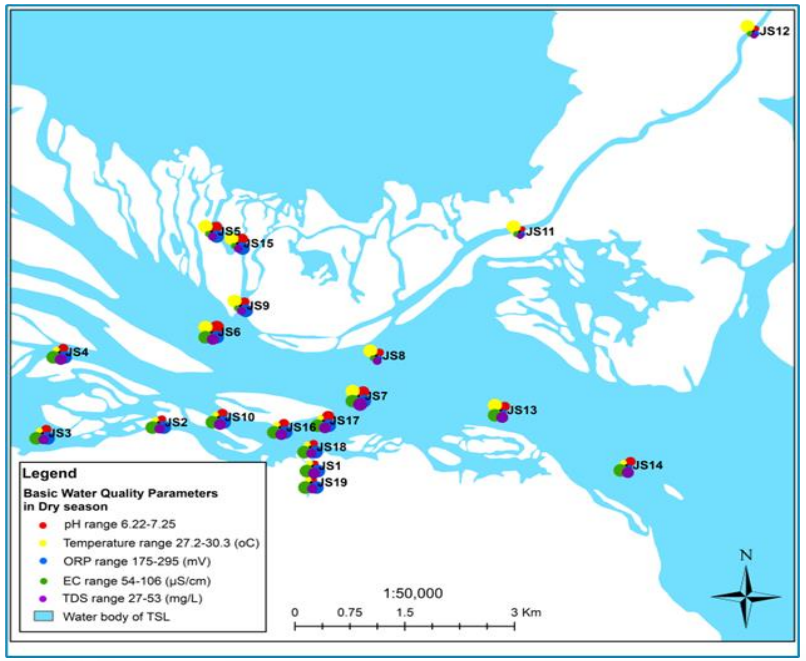
TEMPORAL AND SPATIAL DISTRIBUTION OF BASI

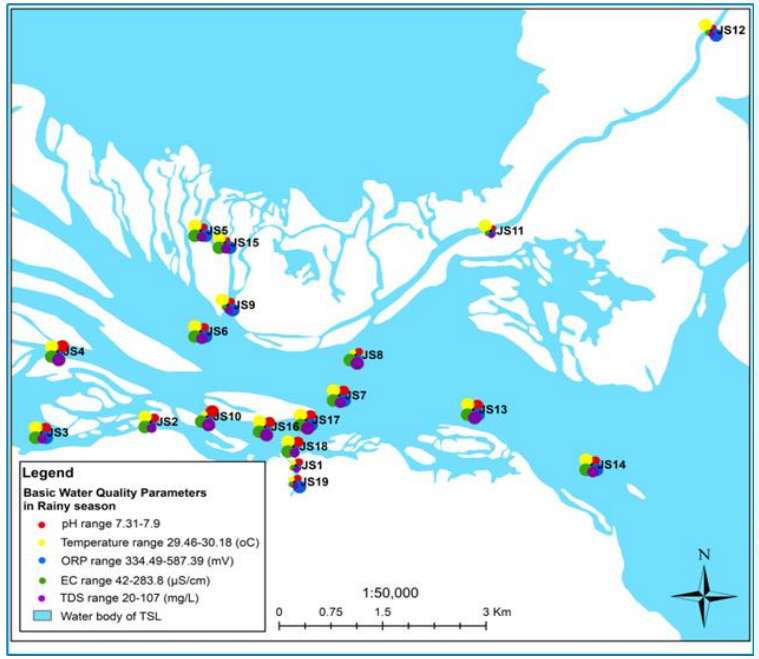
Basic water quality parameters



Box plots of basic water quality parameter in both season

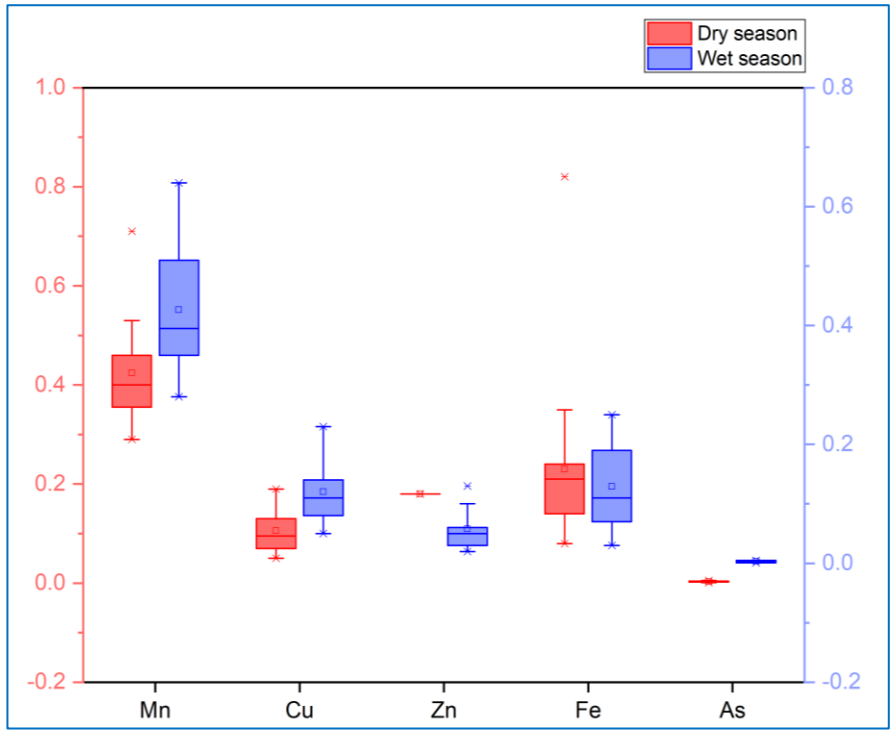
Spatial distribution map of Basic water quality parameter in dry season





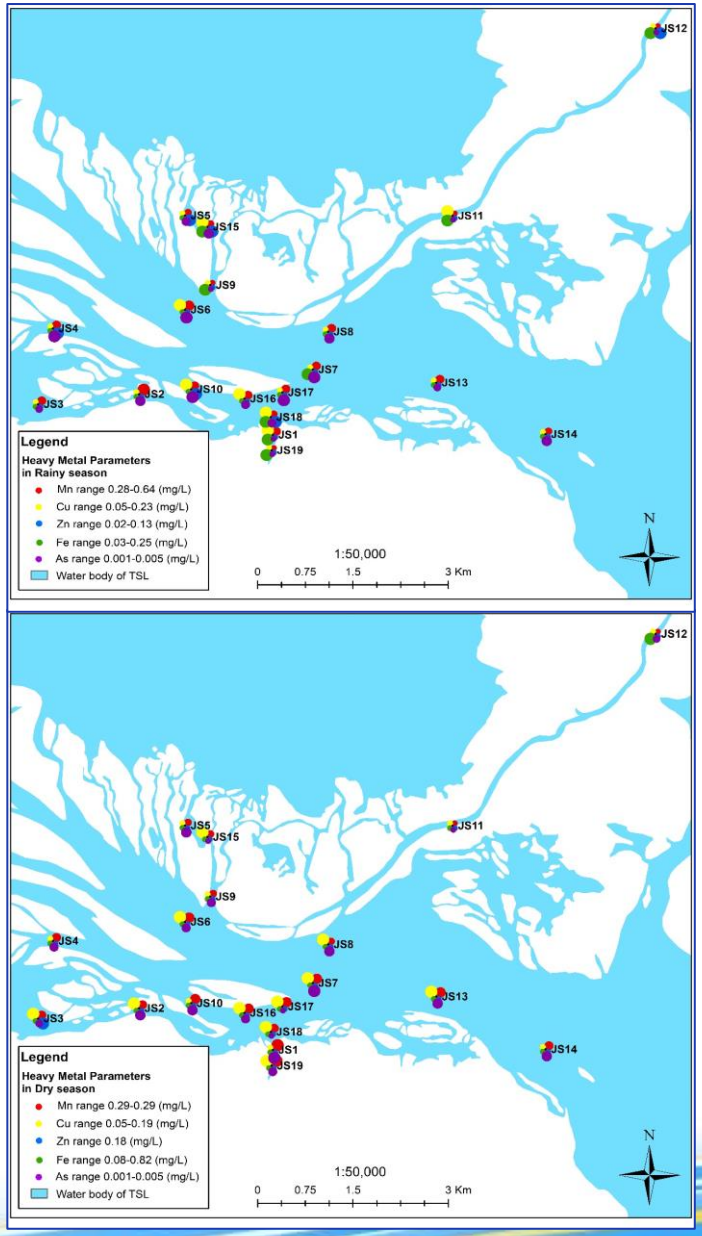
Spatial distribution map of Basic water quality parameter in rainy season

HEAVY MENTAL

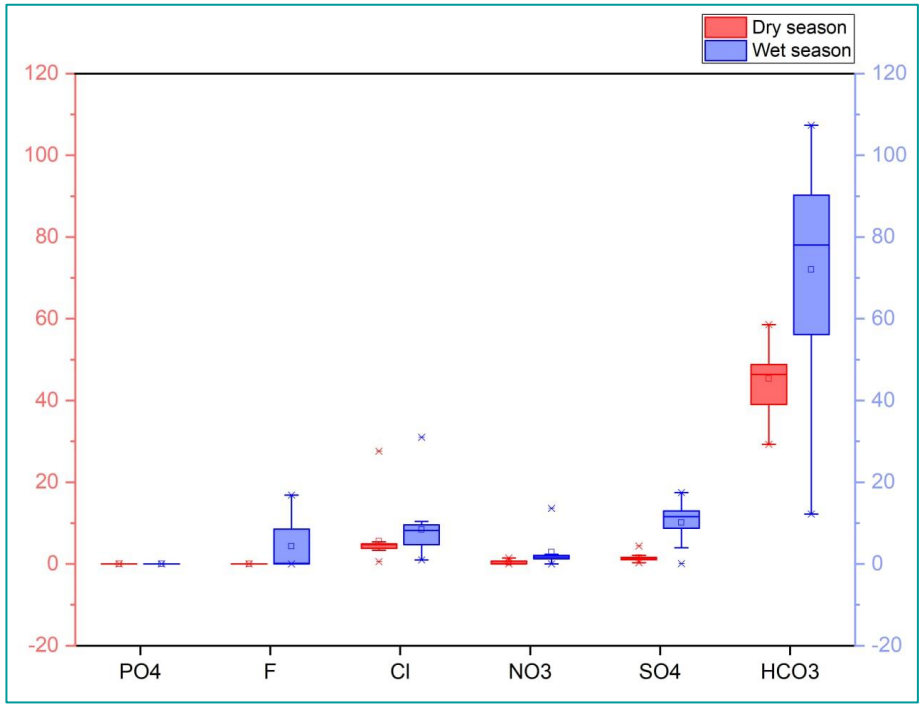


Box plots of heavy mental in both season

Spatial distribution map of heavy mental in rainy and dry season

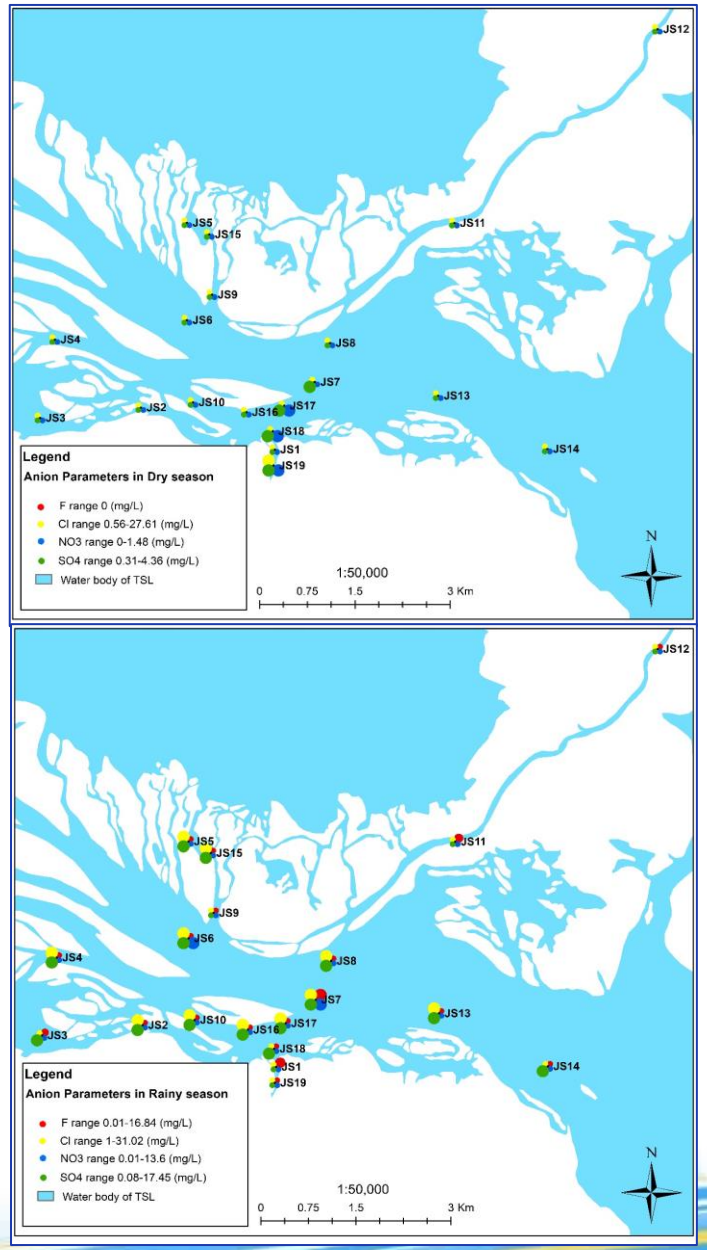


MAJOR ION



Box plots of Anion in both season

Spatial distribution map of Anion in rainy and dry season



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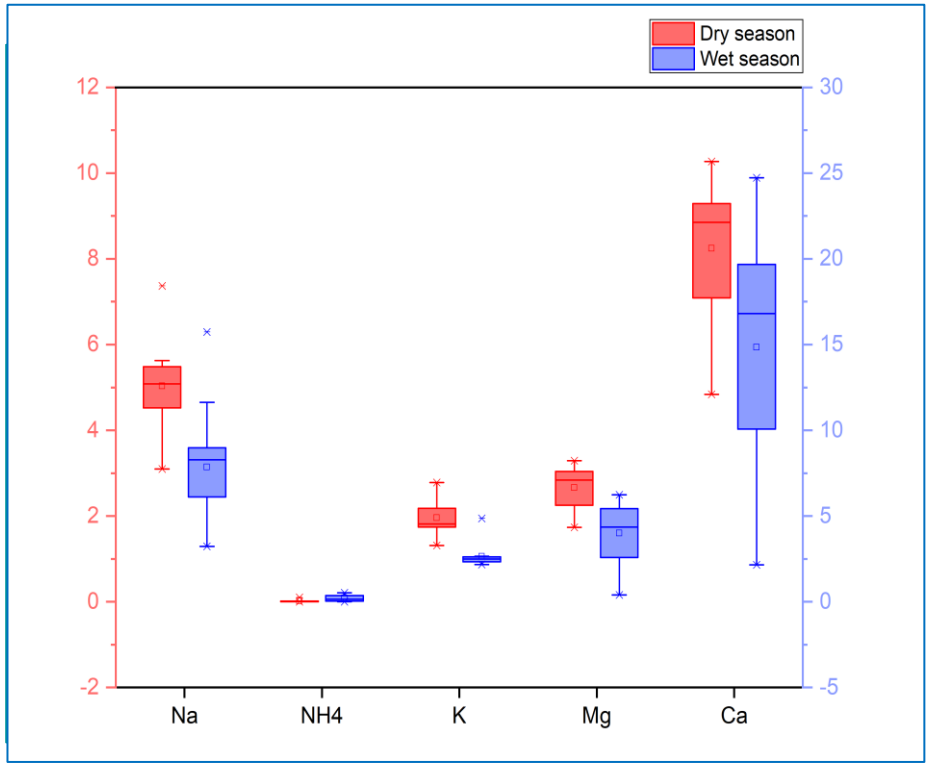
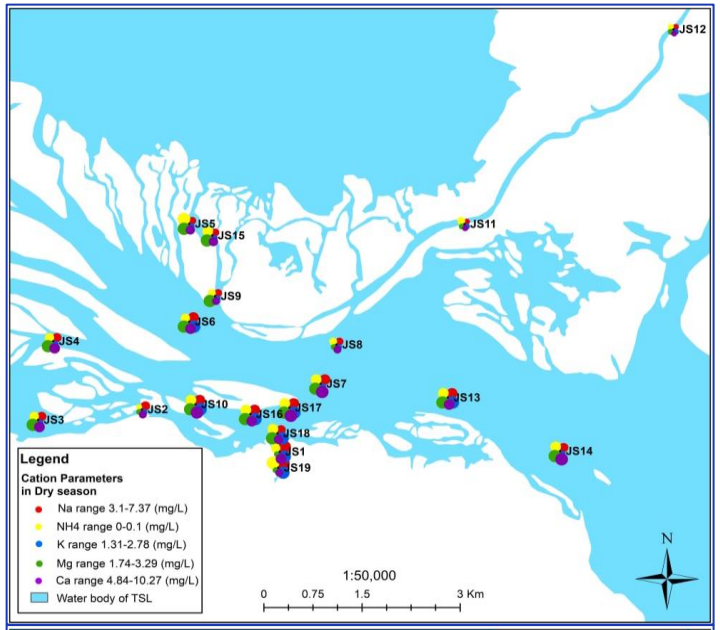
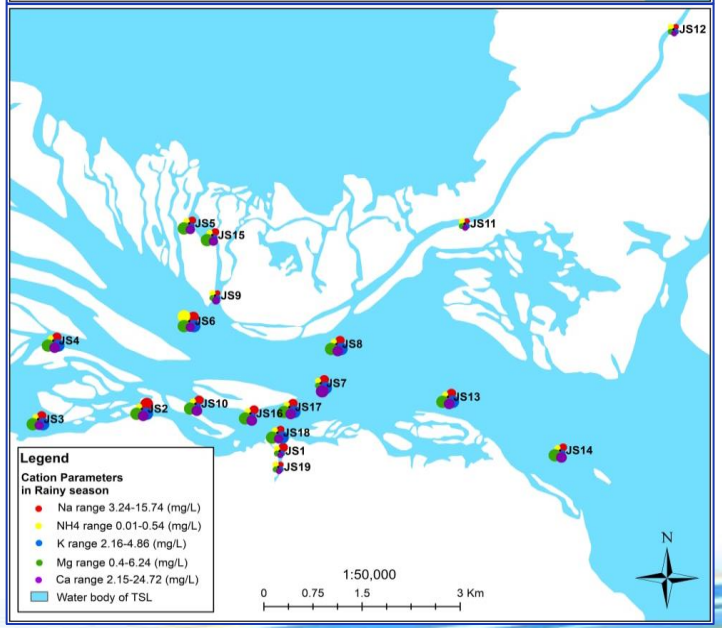


Box plots of cation in both season

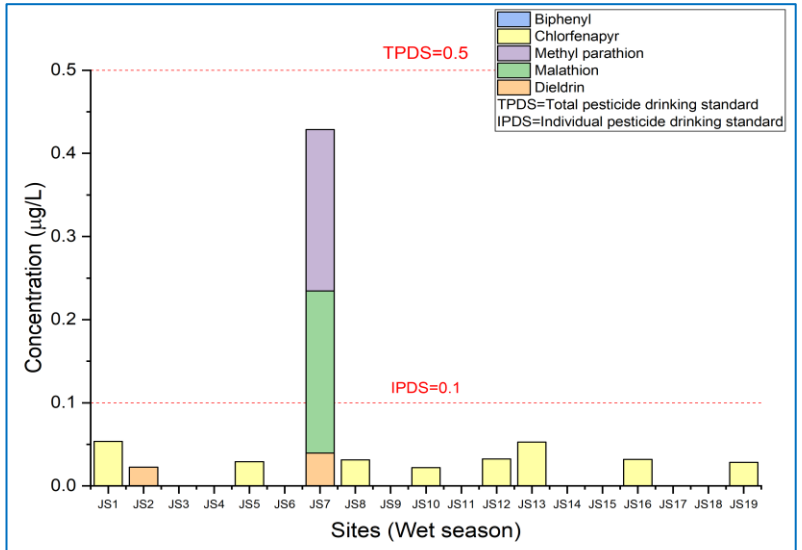
Spatial distribution map of Cation in rainy and dry season

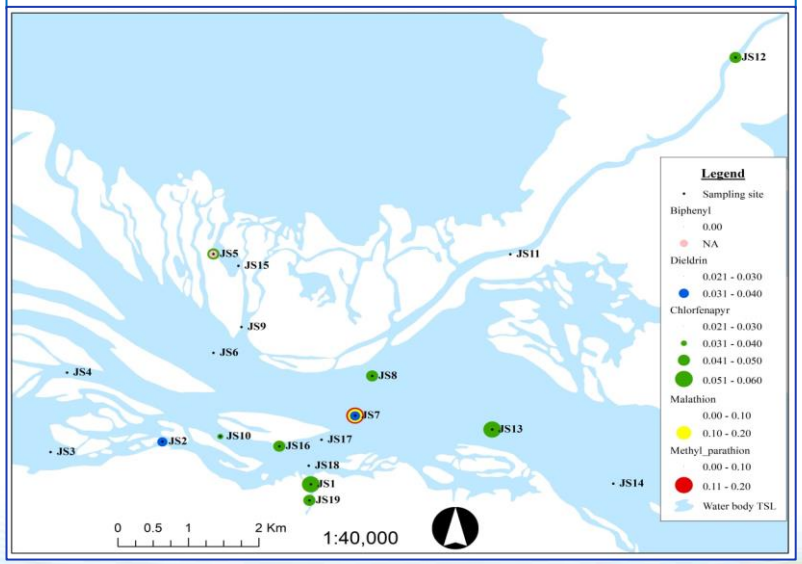


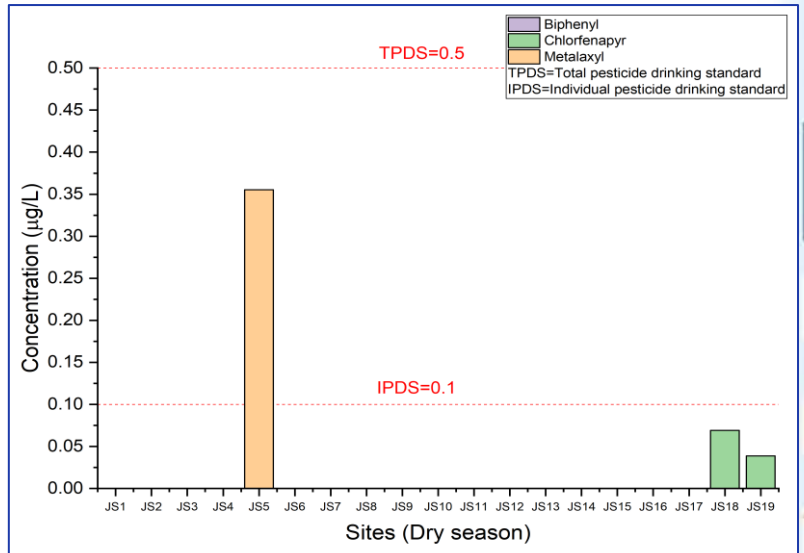


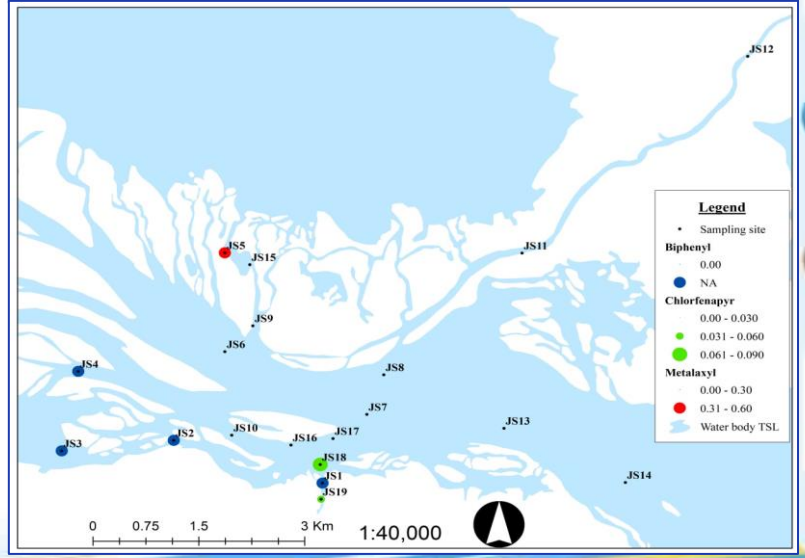
RESULTS OF PESTICIDE RESIDUE

CONCENTRATION OF DETECT PESTICIDE

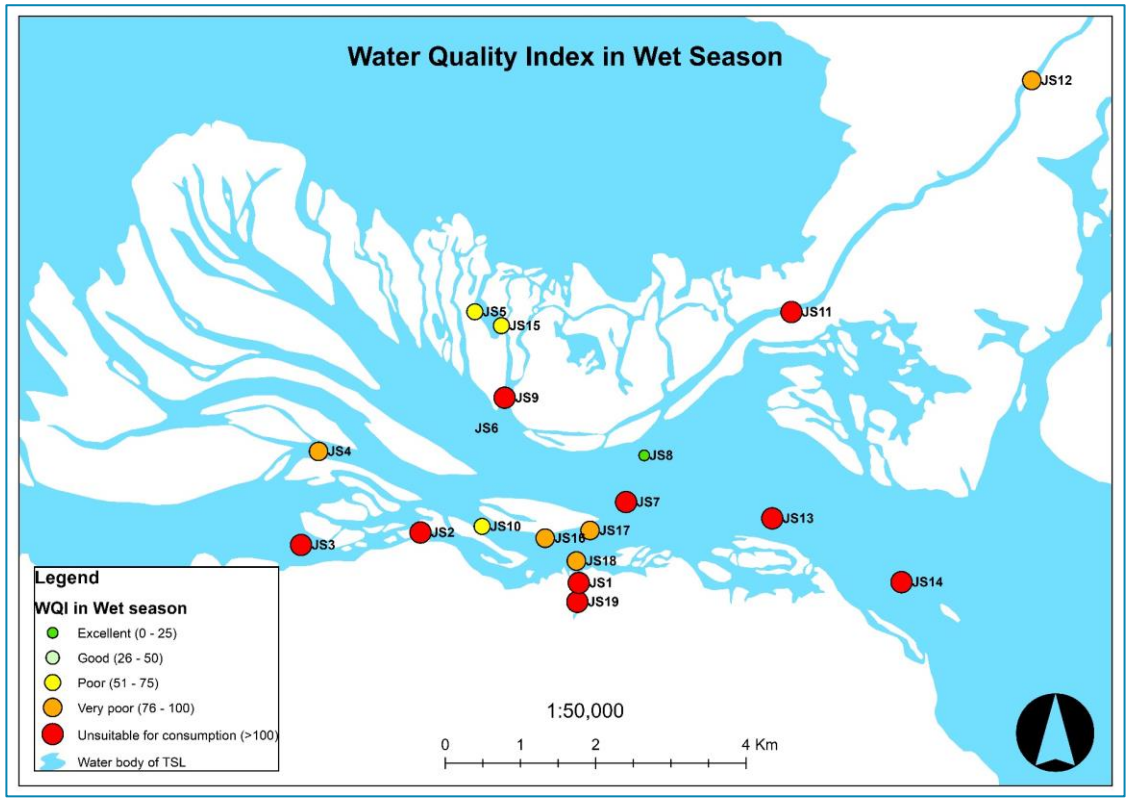






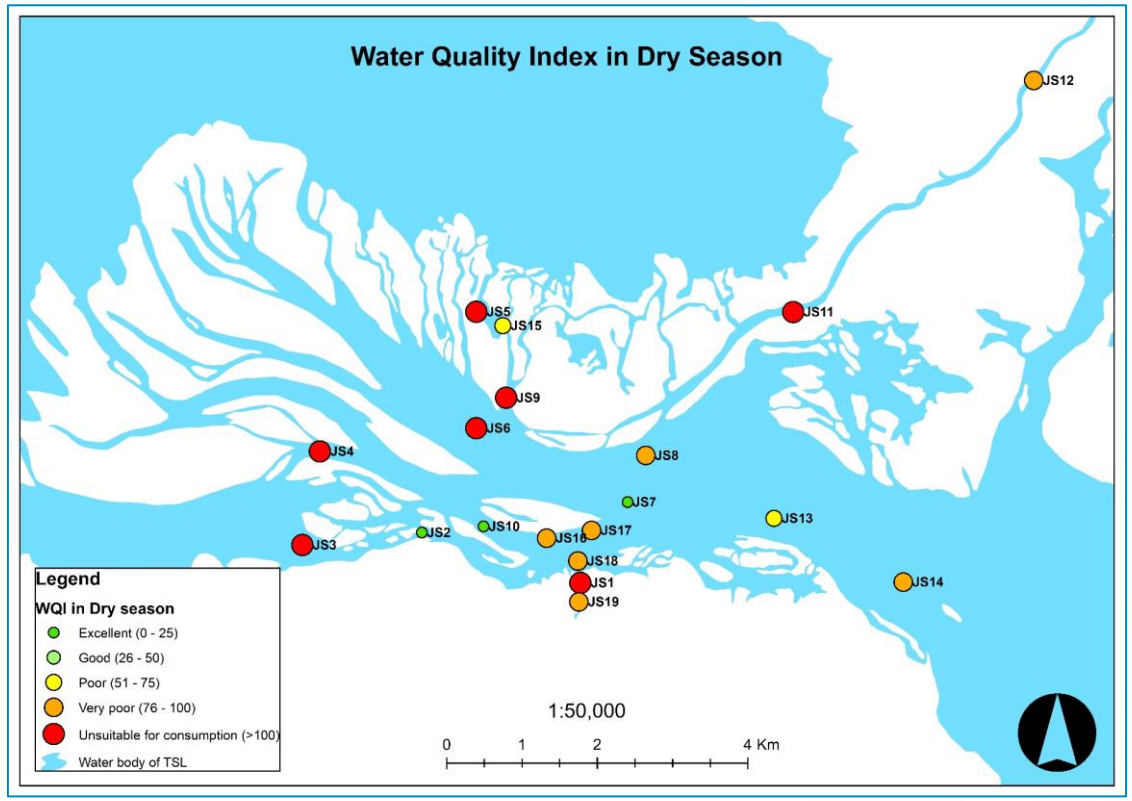


WATER QUALITY INDEX

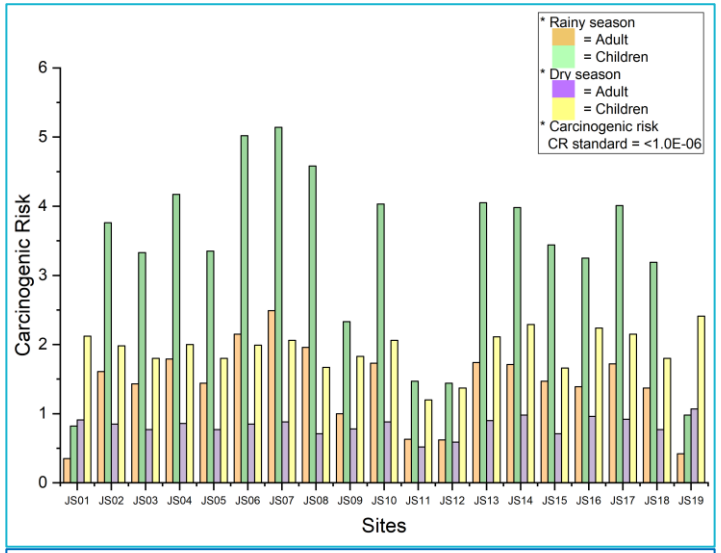


Spatial distribution map of water quality index

Spatial distribution map of water quality index



HEALTH RISK ASSESSMENT



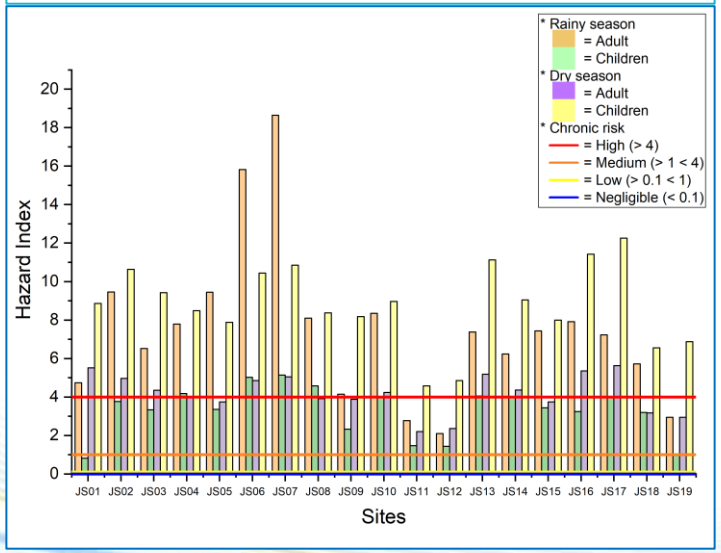
Cancer risk

- Rainy:

Most of sampling sites were medium and high-risk level of non-cancer risk both children and adult except JS 8 is excellent

- Dry season:

Most of sampling sites was medium and high level of non cancer risk both children and adult except 3 location that is excellent



Non-cancer risk

In both rainy and dry season, and both for adult and children have not dangerous risk

CONCLUSION

- pH was slightly under standard drinking in few site. Mn was over the standard of drinking water. Malathion and methyl parathion was over the standard of drinking which is 0.195 µg/L and 0.1942 µg/L.
- Based on WQI, in rainy season: 74% in study area were very poor and 21% were unsuitable for drinking purpose.
- Also in dry season: 42% in study area were very poor and 42% were unsuitable for drinking purpose.
- According to result of health risk assessment, in both season 75% in this study area were medium and high level of non cancer risk both children and adult.
- The water quality of TSL, Chhnok Tru area, is still considered unsuitable for drinking directly without the corresponding treatment.

Recommendation

- Not to use TSL source water to consume directly without any treatment process.
- Using suitable treatment such as the absorption technology like activate carbon in order remove pesticide and heavy metal.
- Future research, it should be regularly monitoring in TSL water in order to provide an information related to the status of water environment and its current situation.

Acknowledgementt

- ✓ Cambodia Higher Education Improvement Project (HEIP#25) and Institute of Technology of Cambodia
- ✓ Acknowledge to Agence Française de Development European (AFD-EU).

HEIP

Higher Education Improvment Project

AFD AGENCE FRANÇAISE DE DÉVELOPPEMENT

THANK YOU
ANY QUESTION?