APPLICATION OF GIS IN ESTIMATING SEASONAL WATER QUALITY IN LOWER DONG NAI RIVER SYSTEM

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ABSTRACT

This paper uses ArcGIS 9.3 software, IDW interpolation method, river and stream network data, and 36 sampling positions to build the maps estimating the seasonal change of water quality in Lower Dong Nai River system (2009 – 2010). The estimation is based on four indicators DO, BOD_5, total N, and total P. The results show that the water quality in the research site has not been improved. The indicators are different according to each season. On the whole, DO in flood season is higher than in dry season while the BOD_5, total N, and total P are in contrast. The finding can be a scientific reference in selection of treatment facilities to improve river water quality in this area.

1. INTRODUCTION

Dong Nai River is the longest river that locates entirely in the Vietnam territory, originating in the mountains of Lam Vien and Bi Dup at over 2,000 meters elevation with two branches of Da Dung and Da Nhim. In addition, there are also 5 major tributaries such as La Nga River with the length approximately 272 km, Be River (344 km), Saigon River (256 km), Vam Co Dong River (218 km) and Vam Co Tay Rivers (140 km) respectively these discharge water to 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 height for 1 km length to downstream [3]. This paper uses ArcGIS 9.3 software, IDW interpolation method, river and stream network data, and 36 sampling positions to build the maps estimating the seasonal change of water quality in Lower Dong Nai River system (2009 – 2010). The estimation is based on four indicators DO, BOD5, total N, and total P.

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 (Fig. 1).

2.2. Sampling process

The water quality collected follows UN Water Programme (1992). The sampling frequencies were taken in March and September from 2009 to 2010. Sample locations at each site were selected in the middle part of the river [5].

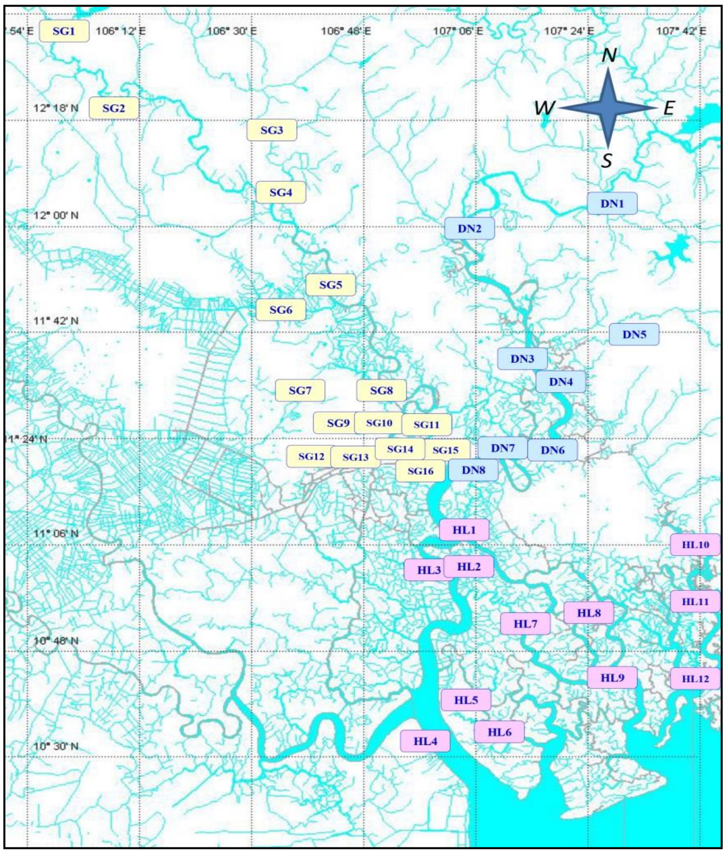

Figure 1. Sampling sites

Table 1. Parameters and methods of water quality analysis

No.	Parameters	Unit	Methods
1	DO	mg/l	HD 98569 – Delta OHM
2	BOD_5	mg/l	TCVN 6001 : 1995
3	Total N	mg/l	TCVN 6624-1:2000
4	Total P	mg/l	TCVN 6202-1996

2.3. Laboratory analysis

The parameters and methods of water quality analysis were presented in Table 1.

2.4 Map building procedures

2.4.1. Inverse Distance Weighted method (IDW method)

IDW estimates cell values by averaging the values of sample data points in the vicinity of each cell. The closer a point is to the center of the cell being estimated, the more influence, or weight, it has in the averaging process. This method assumes that the variable being mapped decreases in influence with distance from its sampled location. Interpolation function [1]:

$$\lambda_i = \frac{\sum_{j=1}^{G} \lambda_j / D_{ij}^p}{\sum_{j=1}^{G} 1 / D_{ij}} \quad (1)$$

Where λ_i is the property at location i; λ_j is the property at 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 is dependent on the value for p. If $p = 0$, there is no decrease with distance, and because each weight λ_i will be the same, the prediction will be the mean of all the measured values. As p increases, the weights for distant points decrease rapidly. If the p value is very high, only the immediate few surrounding points will influence the prediction. $P = 2$ is used as a default value [2].

2.4.2 Search radius

The characteristics of the interpolated surface can also be controlled by applying a search radius, fixed or variable, which limits the number of input points that can be used for calculating each interpolated cell. A fixed search radius requires a distance and a minimum number of points. The distance dictates the radius of the circle of the neighborhood, in map units. The distance of the radius is constant, so for each interpolated cell, the radius of the circle used to find input points is the same. The minimum number of points indicates the minimum number of measured points to use within the neighborhood. All the measured points that fall within the radius will be used in the calculation of each interpolated cell. When there are fewer measured points in the neighborhood than the specified minimum, the search radius will increase until it can encompass the minimum number of points. The specified fixed search radius will be used for each interpolated cell – cell center – in the study area. With a variable search radius, the number of points used in calculating the value of the interpolated cell is specified, which makes the radius distance vary for each interpolated cell, depending on how far it has to search around each interpolated cell to reach the specified number of input points. Thus, some neighborhoods can be small and others can be large, depending on the density of the measured points near the interpolated cell. If the radius for a particular neighborhood reaches the maximum distance before obtaining the specified number of points, the prediction for that location will be performed on the number of measured points within the maximum distance. A barrier is a polyline dataset used as a break that limits the search for input sample points. A polyline can represent a cliff, ridge, or some other interruption in a landscape. Only those input sample points on the same side of the barrier as the current processing cell will be considered [4, 6].

3. RESULTS

DO increases at the locations (Fig. 2):

- near major industrial zones and urban areas suffering from strong impact of organic contamination in Saigon River from Thu Dau Mot city to Nha Rong harbor (SG 5, SG8, SG10, and SG11),
- of Thi Vai River from Vedan to Phu My Industrial Zone (HL10 and HL11).

DO decreases at upper areas of Saigon River, Dong Nai River, and confluence zone.

The opposite situations are applied for the cases of BOD_5, total N, and total P (Figs. 3, 4 & 5). From 2009 to 2010, the water quality in the research site has not been improved. The indicators are different according to each season. DO in flood season is higher than in dry season while the BOD_5, total N, and total P are in contrast. These are showed in Table 2.

Table 2. Seasonal indicators from 2009 to 2010

Year	Month	DO (mg/l)	BOD_5 (mg/l)	Total N (mg/l)	Total P (mg/l)
2009	March	0.2 – 6.0	6.0 – 83.4	1.3 – 4.1	0.12 – 1.77
	September	0.4 – 6.6	4.4 – 81.5	1.2 – 3.5	0.13 – 1.40
2010	March	0.1 – 6.0	5.4 – 83.3	1.1 – 4.3	0.13 – 1.63
	September	0.5 – 6.4	4.5 – 72.2	1.2 – 3.4	0.13 – 1.70

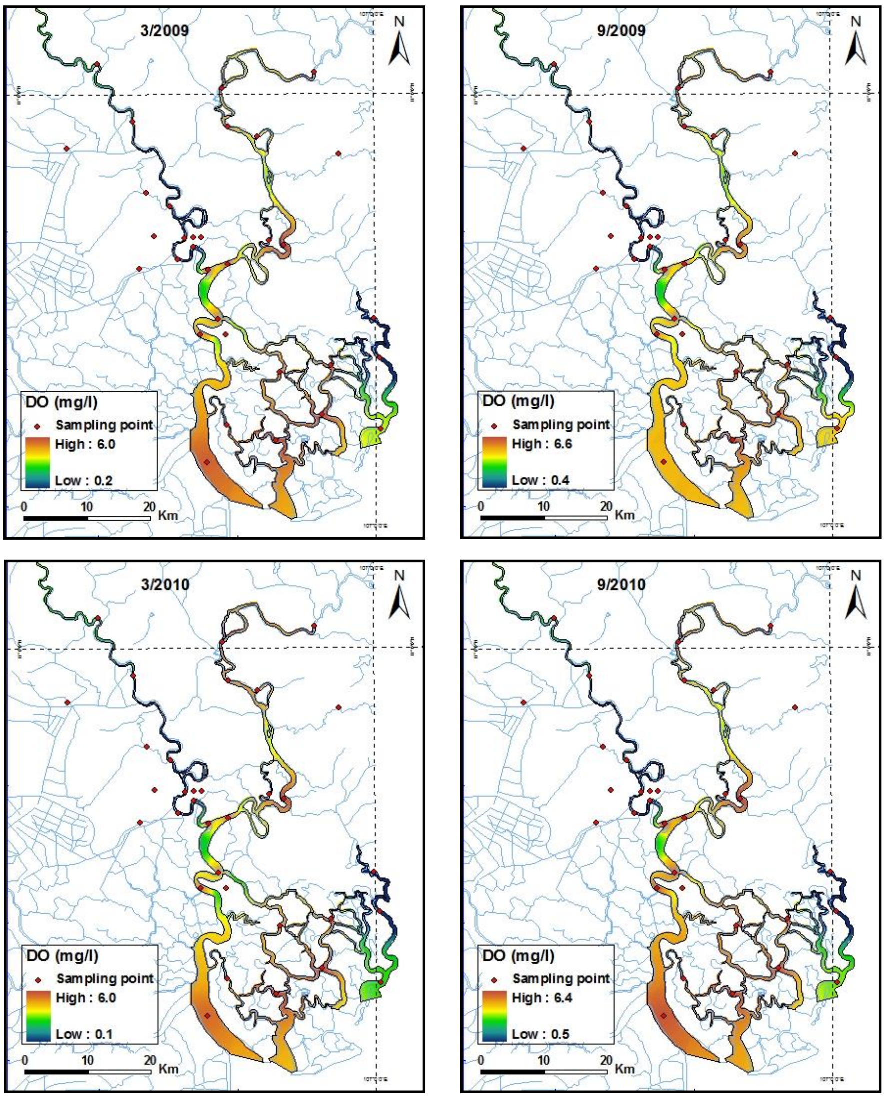

Figure 2. Seasonal change of DO in Lower Dong Nai River system (2009 – 2010)

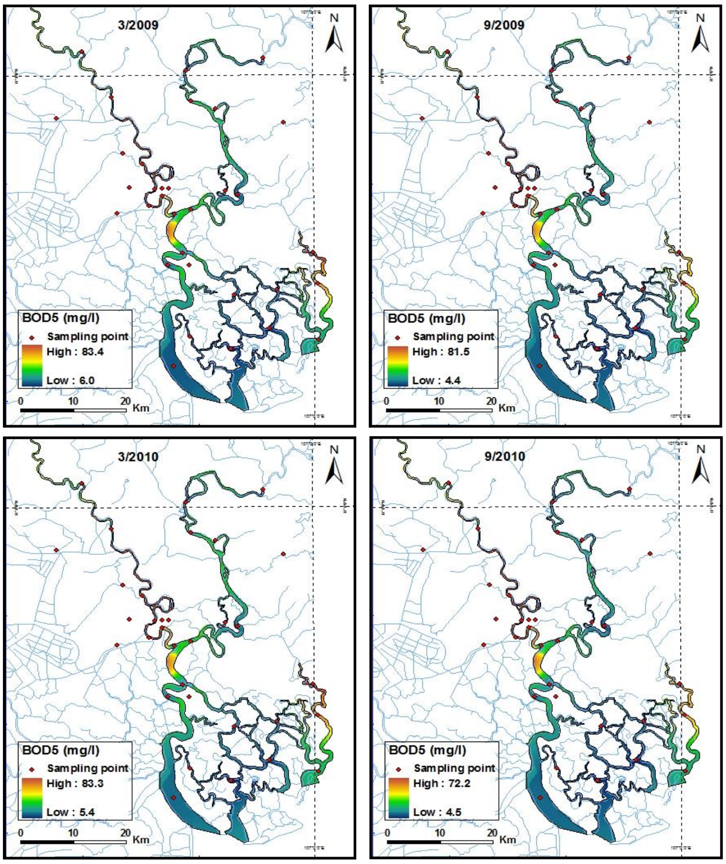

Figure 3. Seasonal change of BOD_5 in Lower Dong Nai River system (2009 – 2010)

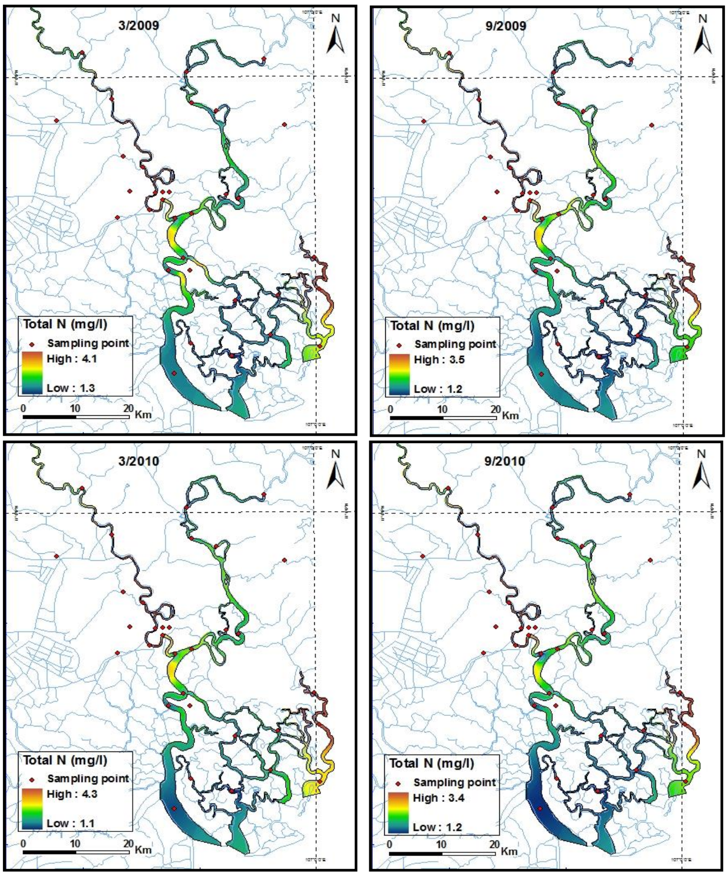

Figure 4. Seasonal change of total N in Lower Dong Nai River system (2009 – 2010)

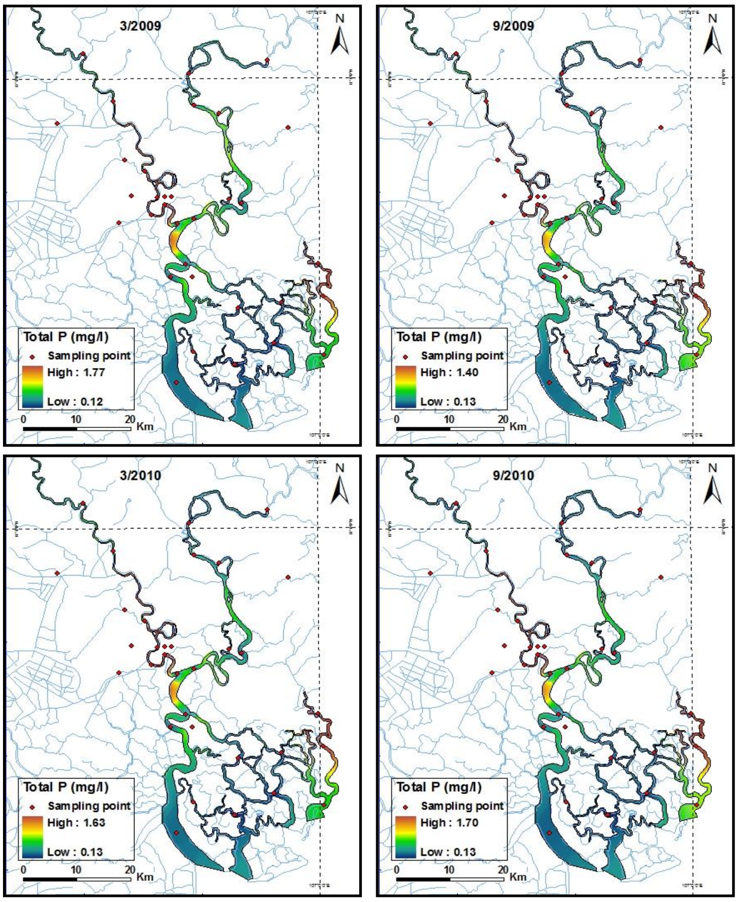

Figure 5. Seasonal change of total P in Lower Dong Nai River system (2009 – 2010)

4. CONCLUSION

Through research results of four indicators DO, BOD5, total N, and total P combined with GIS technology, a set of maps for Lower Dong Nai River system was built. The results show that the water quality in the research site has not been improved. The indicators are different according to each season. On the whole, DO in flood season is higher than in dry season while the BOD5, total N, and total P are in contrast. The finding can be a scientific reference in selection of treatment facilities to improve river water quality in this area.

5. REFERENCES

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