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STUDIES OF THE BENTHIC MACROINVERTEBRATE FOR WATER QUALITY MONITORING IN CAN GIO - HCMC

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ABSTRACT

The program “The studies of benthic macroinvertebrate for water quality monitoring in Can Gio - HCMC” is implemented in the Institute of Tropical Biology, it is aimed to study the water quality monitoring of river system in Can Gio through the studies of community structure of benthic macroinvertebrate, biological indexes and relationship between them and physio-chemical factors.

We have identified the specific species and bioindicators for the characteristics of each water environment, selected the biological criteria of benthic macroinvertebrate to evaluate the water quality for brackish and salt water bodies in Can Gio and neighboring waters, and suggested some reference levels of indexes and a new index (Errantia/Sedentaria ratio) for benthic macroinvertebrate. In addition, we also applied the GIS technology to manage the data basis and display the sampling sites and the water quality on the maps. The results contribute to complete the method of ecological health monitoring for the brackish and salt water bodies that are suitable to the special ecosystem in Can Gio and neighboring waters.

However, with the targets developed for standards of bioindicators and biological criteria for water quality assessment in Vietnam, detailed studies need be done with participation of scientists in different areas.

Keywords: Benthic Macroinvertebrate, Bioindicator, Biological Index, Ecosystem, Organic Pollution, Water Quality Monitoring.

INTRODUCTION

With the development of methodologies for water quality assessment, the chemistry and physics have wide currency among the monitoring. However, apart from the strengths, it always remains its limits, in the most these that have solved by the biological method.

The program “The studies of benthic macroinvertebrate for water quality monitoring in Can Gio - HCMC” is a symbol for the research and apply of biological method served for the water quality monitoring. Especially it has been done in the brackish-salt water environment of Can Gio, where the chemical and physical methodologies have also got many difficulties.

METHODOLOGY

Field sampling

Quantitative and qualitative samples were collected in 20 sites distributed in the whole Can Gio water bodies. (See figure 1)

Quantitative samples: A sample is collected 4 times with an area of 0.1 m² with Petersen grab.

Qualitative samples: Dragging the 0.3 mm mesh Naturalists dredge directly over the substratum until the dredge is filled with sediment and debris fully.

In the laboratory

Qualitative sample analysis: Identify species of benthic macroinvertebrate basing on morphology.

Quantitative sample analysis: Count the quantity of each species.

Analysis.

From the analyze results, we have defined species composition, community structure, densities, indicator and dominant species, relationship of organisms, relationship of species number and densities, relationship of them and physio-chemical factors, diversity index (Shannon & Weaver, 1949), evenness index (Pielou, 1966), dominant index (Berger-Parker, 1970), similarity index (Sorensen, 1948), E/S index - Now it is improved to $E/(E+S)$ (Pham Van Mien 2001),... for assessment and zonation of water quality.

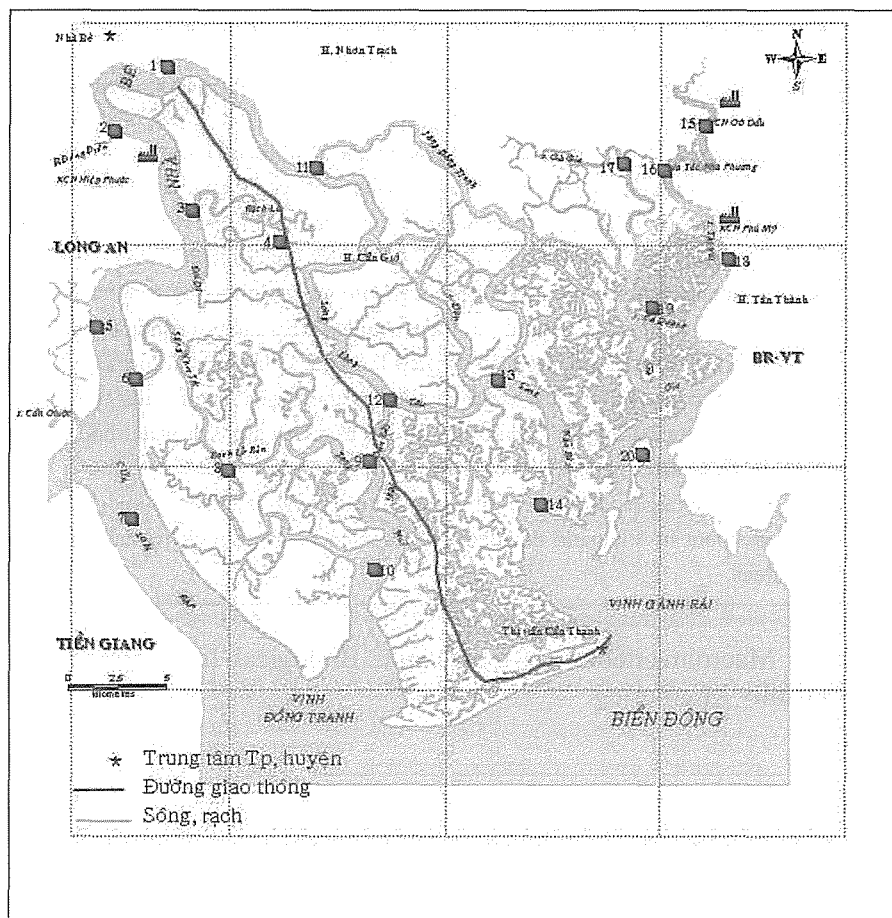


Figure 1. Map of Can Gio - HCMC

RESULTS AND DISCUSSION

Species composition and community structure

In the studies of benthic macroinvertebrate for water quality monitoring in Can Gio from October 2002 to July 2003, we have found 102 species, in which, species number of Polychaeta is highest with 74 species (72.5%), there are 20 species of Crustacea (19.6%), 6 species of Mollusca (5.9%), 1 species of Echinodermata (1.0%) and 1 species of Insect Larva (1.0%). (see Table 1).

The number of benthic macroinvertebrate species collected in April 2003 is highest with 81 species and the species number in October 2002 is lowest with 62 species. In 4 field samplings, the species number of Polychaeta and Crustacea is dominant in the species composition (see Table 1). However, there are not high fluctuations in the percentage of the species number, so these prove that the community structure has not been effected by seasons too much.

Table 1: Community structure of benthic macroinvertebrate in Can Gio.

| Class - Phylum | 10 - 2002 | | 01 - 2003 | | 04 - 2003 | | 08 - 2003 | | 10/02-7/03 | |
|----------------------|-------------|------|-------------|------|-------------|------|-------------|------|-------------|------|
| | No. species | % | No. species | % | No. species | % | No. species | % | No. species | % |
| Polychaeta | 42 | 67,8 | 51 | 71,4 | 56 | 69,2 | 48 | 71,6 | 74 | 72,5 |
| Mollusca | 3 | 4,8 | 4 | 5,6 | 5 | 6,2 | 4 | 6,0 | 6 | 5,9 |
| Echinodermata | 1 | 1,6 | 1 | 1,4 | 1 | 1,2 | 1 | 1,5 | 1 | 1,0 |
| Crustacea | 16 | 25,8 | 14 | 19,2 | 18 | 22,2 | 14 | 20,9 | 20 | 19,6 |
| Insecta Larva | 0 | 0 | 1 | 1,4 | 1 | 1,2 | 0 | 0 | 1 | 1,0 |
| <i>Total species</i> | 62 | 100 | 71 | 100 | 81 | 100 | 67 | 100 | 102 | 100 |

The river system of Can Gio is intruded sea water of East Sea (South China Sea) from low to high brackish, especially in the dry season (2 - 30‰). Therefore, all species collected in this area are species of estuaries and marine. About theory, freshwater species can adapt with water bodies of salt intrusion from 5 - 8‰ in a short time, because these waters are the ecological thresholds of fresh and salt water creatures (Dang, 1970). In fact, the salinity of the North Can Gio water is lower 1‰ in main rainy season, but until now none freshwater species occurs in this area.

Generally, there is not high fluctuation about the species number collected in each site of 4 field samplings, the species number found in Thi Vai River from Tac Nha Phuong to Phu My Industrial Park (IP) is more different than that in other sites of Can Gio. The species number in the sites of Tac Nha Phuong (Site 16) and Go Gia River (17) is lowest from 11 - 19 species. Especially, none benthic macroinvertebrate can be survived in the Go Dau IP (18) because of heavy water pollution with black, thick and decay mud (See Figure 2).

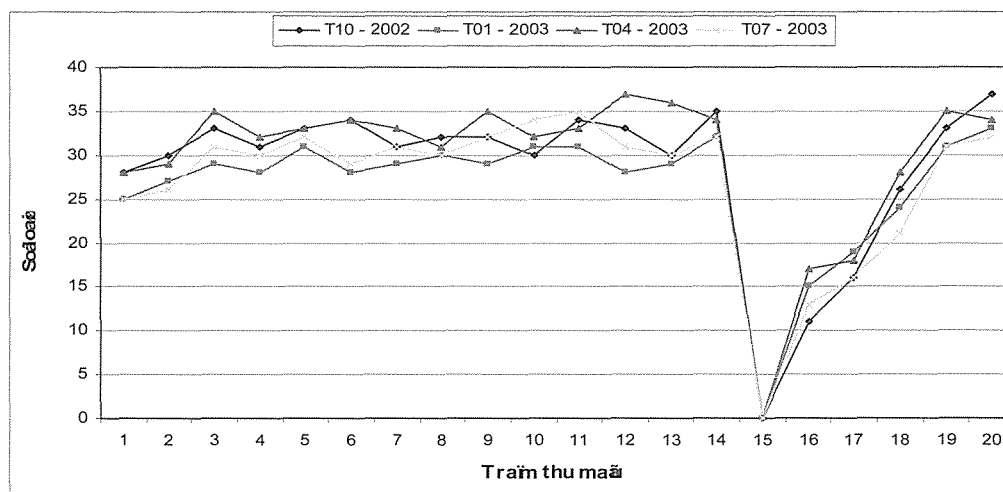


Figure 2: The Change of benthic macroinvertebrate in Can Gio in 4 field samplings from 10/02 to 7/03.

For self-purification, the species number increases clearly in Phu My IP (18) (21 - 28 species) and reaches the stable level about species number in Cai Mep estuaries (19, 20) with 31 - 37 species. These prove that the industrial wastewater has decreased the species number, speaking another way the benthic macroinvertebrate is lost the biodiversity. The species number in the rest sites is from 25 to 35 species, in which the species number in the sites of Nha Be Cap (1) and Nha Be River - Dong Dien Creek (2) (25 - 30 species) is lower than that in others (28 - 35 species). Maybe, The sites Nha Be Cap and Nha Be River - Dong Dien Creek are transitional

areas with the high fluctuation of salinity that is impacted on the development of benthic macroinvertebrate (See figure 2).

The species number of Crustacea in the sites of Thi Vai River from Tac Nha Phuong to Phu My IP is only from 1 to 3 species, it is lower too much than that in the other sites of Can Gio (5 - 13 species). Especially, none species of Mollusca and Echinodermata can be found in these sites. Most species of these organisms are very sensitive to the changes of water environment because of low tolerance with organic pollution.

In quite opposite, *Chironomus halophilus* (Chironomidae - Diptera) indicated for the heavy organic pollution occurs only in three sites of Thi Vai River from Tac Nha Phuong to Phu My IP.

About species of Polychaeta, only few species of Errantia - Polychaeta, especially *Nereidae* occurs in stations from Tac Nha Phuong to Phu My IP, while the species of Sedentaria - Polychaeta are abundant in these areas. So it can be showed that species of Sedentaria can well adapt with the water environment of the organic pollution. This is premise to establish the E/S index.

In this research, the species of benthic macroinvertebrate indicated for the organic pollution have occurred more abundant in all sites. In comparison with the studies of Pham Van Mien from 1996 to 1997), there were not many species well adapting with the organic pollution in Can Gio. These prove that the water quality in Can Gio have decreased in tendency.

Densities

The quantity of benthic macroinvertebrate in 20 sites of Can Gio is from 0 to 22,380 indv./m². The quantity in the sites of Thi Vai River are very high (1,270 - 22,380 indv./m²) or too low (20 - 50 indv./m²), particularly none individual of benthic macroinvertebrate can be found in the Go Dau IP because of the heavy water pollution with black, thick and decay mud.

Generally, the quantity of benthic macroinvertebrate in the sites of Nha Be River (100 - 2,620 indv./m²) is higher than that in the rest sites of Can Gio (100 - 1,260 indv./m²).

The relationship of species number and densities

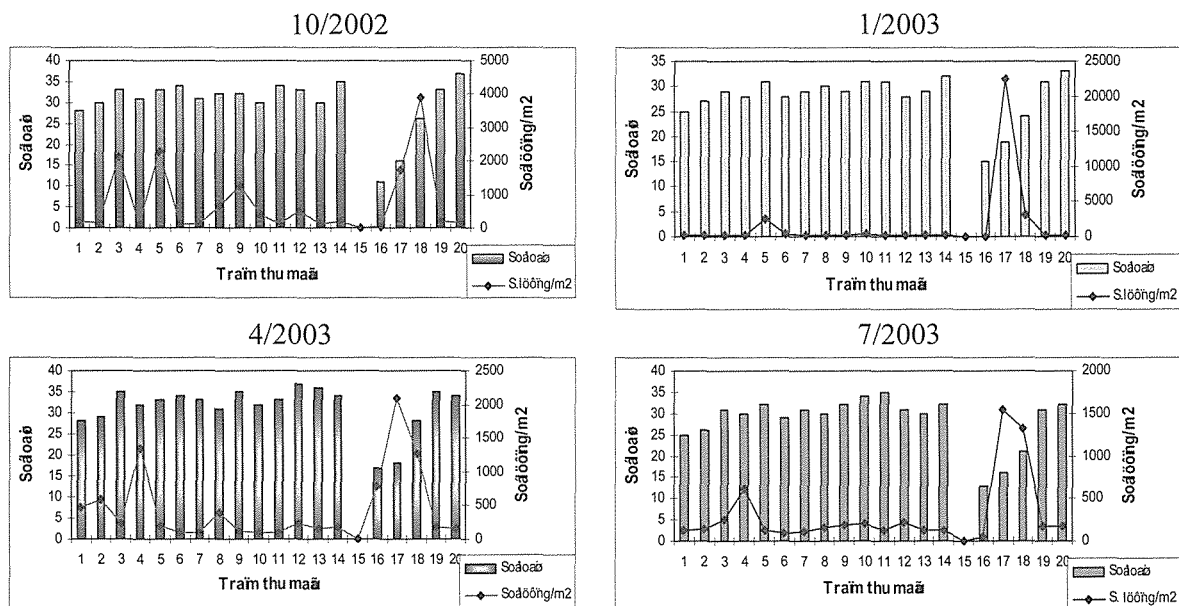


Figure 3. The relationship of species number and densities of benthic macroinvertebrate in Can Gio

Generally, the relationship of species number and densities of benthic macroinvertebrate in the sites of Thi Vai River from Go Dau IP to Phu My IP is so unbalance. In addition, in the sites drained the wastewater from HCMC and intensive shrimp aquaculture areas of Can Gio such as Nha Be Cap (Site 1), Nha Be River - Dong Dien Creek (2), Rach La Bridge (3) and Nha Be River - Lo Canal (4), there is the loss of balance of species number and quantity in there, but it not too serious as Thi Vai River (See figure 3).

Analysis of bioindexes

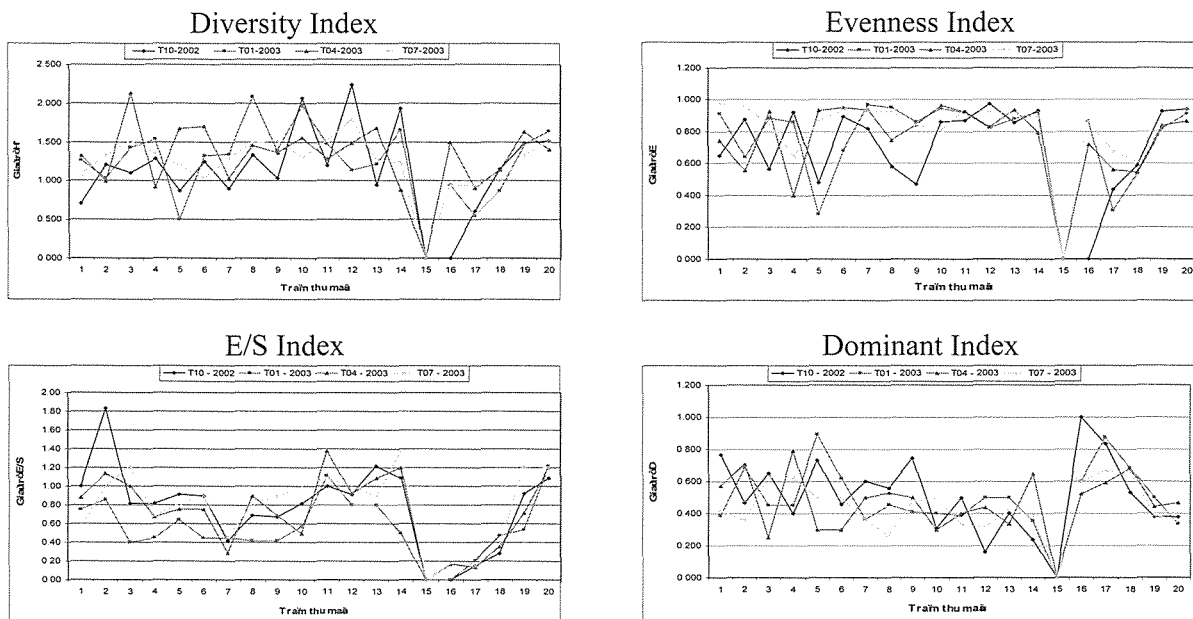


Figure 4. The changes of bioindexes benthic macroinvertebrate in Can Gio

For the indexes of diversity, evenness and E/S, the higher identified values there are, the better water quality. In quite opposite, the higher dominant index identifies for the sites, the worse water quality is (see Figure 4).

With the target of zonation of benthic macroinvertebrate, Similarity index (Sorensen, 1948) is used. From the S values, the studied area can be divided to three zones:

Zone 1 - Thi Vai River surrounding Go Dau IP: $S = 0$.

Zone 2 - Thi Vai River from Tac Nha Phuong to Phu My IP: $0 < S < 0.5$.

Zone 3 - The rest sites: $S > 0.5$.

The relationships of macroinvertebrate and chemical elements

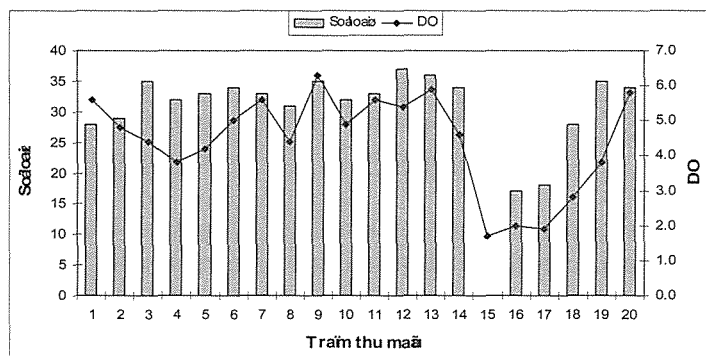


Figure 5. The changes of dissolve oxygen concentration and the species number of benthic macroinvertebrate in Can Gio (4/2003)

Generally, the changes of dissolve oxygen concentration correspond the changes of species number, where the DO is low, the species number is low also (see Figure 4).

The zonation of water quality of Can Gio (See figure 6)

Table 2: The zonation of water quality of Can Gio.

| Index | Zone I | Zone II | Zone III | Zone IV |
|-------------------|--|---|---|--|
| Species number | 0 | 11 - 28 | 25 - 33 | 28 - 37 |
| Indicator species | 0 | <i>Prionospio malmgreni</i> , <i>Disoma carica</i> , <i>Prionospio</i> sp., <i>Pseudopolydora</i> sp., <i>Capitella capita</i> , <i>Terebelides stroemi</i> , <i>Bispira polymorpha</i> | <i>Nephtys polybranchia</i> , <i>Namalycastis abiuma</i> , <i>Leonnates</i> sp., <i>Disoma carica</i> , <i>Maldane sarsi</i> , <i>Grandidierella lignorum</i> , <i>Tachea</i> sp., <i>Cyathura truncata</i> , | <i>Nephtys polybranchia</i> , <i>Neanthes meggitti</i> , <i>Lumbrineris</i> sp., <i>Scoloplos armiger</i> , <i>Sternaspis scutata</i> , <i>Grandidierella lignorum</i> , <i>Hyale</i> sp., <i>Tachea</i> sp., <i>Cyathura truncata</i> |
| Diversity index | 0 | 0 - 1.147 | 0.709 - 1.539 | 0.943 - 2.238 |
| Evenness index | 0 | 0 - 0.865 | 0.280 - 0.981 | 0.470 - 0.972 |
| Dominant index | 0 | 0.519 - 1.0 | 0.300 - 0.791 | 0.160 - 0.653 |
| E/S index | 0 | 0 - 0.47 | 0.29 - 1.14 | 0.40 - 1.38 |
| DO (mg/l) | 0.3 - 1.7 | 0.9 - 2.8 | 3.8 - 5.6 | 3.8 - 6.3 |
| PH | 6.76 | 6.86 - 6.94 | 6.88 - 7.38 | 7.09 - 7.56 |
| Characteristics | Go Dau IP (Station 15), where is strongest impacted by the wastewater of Go Dau IP with the characteristics of grey-black or black-green water, black thick and decay mud. Benthic macroinvertebrate is destroyed. | From Tac Nha Phuong to Phu My IP (16, 17, 18). Watercolor is lighter than that in Go Dau IP. The quantity of benthic macroinvertebrate is unbalance (very low or so high). | Nha Be River Sytem (1, 2, 4, 5 and 7), where receive wastewater from HCMC or strongest aquaculture areas of Can Gio. The turbidity is high. Sometimes in few sites, the watercolor is green because of algae abundance. | Long Tau River (11, 12), Nga Bay (13, 14), Mui Nai (8, 9, 10), Cai Mep (19, 20) and sites 3, 6 in Nha BE River, where is impacted not much the wastewater from HCMC. The turbidity is clearer as blue color of seawater in high tides. |
| Polluted levels | Polysaprobic. | α -mesosaprobic to polysaprobic. | β -mesosaprobic to α -mesosaprobic. | β -mesosaprobic. |

From the above results, there is not the water style of Oligosaprobic in Can Gio because of steep development of urbanization and industrialization recently in HCMC and neiboring areas. Additional, wastewater and mud from aquaculture have polluted to the water quality and arfected on the aquatic ecology system in Can Gio.



Figure 6. Map of water quality zonation in Can Gio - HCMC

Selection and Suggestion of biological criteria for water quality monitoring in Can Gio

Table 3: Applied capacity of biological criteria

| <i>Biological indexes</i> | Discriminate ability | Sensitivity to sample size | Calculation |
|--|-----------------------------|-----------------------------------|--------------------|
| Species number | Good | High | Simple |
| Densities | Moderate | High | Simple |
| Relationship of species number and densities | Good | High | Simple |
| Relationship of organisms | Moderate | High | Simple |
| E/S nndex (Pham Van Mien, 2001) | Moderate | Moderate | Simple |
| Diversity index (Shannon, 1949) | Moderate | Moderate | Intermediate |
| Evenness index (Pielou, 1966) | Moderate | Moderate | Intermediate |
| Dominant index (Berger-Parker, 1970) | Moderate | Moderate | Simple |
| Similarity index (Sorensen, 1948) | Moderate | High | Simple |
| Indicator species | Moderate | Low | Simple |
| Dominant species | Moderate | Moderate | Simple |

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

From the results of benthic macroinvertebrate, the Can Gio water bodies can be divided to 4 zones:

- Zone 1 - Thi Vai River surrounding Go Dau IP (Site 15): The water quality is the organic pollution at polysaprobic level.
- Zone 2 - Thi Vai River from Nha Phuong River Mouth to Phu My IP (Sites 16, 17 and 18): The water quality is from α -mesosaprobic to polysaprobic.

- Zone 3 - Nha Be River System including Nha Be Cap (Site 1), Hiep Phuoc IP (2), Nha Be River - La Creek Bridge (4), Nha Be - Lo Canal (5), and Soai Rap River (7): β -mesosaprobic to α -mesosaprobic.
- Zone 4 - River Sytem of Mui Nai (Site 9), Long Tau (11, 12), Nga Bay (13, 14), Cai Mep (19, 20) and sites 3, 6 in Nha Be River: β -mesosaprobic.

Choose and put forward the bioindicators and the bioindexes of benthic macroinvertebrate for the water quality monitoring of the brackish and salt waters in Can Gio and neighboring.

Establish the score range of some bioindexes for benthic macroinvertebrate. Moreover, create a new index for benthic macroinvertebrate is E/S that evaluate the water quality of brackish and salt-water bodies.

Establish the process of sampling and analyzing, data treatment.

Primarily, apply the biological criteria of benthic macroinvertebrate for water quality monitoring in other brackish and salt waters in Vietnam.

Recommendations

Need the integrated manages for the water resources of Sai Gon - Dong Nai River System and the coastal areas of HCMC and neighboring,

Scheme the system of drainage and wastewater treatment for these areas, especially industrial parks and concentrated resident areas.

To standardize the biological criteria for water quality assessment in whole country, need studies deeply and widely with participatory of many scientists in other areas.

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