INFLUENCE OF WATER TEMPERATURE AND SALINITY ON PH DURING DRY SEASON IN LOWER DONG NAI RIVER SYSTEM, VIETNAM

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ABSTRACT

This paper uses the gvSIG 2.2.0 software, IDW interpolation method, river and stream network data, and 36 sampling sites to build the maps of three monitored parameters such as pH, water temperature, and salinity in the Lower Dong Nai River system (2009–2010) in dry season. Based on an analysis of these maps and statistical assessment by using the R software, the correlations between pH, temperature, and salinity are clarified. The results show that the pH and temperature values have a tendency to decrease, whereas the salinity tends to increase annually. The pH value has good and significant correlations with the water temperature and salinity in both simple and multiple linear regression models. The results aim to provide a scientific reference for further research on the water environment in this area.

Keywords: water temperature, salinity, pH, dry season, lower Dong Nai river system

1 INTRODUCTION

The Dong Nai River is the longest river that locates entirely in the Vietnam territory, originating from the mountains of Lam Vien and Bi Dup at an elevation of over 2,000 metres with two branches of Da Dung and Da Nhim. In addition, there are also 5 major tributaries such as the La Nga River (approximately 272 km in length), Be River (344 km), Saigon River (256 km), Vam Co Dong River (218 km) and Vam Co Tay River (140 km) discharging into the Dong Nai River. The Lower Dong Nai River and its tributaries have the characteristics of flat terrain and low slope (altitude: 0.5–3.0 m) which tend to decrease 2 cm in height per 1 km in length to downstream [1]. In regard to water quality in this area, the river had a range of water quality parameters that modify copper bioavailability and toxicity [2]. The deterioration of water quality in the Dong Nai river system is increasing at an alarming level due to rapid urbanization and industrialization process [3]. The water is polluted by intensive brackish shrimp farming in the Can Gio district of Ho Chi Minh City (HCMC) [4]. The water resources planning and management for Lower Dong Nai River basin is essential [5]. The observed concentration of PCB's, DDT's, and heavy metals in sediments of HCMC's canals may present environmental risks [6]. The relatively high residues of PCBs and DDTs are still found in sediments from Sai Gon–Dong Nai River basin [7]. Besides that, the relationships between temperature, salinity and pH with development of organisms in water were presented in the previous researches [8 - 15]. The temperature and salinity have the clear influences on heavy metal uptake by submersed plants [16]. In this research, we uses the gvSIG 2.2.0 software, IDW interpolation method, river and stream network data, and 36 sampling sites to build maps assessing the influence of water temperature and salinity on pH in the Lower Dong Nai River system in the dry season (March) of 2009 and 2010. The correlations between pH, temperature, and salinity are also clarified based on an analysis of these maps and a statistical assessment using the R software.

2 MATERIALS AND METHODS

2.1 Study area

Based on the characteristics of socio-economic development, water bodies, flows, environmental variables and ecological conditions, the 36 sampling sites in the Lower Dong Nai River and tributaries were collected as shown in Figure 1.

2.2 Sampling process and laboratory analysis

The water quality collected complies with the UN Water Programme (1992) [17]. The sampling was performed 04 times (March, June, September and December) per year from 2007. In the cross section of each site, 3 samples were collected from the right bank, middle part, and the left bank of the river respectively. To clarify the influence of water temperature and salinity on pH during the dry season, in this study, only the data of March 2009 and March 2010 and the data of the middle part were chosen. The parameters and analysis methods are presented in Table 1.

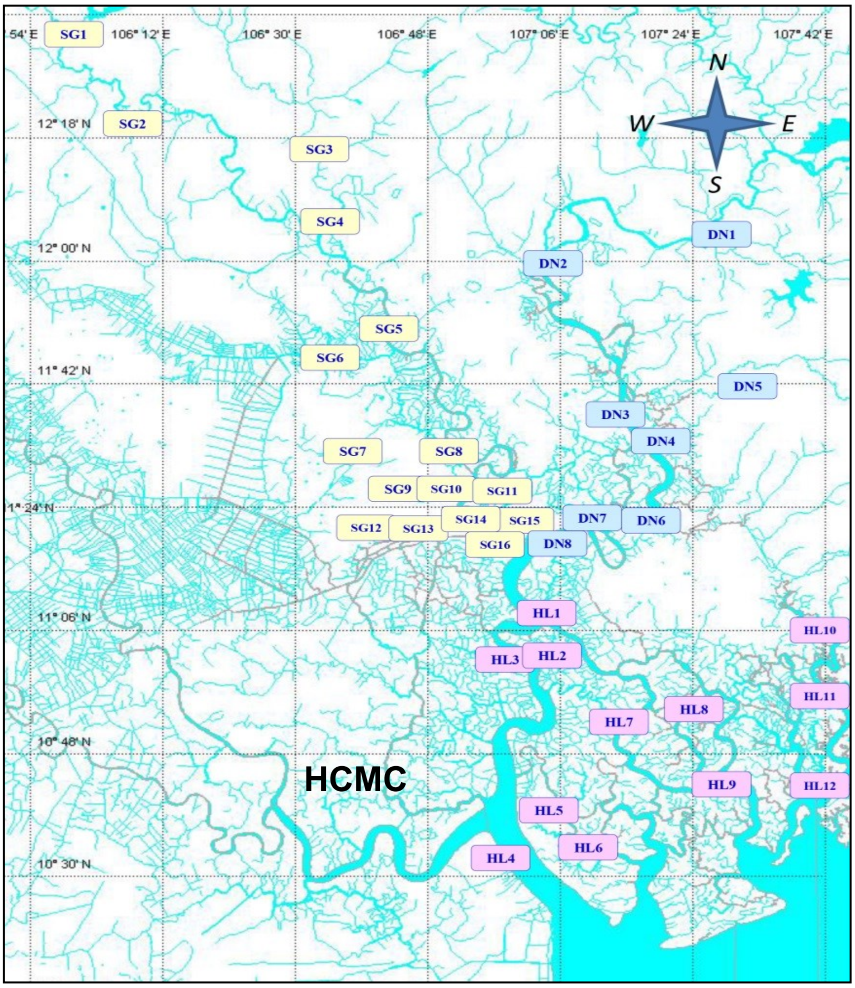

Figure 1: Sampling sites

Table 1: Sample analysis methods

No.	Parameters	Unit	Method
1	pH		TCVN 6492:2000
2	Water temperature	^0C	APHA 2550 B, 20th Ed.
3	Salinity	$^0/_{00}$	APHA 2520 B, 20th Ed.

2.3 Inverse Distance Weighted (IDW method) and Linear Regression Models

The IDW method estimates the cell values by weighted averaging the values of sample data points in the vicinity of each cell. The closer the sampled location is to the centre of the cell being estimated, the more influence, or weight it has in the averaging process.

The influence of a known data point is inversely related to the distance from the unknown location that is being estimated. The interpolation function is as follows [18 - 20]:

$$\lambda_i = \left(\sum_{j=1}^{G} \lambda_j / D_{ij}^{P} \right) \Big/ \left(\sum_{j=1}^{G} 1 / D_{ij} \right) \quad (1)$$

Where λ_i is the property at the location i;
λ_j is the property at the sampled location j;
D_{ij} is the distance from i to j;
G is the number of sampled locations; and
p is the inverse-distance weighting power.

Weights are proportional to the inverse distance raised to the power value p. As a result, as the distance increases, the weights decrease rapidly. How fast the weights decrease, it depends on the value of p. As p increases, the weights for distant points decrease rapidly. If the p value is very high, only the immediate few surrounding points influence the prediction. $P = 2$ is normally used in the interpolation [21, 22].

The linear regression models are described as follows [23, 24]:

The simple linear regression model:

$$y = \alpha + \beta x + \varepsilon \qquad (2)$$

Where y is the dependent variable;
x is the independent variable;
α is the y-intercept;
β is the slope of line;
ε is the random error.

The multiple linear regression model:

$$y = \beta_0 + \beta_1 x_1 + \ldots \beta_m x_m + \varepsilon \qquad (3)$$

Where the numbers $\beta_0, \beta_1, \ldots$ and β_m are the population parameters.

3 RESULTS

The distribution ranges across the river system of pH, temperature, and salinity in the dry season in the Lower Dong Nai River system (2009–2010) are shown in Table 2 and Figures 2, 3 & 4 respectively.

The results extracted from the maps analysis show:

- pH is neutral and basic from the confluence zone to the estuary. Conversely, pH has the acidic property:
  - near major industrial zones and urban areas suffering from strong impacts of organic contamination in the Saigon River from the Thu Dau Mot city to the Nha Rong harbor (SG 5, SG8, SG10, and SG11),
  - in the Thi Vai River from Vedan to the Phu My Industrial Zone (HL10 and HL11).
- The temperature tends to increase from the confluence zone to the estuary due to a positive influence of the Can Gio mangrove forest and a good mixture between fresh water and sea water.

Table 2: Parameters in March of 2009 and 2010

Year	pH	Temperature (^{0}C)	Salinity ($^0/_{00}$)
2009	4.0–7.49	29–31	0.0–30
2010	4.0–7.59	29–31	0.0–30

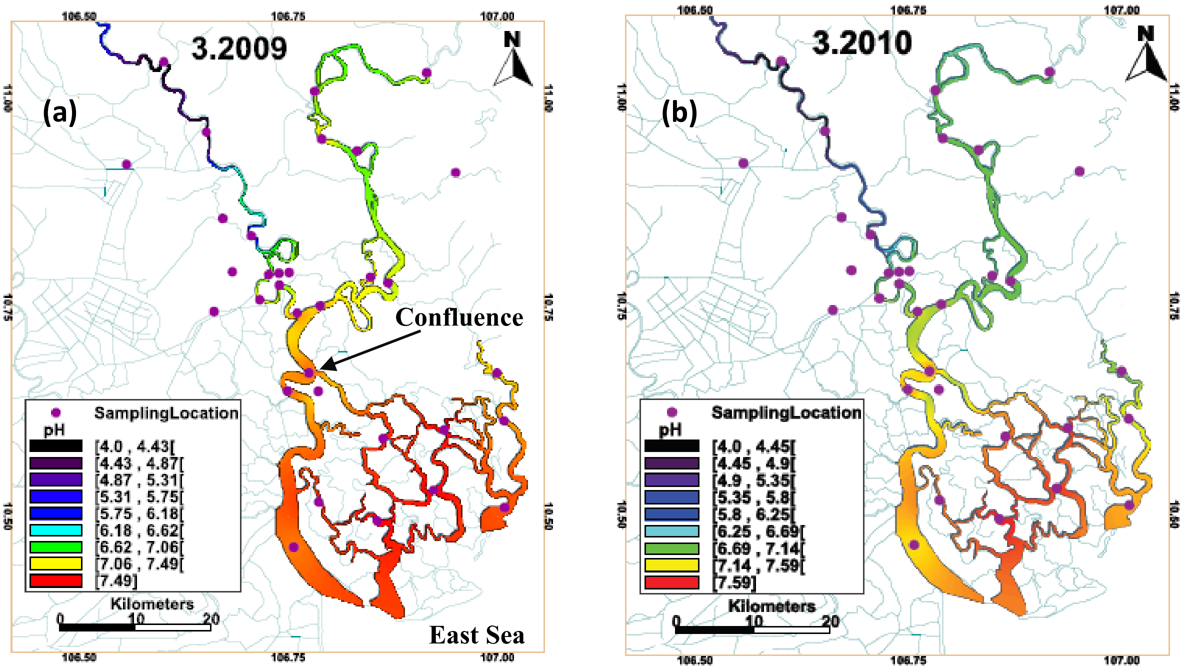

Figure 2: Distribution of pH in March – (a) 2009 and (b) 2010

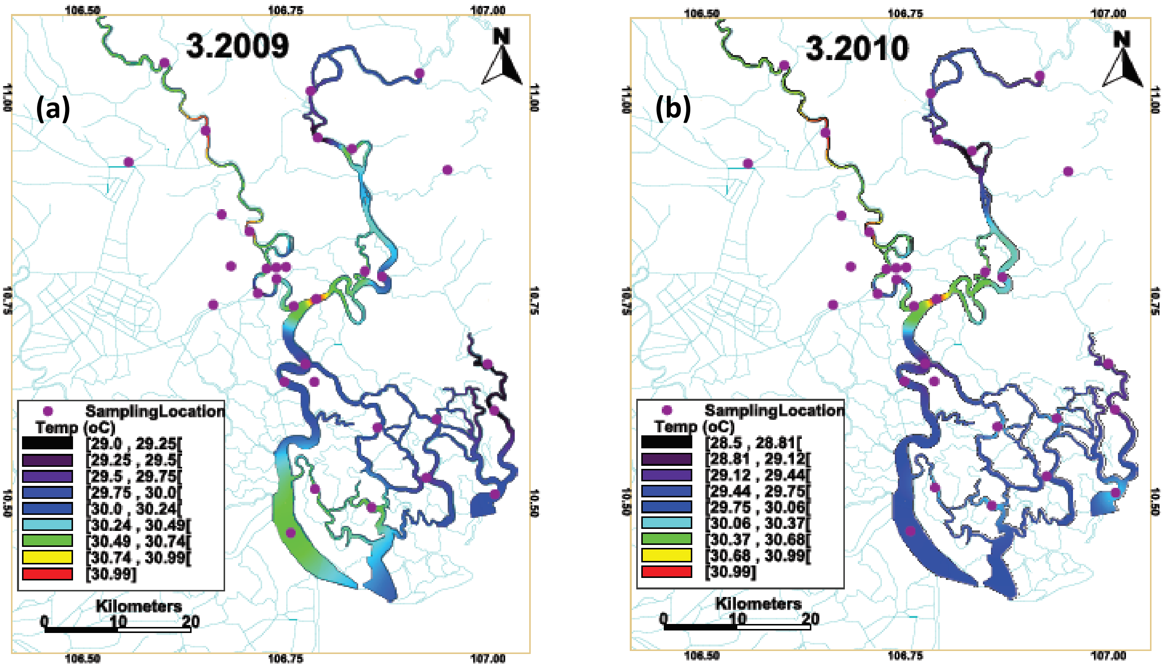

Figure 3: Distribution of water temperature in March – (a) 2009 and (b) 2010

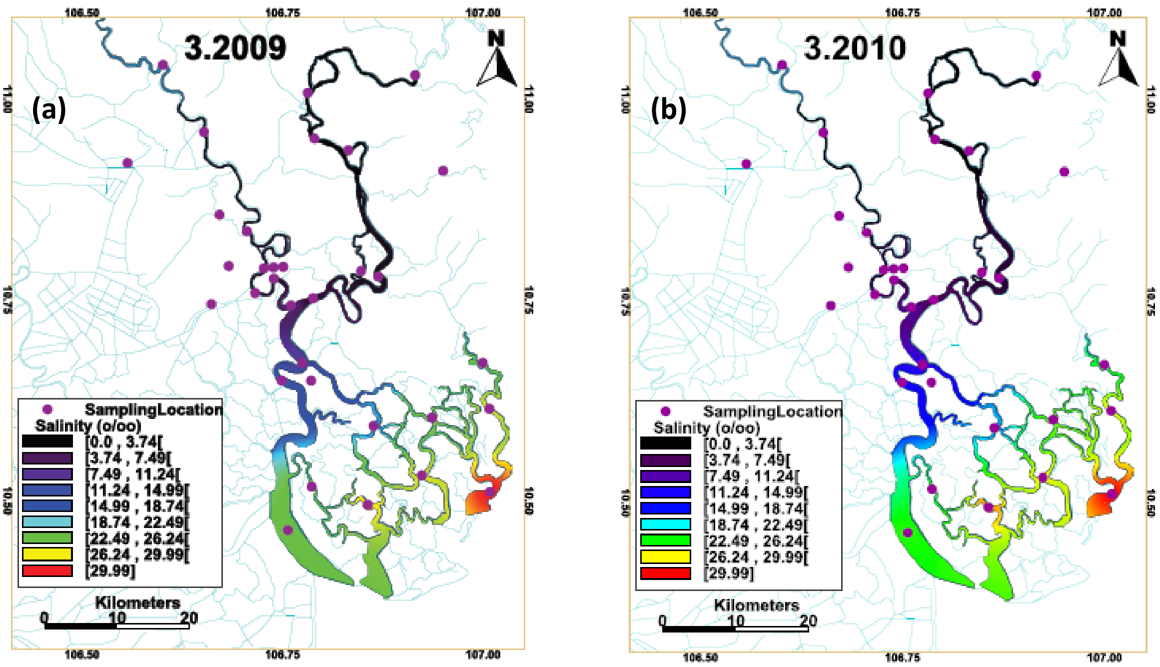

Figure 4: Distribution of salinity in March – (a) 2009 and (b) 2010

- Salinity gradually increases from the confluence to the estuary and reaches the highest values at HL12. This is the estuary zone strongly affected by tides from the East Sea.
- The correlations between temperature and salinity with pH are sequentially shown in Figures 5, 6, & 7. The statistical analysis is conducted on 36 sample values of each parameter. The linear regression models are used through the R software. In this research, the correlation estimations are mainly based on the data trend.

It is realized that there are good and significant correlations between pH with water temperature and salinity in both simple and multiple linear regression models.

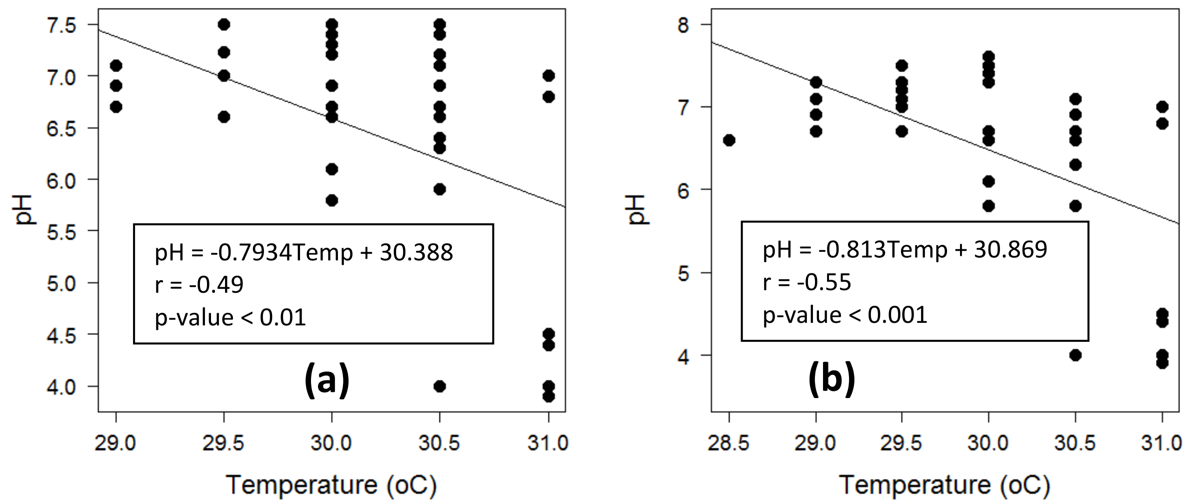

Figure 5: Temperature and pH in March – (a) 2009 and (b) 2010

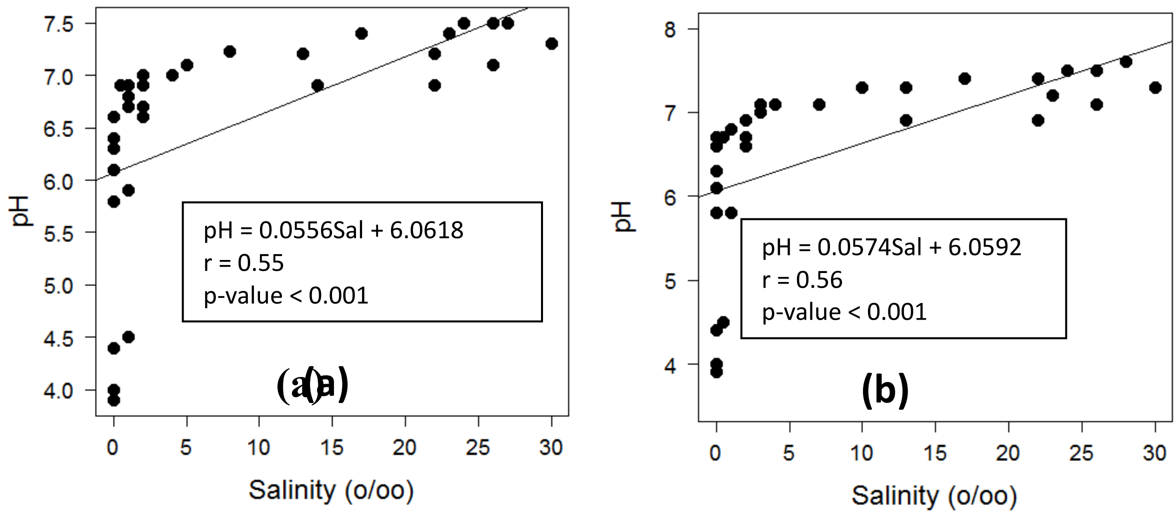

Figure 6: Salinity and pH in March – (a) 2009 and (b) 2010

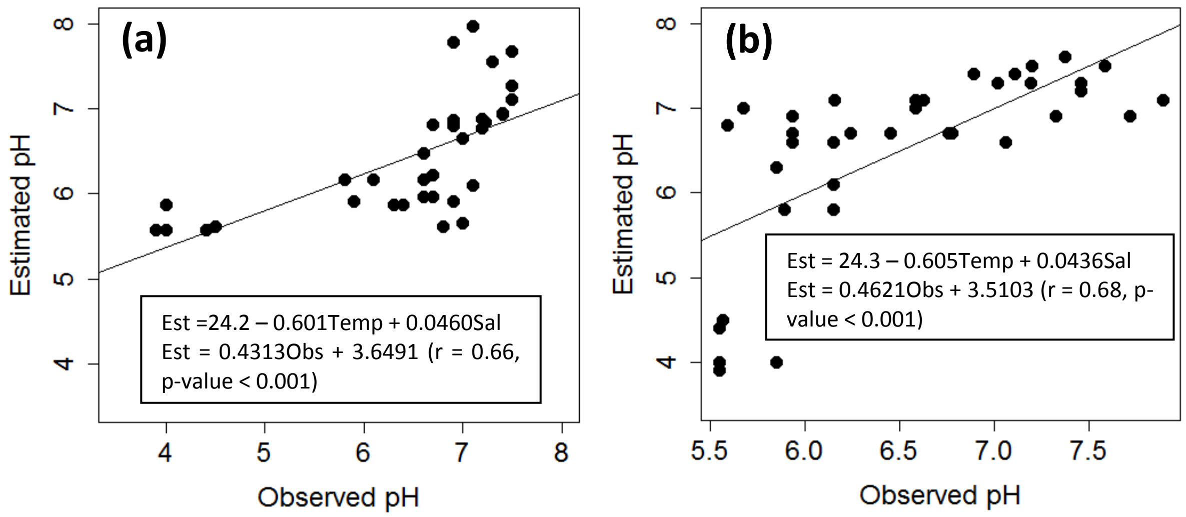

Figure 7: Observed and estimated pH in March – (a) 2009 and (b) 2010

4 CONCLUSION

In this study, we introduce the temperature and salinity factors into estimation of the pH in the Lower Dong Nai River system. The maps of water temperature, salinity and pH in March of 2009 and 2010 were built through gvSIG 2.2.0 software, IDW method, river and stream network data, and 36 sampling sites. The results show that there is a decrease in pH, temperature and an increase in salinity annually. pH,, ranging from 4.0 – 7.9, is neutral and basic from the confluence zone to the estuary, and has the acidic property near major industrial zones. Temperature, in the range of 290C – 310C, and salinity, in the range of 00/00 - 300/00, tends to increase from the confluence zone to the estuary. It is found that pH has high significant correlations with water temperature and salinity in both simple and multiple linear regression models with p-value < 0.001. The results aim to provide a scientific reference for further research on the water environment in this area.

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