NIPES

Journal of Energy Technology and Environment

Journal homepage: www.nipesjournals.org.ng

# Characteristics of Sediment in Bung Binh Thien Reservoir, An Giang Province, Vietnam

***Truong Hoang Dan[1] and Nguyen Thanh Giao[1*]***

[1]College of Environment and Natural Resources, Can Tho University, Vietnam
*Corresponding Author Email: ntgiao@ctu.edu.vn

**Article Info**

*Article history*:
*Received 6 February 2021*
*Revised 20 February 2021*
*Accepted 24 February 2021*
*Available online 10 June 2021*

*Keywords:*
*sediment, organic matters, total phosphorus, Bung Binh Thien, An Giang*

https://doi.org/10.37933/nipes.e/3.2.2021.3

**https://nipesjournals.org.ng**


**Abstract**

*This study was conducted from March to September 2019 to evaluate the quality of sediment in Bung Binh Thien through the indicators of organic matter, total nitrogen, and total phosphorus by collecting the sediment samples in the outside, inlet, middle, and end areas of the reservoir in the dry and rainy seasons. The findings revealed that the quality of sediment in the area of Bung Binh Thien was spatially and temporally fluctuated. In the dry season, the content of organic matter, total nitrogen, total phosphorus fluctuated respectively from 1.04 to 5.35%; 0.06-0.35% and 0.036-0.076% which were higher than those in the rainy season with the corresponding values were 1.51-4.65%; 0.10-0.28% and 0.042-0.072%, respectively. The nutrients in the sediment inside the reservoir was relatively higher than those in the outside area. There was a strong correlation between total nitrogen, total phosphorus and organic matter in the study area. This partially reflected the impact of living activities and production of the surrounding community on environmental quality in the area of Bung Binh Thien.*

## 1. Introduction

According to Beklioglu et al. (2015) [1], shallow lakes contribute significantly to biodiversity because they are habitats for fish, invertebrates, waterfowl, and many ecosystem services including the global biochemical cycle (often carbon fixation), produce food through farming or fishing. Shallow lakes have relatively small depths, so they are easily disturbed by human activities or natural activities. Many of the compounds that arrive at upstream lakes are stored in sediments - storage of organic matters from aquatic organisms and inorganic matters from the weathering of soil and rocks. In lake sediments, eutrophication can be an important internal source of nutrients, particularly phosphorus [2] and this is also a sink for the deposition of contaminants, for example, the heavy metals. In the study of Nemery et al. (2015) [3] pointed out the human impact on the natural progression of tropical lakes when urbanization and limited legal policies on water resource management have impaired water quality. The reservoir nutrient storage capacity for contents of C, N and P were 31%, 46% and 30% at the outlet, respectively, at the outlet of Lake Cointzio. A study at Daihai Lake in China was conducted to evaluate the interplay between the concentration of nutrients in sediment and the water environment. The results showed that the total nitrogen (TN) and phosphorus (TP) concentrations in surface sediments ranged from 0.27 to 1.78 g/kg and from 558.31 to 891.29 mg/kg respectively [4]. In Vietnam, several studies have also shown that the impact of human activities which accelerates the sedimentation rate of lakes. The study of Cuong (2016) [5] has shown that pollution caused by discharge activities and wastes from activities of residential areas, industrial zones and craft villages have rapidly increased the

sedimentation rate of Phan river. Bung Binh Thien reservoir is the largest inland freshwater lake in An Giang province with a water surface area of 200 hectares in the dry season and 800 hectares in the rainy season, located in the North of An Phu district, An Giang province. This is a natural inland wetland ecosystem with important environmental, ecological, socio-economic values, including being a long-standing place of residence of population communities; water supply for domestic use; areas with biodiversity values, fisheries production areas, and potential areas for tourism development. Bung Binh Thien is the area mainly affected by natural and man-made sedimentation (agricultural cultivation), in addition to the influence of production and tourism exploitation. The process of sedimentation of the water body is happening more complicated. The top area and the section that leads water to the basket are reinforced, raising the soil level to practice the cultivation of hydrophilic plant groups. The impact from poultry farming and agricultural cultivation in the middle and the end of the reservoir has strongly influenced the local environmental quality of the water body. There have been many studies on water quality and biodiversity at Bung Binh Thien reservoir [6-8]. However, information on the contents of organic matters, phosphorus and nitrogen in the sediment is limited. This study was conducted to assess the quality of the sediment through the analysis of organic matters (OM), total nitrogen (TN) and total phosphorus (TP). The results of the present study provide very useful information for the management of the sediment in the study area.

## 2. Methodology

### 2.1 Sediment sampling

Sediment samples were collected at 10 points in the water body of Bung Binh Thien and part of Binh Di river (the section that leads water into the Bung Binh Thien) (Figure 1). The sediment samples were collected using Petersen grab. At each collection point, the collection of sediment were repeated three times. The collected samples were placed in plastic bags, labeled and immediately brought to the laboratory.


**Figure 1. Sites of sediment sampling at Bung Binh Thien reservoir**

Ten sediment samples (denoted from VT1-VT10) were collected at Bung Binh Thien reservoir including 8 positions inside the Bung Binh Thien and 2 sites outside the reservoir. The selection of sampling sites as described was aimed to evaluate the distribution of organic matters, total nitrogen, total phosphorus that being influenced by human and natural activities. The sediment

samples were collected twice in dry season (March-April) and in rainy season (September-October) in 2019. Samples of sediment after air dried was pulverized, and sieved through a size-mesh of 0.5 mm for analysis of organic matter (OM, %), total nitrogen (TN, %), total phosphorus (TP, %). Organic matter was analyzed by Walkley-Black dichromate wet oxidation method, total nitrogen (TN, %) was analyzed by Kjeldahl method, and total phosphorus (TP, %) was analyzed by colorimetric method after the samples were digested with a mixture of $H_2SO_4$ and $HClO_4$.

**Table 1. Location, characteristics and main sources influencing sediment**

| No. | Coordinates | | Position | Potential sources impact on sediment quality |
|---|---|---|---|---|
| | X | Y | | |
| VT1 | 10.917038 | 105.063845 | Initial of the reservoir | Agriculture |
| VT2 | 10.918773 | 105.063830 | Initial of the reservoir | Agriculture and domestic activity |
| VT3 | 10.921976 | 105.073439 | Middle of the reservoir | Aquatic farming |
| VT4 | 10.919974 | 105.073696 | Middle of the reservoir | Transportation |
| VT5 | 10.917916 | 105.073460 | Middle of the reservoir | Aquatic farming, domestic activity |
| VT6 | 10.922576 | 105.084364 | End of the reservoir | Agriculture |
| VT7 | 10.924885 | 105.084389 | End of the reservoir | Aquatic farming, domestic activity |
| VT8 | 10.916749 | 105.058464 | Intersection between the Bung Binh Thien and Binh Di river) | Transportation, domestic activity |
| VT9 | 10.917453 | 105.054431 | In Binh Di river | Transportation |
| VT10 | 10.915400 | 105.054811 | In Binh Di river | Transportation |

## 3. Results and Discussion

### 3.1 Organic matters in the sediment

*3.1.1 Dry season*

The content of OM in sediments in Bung Binh Thien (BBT) in the dry season had a large difference between the locations, ranging from 1.04 to 5.35% (Figure 2), which was low in the area outside BBT (VT8, VT9, VT10) and was medium inside BBT. Inside BBT, the content of OM increased gradually when moving from the beginning to the middle and the end of BBT with average values of 4.13 ± 0.78%, 4.45 ± 0.69%, 4.73 ± 0.25%, respectively. Impacts from aquaculture activities, agriculture, aquaculture, and the activities of people in the area have resulted in relatively high OM, especially in VT5 (5.26%). Influenced by transportation activities,

the average content of OM in the sediments in the Binh Di River area (1.25 ± 0.29%) and the water inlet section (1.61%) were relatively low and lower than those at inside BBT. The contents of OM in areas in the BBT ranged from 3.41 to 5.3% (averaged at 4.49 ± 0.69%) which was much higher than that in Tam Giang - Cau Hai lagoon and Thi Nai lagoon since the content of OM was recorded at the average level of 1-2% [9] and from 0.14 to 1.14% [10, respectively.

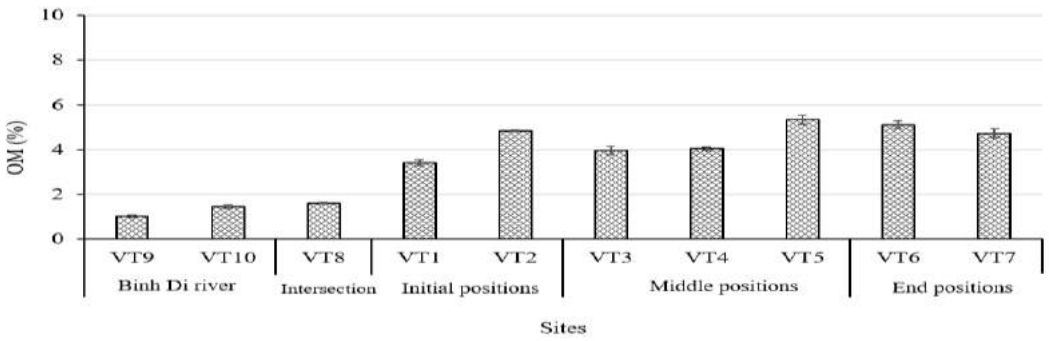


**Figure 2. Organic carbon content in sediment in dry season**

The difference in OM content between the sampling locations should be considered from the effect of flow to sedimentation capacity of the substances in sediments when the area inside the BBT has a higher average OM content than that in Binh Di river up to 2.94%. The ratio of OM in the sediment between the sampling locations not only changes according to hydraulic factors, but is also influenced by human factors. The high contents of OM in the dry season showed that the daily activities of people had a significant impact on the increase in the content of OM in sediment.

*3.1.2 Rainy season*

The content of OM in sediment of BBT in the rainy season had an uneven variation between the locations with the range from 1.51 - 4.65% (Figure 3) which was higher than the research results of Vinh et al. (2010) [10] when OM in Thi Nai lagoon was between 0.17 and 1.16%. Content of OM accumulated low in the locations in Binh Di river (2.11%) and at the intersection location between BBT and Binh Di river (1.58%). OM was high in the initial areas (4.43%) and in the middle (4.17%) then gradually decreased in the area at the end of BBT (2.51%). Thus, the content of OM in the rainy season was more fluctuated than that in the dry season and tended to decrease at the end of BBT, the intersection and some locations in the beginning (VT2) and middle (VT5) in the rainy season.

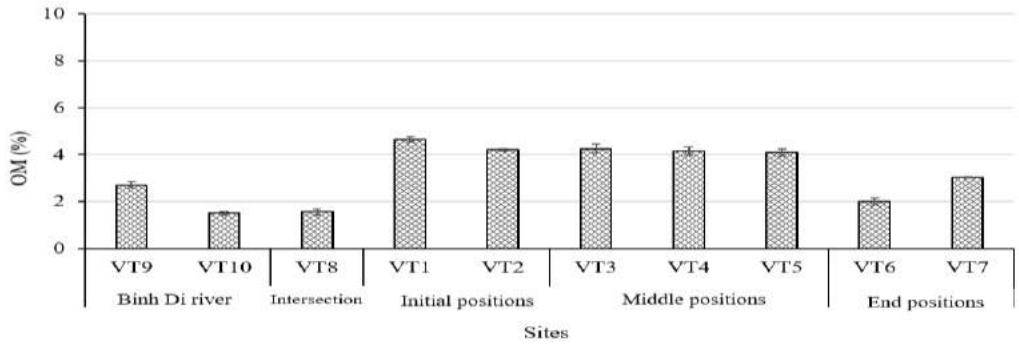


**Figure 3. Organic carbon content in sediment in rainy season**

In Binh Di river area and in BBT, most sampling sites had OM approximately 1.5%. OM was highly varied at the intersection (VT9) with OM 2.7%. The accumulated OM content in BBT was divided into two main groups, including the initial - the middle of BBT and the end of BBT. In the initial- middle area, OM was highly accumulated (4.28 ± 0.22%), in which the highest OM was found at VT1 (4.65%). Affected by relatively similar impact sources as well as the easy water exchange process in the rainy season, the content of OM in the initial and middle areas have relatively close and stable values. However, at the end of BBT, OM content decreased significantly with the average value of about 2.51 ± 0.73% and there was a large difference between the locations since OM reached 3.03 ± 0.02% at VT7. This variation was due to the dilution and runoff factor of the water body during the rainy season or limited sources of organic matters addition.

### 3.2 Total nitrogen in the sediment

*3.2.1 Dry season*

Total nitrogen in sediment of BBT watershed in the dry season had spatial fluctuations with values ranging mainly from 0.06 to 0.35% (Figure 4). There were four groups of the areas where TN values in the sediments were close together such as the river area - the intersection section; the initial location; the middle - end of BBT. TN content in the area of Binh Di River (VT9, VT10) and the intersection (VT8) had the average value of 0.077 ± 0.015% which was relatively lower than that at the remaining locations. In the area at the beginning and the middle of BBT, where the activities of growing aquatic plants and other activities of raising aquatic species, the amount of TN was much higher than that in Binh Di river (0.306 ± 0.016> 0.077 ± 0.015%). Thereby, it showed that TN content in sediments in this area was strongly influenced by a number of production activities, especially the use of chemical fertilizers. In the area of VT5 and at the end of BBT, TN content in the sediment was high at 0.3 - 0.35% (the highest was at VT5) which was affected by activities of fish farming and domestic activities. Similar to the beginning and end of BBT, there were agricultural activities, mainly growing vegetables and influenced from the daily life of community living around BBT. The analysis results showed that, TN in the sediments outside BBT was very poor while it was medium in BBT area. Former study reported that TN content in the Phan river was low at 0.02 - 0.08% [5]. Thus, in addition to the influence of natural hydraulic factors, human activities, farming and production contribute significantly to the accumulation of TN in the sediment in BBT.

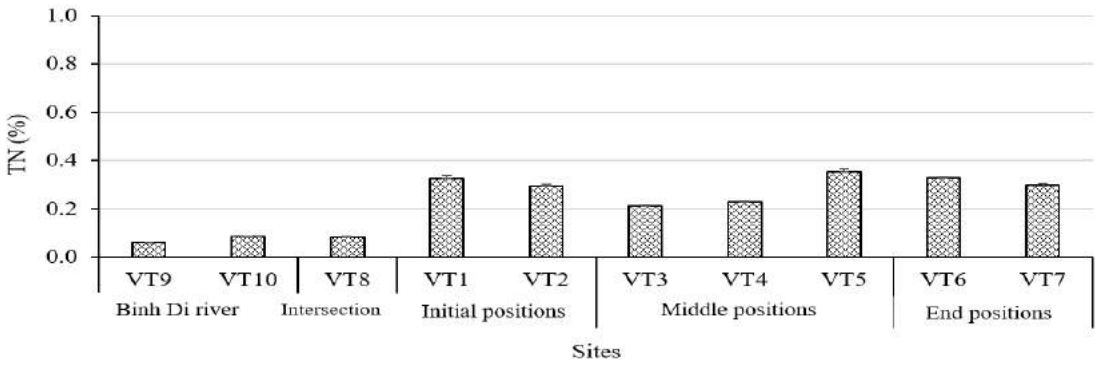


**Figure 4. Total nitrogen concentration in sediments in dry season**

*3.2.2 Rainy season*

TN content in sediment in the rainy season changed similar to the content of OM with the range from 0.10 to 0.26% dividing in three main areas including in Binh Di river - the intersection, the the initial - middle areas and the end areas of BBT (Figure 5). In the area in Binh Di river and the intersection positions had TN content of about 0.17 ± 0.006% and there was no difference between the locations in this area. At the initial - middle of BBT, the average TN content in the sediment fluctuated in the range of 0.231 ± 0.026%. The variation of OM and TN in sediments at BBT in the rainy season had many similarities when there was a sudden decrease of accumulated TN content with an average value of 0.154 ± 0.023%.

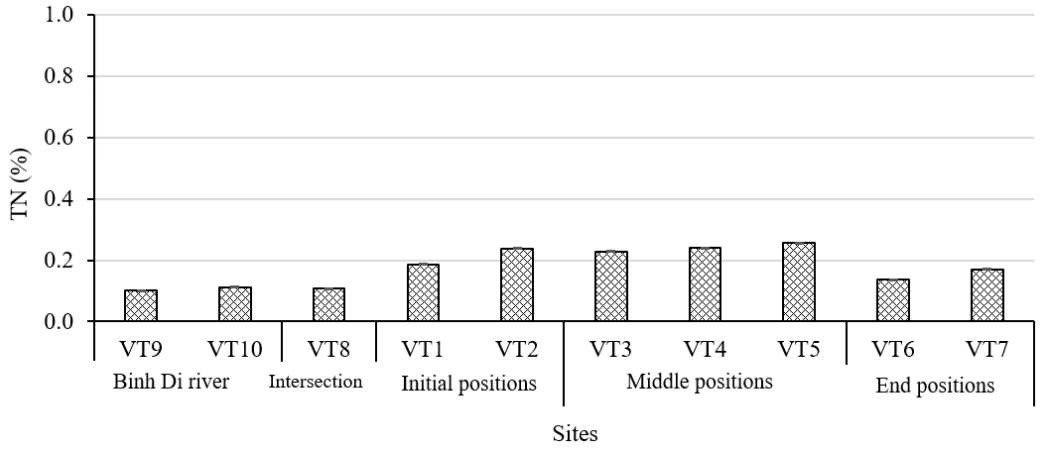


**Figure 5. Total nitrogen concentration in sediment in rainy season**

In BBT, the content of TN accumulated in sediments at most locations except (VT3 and VT4) in the rainy season has decreased compared to the dry season, so it was relatively poor in nitrogen at the end of BBT but at the beginning and the middle these levels were still moderate. The dilution of nitrogen content in surface water and strong currents in the rainy season led to less accumulation in sediments when the TN accumulation capacity was only 46% [3]. The analysis results were relatively consistent with the study of Thang and Anh (2006) [9] when TN content in Tam Giang - Cau Hai Lagoon tended to decrease in the rainy season. However, in the river area and in the intersections, TN tended to increase due to the amount of sediment that flows from the upstream during the rainy season but it was still relatively poor in nitrogen.

**3.3 Total phosphorus in the sediment**

*3.3.1 Dry season*

TP concentrations in sediments of BBT in the dry season were less fluctuated than the contents of OM and TN. There was not much difference between the areas outside and inside BBT ranging from 0.036 to 0.076% (Figure 6). TP concentration was the lowest in Binh Di River (0.044 ± 0.013%), gradually increased at the intersection positions (0.055%) and inside BBT (0.065 ± 0.006%). TP content increased highest at the beginning and middle of BBT with the average value of 0.0685 ± 0.005% and 0.067 ± 0.004%, respectively, then decreased slightly to 0.058 ± 0.001% at the end of BBT. The results showed that the sources of phosphorus in sediment in the water body originate mostly from the initial and middle areas of BBT.

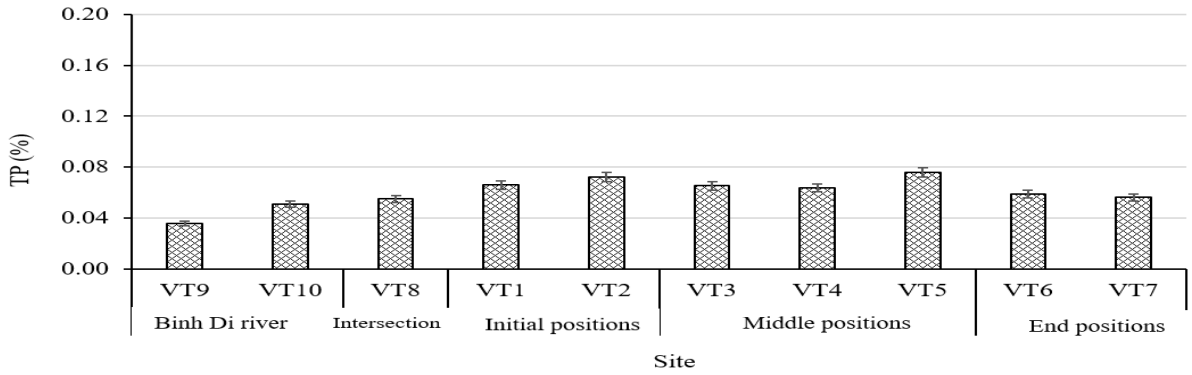


**Figure 6. Total phosphorus concentrations in sediments in dry season**

*3.3.2 Rainy season*

The concentration of TP accumulated in sediments in the wet season was from 0.042 to 0.072% (Figure 7). Based on the concentration, TP in the sediment can be divided into major groups including the sites in Binh Di river-the intersection position; the initial-the middle position of BBT; the end of BBT. In Binh Di river-the intersection positions, the concentration of TP accumulated in sediments was at 0.044 ± 0.003%. For the initial-the middle position of BBT, the amount of TP accumulated into the sediment increased, on average, at 0.0627 ± 0.0062%. TP was found highest at the position VT5 (0.0723%) and VT1 (0.0667%). Similar to OM and TN, TP content at the end of BBT was low at 0.048%.

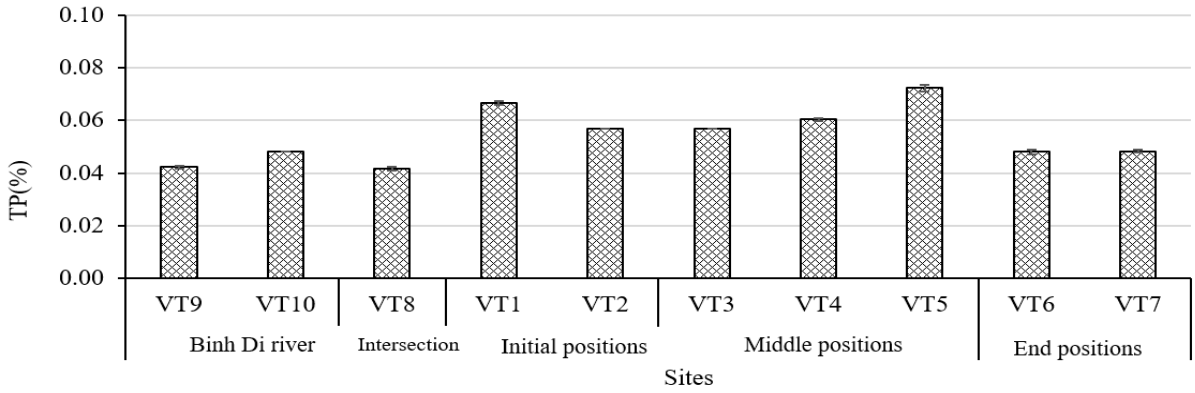


**Figure 7. Total phosphorus concentration in sediment in rainy season**

The content of TP in the rainy season in the BBT area was lower than that in the dry season. The impacts from the hydrological conditions and the flow regime have probably contributed to less sedimentation of TP in the rainy season, but still at an acceptable level, without affecting the overall sediment environment quality of the water body. The social and economic activities of the people living near BBT during this time were not the main cause of excessive increase in the TP content in sediment. In the initial and middle areas, the content of TP remained at an average level.

**3.4 Correlation among the sediment quality parameters**

*3.4.1 Dry season*

Correlation between OM, TN or TP in the dry season was analyzed and presented in Table 2. The correlation analysis results showed a very close correlation between OM and TN in sediments at

BBT with a high correlation coefficient ($r = 0.927$, $p < 0.01$). TN in sediment was largely influenced by OM. This could mean that the accumulation of TN in BBT in the dry season was mainly organic nitrogen because it was strongly influenced by OM content in the sediment. TP content has a close positive correlation with OM ($r = 0.769$, $p < 0.01$) and high correlation with TN ($r = 0.764$, $p < 0.01$). Thereby, it showed the similarity between the TN and TP content in sediment when both were strongly influenced by OM. However, the correlation level of OM with TP was lower than that of OM and TN.

**Table 2. Correlation between the sediment quality in the dry season**

| Variables | OM | TN | TP |
|---|---|---|---|
| OM | 1 | | |
| TN | 0.927 | 1 | |
| TP | 0.769 | 0.764 | 1 |

*3.4.2 Rainy season*

The correlation analysis results showed very close correlation between OM and TN in sediment in BBT with high correlation coefficient ($r = 0.858$ ($p < 0.01$) (Table 3). Thereby, it showed that TN was dominated, strongly dependent on OM in sediment in the rainy season. However, the correlation in the rainy season between OM and TN was lower than that in the dry season. The correlation between TP and OM in the rainy season increased with $r = 0.813$ ($p < 0.01$). TN and TP had a high correlation with $r = 0.842$ ($p<0.01$) and this correlation was higher than that in the dry season.

**Table 3. Correlation between the sediment quality in the rainy season**

| Variables | OM | TN | TP |
|---|---|---|---|
| OM | 1 | | |
| TN | 0.858 | 1 | |
| TP | 0.813 | 0.842 | 1 |

## 4. Conclusion

The sediment characteristics in the areas inside the BBT were relatively higher than that in the position in Binh Di River and the intersection positions. Content of OM in the dry and rainy seasons fluctuated from 1.04 to 5.35% and 1.51 to 4.65%, respectively. Total phosphorus contents were 0.036 - 0.076%; 0.042 - 0.072%, in the dry and wet season, respectively. TN were from 0.06 - 0.35% (dry season) and 0.10 - 0.257% (rainy season). TN and TP in sediments were from poor to medium and it was strongly influenced by the content of OM since TN, TP is highly positively correlated with OM both in dry and wet seasons. Both natural process and human activities had significant impact on the sediment characteristics in Bung Binh Thien reservoir. The results from the current study provide important information for efficient management of the sediment in the future.

## References

[1] Beklioglu M., Meerhoff M., Davidson T.A., Ger K.A, Havens K. And Moss B. (2016). Preface: Shallow lakes in a fast changing world. Hydrobiologia 778: 9-11. doi.org/10.1007/s10750-016-2840-5.
[2] James W. (2017). Internal phosphorus loading contributions from deposited and resuspended sediment to the Lake of the Woods. Lake Reserv Manag, 33:347-359.
[3] Nemery J., Gratiot N., Doan P. T. K., Duvert C., Alvarado-Villanueva R., Duwig C. (2015). Carbon, nitrogen, phosphorus, and sediment sources and retention in a small eutrophic tropical reservoir. Aquatic Sciences, 19 pages. DOI 10.1007/s00027-015-0416-5.
[4] Hou D., He J., Lü C., Sun Y., Zhang F., and Otgonbayar K. (2013). Effects of Environmental Factors on Nutrients Release at Sediment-Water Interface and Assessment of Trophic Status for a Typical Shallow Lake, Northwest China. Hindawi Publishing Corporation The Scientific World Journal, 16 pages.
[5] Tran Thien Cuong (2016). Evaluate the environmental quality of sediments and propose solutions to control downstream Phan River in Binh Xuyen district, Vinh Phuc province. VNU Journal of Science: Earth and Environment Sciences, 32 (1S): 77-82.
[6] Le Cong Quyen (2015). Distribution of phytoplankton in Bung Binh Thien, An Giang. Scientific Journal of An Giang University, 7 (3): 66-74.
[7] Dang Van Ty, Nguyen Hoang Huy, Chau Thi Da, Vu Ngoc Ut and Tran Van Viet (2018). Assessment of water quality fluctuation in Bung Binh Thien, An Giang province. Scientific Journal of Can Tho University, 53 (3B): 125-131.
[8] Nguyen Thanh Giao (2020). Surface Water Quality Assessment Using Phytoplankton and Zoobenthos: A Case Study at Bung Binh Thien, An Giang Province, Vietnam. Journal of Vietnamese Environment, 12(1): 7-16.
[9] Nguyen Manh Thang and Nguyen Thi Kim Anh (2006). Evaluation of changes in environmental quality and sediment quality of Tam Giang - Cau Hai Lagoon System (Thua THien Hue). Project 14 EES Vietnam - Italy Cooperation in the period 2004-2006.
[10] Le Thi Vinh, Nguyen Thi Thanh Thuy, Tong Phuoc Hoang Son, Duong Trong Kiem, Nguyen Hong Thu, Pham Huu Tam and Pham Hong Ngoc (2010). Sediment quality in Dam Thi Nai, Binh Dinh province. Journal of Marine Science and Technology, 04: 01-13.