



Research Title: The Impact of High NPK Concentration on Floral Diversity in the Coastal Zone of Samet, Chonburi, Thailand

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ABSTRACT

This current study aims to investigate the relationship between high NPK concentrations in the soil and the resulting changes in floral diversity within the coastal zone of Samet, Chonburi, Thailand. The quality of the soil from the chosen site was tested using the standard protocol from Globe and equipment from Extech. Then, plants thriving in the study site was identified and recorded. The results of the different experiments were observed, gathered, and compared using one-way ANOVA and Tukey HSD Test. Based on the experimentations, results and gathered data, the researchers concluded that there are significant differences ($p < 0.05$) in soil temperature measured at 5 cm, air temperature, and relative humidity, but there was no significant difference ($p > 0.05$) in soil pH, soil temperature at 10 cm, and NPK concentration. Furthermore, greater NPK concentrations have a significant impact on floral diversity in Samet, Chonburi, Thailand. Lastly, to strengthen this study, more research is required by comparing the soil quality in Samet's coastline area and nearby districts, as well as the types of plants that thrive in these areas.

Keywords: Soil Fertility, Soil Parameter, NPK, Floral Diversity

INTRODUCTION

Many years ago, the coastal region of Samet, Chonburi, Thailand, where the current study was carried out, was not yet completely covered by different halophytes, such as mangrove plants, according to the Center of Expertise on Eco-tourism for Mangrove Conservation Chonburi Province. At high tide, marine water readily floods the area. In order to prevent the negative impacts of the high tide phenomenon on the community close to the intertidal zone, the circumstance inspired several groups to turn the area into a habitat for a variety of plants. In its current condition, the place is fully covered by various plants which are valuable in protecting the place from high tide, flooding, and storm surges.

This study focuses on the impact of high NPK concentration on floral diversity in the coastal zone of Samet, Chonburi, Thailand, a region experiencing heightened nutrient concentrations potentially stemming from various sources, including agricultural runoff, wastewater discharge, and tourism-related activities. The delicate balance of floral communities in these coastal areas is crucial for maintaining ecosystem stability, providing habitat for diverse fauna, and supporting local livelihoods. However, the potential impact of elevated NPK levels on the intricate web of plant life remains poorly understood in this specific context. This research aims to investigate the relationship between high NPK concentrations in the soil and the resulting changes in floral diversity within the coastal zone of Samet. By quantifying the spatial distribution of these nutrients and correlating them with floral species richness and composition, the researchers aim to illuminate the ecological significances of nutrient enrichment and provide valuable insights for informed conservation and management strategies. Ultimately, this study endeavors to correlate the abundance of NPK to the diversity of plants in the area, contributing to the sustainable preservation of Samet's unique coastal ecosystem.

Research Questions:

1. Is there a significant difference in soil quality measured for 3 times in the coastal area of Samet, Chonburi, Thailand?
2. Do N (Nitrogen), P (Phosphorus), and K (Potassium) concentration have significant impact on floral diversity in the coastal zone of Samet, Chonburi?
3. What floral species are abundant in the experimental site?

Objectives:

1. To Investigate if there is a significant difference in soil quality in the coastal zone of Samet, Chonburi.
2. To determine the significant impact of high NPK concentration on floral diversity in Samet, Chonburi.
3. To identify various species of plants thriving in the experimental site.

Hypotheses:

Alternative: The soil quality varies significantly, and increased NPK concentrations have a considerable impact on Floral Diversity in the Coastal Zone of Samet, Chonburi, Thailand.

Null: The soil quality did not vary significantly, and increased NPK concentrations have no considerable impact on Floral Diversity in the Coastal Zone of Samet, Chonburi, Thailand.

RESEARCH METHODOLOGY

Research Design

This environmental science research employed a true experimental research design, which relies on statistical analysis to prove or disprove a hypothesis. It is the most accurate type of experimental design for this type of environmental research because it includes a control group as well as variables that can be manipulated by the researcher. This is extremely relevant and useful for soil testing to determine if there is significant difference among the gathered data. The results of soil quality measurement were compared using the appropriate statistical tool. Following that, the researchers can choose to accept or reject the given hypothesis. Descriptive research was also used, that involves observing and describing a subject's behavior without influencing it in any way. It is extremely important during the qualitative testing, as well as in identifying various floral species thriving in the experimental site.

Materials used in this environmental science research.

Shovel	NPK measuring kit	pH meter
Thermo-Hygrometer	Meterstick	2 in 1 soil analyzer
Digital thermometer	2 in 1 Soil Analyzer	3 Way Soil Meter

Study Site

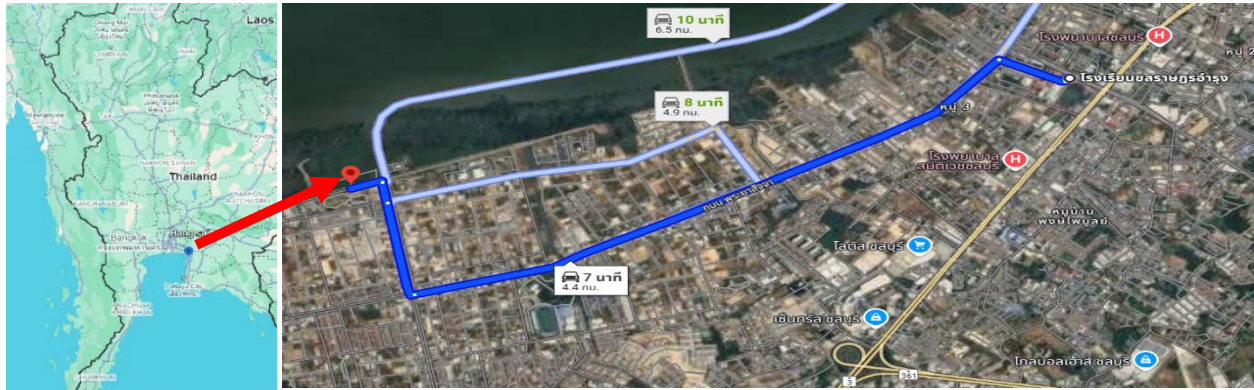


Figure 1. The study site at Samet, Chonburi, Thailand.

The study site is located at Samet, Chonburi Coastal Area with Latitude $13^{\circ}20'7772''\text{N}$, and Longitude $100^{\circ}56'51.4284''\text{E}$.

Survey and preparation of materials

Researchers have selected the Samet Subdistrict in Chonburi Province, Thailand, as the focus of their survey. They have identified the surrounding soil in the Chaloem Phra Kiat Rachini Park area as an appropriate site for their study, given its suitability for soil testing and sample collection. Following the site selection, the required materials and equipment for soil quality analysis have been sourced from the science laboratory at Chonradsadornumrung School.

Soil Quality testing

The soil quality assessment was conducted on December 13, 2024, January 10, 2025, and February 10, 2025, all recorded at 4:00 PM. Numerous soil characteristics, including pH,



Figure 2. Researchers at the study site.



Figure 3. *In situ* measurement of soil quality

temperature, humidity, texture, color, and fertility, were considered while evaluating the soil quality close to Chaloem Phra Kiat Rachini Park. To determine the soil pH, the following steps were carried out: 40 g of dried and sieved soil with 40 mL of distilled water (or other amount in a 1:1 soil to water ratio) was mixed in a beaker using the stirring rod, the mixture was allowed to settle until a supernatant (clearer liquid above the settled soil) formed, the pH of the supernatant was measured using the pH meter. Extech standard thermometer was used to determine the air temperature and relative humidity of the study site. Moreover, NPK concentration sensors were used to determine the amount of nitrogen (N), phosphorus (P), and potassium (K) present in the soil. The standard protocols from www.globe.gov were used in all the tests needed to evaluate the soil quality of the study site. Lastly, the researchers identified various species of plants thriving in the area.



Figure 4. Measuring the NPK concentration.

RESULTS AND DISCUSSIONS

The figures below show the data encoded on the Globe website from December 2024 to February 2025. Figures 5 through 10 depict the Globe data entry for air temperature, relative humidity, soil pH, soil temperature (5cm and 10 cm depth), and soil fertility measured in the coastal zone of Samet, Chonburi, Thailand.

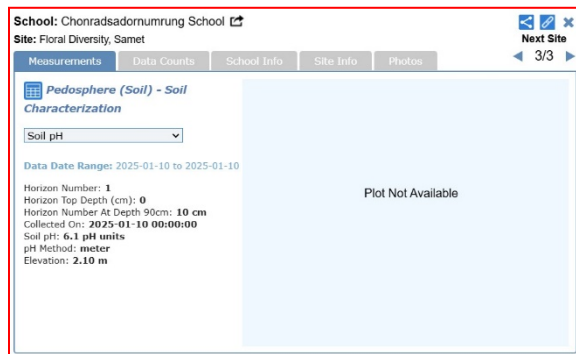


Figure 5. Globe Data Entry for soil pH.

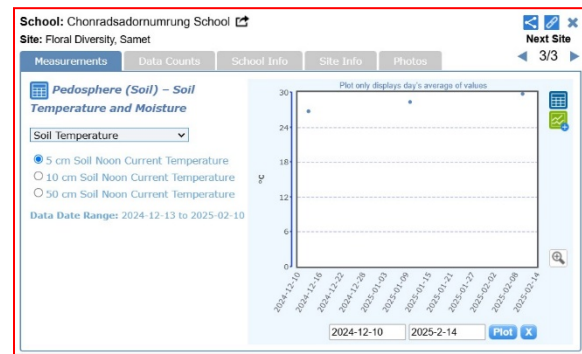


Figure 6. Globe Data Entry for soil temperature (5 cm depth).

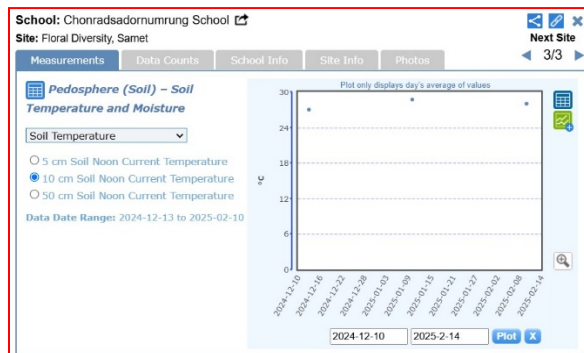


Figure 7. Globe Data Entry for soil temperature (10 cm depth)

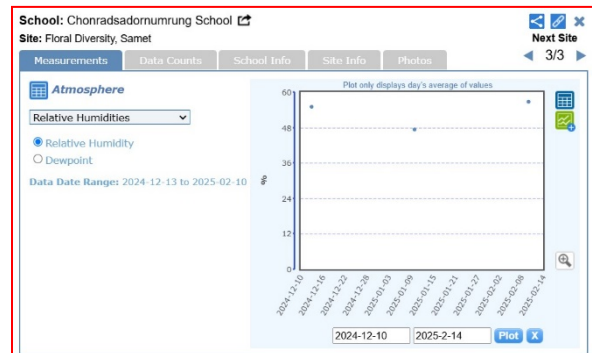


Figure 8. Globe Data Entry for relative humidity.

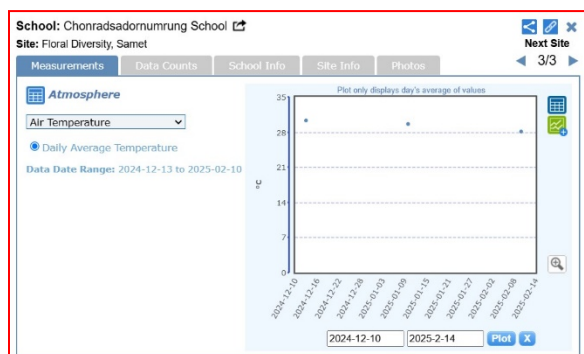


Figure 9. Globe Data Entry for air temperature.

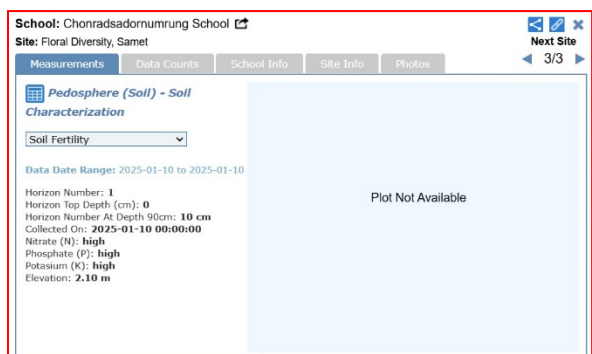


Figure 10. Globe Data Entry for soil fertility.

Table 1. Average results of soil parameters measured in the coastal zone of Samet, Chonburi.

Parameters	13 Dec 2024 (4:00 PM)	10 Jan 2025 (4:00 PM)	10 Feb 2025 (4:00 PM)
Soil Fertility	Ideal	Ideal	Ideal
Soil pH	5.4	6.13	6.67
Soil Temperature (5 cm) (°C)	26.67	28.33	29.67
Soil Temperature (10 cm) (°C)	27	28.67	28
Relative Humidity (%)	55	47.33	56.67
Air Temperature (°C)	30.3	29.6	28.1
Soil Color	Brown	Brown	Gray
Soil Texture	Clay	Clay	Clay
Nitrogen (mg/kg)	437.33	446.67	304.33
Phosphorus (mg/kg)	627.33	661.33	449.67
Potassium (mg/kg)	1971	1897.33	1431.33

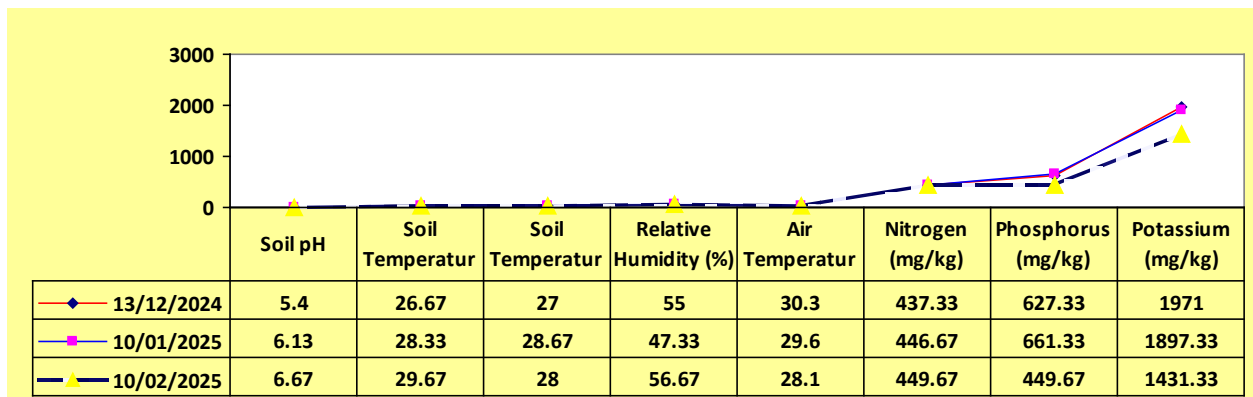



Table 1 and Figure 11 shows the average results of all soil parameters measured in the coastal zone of Samet, Chonburi, Thailand. These results were summarized after 3 series of experiments that started from 13 December 2024 to 10 February 2025. The average soil pH ranges from 5.4 – 6.67, soil temperature at 5cm depth ranges from 26.67 – 29.67°C, soil temperature at 10cm depth ranges from 27 – 28.67°C, relative humidity ranges from 47.33 – 56.67%, air temperature ranges from 28.10 – 30.30°C, nitrogen (N) concentration ranges from 437.33 mg/kg –

449.67 mg/kg, phosphorus (P) concentration ranges from 449.67mg/kg – 661.33 mg/kg, and potassium (K) ranges from 1431.33 mg/kg – 1897.33 mg/kg. The soil tested from the experimental site also possess the following characteristics: brown color, clay texture, firm consistency, wet, and has high concentration of Nitrogen (N), Phosphorus (P), and Potassium (K). The study published by Ramadas, S. et. al, 2018, indicated that the amount of nitrogen (N) is high if it is greater than 140 mg/kg (>140mg/kg). In the same study, if the amount of phosphorus (P) is <5 mg/kg it is low, 5 - 12.5 mg/kg (medium), >12.5 mg/kg (high). Moreover, the research of Ramadas, S. et. al, 2018 emphasized that potassium (K) level is low if it is <60 mg/kg, medium if 60-140 mg/kg, and high if >140 mg/kg. The results seen in table 1 and figure 13 revealed that NPK concentration of the study site is significantly high.

One-way ANOVA and Tukey HSD test were used to determine if there was a significant difference in all soil parameters measured quantitatively in the coastal zone of Samet, Chonburi. It was found out that the p-value corresponding to the F-statistic of one-way ANOVA is lower than 0.05 for soil temperature measured at 5 cm depth, air temperature, and relative humidity suggesting that one or more treatments is/are significantly different. For soil pH, soil temperature (10 cm depth), and NPK concentration, the p-value corresponding to the F-statistic of one-way ANOVA is higher than 0.05, suggesting that the treatments are not significantly different for that level of significance. It means that there were no significant changes in the aforementioned factors measured for 3 times from the sampling site. Additionally, the data also manifested that the amount of NPK was consistently high which is the main reason of the abundance of various plants in the experimental area.

Table 2. Common Plants in the coastal zone of Samet, Chonburi, Thailand.

Plant Photo	Plant Species (Common Name)	Scientific Name	Abundance
	Field sagewort	<i>Artemisia campestris</i>	Highly Abundant

	Black mangrove	<i>Lumnitzera racemosa</i>	Highly Abundant
	Red Mangrove	<i>Rhizophora mangle</i>	Highly Abundant
	Annual seablite	<i>Sueda maritima</i>	Highly Abundant
	Portia Tree	<i>Thespesia populnea</i>	Highly Abundant


	Shoreline Sea-purslane	<i>Sesuvium portulacastrum</i>	Highly Abundant
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Table 2 shows the common plants thriving in the coastal zone of Samet, Chonburi, Thailand. Throughout the duration of the study, it was found out that abundant amount of the following plants was observed in the study site: Field sagewort (*Artemisia campestris*), Black mangrove (*Lumnitzera racemosa*), Annual seablite (*Sueda maritima*), Portia Tree (*Thespesia populnea*), Shoreline Sea-purslane (*Sesuvium portulacastrum*), and Red Mangrove (*Rhizophora mangle*). These floral varieties fully covered the coastal zone of the said place. The evident diversity of these plants is correlated to the nutrients that plants absorbed from the soil. The more nutrients there are, the healthier the plants will be, and the location will be beneficial to the plants' survival and reproduction (Yildirim et al., 2011).

Discussion

The results of field measurement, ANOVA, and post-hoc Tukey HSD test showed that there was a significant difference in some soil parameters measured in coastal zone of Samet, Chonburi, Thailand such as soil temperature measured at 5 cm, air temperature, and relative humidity but there was no significant difference in soil pH, soil temperature at 10 cm depth, and NPK concentration. It shows that there were no significant changes in some of the the soil quality of the study site. The acquired data is pertinent to the study of Milosevic et al., 2020 that claims that the physical characteristics of soil are largely fixed and won't change over time. The main factors that can contribute to changes in soil health are soil organisms, including the abundance and diversity of bacteria, fungi, and nematodes, as they respond sensitively to anthropogenic disturbance (Lynch, 2015).

The soil in coastal zone of Samet, Chonburi is so rich in nutrients due to high concentration of organic matters and minerals such as nitrogen, phosphorus, and potassium as shown in Table 1. The amount of NPK ranges from 437.33 to 1,971 mg/kg. The research published by Ramadas, S. et. al, 2018, indicated that the amount of nitrogen (N) is low if it is lower than 140 mg/kg (<140mg/kg) and it is higher if the amount of N is greater than 140mg/kg. In the same study, if the amount of phosphorus (P) is <5 mg/kg it is low, 5 - 12.5 mg/kg (medium), >12.5 mg/kg (high). Potassium (K) level is low if it is <60 mg/kg, medium if 60-140 mg/kg, and high if >140 mg/kg. The richness of the soil is noticeable due to the presence of abundant and various plants in the area. The nutrients absorbed by the plants like phosphorus is involved in energy metabolism and photosynthesis during plant growth (Yan et al., 2021). Whereas, potassium plays an important role in carbohydrate and protein metabolism (Hassanein et al., 2021), indicating that a reasonable proportion of nutrition (NPK) factors directly promote the absorption and assimilation of plants, thereby affecting their growth and development (Yildirim et al., 2011). Since plant's biological and physiological needs are satisfied, their growth, development, and reproduction in the intertidal zone continued.

CONCLUSION

Based on the experimentations, results and gathered data, the researchers concluded that there are significant differences ($p < 0.05$) in soil temperature measured at 5 cm, air temperature, and relative humidity but there was no significant difference ($p > 0.05$) in soil pH, soil temperature at 10 cm, and NPK concentration. Furthermore, greater NPK concentrations have a significant impact on floral diversity in Samet, Chonburi, Thailand.

RECOMMENDATIONS

For the improvement of the study, more research is required by comparing the soil quality in Samet's coastline area and nearby districts, as well as the types of plants that thrive in these areas. Furthermore, the study will be integrated with other branches of science, such as botany and microbiology, to assess the beneficial impacts of the plants in the area on humans.

GLOBE Badges

I am a Collaborator

This environmental research was finished completely because of the collaborative efforts of various individuals. The researchers were allowed by the administration of the Center of Expertise on Eco-tourism for Mangrove Conservation, Chonburi Province Office to conduct a study in the coastal area of Samet District where many plants are thriving. The survey done in the said office had given the team enough ideas pertaining to the previous and current condition of the place as well as the factors that need to be studied in the area. During the conduct of the study, the researchers were thoroughly guided and given knowledge by their teachers namely Ms. Rawadee Meesuk and Mr. Marvin Servillos. Furthermore, the soil and water quality testing were carried out properly because of the materials provided by the administrators of the school, including the school van, which was used for seamless transit from school to the study site. Thorough guidance and invaluable ideas from the above names were very significant to completely understand all the scopes of this research. Finally, the researchers of this science research have cooperated to finish the work entirely from the planning stage, experiments, analyzing of data, and packaging of the final research paper.

I am a Data Scientist

The researchers have studied systematically the current condition of soil sample in the coastal zone of Samet, Chonburi, Thailand. The information gathered from the administration of the Center of Expertise on Eco-tourism for Mangrove Conservation, Chonburi Province Office about the past and current condition of the place, are invaluable to determine the impact of higher NPK on floral diversity of the site. The results were collected, recorded, and analyzed properly. All of the data gathered from the field measurement were analyzed using some statistical models like ANOVA (Analysis of Variance) with post-hoc Tukey HSD (Honestly Significant Difference) Test. The results of the analysis were discussed and presented properly. Moreover, the results of the experiment were linked to the research done by other researchers.

I work with a STEM Professional

This environmental research is not possible without the invaluable insights from various STEM Professionals. The researchers were able to formulate research topic and questions by

asking their Biology teacher pertaining to possible studies that they can pursue that is relevant to the mission and vision of Globe IVSS. During data gathering and interpretation, the statistician of the school was consulted about the accurate research design and statistical method that can be used in interpreting the data about soil quality in Samet, Chonburi, Thailand. From the consultation with the school's statistician, the researchers learned that ANOVA (Analysis of Variance) and post-hoc Tukey HSD (Honestly Significant Difference) Test are the most appropriate tool to analyze the collected data. Moreover, the researchers also asked help from the statistician of the school to calculate and interpret the results of the study.

Acknowledgment

The researchers of the study would like to acknowledge the following for making this science project possible. First, they would like to convey their genuine thanks to the Head of CRU English Program Ms. Rawadee Meesuk for her utmost support, suggestions, and encouragement as well as for providing all the Laboratory equipment and chemicals that they need in their study. Second, the researchers would like to thank their Science teacher- Mr. Marvin Servillos, for his guidance towards the completion of the study. Finally, the researchers would like to give their special thanks to the committee of IPST, Globe Student Research Competition, and Globe International Virtual Science Symposium for conducting this prestigious event that enabled young scientists to share their scientific discoveries.

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Appendix 1

ANOVA (Analysis of Variance) for soil pH that was measured for 3 consecutive times in the coastal zone of Samet, Chonburi, Thailand.

Treatment →	A	B	C	source	sum of squares SS	degrees of freedom	mean square MS	F statistic	p-value
Input Data →	5.4	6.8	6.0	treatment	2.4267	2	1.2133	4.3506	0.0680
	5.0	5.7	7.0	error	1.6733	6	0.2789		
	5.8	5.9	7.0	total	4.1000	8			

Conclusion from ANOVA:

The p-value corresponding to the F-statistic of one-way ANOVA is **higher** than 0.05, suggesting that the treatments are not significantly different for that level of significance. The Tukey HSD test multiple comparison tests follow. This post-hoc tests would likely identify which of the pairs of treatments are significantly different from each other.

Tukey HSD results for soil pH.

Treatments pair	Tukey HSD Q statistic	Tukey HSD p-value	Tukey HSD inference
A vs B	2.4052	0.2795606	insignificant
A vs C	4.1544	0.0585242	insignificant
B vs C	1.7492	0.4775249	insignificant

Appendix 2

ANOVA (Analysis of Variance) for soil temperature (5 cm) that was measured for 3 consecutive times in the coastal zone of Samet, Chonburi, Thailand.

Treatment →	A	B	C	source	sum of squares SS	degrees of freedom	mean square MS	F statistic	p-value
Input Data →	27.0	28.0	30.0	treatment	13.5556	2	6.7778	30.5000	0.0007
	27.0	28.0	29.0	error	1.3333	6	0.2222		
	26.0	28.0	30.0	total	14.8889	8			

Conclusion from ANOVA:

The p-value corresponding to the F-statistic of one-way ANOVA is **lower** than 0.05, suggesting that one or more treatments are significantly different. The Tukey HSD test multiple

comparison tests follow. This post-hoc tests would likely identify which of the pairs of treatments are significantly different from each other.

Tukey HSD results for soil temperature (5 cm).

Treatments pair	Tukey HSD Q statistic	Tukey HSD p-value	Tukey HSD inference
A vs B	4.8990	0.0308323	* p<0.05
A vs C	11.0227	0.0010053	** p<0.01
B vs C	6.1237	0.0116292	* p<0.05

Appendix 3

ANOVA (Analysis of Variance) for soil temperature (10 cm) that was measured for 3 consecutive times in the coastal zone of Samet, Chonburi, Thailand.

Treatment →	A	B	C	source	sum of squares SS	degrees of freedom	mean square MS	F statistic	p-value
Input Data →	27.0	29.0	27.0	treatment	4.2222	2	2.1111	4.7500	0.0580
	27.0	28.0	28.0	error	2.6667	6	0.4444		
	27.0	29.0	29.0	total	6.8889	8			

Conclusion from ANOVA:

The p-value corresponding to the F-statistic of one-way ANOVA is **higher** than 0.05, suggesting that the treatments are not significantly different for that level of significance. The Tukey HSD test multiple comparison tests follow. This post-hoc tests would likely identify which of the pairs of treatments are significantly different from each other.

Tukey HSD results for soil temperature (10 cm).

Treatments pair	Tukey HSD Q statistic	Tukey HSD p-value	Tukey HSD inference
A vs B	4.3301	0.0501769	insignificant
A vs C	2.5981	0.2362531	insignificant
B vs C	1.7321	0.4836095	insignificant

Appendix 4

ANOVA (Analysis of Variance) for relative humidity that was measured for 3 consecutive times in the coastal zone of Samet, Chonburi, Thailand.

Treatment →	A	B	C
Input Data →	56.0	49.0	57.0
	54.0	44.0	56.0
	54.0	49.0	57.0

source	sum of squares SS	degrees of freedom	mean square MS	F statistic	p-value
treatment	144.8889	2	72.4444	21.7333	0.0018
error	20.0000	6	3.3333		
total	164.8889	8			

Conclusion from ANOVA:

The p-value corresponding to the F-statistic of one-way ANOVA is **lower** than 0.05, suggesting that one or more treatments are significantly different. The Tukey HSD test multiple comparison tests follow. This post-hoc tests would likely identify which of the pairs of treatments are significantly different from each other.

Tukey HSD results for relative humidity.

Treatments pair	Tukey HSD Q statistic	Tukey HSD p-value	Tukey HSD inference
A vs B	6.9570	0.0063304	** p<0.01
A vs C	1.8974	0.4264297	insignificant
B vs C	8.8544	0.0018604	** p<0.01

Appendix 5

ANOVA (Analysis of Variance) for air temperature that was measured for 3 consecutive times in the coastal zone of Samet, Chonburi, Thailand.

Treatment →	A	B	C
Input Data →	30.2	28.2	27.8
	30.2	30.3	28.1
	30.2	30.3	28.4

Source	Sum of Square	Degrees of freedom	Mean Square	F Statistic	P-value
treatment	7.02	2	3.51	6.75	0.02913
error	3.12	6	0.52		
total	10.14	8	1.2675		

Conclusion from ANOVA:

The p-value corresponding to the F-statistic of one-way ANOVA is **lower** than 0.05, suggesting that one or more treatments are significantly different. The Tukey HSD test multiple

comparison tests follow. This post-hoc tests would likely identify which of the pairs of treatments are significantly different from each other.

Tukey HSD results for air temperature.

Treatments pair	Tukey HSD Q statistic	Tukey HSD p-value	Tukey HSD inference
A vs B	1.4412	0.5928	insignificant
A vs C	5.044	0.02746	* p<0.05
B vs C	3.6029	0.09607	insignificant

Appendix 6

ANOVA (Analysis of Variance) for Nitrogen concentration that was measured for 3 consecutive times in the coastal zone of Samet, Chonburi, Thailand.

Treatment →	A	B	C	source	sum of squares SS	degrees of freedom	mean square MS	F statistic	p-value
Input Data →	341.0	378.0	297.0						
	531.0	454.0	289.0						
	440.0	508.0	327.0						
				treatment	38,034.8889	2	19,017.4444	4.1653	0.0734
				error	27,394.0000	6	4,565.6667		
				total	65,428.8889	8			

Conclusion from ANOVA:

The p-value corresponding to the F-statistic of one-way ANOVA is **higher** than 0.05, suggesting that the treatments are not significantly different for that level of significance. The Tukey HSD test multiple comparison tests follow. This post-hoc tests would likely identify which of the pairs of treatments are significantly different from each other.

Tukey HSD results for the nitrogen concentration.

Treatments pair	Tukey HSD Q statistic	Tukey HSD p-value	Tukey HSD inference
A vs B	0.2392	0.8999947	insignificant
A vs C	3.4093	0.1140159	insignificant
B vs C	3.6485	0.0918583	insignificant

Appendix 7

ANOVA (Analysis of Variance) for Phosphorus concentration that was measured for 3 consecutive times in the coastal zone of Samet, Chonburi, Thailand.

Treatment →	A	B	C
Input Data →	760.0	590.0	404.0
	677.0	714.0	441.0
	445.0	680.0	504.0

source	sum of squares SS	degrees of freedom	mean square MS	F statistic	p-value
treatment	77,524.2222	2	38,762.1111	3.4902	0.0988
error	66,636.0000	6	11,106.0000		
total	144,160.2222	8			

Conclusion from ANOVA:

The p-value corresponding to the F-statistic of one-way ANOVA is **higher** than 0.05, suggesting that the treatments are not significantly different for that level of significance. The Tukey HSD test multiple comparison tests follow. This post-hoc tests would likely identify which of the pairs of treatments are significantly different from each other.

Tukey HSD results for the phosphorus concentration.

Treatments pair	Tukey HSD Q statistic	Tukey HSD p-value	Tukey HSD inference
A vs B	0.5588	0.8999947	insignificant
A vs C	2.9200	0.1773266	insignificant
B vs C	3.4788	0.1070601	insignificant

Appendix 8

ANOVA (Analysis of Variance) for Potassium concentration that was measured for 3 consecutive times in the coastal zone of Samet, Chonburi, Thailand.

Treatment →	A	B	C
Input Data →	1999.0	1694.0	1328.0
	1999.0	1999.0	1828.0
	1915.0	1999.0	1998.0

source	sum of squares SS	degrees of freedom	mean square MS	F statistic	p-value
treatment	101,596.2222	2	50,798.1111	0.9853	0.4265
error	309,320.6667	6	51,553.4444		
total	410,916.8889	8			

Conclusion from ANOVA:

The p-value corresponding to the F-statistic of one-way ANOVA is **higher** than 0.05, suggesting that the treatments are not significantly different for that level of significance. The

Tukey HSD test multiple comparison tests follow. This post-hoc tests would likely identify which of the pairs of treatments are significantly different from each other.

Tukey HSD results for the potassium concentration.

Treatments pair	Tukey HSD Q statistic	Tukey HSD p-value	Tukey HSD inference
A vs B	0.5620	0.8999947	insignificant
A vs C	1.9300	0.4155871	insignificant
B vs C	1.3680	0.6185535	insignificant