

Water Quality Assessment using Benthic Macroinvertebrates in Water Bodies, Tien Giang Province, Vietnam

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Abstract. This study to enhance the discussion about the usefulness of benthic macroinvertebrates for water quality assessment in Mekong Delta provinces. Data from 30 sites were used as a representative example for water bodies in 2,482 km² Tien Giang Province. The data covered the period 2012 – 2013. To implement this evaluation, the analyses were based on accepted MRC methods and classifications, and the working experiences of scientific group for the biological status assessment. Selected environmental variables were compared with ecological indices, based on benthic macroinvertebrates.

The characteristics for the communities of benthos macroinvertebrates were described. Both univariate and multivariate analyses were used to examine the spatial patterns of water quality and biological groups, and to relate these patterns to environmental variables. The results demonstrated that these organisms could be applied to describe the ecological health in water bodies of Tien Giang Province.

Keywords: Tien Giang Province, benthic macroinvertebrates, environmental variables, water quality, ecological health.

1. Introduction

Tien Giang Province located to the North of the Mekong Delta with area 2,482 km², along the North of Tien River, Long An Province shares border with Long An Province and HoChiMinh City on the north, Dong Thap Province on the west, East Sea on the east, and Ben Tre Province on the south. Tien and Vam Co Tay rivers with Soai Rap, Tieu, Dai river mouths make good condition to develop aquaculture. The terrain is divided into distinct three regions: fruit gardens along the bank of Tien River, plain and seaside. The policies for socio-economic development and land-use change have impulsed the economic growth of Tien Giang Province, but the water pollution have a tendency to increase. These consequences of environmental pollution are thus far from inevitable [1].

In order to contribute the water resources management and improve the water quality monitoring for Tien Giang Provinces, besides the physiochemical measurements, the using of aquatic organisms for the ecological health monitoring has been applied more and more because of many their advantages. Up to now, the application of these organisms is rather limited and not verified, especially, the relationships between benthic macroinvertebrates and physicochemical variables for the water quality evaluation.

The water bodies of Tien Giang Province was chosen to assess the impact of socio-economic development and land-use change on water quality and ecological health. This work will support for scientists and managers in field of ecology, resources and environment, who can applied these studies for the ecological health monitoring in Tien Giang Province and Mekong Delta as well.

2. Materials and Methods

2.1. Study Sites

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The 30 sampling sites at water bodies in Tien Giang Province were collected. The sampling frequencies were taken two times in March, 2012 – 2013 (Figure 1).

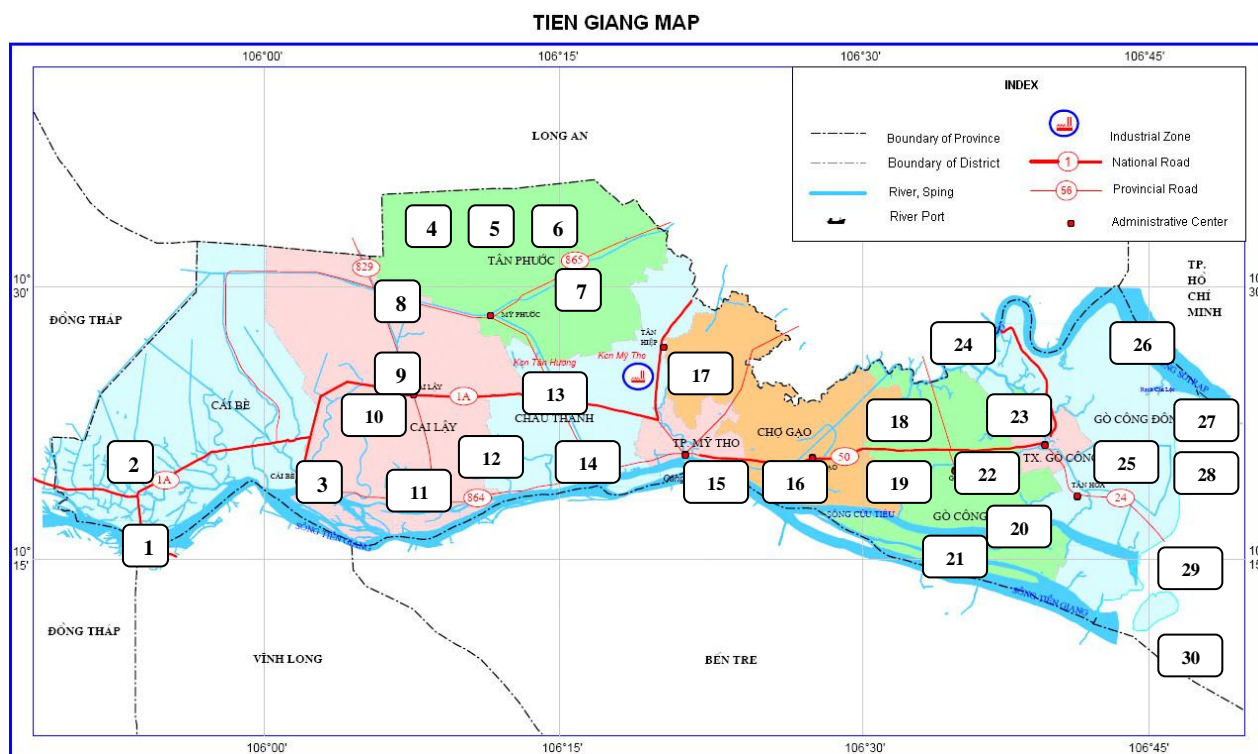


Fig. 1: Map of Sampling Sites in Tien Giang Province

2.2. Sampling and Sample Process

The sampling and sample techniques were based on the standardized methods [2, 3, 4].

2.3. Data Analysis

For all sites sampled in March, 2012 and 2013, the following metrics were calculated (which is 1 m²): (i) taxonomic richness (i.e. number of taxa); (ii) abundance (i.e. numbers of individuals per site); (iii) the Berger-Parker Dominance Index [5]; (iv) the Shannon-Wiener Diversity Index [6]; (v) the Evenness Index [6]; (vi) the Simpson Density Index [6]; and, (vii) Average Tolerance Score Per Taxon [7, 8]. The water quality assessment for a range of bio-index values were presented in Table 1.

Table 1: Ranking of bio-index values using benthic macroinvertebrates [7, 8]

ATSPT	D _{BP}	H'	E	D _s	Ranking	Color Indicators
≤ 35	> 0.75	> 3.25	> 0.85	> 0.90	Non pollution	Blue
36 – 45	0.50-0.75	2.20-3.25	0.65-0.85	0.65-0.90	Light pollution	Green
46 – 50	0.30-0.50	1.40-2.20	0.45-0.65	0.40-0.65	Low moderate pollution	Yellow
51 – 55	0.15-0.30	0.80-1.40	0.30-0.45	0.25-0.40	High moderate pollution	Red
> 55	0.05-0.15	0.10-0.80	0.15-0.30	0.10-0.25	Heavy pollution	Brown
Not any benthic macroinvertebrate	< 0.05	< 0.10	< 0.15	< 0.10	Very heavy pollution	Dark

Notes: ATSPT (Average Tolerance Score Per Taxon); D_{BP} (Berger-Parker Dominance Index); H' (Shannon-Wiener Diversity Index); E (Piluou Evenness Index); D_s (Simpson Dominance Index).

3. Results

3.1. Biota Collected

In total, 8,590 benthic macroinvertebrates belonging to 34 taxa were collected in 2012 – 2013.

3.2. Richness

Richness per site ranged from 3 to 9 taxa, and was significantly positively correlated with pH, salinity, nitrate, and ammonia (Figure 2).

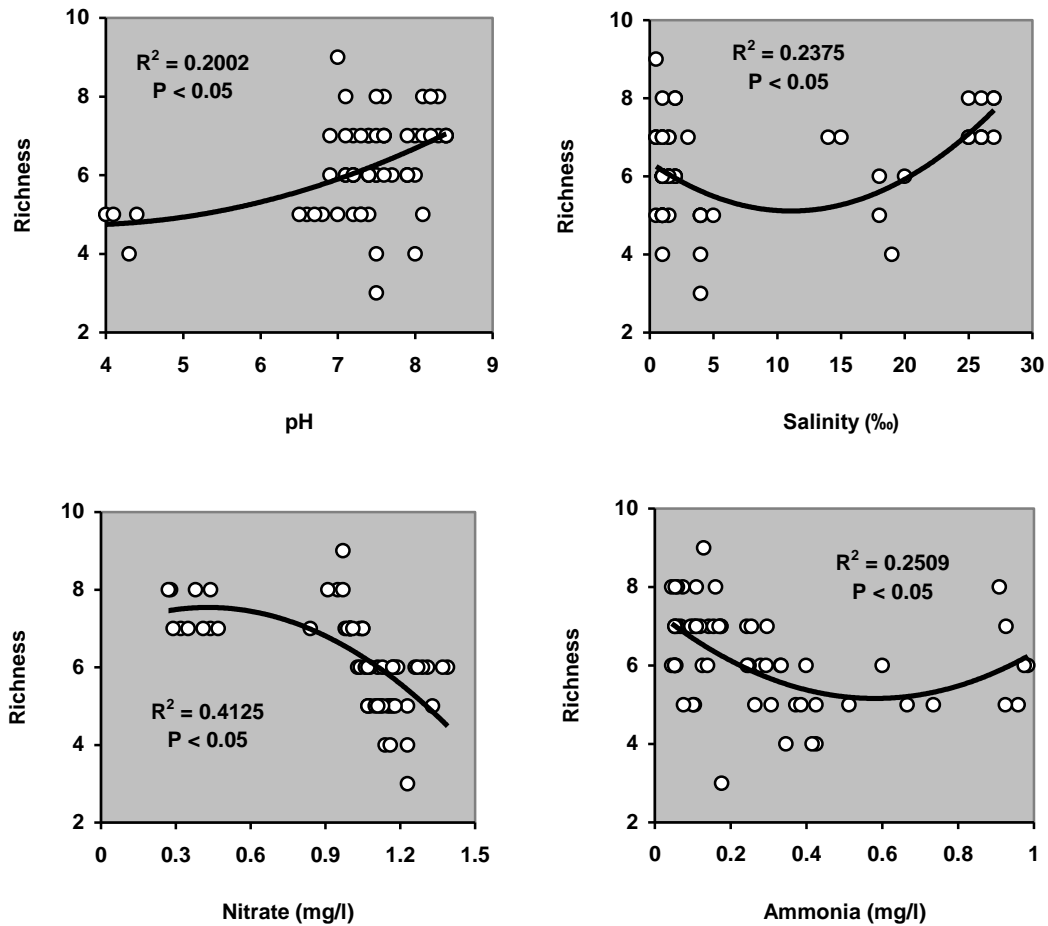


Fig. 2: Statistically significant relationships of richness of benthic macroinvertebrates to environmental variables.

3.3. Abundance

The number of individual macroinvertebrates per benthic site ranged from 40 to 900 individuals/m². The abundance had a significant positive correlation with suspended solid.

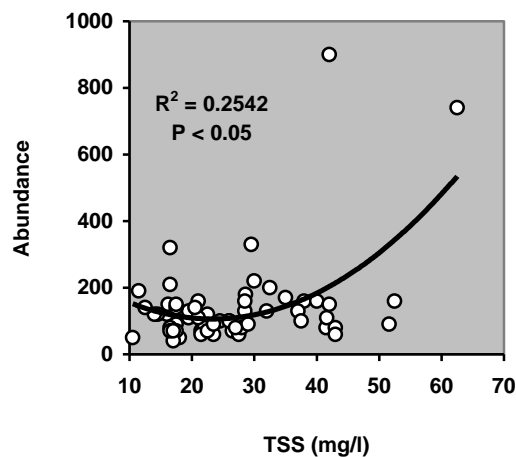


Fig. 3: Statistically significant relationship of abundance of benthic macroinvertebrates to suspended solid.

3.4. Bio-Index and ATSPT Analysis

The values of ATSPT and bio-indices for the water quality assessment for the water bodies in Tien Giang Province were presented in Table 2.

Table 2: Metrics of benthic macroinvertebrate for water quality assessment in the studied sites (2012 – 2013).

Sites	ATSPT	D _{BP}	H'	E	D _s
1	43 – 44	0.60 – 0.70	1.75 – 1.83	0.90 – 0.94	0.78 – 0.82
2	44 – 45	0.62 – 0.64	1.72 – 1.74	0.79 – 0.89	0.77 – 0.78
3	42 – 43	0.64 – 0.70	1.64 – 1.97	0.92 – 0.94	0.78 – 0.84
4	42	0.42 – 0.60	1.23 – 1.33	0.77 – 0.96	0.61 – 0.72
5	42	0.57 – 0.62	1.24 – 1.49	0.90 – 0.93	0.67 – 0.75
6	41	0.57 – 0.67	1.47 – 1.56	0.92 – 0.97	0.73 – 0.78
7	45 – 47	0.67 – 0.71	1.56 – 1.75	0.97 – 0.98	0.78 – 0.82
8	45	0.62	1.49	0.93	0.75
9	44	0.69 – 0.75	1.84 – 1.93	0.93 – 0.95	0.83
10	42	0.61 – 0.67	1.29 – 1.68	0.66 – 0.94	0.60 – 0.79
11	44	0.64 – 0.67	1.77	0.91	0.79 – 0.80
12	42	0.64 – 0.67	1.63 – 1.68	0.91 – 0.94	0.78 – 0.79
13	42	0.56 – 0.67	1.58 – 1.68	0.88 – 0.94	0.74 – 0.79
14	42	0.12 – 0.50	0.55 – 1.44	0.31 – 0.80	0.22 – 0.69
15	42	0.45 – 0.69	1.54 – 1.93	0.74 – 0.93	0.67 – 0.83
16	39 – 42	0.11 – 0.56	0.50 – 1.63	0.28 – 0.84	0.21 – 0.74
17	42 – 46	0.42 – 0.71	1.35 – 1.81	0.75 – 0.93	0.63 – 0.82
18	41 – 42	0.60 – 0.62	1.61 – 1.67	0.90 – 0.93	0.76 – 0.78
19	41	0.62 – 0.71	1.55 – 1.75	0.86 – 0.98	0.75 – 0.82
20	44	0.64 – 0.67	1.77 – 1.83	0.91 – 0.94	0.79 – 0.81
21	46 – 47	0.53	1.24 – 1.29	0.77 – 0.80	0.64 – 0.65
22	45 – 47	0.50 – 0.60	1.04 – 1.33	0.95 – 0.96	0.63 – 0.72
23	42	0.57 – 0.67	1.48 – 1.56	0.92 – 0.97	0.73 – 0.78
24	45	0.62 – 0.71	1.67 – 1.75	0.93 – 0.98	0.78 – 0.82
25	45 – 50	0.50 – 0.62	1.24 – 1.49	0.90 – 0.93	0.67 – 0.75
26	44 – 45	0.55 – 0.59	1.62 – 1.68	0.81 – 0.84	0.74 – 0.75
27	43	0.61 – 0.69	1.80 – 1.93	0.86 – 0.93	0.78 – 0.83
28	44	0.64 – 0.67	1.77 – 1.79	0.91 – 0.92	0.80 – 0.81
29	43 – 44	0.57 – 0.62	1.61 – 1.69	0.83 – 0.87	0.74 – 0.77
30	45	0.60 – 0.67	1.71 – 1.91	0.88 – 0.92	0.77 – 0.82

TIEN GIANG MAP

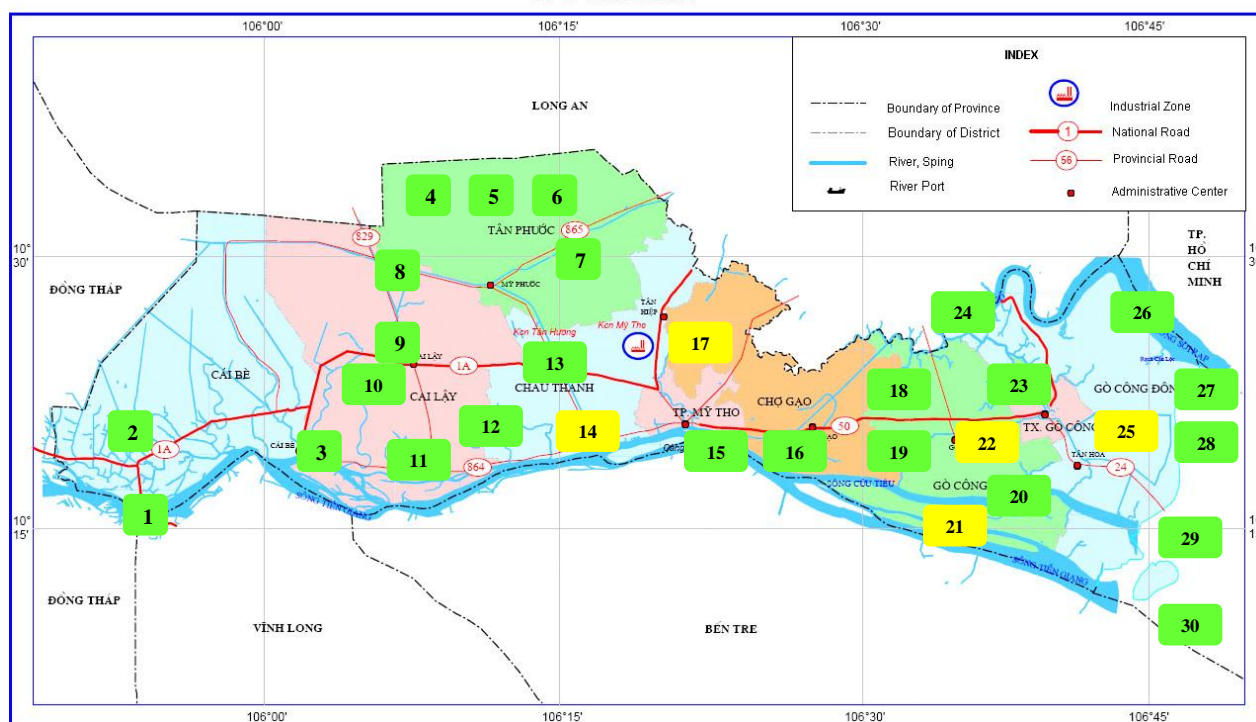


Fig. 4: Pollution zonation based on the values of ATSPT and bio-indices for water bodies in Tien Giang Province

4. Discussion

The positive relationships of benthic richness with pH and salinity may represent a response to the changes of aquatic ecosystems from freshwater to estuaries and coastal areas, and some sites were affected by acid sulphate water. Reasons for the positive relationships of benthic richness with nitrate and ammonia were expected, because many benthic species are sensitive to high nitrate and ammonia concentrations resulting to organic pollution. The positive correlations between benthic abundance and TSS may have been related to substrates, since soft bottom is typically associated with a higher TSS.

Based on the values of ATSP and bio-indices, the water quality assessment for the water bodies in Tien Giang Province were classified in Figure 4. The water quality at 30 sites in the water bodies of Tien Giang Province was divided 2 levels: (1) Light pollution; and, (2) Low moderate pollution.

5. Conclusion

This study to date has defined suitable biological groups and indicators for monitoring the aquatic ecosystems of the water bodies in Tien Giang Province. It was a useful method to evaluate and zoning the water quality because of the clear, detail, easily understandable, trustable results.

6. Acknowledgements

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