



VARIATION OF SOIL, WATER QUALITY AND IMPACTS ON BIODIVERSITY IN XUAN THUY RAMSAR SITE

Tran Thi Kim Tinh¹, Nguyen Xuan Hai², Pham Van Quang² and Nguyen Thi Yen³

¹Biodiversity Conservation Agency, VEA, Ton That Thuyet, Hanoi

²Faculty of Environmental Sciences, VNU University of Science, Nguyen Trai, Hanoi

³Hanoi University of Natural Resources and Environment, Phu Dien, Tu Liem, Hanoi

E-Mail: nguyenxuanhai@hus.edu.vn

ABSTRACT

Soil and water quality are important environmental condition for biodiversity development in Xuan Thuy Ramsar site. This research is carry out in order to assess the variation of some parameters of soil and water quality and its impacts on biodiversity, especially flora in there. Investigating and survey methods and samples analysing are implement to meet with purposes of research during 3 years (period 2011-2013). The result of research showed that the water quality in two main rivers (Tra and Vop rivers) had a freshening trend for the duration of the study, beginning with 1.53% in 2011 the average salinity fell to 0.78% and 0.35% in 2012 and 2013, respectively. Biological decomposition of organic matters and eutrophication phenomena increased remarkably in these years (average DO in 2011 was $8.03\text{mgO}_2\cdot\text{L}^{-1}$, decreased to $4.59\text{mgO}_2\cdot\text{L}^{-1}$ in 2013; while average COD increased 191.22% by 2011 and average BOD increased 248.56% by 2011). Nutrient content in the soil which is sampled in 2013 is slightly decrease than that in 2012 (from 886.00 and 535.00 (2012), Nitrogen content (N) reduced to 758.72 and 527.7 $\text{mg}\cdot\text{Kg}^{-1}$ (2013) in Con Ngan and Con Lu respectively; with the similar trend, Phosphorus content (P) has already shown off the downward trend when decreased from 563.38 and 438.94 (2012) to 446.22 and 415.80 $\text{mg}\cdot\text{Kg}^{-1}$ (2013) in Con Ngan and Con Lu respectively) and the scale of low nutrient soil tend to increase. The negatively changing environment has significant impacts on floating flora and fauna cause the variation of area and number of species in mangrove ecosystem as well as the biodiversity of Ramsar site. The study results will be the important baseline and helpful to develop solutions on sustainable management for Xuan Thuy Ramsar site.

Keywords: soil and water quality, mangrove forest, Xuan Thuy Ramsar site, Vop River, Tra River.

INTRODUCTION

Xuan Thuy Ramsar site belongs to Giao Thuy district, Nam Dinh province and located in the Red river estuary (at latitude $20^{\circ}10'$ to $20^{\circ}21'$ North, and longitude $106^{\circ}2'$ to $106^{\circ}35'$ East). This site has character of tidal flat and includes Bai Trong, Con Ngan, Con Lu and Con Xanh with total area is 12, 000ha (with 7, 100ha of core zone) [1]. Xuan Thuy Ramsar site contains abundant natural resources with high biodiversity characteristic and important habitats for valuable and rare species in coastal estuaries of Northern in Vietnam. The increase area of mangrove ecosystem (1459.0ha in 1986 increased to 1711.5ha in 2007) [2] is created a favourable environment for the growth and development of aquatic organisms.

Nowadays, under the pressure of economic developing activities (the zoning of intertidal zones to raise clams, and ponds used for raising aquatic products without plans), the area of mangrove forest has declined significantly (with the scale of mangrove is only 1660.9ha in 2013). Besides that, resources are exploiting with high intensity exploitation and using by destructive harvesting tools, cause the change of environmental quality. Therefore, assessment on changing trend of water and soil environment, and their impacts to the biodiversity in Xuan Thuy Ramsar site are very necessary in term of investigating negative impacts and proposing efficient management solutions; in order to accomplish conservation targets and sustainable development of this

Ramsar site following the commitments of member nations of the Ramsar Convention.

MATERIALS AND METHODS

Objectives

- **Soil environment:** physicochemical criteria: pH, inorganic components of soil, total dissolved salt, CEC, Cl⁻, SO₄²⁻, Ca²⁺, Mg²⁺; organic matter content, (CHC); nutrient elements N, P, K and content of mobile heavy metals (Cu, Pb, Zn, Cd, As).
- **Water environment:** temperature, pH, salinity, turbidity, total suspended solid, DO, BOD, COD, NH₄⁺, PO₄³⁻, Ca²⁺, Mg²⁺ and dissolved heavy metals content (Cu, Pb, Zn, Cd, As).
- **Vegetation:** ecological and floristic characteristics and concentrations of heavy metals (Cu, Pb, Zn, Cd, As).

Research scope

Water and soil samples were taken in two main water basins (Tra River and Vop River) in the core zone and the buffer zone of Xuan Thuy Ramsar site. These areas are mangrove ecosystems and are affected strongly by increases in aquatic product activities. In detail, the sites where samples were taken over 3 years, from 2011-2013 are listed in the following table:

**Table-1.** Location and description of samples

Sample	Location	Descriptions
XT1	20°14'37.62"N 106°32'52.98"E	Buffer zone, mudflat along Vop river
XT2	20°13'28.62"N 106°32'39.48"E	Buffer zone, intersection between Tra river and Vop river
XT3	20°13'27.85"N 106°33'23.16"E	Core zone, the rest of Tra river
XT4	20°13'40.08"N 106°33'49.20"E	In the middle of Core zone, in the middle of Tra river (in the direction to Vop river)
XT5	20°14'6.48"N 106°34'22.02"E	In the middle of Core zone, in the middle of Tra river (in the direction to ranger station)
XT6	20°14'44.94"N 106°34'25.86"E	Estuary of Tra river (intersection between Con Ngan and Con Lu)
XT7	20°14'29.34"N 106°34'13.08"E	Outside the discharge drain of lagoon (outside the dyke)
XT8	20°14'30.12"N 106°34'12.84"E	Inside lagoon (inside the dyke), Con Ngan

**Figure-1.** Distribution of samples.

METHODS

Site survey methods

- Collection of documents:** through surveying households living in the studying area, interviewing authorities, gathering and synthesizing the documents provided by managers.
- Site survey methods:** cooperated with specialist survey teams (including vegetation, bottom fauna, insects, amphibians, soil environment, and water environment) from the Institute of Chemistry and Institute of Ecology and Biological Resources to assess the biodiversity status of Xuan Thuy Ramsar site (flora and fauna areas), water quality, and soil quality.
- Samples collection methods:** water samples, soil samples and flora samples were taken continually in

identified areas, based on the general character of sample area:

- + **Soil samples:** were taken from the surface horizon (0 - 20cm);
- + **Water samples:** were taken from the surface of the two main hydrological systems of Xuan Thuy Ramsar site with the samples stored in a refrigerator before analysis.
- + **Flora:** the dominant species in two mud flat areas were sampled.

Analysis methods in the laboratory

- Measuring directly some of parameters of water quality (temperature, pH, salinity, turbidity, DO) in the Ramsar site by Water Analyzer U-10;
- BOD - Vietnam Standards 6001:1995; COD - Vietnam Standards 6491:1999; total N in soil - Kjeldahl, Vietnam Standards 6498:1999; NH_4^+ - photometry using Nessler reagent; PO_4^{3-} colorimetric comparison using Tintometer and molipdat; K - Flame Photometer.
- Content of Metal cations: (Cu, Pb, Zn, Cd, As, Ca, Mg) were measured by Atomic Absorption Spectrometric - AAS model Shimadzu AA-6800F.

pH_{KCl} - pH meter Starter 3000; inorganic components - Vietnam Standards 6862:2001, CEC - Vietnam Standards 6864:2001, total dissolved salts - mass method; Cl^- - titration using Ag^{2+} ; SO_4^{2-} - Vietnam Standards 6656:2000.

RESULTS AND DISCUSSIONS

The variation in environmental elements over three recent years and their impacts on the biodiversity in Xuan Thuy Ramsar site were assessed for the following main factors: salinity, pH, nutrient content in water (N-NH_4^+ , $\text{P-P}_2\text{O}_5$), DO, COD, BOD), the heavy metal concentrations in water and soil, and the nutrient content of the soil surface layer. These factors have directed



effects on the distribution, development and regeneration of salt marsh plants. Samples were taken in July - 2011 (7 samples) [3], July - 2012 (9 samples) and July - 2013 (8 samples). The figures were calculated by averaging the upstream and downstream sites of the Vop River, and the upstream and downstream sites of the Tra River (TL-V, HL-V, TH-Tr, and HL-Tr).

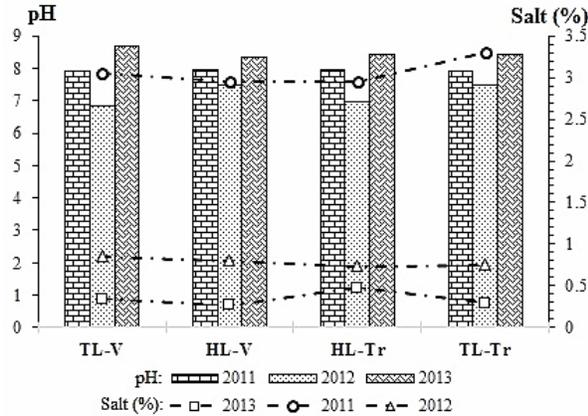


Figure-2. Salinity and pH variation of surface water in Xuan Thuy Ramsar site.

The analysis figures gives results that reflect these flood flows, with the average salinity in observed sites in 2011 at 1.53%; which went down to 0.78% and 0.35% in 2012 and 2013, respectively. Corresponding to the reduction of salinity in surface water, the aquatic species composition showed many changes. Counting on area where salinity is lower than 4%, the water surface area that is fresher increased on a large scale across the estuary. The characteristic of a fresher water environment is obviously depicted by the ratio of new-coming species in the floating fauna, flora and fish groups. In combination with salt-water intrusion up to 20km in mainland in the dry season, the freshening process, Salinity and pH variations across a large scale will affect flora distribution. A typical example is shown in Con Lu. In this area survey in 2009, more than two ha of *Casuarina* had disappeared, compared with 2007 survey results by these variations [5]. In addition, *Sonneratia* species, which is only intercropped with *Kandelia obovata* (the species whose planting purpose is wave resistance, seashore protection) develops robustly and generates the next generations. Although the species have become fully-grown since 2008, a large area of *Sonneratia* species have been disappeared or degraded.

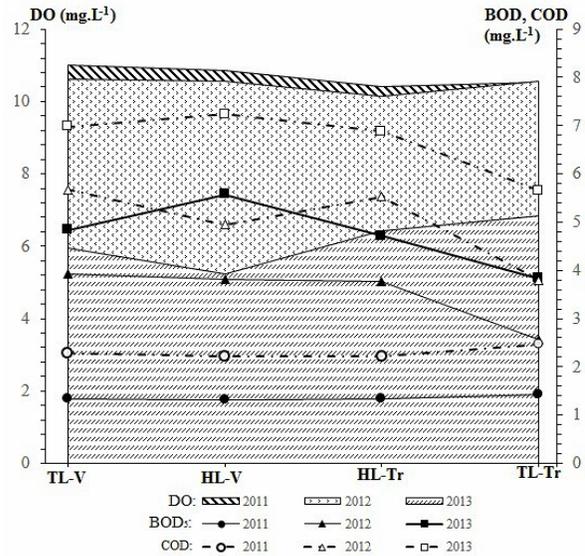


Figure-3. DO, BOD, COD variation of surface water in Xuan Thuy Ramsar site.

Due to the increase of aquatic products, the widening scale of production and lagoons areas aim to enhance local people's income in Xuan Thuy Ramsar site, lead to the negative impacts on water of two main basins quality in Tra River and Vop River. The concentrations of dissolved O₂ index in rivers dropped significantly (average concentration of dissolved O₂ in 2011 was 8.0 mgO₂.L⁻¹ went down to 4.59 mgO₂.L⁻¹ in 2013), the content of both BOD and COD went up greatly (in 2013, COD with the BOD content rising 191.22% and 248.56% by 2011, respectively). Conclusion, biological decomposition processes tended to increase annually along with the development of aquaculture areas. The lack of planning for aquaculture zones cause discharge directly a huge amount of organic matter to two main rivers, as well as causing a eutrophication risk when the content of N, P were increased, especially the content of N-NH₄⁺ in Vop river and Tra river (Figure-4).

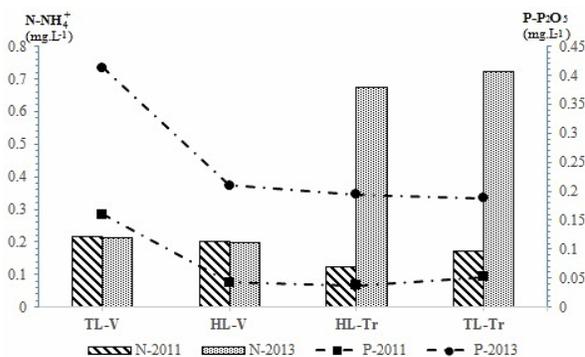


Figure-4. Nutrient elements content variation of surface water in Xuan Thuy Ramsar site.



Pollutant emissions and aquaculture activities directly influenced aquatic species of Xuan Thuy Ramsar site and mangrove ecosystem. Moreover, the number of aquatic species declined; some disappeared, forest density was not homogeneous (especially in the strictly protected areas in which exploitation was permitted), with these changes somehow affecting the development of flora in the area [6, 7].

Soil in the survey area is low nutrient types (except K, nutrient content depend on the fluctuation of sea water), soil quality in Con Ngan is better and less fluctuating than that in Con Lu (Table 2). Results of two-

year-monitoring showed that the nutrient content slight decrease when comparing to 2012, with the number of low nitrogen samples increased from 38% (2012) to 55% (2013) and the number of poor phosphorus samples accounted for 77% (2013) compared with 76% (2012).

The content of heavy metals in water and mobile form in soil was not fluctuating noticeably in 3 years. One thing that should be noted is the strange accumulation of As in plants living on mudflats along main rivers (Table 3). However, any relationship between high content of As and the growth of accumulating plants was not obvious in survey sites.

Table-2. The nutrient content and total organic carbon in the topsoil of Xuan Thuy Ramsar site.

Sample	mg.kg ⁻¹	2012			2013		
		Min	Max	Average	Min	Max	Average
C.Ngan	total N	665.00	1681.00	886.00	603.21	1435.34	758.72
	total P	478.05	697.99	563.38	362.04	497.81	446.22
	total K	20175.44	22631.58	21526.68	18629.79	21504.256	19682.98
	TOC	10939.70	25589.40	17127.90	11111.07	23102.21	14155.28
C.Lu	total N	175.00	980.00	535.00	210.00	1190.00	527.70
	total P	257.46	688.20	438.94	307.25	608.27	415.80
	total K	8888.89	23509.93	15803.80	2125.98	17320.63	10007.00
	TOC	2568.50	20352.80	10450.50	1700.00	27560.00	11655.00

Table-3. Content of heavy metals in water, soil and flora (2013).

	Zn	Cu	Cd	As	Pb
Water sample (µg.L⁻¹)					
average	3.15	23.02	20.67	30.82	17.86
min	2.08	3.17	4.65	0	1.17
max	5.29	95.86	70.83	154.13	89.39
Soil sample (available - mg.kg⁻¹)					
average	99.11	23.47	0.6058	91.7501	46.12
min	77.06	12.28	0.521	45.052	30.29
max	118.36	47.65	0.761	118.665	56.23
Flora (accounting follow quantity of dry flora - mg.kg⁻¹)					
average	1.82	16.31	0.06063	228.665	0.26
min	1.24	8.89	0.00738	104.44	0.08
max	2.85	36.35	0.062	320.02	0.56

CONCLUSIONS

Hydrological and geographical factors create favourable conditions for the growth and development of mangrove ecosystem in Xuan Thuy Ramsar site. However, the tidal regime (Red River and tide) is not balanced in time and space, so a localized freshening phenomenon happens annually in July (the average of 2011 was 1.53% dropping to 0.78% and 0.35% in 2012 and 2013, respectively). The impacts of climate change with increases in storm frequency and greater fluctuations in river flows will affect plant distribution in the mangrove.

The variations in environmental elements in Xuan Thuy Ramsar site have shown of the negative trend, threatening to population of aquatic species in this area (especially floating flora and fauna). Besides, the existence of mangrove vegetation is threatened with the degradation large area of mangrove, reduction of plant density; decrease in survival index. Many endemic species will decline if there is not any effective and timely management solution.

**REFERENCES**

- [1] Hong P. N., Tuan L. X. and Dao P. T. A. 2007. Biodiversity of the Xuan Thuy National Park. MERC - MCD, Hanoi, Vietnam. p. 41.
- [2] Kế hoạch chiến lược quản lý vườn quốc gia Xuân Thủy tỉnh Nam Định. 2008. Chương trình Liên minh đất ngập nước - Sở Tài nguyên và Môi trường tỉnh Nam Định.
- [3] Nguyễn Xuân Hải and Trần Thị Kim Tinh. 2011. Nghiên cứu một số chỉ tiêu chất lượng môi trường đất và nước phục vụ bảo tồn đa dạng sinh học khu Ramsar Xuân Thủy. Tạp chí Khoa học ĐHQGHN, Khoa học Tự nhiên và Công nghệ, ISSN 0866-8612, tập 27, số 5S, tr. 68-75.
- [4] Nguyễn Việt Cach. 2010. Kinh tế hóa các công tác bảo tồn đa dạng sinh học vườn quốc gia Xuân Thủy, Kỳ yêu hội nghị quốc gia về đa dạng sinh học.
- [5] Mai Trọng Nhuận, Nguyễn Thị Minh Ngọc, Nguyễn Quỳnh Hương, Nguyễn Thị Hồng Huệ, Nguyễn Tài Tuấn and Phạm Bảo Ngọc. 2009. Assessment of Vietnam Coastal Wetland Vulnerability for Sustainable Use (Case Study in Xuanthuy Ramsar Site, Vietnam). Journal of Wetlands Ecology. 2: 1-16.
- [6] Phạm Việt Hưng,DAC Anh Tuấn, Đặng Hải Quang. 2008. Nghiên cứu đánh giá biến động tài nguyên Vườn Quốc gia Xuân Thủy bằng phương pháp Viễn thám và hệ thống thông tin địa lý.
- [7] Nguyễn Văn Thang, Nguyễn Trọng Hieu, Trần Thúc. 2011. Biến đổi khí hậu và tác động ở Việt Nam, NXB Khoa học và Kỹ thuật, Hà Nội.