# Evaluating Bottom Water Quality at the Flood Control Area in An Giang Province, Vietnam Using Zoobenthos' Diversity Index

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| Article information | Abstract |
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| | *The aquatic environment and zoobenthos fauna are closely related in a water body. In recent years, the use of zoobenthos to assess the quality of surface water environment is of interest because this method causes less environmental pollution and is less costly. The study was conducted to evaluate the distribution of zoobenthos fauna in the Bac Vam Nao flood control area, An Giang. Three samples of benthos (VN1-VN3) were collected in two periods, the first in March and the second in September 2020. The results have found eight species belonging to three phyla of Mollusca, Annelida and Arthropoda. In which, Mollusca phylum had the highest number of species with six species (70%) and the lowest was Annelida and Arthropoda with one species each (12.5%). In the dry season, Macrobrachium sp. (Arthropoda) dominated at all three sampling positions. In the rainy season, Mollusca is dominant with Pomacea canaliculate, Gyraulus sp., Filopaludina (F.), Sumatrensis speciosa species. Density of zoobenthos at three monitoring locations in the Bac Vam Nao flood control area ranged from 170 to 290 individuals/m$^2$ in March and from 40 to 70 individuals/m$^2$ in September, reaching the highest value is at the end of Than Nong canal adjacent to Cai Tac canal (VN3) in March and the lowest at the middle point of Than Nong canal adjacent to K26 canal (VN2) in September. The diversity index H' of zoobenthos at three locations in the Bac Vam Nao flood control area through two monitoring periods in 2020 ranged from 0.36 to 2.24, classifying water quality from mild to very polluted. The diversity of zoobenthos at the monitoring sites is subjected to seasonal change in which the H' index in the dry season is lower than that in the rainy season. The current findings showed that the zoobenthos composition reflected the bottom water quality of the study area. More studies are needed to increase the accuracy of this assessment method.* |

## 1. Introduction

Zoobenthos is a collection of aquatic invertebrates, living on the bottom surface or in the bottom layer of a water body, in addition, some species live freely in the water layer but also have a relatively long time (in proportion life time) living on the substrate or buried in the bottom is still classified as zoobenthos [1].

Zoobenthos animals are not only affected by physico-chemical factors but also directly affected by the substance in the bottom [2]. The life of zoobenthos groups is relatively fixed at the bottom of rivers and lakes, they are often affected by continuous changes in water quality and hydrological regimes during the day. Zoobenthos animals have characteristics such as: rather long development time, the ability to accumulate heavy metals, plant protection chemicals in the body, especially some other groups that are resistant to polluted environmental conditions. heavy organic contamination. Therefore, this is a very important group of organisms used as an indicator of water quality, especially in flowing water bodies [4-5].

Changes in water conditions will affect the distribution of zoobenthos groups because they have a life attached to the bottom. Moreover, zoobenthos is a group of organisms that have slow changes in species composition and are often affected by changes in the bottom structure of the water body [6]. The study of [7] concluded that based on previous data on wastewater bodies in Hanoi, zoobenthos animals (through values of biomass, difference in diversity, degree of species richness, etc.) is a good indicator of the pollution level of water bodies in negative correlation. For example, if the pollution level of the water body increases, the values of chemical oxygen demand (COD), biological oxygen demand (BOD) increase, dissolved oxygen (DO) decreases, and the species composition and number of zoobenthos also decrease. The fauna composition on Hau river showed that a total of 61 zoobenthos species were discovered belonging to 6 classes, of which the Gastropoda class had the richest species composition with 26 species, the remaining classes had a variable number of species from 3-16. There is a very high similarity in fauna species composition between main and tributary rivers. The research results are the basic data source for building a biological monitoring program on the Hau River [8].

Although there have been many studies on the composition of zoobenthos species in rivers, canals, ponds, lakes but there are few studies on the distribution of fauna in the flood control area of Bac Vam Nao. Therefore, the studying of distribution of zoobenthos composition and predicting the bottom water quality in the flood control area is needed.

## 2. Materials and methods

Samples were collected at 3 locations VN1, VN2, VN3 in Bac Vam Nao flood control area in March and September 2020. Samples were collected using Petersen bucket with $0.02m^2$ bucket, using 5 buckets at each different location, then sieve the sample with a bottom sieve with 0.5x0.5 mm mesh to remove some sludge and garbage. Then put all zoobenthos samples into nylon wrap and fix with 8% formol, then bring back to the laboratory for analysis. All the debris and organic matters were removed. Then, the selected zoobenthos species were fixed in 4% formol solution [9].

Qualitative sampling is performed by sampling to wash away formol and organic matter, pick up large zoobenthos animals, and then immerse in formol. Samples were observed under microscope, magnifying glass and stereoscope at appropriate magnification to determine morphological and structural characteristics and taxonomic characteristics according to taxonomic literature of [6,10].

For quantitative analysis, the zoobenthos in each sample were counted separately for each individual and deter-mined density by Equation (1):

$$D = X/S \qquad (1)$$

where D is the density calculated by individual per $m^2$, X is the number of counted individuals in the collected sample; S is the sampling area (S = n x d), n is the number of collected Petersen grab, d is the open mouth area of the grab ($0.02m^2$).

Data on species composition and density of zoobenthos were used to calculate Shannon-Weiner diversity index (H') using Equation 2 [11].

$$H'=-\sum p_i . \ln . p_i \qquad (2)$$

Where: $p_i = n_i/N$; $n_i$ is the number of individuals of species I; N is the total number of zoobenthos organisms in the sample. Water quality is divided at three levels of pollution based on H' values. H' is greater than 3 indicates good water quality or water is not polluted. H' is in the range from 1 to 3 showed moderate water pollution. Finally, H'<1 revealed that water is highly polluted [11].

## 3. Results and discussion

### 3.1 Composition structure of zoobenthos species

The results of monitoring of zoobenthos fauna parameters at 3 monitoring locations in the Bac Vam Nao flood control area in 2020 have recorded 08 species belonging to 3 phyla including Mollusca, Annelida and Arthropoda. In which, the Mollusca phylum had the highest number of species with 06 species (70%) and the lowest was the Annelida and Arthropods with 01 species each (12.5%) (Table 1).

Table 1. Composition of zoobenthos in the flood control area

| No. | Phyla | March | | September | | Whole year | | Overall | |
|---|---|---|---|---|---|---|---|---|---|
| | | No. of species | % | No. of species | % | No. of species | % | No. of species | % |
| 1 | Mollusca | 1 | 50 | 5 | 83.3 | 0 | 0 | 6 | 75.0 |
| 2 | Annelida | 0 | 0 | 1 | 16.7 | 0 | 0 | 1 | 12.5 |
| 3 | Arthropoda | 1 | 50 | 0 | 0 | 0 | 0 | 1 | 12.5 |
| | Total | 2 | 100 | 6 | 100 | 0 | 0 | 8 | 100 |

In the dry season (March), the study recorded 02 species of zoobenthos animals belonging to 02 phylum Mollusca and Arthropoda. In which, each phylum has 1 species recorded, each phylum accounted for 50% of the species. In the rainy season (September), the study recorded 06 species belonging to 02 phylum Mollusca and Arthropoda. In which, Mollusca is more dominant with 05 species, rate 83.3%.

The comparison between the two monitoring periods in 2020 shows that the total number of species in the September monitoring period increased compared to the March period (increased by 04 species). In which, the fluctuations mainly concentrated in Mollusca (increase of 04 species), Angiosperms (increase of 01 species), Arthropods (decrease of 01 species). The composition of zoobenthos fauna at 3 locations of Bac Vam Nao flood control area in both dry season (March) and rainy season (September) are mainly specific species for freshwater system and the difference in species composition was obvious between the two seasons.

The number of zoobenthos species recorded at 3 locations in the Bac Vam Nao flood control area through 2 monitoring periods in 2020 ranged from 1 to 5 species, reaching the highest value at the top of Than Nong canal adjacent to Vinh An canal (VN1) in the rainy season and the lowest in the dry season at the beginning of Than Nong canal adjacent to Vinh An canal (VN1), at the midpoint of Than Nong canal adjacent to K26 channel (VN2). In general, the number of species at most monitoring locations in Bac Vam Nao area is higher in the rainy season than in the dry season, ranging from 1 to 4 species, the most variation is at the head of Than Nong canal adjacent to Vinh An canal (VN1).

*3.2 Density and dominant species of zoobenthos*

Density of zoobenthos animals at three monitoring locations in the Bac Vam Nao flood control area ranged from 170 to 290 individuals/m$^2$ in March and from 40 to 70 individuals/m$^2$ in September, reaching the highest value is at the end of Than Nong canal adjacent to Cai Tac canal (VN3) in March and lowest at the middle point of Than Nong canal adjacent to K26 canal (VN2) in September (Table 2).

Table 2. Density of zoobenthos in the flood control area

| Site | Number of species | | Density (individuals/m$^2$) | |
|------|-------|-----------|-------|-----------|
| | March | September | March | September |
| VN1 | 1 | 5 | 190 | 70 |
| VN2 | 1 | 2 | 170 | 40 |
| VN3 | 2 | 3 | 290 | 50 |

The research results showed that the dominant zoobenthos species composition was different between the locations over the two monitoring periods. In March (dry season), *Macrobrachium* sp. belongs to the branch of *Rheumatoid arthritis* dominated at all 03 locations, specifically, at the beginning of Than Nong canal adjacent to Vinh An (VN1) canal and at the middle point of Than Nong canal adjacent to K26 channel, both accounted for 100%; the position at the end of Than Nong canal adjacent to Cai Tac canal dominates 93.10%. In September (rainy season), Mollusca species dominate at all 3 monitoring locations, in which, at the beginning of Than Nong canal bordering Vinh An canal, there are *Pomacea canaliculata* and *Gyraulus* sp. dominating with the rate of 28.6% each species; At the midpoint of Than Nong canal adjacent to K26 channel, there is a species of *Gyraulus* sp. predominate with the rate of 75%; while at the end of Than Nong canal adjacent to Cai Tac canal, *Filopaludina* (F.) *sumatrensis speciosa* species predominates with 60%.

Table 3. Dominant species of zoobenthos in the flood control area

| Site | March | | September | |
|------|-------------------|-----|-------------------|-----|
| | Dominating species | % | Dominating species | % |
| VN1 | *Macrobrachium* sp. | 100 | *Pomacea canaliculata Gyraulus* sp. | 28.6 |
| VN2 | *Macrobrachium* sp. | 100 | *Gyraulus* sp. | 75 |
| VN3 | *Macrobrachium* sp. | 93.10 | *Filopaludina (F.) sumatrensis speciosa* | 60 |

*3.3 Evaluating bottom water quality using zoobenthos*

The calculation results show that the diversity index H' of zoobenthos fauna at three locations in the Bac Vam Nao flood control area through two monitoring periods in 2020 ranges from 0.36 to 2.24, of which H' index is highest at the beginning of Than Nong canal adjacent to Vinh An canal (VN1) in September and lowest at the end of Than Nong canal adjacent to Cai Tac canal (VN3) in March. The zoobenthos material at the monitoring locations tends to change with the seasons, the H' index in the dry season is lower than that in the rainy season. Particularly, at the beginning of Than Nong canal adjacent to Vinh An canal (VN1) and at the middle point of Than Nong canal adjacent to K26 canal (VN2) in March are not eligible to calculate the H' index. The water quality according to the biological index of zoobenthos animals at the end of Than Nong canal adjacent to Cai Tac canal (VN3) improved from very polluted in the dry season to pollution in the rainy season. Particularly, the first position of Than Nong canal adjacent to Vinh An canal (VN1) was slight pollution and the middle position of Than Nong canal adjacent to K26 canal (VN2) was very polluted in the rainy season (September).

Table 4. Shannon Wiener biodiversity index (H') of zoobenthos in the flood control area

| Site | March | | September | |
|------|------|---------------|------|---------------|
| | H' | Water quality | H' | Water quality |
| VN1 | - | - | 2.24 | Slight pollution |
| VN2 | - | - | 0.81 | Very pollution |
| VN3 | 0.36 | Very pollution | 1.37 | Pollution |

*Note: (-) Cannot be determined due to insufficient criteria to calculate H' index. The diversity index H' calculated only at that point must have at least 2 species or more.*

## 4. Conclusion

The composition of zoobenthos species has a low diversity, only 08 species belonging to 3 branches have been identified. The number of zoobenthos species at the monitoring sites in the rainy season is higher than in the dry season, in which the number of species fluctuates the most at the head of Than Nong canal adjacent to Vinh An canal. *Macrobrachium* sp. (Arthropoda) dominated at all 3 positions in March; *Pomacea canaliculata*, *Gyraulus* sp., *Gyraulus* sp., *Filopaludina* (F.) *sumatrensis speciosa* species predominated at locations in September. Density of zoobenthos at 3 monitoring locations in Bac Vam Nao flood control area during March and September are 170 – 290 and from 40 – 70 individuals/m$^2$, respectively. The diversity index H' of zoobenthos animals at monitoring locations during the year ranged from 0.36 to 2.24, the highest at the beginning of Than Nong canal adjacent to Vinh An canal in September and the lowest at the end of Than Nong canal, adjacent to Cai Tac canal in March. The diversity of zoobenthos at the monitoring locations tends to change with the seasons, the H' index in the dry season is lower than that in the rainy season. The water quality according to the biological index of zoobenthos at the end of Than Nong canal adjacent to Cai Tac canal improved from very polluted in the dry season to pollution in the rainy season. Particularly, at the first position of Than Nong canal adjacent to Vinh An canal, the water quality is at "slightly polluted" level and the middle position of Than Nong canal adjacent to K26 canal is at very polluted level in the rainy season (September). The current results show that zoobenthos have reflected the water quality in the study area.

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