

Title: Study on the Relationship Between Runoff, Water Quality, and Saltwater Intrusion in the Bang Pakong River

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Abstract

This study, titled "A Study of the Relationship Between Runoff Volume, Water Quality, and Saltwater Intrusion in the Bang Pakong River," aimed to investigate the relationships between runoff volume, water quality, and saltwater intrusion, as well as the relationship between distance from the river mouth and water quality parameters and saltwater intrusion. Data was collected from June to October. Runoff volume ranged from 102.745 to 550.07 million cubic meters, and average salinity ranged from 0.13 to 1.85 ppt. Runoff volume showed an inverse relationship with salinity, while TDS and electrical conductivity showed a direct relationship with salinity. This is because runoff dilutes salt and pushes back seawater intrusion. However, high tides in late October led to higher salinity. Dissolved oxygen (DO) levels ranged from 2.75 to 8.25 mg/L, exceeding standards at several points. No significant relationship was found between runoff volume, distance from the river mouth, and salinity, due to the influence of organic leaching and local activities. Nitrate levels were not detected at any point except point A in June, where levels exceeded the standard. While nitrite and ammonia levels remained within standard limits throughout the study, the temperature and pH also remained within standard

limits at all points. Monthly CCME WQI values ranged from 85.32 to 95.32, classified as good to very good, primarily affected by DO levels below standard and nitrate levels exceeding standard in some areas. Furthermore, location-based comparisons revealed that salinity was highest near the river mouth and decreased with distance from the mouth. DO and CCME WQI values also varied with local activities. In conclusion, runoff volume and land location play significant roles in changes in salinity and water quality of the Bang Pakong River.

Keywords: Bang Pakong River, saltwater intrusion, water quality

Introduction

Approximately 97% of the Earth's water is saltwater, and only 3% is freshwater. Of that freshwater, only 1% is usable for consumption. Most freshwater is distributed in rivers, lakes, and aquifers, while a large amount is stored in glaciers and polar ice sheets (Groundwater Resources Department, 2021). This situation reflects the limited nature of freshwater resources, which are declining due to several factors, especially climate change, which directly affects the quantity and distribution of freshwater sources (NuWater, 2023). Freshwater resources are important, aligning with the United Nations' Sustainable Development Goals (SDGs), particularly Goal 6, which focuses on ensuring access to clean water and sanitation for all, including sustainable water management, and Goal 15, which emphasizes the conservation and restoration of freshwater ecosystems to maintain biodiversity and the sustainability of natural resources (SDG MOVE, 2024).

Saltwater intrusion into freshwater sources, especially in rivers connected to the sea, often occurs during certain times of the year, most frequently during the dry season. Due to insufficient freshwater in the river to push saltwater back into the sea (Supanat Hensawang, 2022), combined with the impacts of climate change and global warming, which have significantly reduced river water volumes, the problem of saltwater intrusion has become more severe (Thammanoon Rasmimasuang and colleagues, 2022). This problem affects the utilization of water resources, including for consumption, water supply production, agriculture, and industry.

The Bang Pakong River basin experiences significant seasonal changes in water salinity, driven by rainfall, river water levels, and seawater intrusion. Different seasons affect river salinity levels (Department of Agricultural Extension, 2024). In addition, the Bang Pakong River is a significant water source supporting the Eastern Economic Corridor (EEC). It is used for consumption, water supply and production, agriculture, and industrial activities, as well as for diverting water for storage as a reserve during the dry season. The aforementioned saltwater intrusion problem in the Bang Pakong River is therefore a significant concern. The researchers are therefore interested in studying the relationship between rainfall and saltwater intrusion in the Bang Pakong River area to provide information for future water resource management.

Research Question

How does runoff affect changes in salinity and water quality in the Bang Pakong River?

Hypothesis

1. Months with higher runoff will have better water quality than months with lower runoff.

2. Months with higher runoff will have less saltwater intrusion than months with lower runoff.

3. Areas that are closer to the estuary will have higher salinity.

4. Areas further from the estuary tend to have better water quality indices.

Equipment and Supplies

1. Multiparameter
2. pH meter
3. Reagent Bottle (PE) 100ml
4. foam box
5. DO Test Kit
6. Ammonia Test Kit
7. Sona Nitrite Test Kit
8. sera nitrate-Test

Procedure

Step 1: Determining Water Sampling Points from the Bang Pakong River

1.1 Water samples were collected from 7 locations, selected from some existing water monitoring stations, which the Royal Irrigation Department operated, and additional samples from areas easily and safely accessible to the public. These locations included: Krua Rabaiang Nam (restaurant), Bang Pakong Dolphin Watching Boat Trip Point, Bang Pakong District Office, Ban Pho District Office, Bang Pakong Riverside Clock Tower on Maruphong Road, Wat Mai Bang Khla, and Wat Pak Nam Cho Lo.

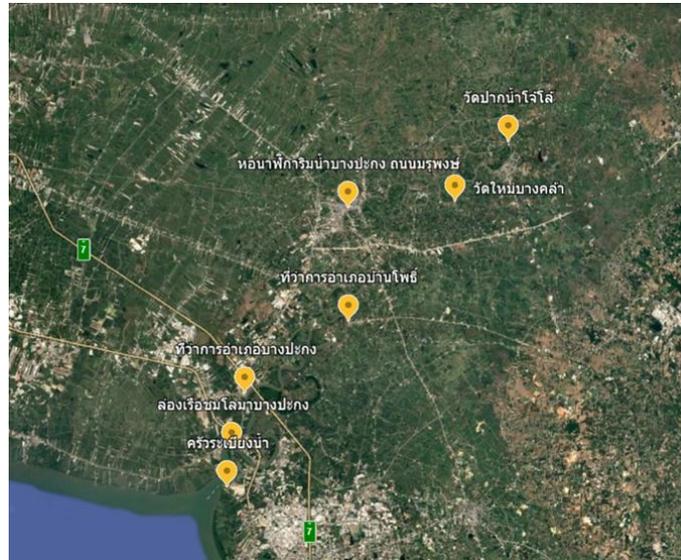


Image 1 : Satellite image showing each sampling point.

Step 2: Collect Water Samples and Check Water Quality

Water samples will be collected in the field, and the collection bottles will be rinsed 2-3 times to ensure they are free of impurities.

2.1 Field Water Quality Measurement

Water quality was measured using a multiparameter by measuring the following values Temperature ,Salinity ,Conductivity and TDS (Total dissolved solids).

2.2 Nitrite content in the water.

2.3 Nitrate content in the water.

2.4 Amount of oxygen dissolved in water.

2.5 Ammonia content.

2.6 Calculate CCME WQI values.

Step 3: Field Data Recording

3.1 Record the coordinates of the water sample collection points using Google Earth.

3.2 Take photographs and record details of each image of the area surrounding the water source and the water sample collection point.

3.3 Record the runoff volume on the day the water sample was collected on the Royal Irrigation Department website.

Research Results

The results can be summarized in the following table.

Table 1: Water Quality Monitoring Results on June 15, 2025.

Items tested	unit	Standard criteria	Test results						
			A	B	C	D	E	F	G
Temperature	Celsius degrees	23 - 32	29.72	31.14	30.76	30.97	30.91	31.22	31.19
Salinity	g/L	≤ 0.5	3.61	1.73	0.70	0.40	0.26	0.24	0.22
pH	-	5 - 9	7.17	7.33	7.07	6.93	6.78	6.80	6.70
DO	mg/L	≥ 6	7	6.25	5.25	6	5.75	5	5.25
Ammonia	ppm	≤ 0.5	0.5	0.25	ND.	ND.	ND.	ND.	ND.
Nitrate	mg/L	≤ 5	10	ND.	ND.	ND.	ND.	ND.	ND.
Nitrite	mg/L	≤ 5	0.25	0.1	0.1	0.1	0.1	0.1	ND.
Conductivity	μS/cm	100 - 1000	7250.80	3732.13	1576.71	922.40	600.50	573.56	508.68
TDS	g/L		4.32	2.17	0.92	0.54	0.35	0.33	0.30
CCME WQI	-		81.045	100	83.589	100	83.667	83.519	83.589

Note : ND means "not detected".

Table 2 : Water Quality Monitoring Results on July 22, 2025.

Items tested	unit	Standard criteria	Test results						
			A	B	C	D	A	F	G
Temperature	Celsius degrees	23 - 32	29.57	29.95	29.90	29.90	29.95	30.06	30.15
Salinity	g/L	≤ 0.5	0.65	1.35	0.28	0.24	0.20	0.19	0.15
pH	-	5 - 9	7.95	7.48	7.50	7.32	7.17	7.03	7.08
DO	mg/L	≥ 6	6	6	5.75	5.50	5.25	8.50	7.50
Ammonia	ppm	≤ 0.5	0.25	ND.	ND.	ND.	ND.	ND.	ND.
Nitrate	mg/L	≤ 5	ND.	ND.	ND.	ND.	ND.	ND.	ND.
Nitrite	mg/L	≤ 5	0.1	0.1	0.1	0.1	0.1	ND.	ND.
Conductivity	μS/cm	100 - 1000	1006.75	611.75	506	506	378.67	343.71	281.5
TDS	g/L		0.58	0.30	0.25	0.25	0.19	0.17	0.14
CCME WQI	-		100	100	83.667	83.638	83.589	100	100

Table 3 : Water quality inspection results on August 17, 2025.

Items tested	unit	Standard criteria	Test results						
			A	B	C	D	A	F	G
Temperature	Celsius degrees	23 - 32	30.07	30.43	30.93	30.70	29.75	30.35	29.89
Salinity	g/L	≤ 0.5	0.47	0.35	0.25	0.20	0.15	0.15	0.11
pH	-	5 - 9	7.68	7.61	7.47	7.43	7.31	7.38	7.43
DO	mg/L	≥ 6	5.75	6.25	6.25	7	6	6.25	5.25
Ammonia	ppm	≤ 0.5	0.25	ND.	ND.	ND.	ND.	ND.	ND.
Nitrate	mg/L	≤ 5	ND.	ND.	ND.	ND.	ND.	ND.	ND.
Nitrite	mg/L	≤ 5	0.1	0.1	ND.	ND.	ND.	ND.	ND.
Conductivity	µS/cm	100 - 1000	1058	810	577	461	360	358	261
TDS	g/L		0.63	0.48	0.34	0.27	0.22	0.21	0.15
CCME WQI	-	-	83.667	100	100	100	100	100	83.589

Note : ND means "not detected".

Table 4 : Water quality monitoring results on September 28, 2025.

Items tested	unit	Standard criteria	Test results						
			A	B	C	D	A	F	G
Temperature	Celsius degrees	23 - 32	29.01	29.30	29.33	29.70	29.23	29.37	29.39
Salinity	g/L	≤ 0.5	0.19	0.15	0.14	0.12	0.13	0.09	0.09
pH	-	5 - 9	7.60	7.05	7.03	7.03	7.02	7.05	7.12
DO	mg/L	≥ 6	4.25	8.25	2.75	5.5	4.75	4.25	5.75
Ammonia	ppm	≤ 0.5	0.25	0.25	0.25	ND.	ND.	ND.	ND.
Nitrate	mg/L	≤ 5	ND.	ND.	ND.	ND.	ND.	ND.	ND.
Nitrite	mg/L	≤ 5	0.1	0.1	0.1	0.1	0.1	ND.	ND.
Conductivity	µS/cm	100 - 1000	428	346	331	270	303	217	199
TDS	g/L		0.26	0.21	0.20	0.16	0.18	0.13	0.12
CCME WQI	-	-	83.093	100	80.298	83.638	83.417	83.093	83.667

Note : ND means "not detected".

Table 5 : Water Quality Monitoring Results on October 26, 2025.

Items tested	unit	Standard criteria	Test results						
			A	B	C	D	A	F	G
Temperature	Celsius degrees	23 - 32	28.55	28.96	29.29	29.16	29.11	29.15	28.76
Salinity	g/L	≤ 0.5	6.21	6.08	0.17	0.13	0.12	0.11	0.13
pH	-	5 - 9	8.42	8.37	8.38	7.43	7.57	7.16	7.84
DO	mg/L	≥ 6	3.75	5.75	3.25	6.5	6.25	4.25	5.25
Ammonia	ppm	≤ 0.5	0.25	0.25	0.25	0.25	0.25	0.25	ND.
Nitrate	mg/L	≤ 5	ND.	ND.	ND.	ND.	ND.	ND.	ND.
Nitrite	mg/L	≤ 5	0.25	0.25	0.1	0.1	0.1	0.1	0.1
Conductivity	µS/cm	100 - 1000	11737	11610	388	301	268	250	303
TDS	g/L		7.15	4.89	0.23	0.18	0.16	0.15	0.18
CCME WQI	-	-	82.537	83.667	81.66	100	100	83.093	83.589

Note : ND means "not detected".

Summary and Discussion of Research Findings

The study found that runoff volume in the Bang Pakong River has an inverse relationship with salinity. In months with high runoff volume, salinity is low due to dilution and the prevention of seawater intrusion into the river. Conversely, months with low runoff volume combined with high tides result in increased salinity. Total Dissolved Solids (TDS) and electrical conductivity are directly related to salinity, indicating that an increase in salt content in the water directly affects these parameters. Dissolved oxygen (DO) levels at many measurement points did not meet the standard criteria. They showed no significant relationship with runoff volume, distance from the river mouth, or salinity, due to the influence of human activities and land use in the surrounding area. Other findings showed that nitrate levels did not exceed the standard, except at measurement point A in June. Nitrite and ammonia levels remained within standard limits throughout the study. The CCME Water Quality Index (WQI) was mostly good to very good,

with the main factor affecting the index being DO levels below the standard in some locations. Furthermore, salinity showed a clear decreasing trend with increasing distance from the river mouth.

Recommendations

1. Standardize the use of water quality testing instruments to prevent instrument errors.
2. Implement a more rigorous operational plan to prevent potential problems during testing.
3. Speed up the laboratory testing process to avoid variations in testing time that could result in differences in the characteristics or properties of individual water samples.

Further development

1. The study results can be applied to effective water management planning in the Bang Pakong River basin, particularly in predicting periods of saltwater intrusion risk, which directly affects the quality of raw water for water supply.
2. This can be further developed into innovations, such as a program to predict salinity from runoff volume.

Acknowledgements

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Submitting environmental monitoring data to the GLOBE project database.

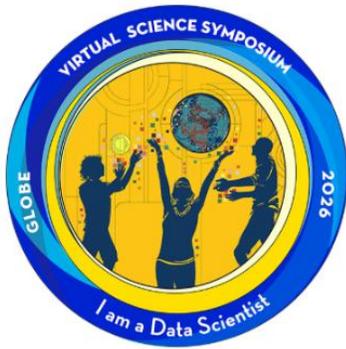
Conductivity	
Measured Date:	2025-07-22
Organization Name:	Princess Chulabhorn Science High School Chonburi
Site ID:	408555
Site Name:	Bang Pakong River #B
Country Name:	Thailand
Country Code:	THA
Latitude:	13.49681
Longitude:	100.98333
Elevation:	1.9m
Measured At:	2025-07-22T01:30:00
Conductivity Micro Siemens per cm:	612 μ S/cm
Water Body State:	normal

Conductivity	
Measured Date:	2025-09-28
Organization Name:	Princess Chulabhorn Science High School Chonburi
Site ID:	408549
Site Name:	Bang Pakong River #A
Country Name:	Thailand
Country Code:	THA
Latitude:	13.49633
Longitude:	100.97944
Elevation:	3m
Measured At:	2025-09-28T01:00:00
Conductivity Micro Siemens per cm:	428 μ S/cm
Water Body State:	normal

pH	
Measured Date:	2025-07-22
Organization Name:	Princess Chulabhorn Science High School Chonburi
Site ID:	408555
Site Name:	Bang Pakong River #B
Country Name:	Thailand
Country Code:	THA
Latitude:	13.49681
Longitude:	100.98333
Elevation:	1.9m
Measured At:	2025-07-22T01:20:00
Water Body pH:	7.6 μ H units
Water Body State:	normal
pH Method:	meter
pH Buffer 1:	9.20
pH Buffer 2:	9.20
pH Buffer 10:	9.20

Image 2: Submitting data via Globe's data entry website: <https://www.globe.gov/globe-data/data-entry>

Badges selection



I AM A DATA SCIENTIST

- Looking for data representation for analysis and estimation in unexplored areas using the spatial IDW method.
- Identifying data representation from different units using the CCME WQI water quality standard.
- Presenting data in the form of bar charts and surface plots of the study area.



I AM AN EARTH SYSTEM SCIENTIST

- This research demonstrates the interconnectedness of the hydrosphere by analyzing key water parameters and salinity changes across different points and months. We highlight how runoff and other phenomena affect saltwater intrusion.



I WORK WITH A STEM PROFESSIONAL

- I consulted with an assistant professor at Burapha University in Thailand, specializing in aquatic science, to improve the sampling process.
- I consulted with teachers from various schools, who offered advice on preparing the presentation.