RETROSPECTIVE ASSESSMENT OF ZOOBENTHOS - VAN PHONG BAY, KHANH HOA PROVINCE AS A CASE OF STUDY

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ABSTRACT: The retrospective assessment of risk plays an important role of management and strengthening risk management of marine pollution. This paper presents a risk assessment in accordance with the method of PEMSEA (Regional Programme on Building Partnerships in Environmental Management for the Seas of East Asia) for the zoobenthos in Van Phong bay. The results have shown evidence of declining the zoobenthos, evidences of declining the zoobenthos on soft bottom and on coral reefs of Vân Phong bay. Potential agents that could cause zoobenthos decline in the Van Phong bay were identified. The agents range from chemical to physical and biological, such as BOD/COD, TSS, nutrients, oil and grease, heavy metals, coliform, sedimentation, destructive fishing, illegal exploitation, physical disturbance, port dredging, declining the coral reefs, mangrove forest and seagrass beds, motive power and sediment deposit elements. The results have used to manage the agents with application of GIS technique for database management, and minimizing the harm for the zoobenthos.

1 INTRODUCTION

The Van Phong bay is facing a string of enviromental problems that impact not only public health but also on the environment. The application of management tools, such as risk assessment, where the state of the environmental condition is assessed and areas that require management intervention are identified, is currently gaining wider recognition. Risk can be carried out as a retrospective risk assessment. Retrospective risk assessment can be used as a basis for the environmental management and imply the desire to control activities to prevent the contaminant level from exceeding an allowable level that presents an acceptable risk. This paper presents a risk assessment with the method of PEMSEA for the zoobenthos in Van Phong bay.

2 METHOD OF STUDY

Van Phong bay is located within the coordinates $12^0$29’ to $12^0$48’ latitude and $109^0$10’ to $109^0$26’ longitude. Retrospective risk assessment is an evaluation of the causal lingaes between observed ecological effects and stressor(s) in the environment. The retrospective approach employed for Van Phong bay was of the “effects-driven assessment” type that addresses apparent ecological effects that have uncertain causes [1],[2]. Under this retrospective, risk is viewed as the likelihood that current impacts are occurring and the demonstration of the existing impacts confirms that a risk exists. The basic principles and techniques for retrospective risk assessment are described in *Environmental Risk Assessment Manual: A practical Guide for the Tropical Ecosystems* (MPP-EAS, 1999a).[1]. A considerable volum of materials on the Van phong bay, from various studies reports, and projects, were reviewed and relevant data on zoobenthos in the Van phong bay were put together for the retrospective risk assessment. To

elaborate on the interrelatedness of agents and targets, a simplified risk pathway was used. It shows the agents that presnet potential adverse effects to human health and the coastal and terrestrial environment, as well as effects on the ecosystem. It also shows the relationships bettween the harmful agents and the various social and economic activities, and presents potentially important concerns for management of activities that could cause adverse effects to human health and environment. Comparison with the data on the time and space is done. Analyzing the zoobenthos system structure, rated qualitative and quantitative views, referred to the previous views, to determine the evaluation of the causal lingaes between observed ecological effects and stressor(s) in the environment, and the important changes for zoobenthos, particularly the declines. Matrix table of retrospective analyses with selection effect systematically the elements cause damages. Summaries of the likelihood for agents to have caused the decline in zoobenthos were prepared and were made part of the basis for the results of the retrospective risk assessment.

3 USED DATA AND MATERIALS

3.1 Comparision of species abundance, density and mean biomass of zoobenthos on the soft bottom regions in Van Phong bay

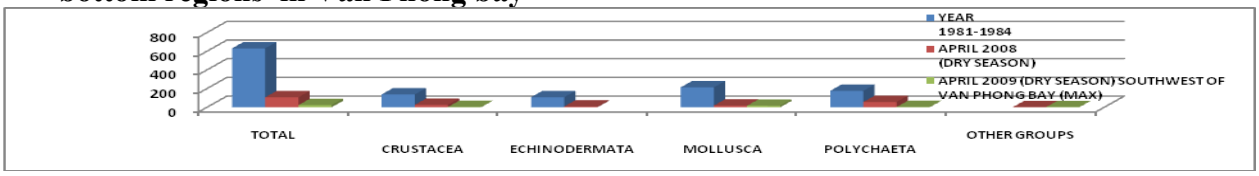


Fig. 1 : Species of zoobenthos in Van Phong bay (from [3])

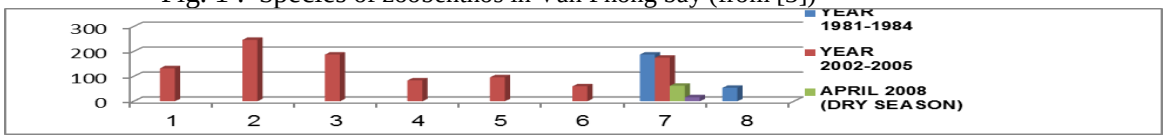
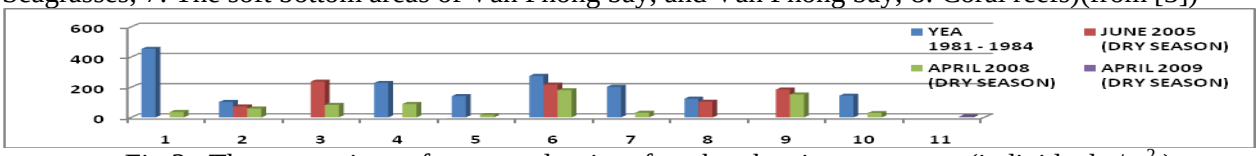


Fig 2: The comparison of average density of zoobenthos of different habital types (individuals/ m^2) (1 : Sandy areas; 2: Mudy – sandy areas; 3: Sandy - mudy areas ; 4: Mudy areas; 5: Dead corals; 6: Seagrasses; 7: The soft bottom areas of Van Phong bay, and Van Phong bay; 8: Coral reefs)(from [3])



. Fig 3 : The comparison of average density of zoobenthos in some areas (individuals /m^2) (1:The middle of Hon Duoc and Co Co cape; 2:Vung Trau Nam; 3:Xuan Tu; 4:The middle of Hon Khoi and Hon Lon; 5:The middle of Bai Hon Khoi and Vung Tre; 6:Co Co channel; 7:Cua Be channel; 8:Dam Mon; 9:My Giang; 10:The inlet of Van Phong bay; 11:Southwest part of Van Phong bay) (from [3])

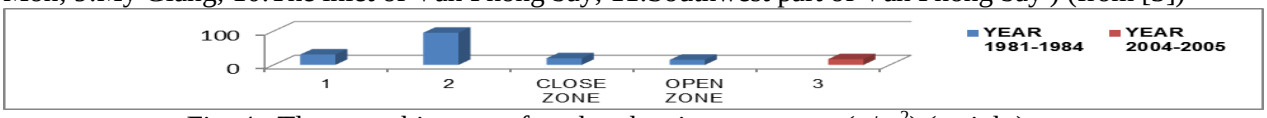


Fig. 4 : The mean biomass of zoobenthos in some areas (g/m^2) (weight)
(1: *Van Phong bay*; 2: *Transition zone* (medial characteristic of two above zones: *Open zone and Close zone*, the mean weight was hight); *Open zone* : influented by open sea, the mean weight was low; *Close zone* : influented by the river and the streams from the ground, the mean weight was rather moderately low; 3: *Ran Trao Marine Protected Area.* (from [3])

Table 1:The density of zoobenthos in sea area of Hon Khoi (Van Phong bay)(individuals/m^2)(from [3])

Species	Polychaeta	Crustacea	Mollusca	Echinodermata	Total

YEAR 1990	28 ; (1.89 g/m^2)	>26 ; (1.1 g/m^2)	>13 ; (1.63g/m^2)	62.3; (109 g/m^2)	176.2
YEAR 2009	1	1	11		13

3.2 Comparision of species abundance, density and mean biomass of zoobenthos on the hard bottom areas (coral reefs) in Van Phong bay

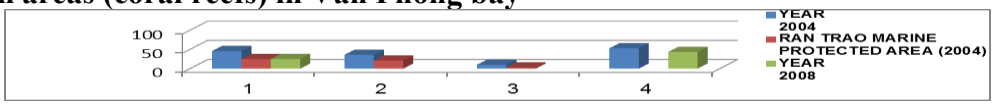


Fig 5:Species and density of zoobenthos on hard bottom areas (coral reefs) of VanPhong bay (from[3]) (1:Sum of species;2:Mollusca;3:Echinodermata;4:The average density of zoobenthos (individuals/400m^2)

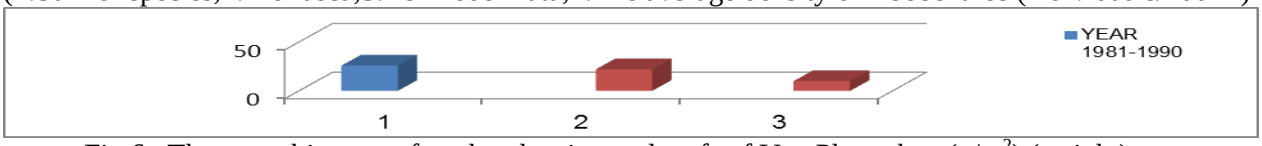


Fig 6 : The mean biomass of zoobenthos in coral reefs of Van Phong bay (g/m^2) (weight)
(1: The coral reefs of Van Phong bay; 2: The coral reefs at Ran Trao, 2005 (Ran Trao Marine Protected Area); 3: The coral reefs at Ran Dung (in Ran Trao Marine Protected Area).), 2005 (from [3]).

4 THE RESULS

4.1 Evidences of declining the zoobenthos:

4.1.1 Evidences of declining the zoobenthos on soft bottom regions of Vân Phong bay:

From 1981-1984, the density of the zoobenthos 140 individuals/m^2, decreasing at 62 individuals/m2 in 2008 (April, dry season), (particularly gulf southwest area in 2009 (April, dry season) at 12.57 individuals/m^2), lower than mud bottom with the zoobenthos density lowest at 83.73 individuals/m^2 in 2002. Zoobenthos density decrease strongly in the aquaculture region, industrial activities including the areas between Hon Duoc–Co Co cape, Xuan Tu, Lach Co Co, Lach Cua Be, My Giang. My Giang region in Southwest of gulf from 1972–1995, crustacean decreases 3 times, polychaeta decreases 3.3 times, bivalvia decreases 8 times…. From 1981-1984, total zoobenthos amount is 630 kinds, decreasing strongly at 106 kinds in 2008 (April, dry season), separately Southwest of gulf only have 22 kinds in 2009 (April, dry season), crustacean with 3 kinds, polychaeta with 2 kinds, other groups with 1 kind. Average zoobenthos amount in 1981–1984: 30.54g/m^2 decreasing at 22g/m^2 even in Ran Trao sea conservation area. Biomass of zoobenthos with the trend decreasing from the shore to open sea, at the depth of 20-50m, average zoobenthos weight at 5.58g/m^2 and the density of 84 individuals/m^2. However, the section through the gulf is Hon Khoi–Vung Tre beach with the average zoobenthos weight at 77.36g/m^2 and density at 140.95 individuals/m^2 in 1991. Hon Khoi beach inshore only has the density of 13 individuals/m2, inshore of Southwest of gulf from Ninh Thuy to Ninh Van with the zoobenthos density only from 6-16 individuals/m^2 (2009). There is the decreasing about the zoobenthos at Van Phong gulf. Capacity of exploring naturally the seafood in the gulf decreases strongly, bivalvia decreases 67%, crab decreasing 25%, shrimp decreasing 65% than 25 years ago.[3].

4.1.2 Evidences of declining the zoobenthos on coral reefs of Vân Phong bay:

The coral reefs in the gulf specifically Mollusca, Crustacea, Polychaeta, Echinodermata kinds, with one of important properties of the creature system region at variety of zoobenthos with big sizes such as Echinodermata, Mollusca with advantages, ampipoda and polychaeta kinds with small sizes with low variety. Pedum spondyloideum and Selftifer bilocularis with the highest appearance frequency, then snail kinds such as Chicoreus bruneus, Drupella cornus, Turbo chrysostomus and Isognomom sp., Trochus niloticus Linnacus, T.m ulatus. Turbo

marmratus Linnacus, Cassis cornuta Linnacus with numerous amount. Kinds: Penaeus merguiensis, Panulirus spp., cuttle-fish, Haliotis ovina Gmelin, Atrina vexillum, Pinna vexillum, P. pumata, P. nigra, Lutratia sieboldii,… with numerous amount. Some sea cucumber kinds such as Holothuria atra, Stichopus chloronotus and Bohadschia graeffei relatively valuable, sea cucumber kinds such as Tinopuga echinites, A. Mauritiana, Holothuria atra, H. scabra, H. leucospilota, Microthele nobilis with numerous amount...[3]. Apart from coral rows in the peninsula of Hon Gom, Hon Lon, My Giang, Mui Du, Bai Dai, Ninh Van far from the population region, relatively far from tourist, relaxation area, not yet affected strongly by human life, relative high biodiversity, high coverage of hard coral and soft coral, various fish ingradients, rate of the non-biology elements such as sand, mud, stone lower, most of coral rows in gulf regress. Spineless animals appear in the bottom region: Stenopus hispidus, lobster, Charonia tritonis Linnacus, Trchus niloticus Linnacus, T.m ulatus, Lambis lambis, Strompus Luhuanus linnaeus, 1758, Tridacna spp., Lutraria sieboldii, Tinopuga echinites, A. mauritiana, Stichopus chloronotus, Bohadschia graeffei, Holothuria atra, H. scabra, H. leucospilota, Microthele nobilis, cuttle-fish, Haliotis ovina Gmelin, Atrina vexillum, Pinna vexillum, P. pumata, P. nigra, ... become scarce in most of coral reess (2005-2008).[3].

4.2 Doubt effect causing declining zoobenthos:

4.2.1 Declining the coral reefs, mangrove forest, seagrasses:

In 1996, coverage of hard coral gains average 51.5%; in 2008 at 10%-38.7%. Coverage of soft coral gains average from 0.3%-14.9%. Declining speed of living coral coverage now in some coral reefs of Western of gulf is assessed from 15-35% in 20 latest years (1988-2008).[3]. Hundreds of ha on water surface of coral reefss, sea grass driven in stake to bear sea. Aquaculture, seaport dredging, catching over seafood and growing breeds, particularly catching the soft animals such as arca, snail exhausting the benefit of mussel and harming heavily sea grass beds. Presently, the coverage size of sea grass in many locations of gulf remains 1/3 than previously. After over 20 latest years, mangrove forest losses 300 ha, directly decreasing the exploring productivity in some seafood kinds in the gulf, capacity of exploring naturally seafoods in the gulf down quickly. Declining the coral reefs, mangrove forest, seagrass beds and many specific ecological systems by rearing cage for seafood exhausting profits, decreasing biodiversity. Zoobenthos reside in the locations of coral rows, mangrove forest, seagrass are disadvantageously affected to the living and development activities. Soft body with bivalvia down to 67%, crabs, portunus down 25%, shrimp down 65% than 20 previous years.[3].

4.2.2 The pollution of oil and grease,metals, organic substances,nutrients, suspended solids

The content of oil and grease in all locations in the gulf from 217–850 µg/l and the heavy metal Fe continuous in many years exceeding critical value of Vietnamese regulations (GTGH QCVN10:2008/BTNMT and QCVN43: 2012/BTNMT) from 1994-2013. Hydrocarbon content in sediment from 208-678 µg/g (2002-2005). Flood regions of the river mouth near the great seaports (Van Gia–Tu Bong lengthening to Xuan Tu, Xuan Ha,...), the oil and grease in sediments are fair high 62.8–153.2 µg/g (April 2009).[3]. The content of oil and grease in the water and flood sediments and Hyundai port (excedding the critical value of Vietnamese regulations) causing death and limiting the salt marsh plant development, destroying the zoobenthos sticking or living underground the sediment bottom mud layer. Heavy metals in saccostrea cucullata, kind of bivalvia with habit of eating with selection surveyed, Zn content is from 499.6–715.3 (µg/g. fresh), and 200-400 (µg/g.fresh) at Mui Du in 2005; Cu content is from 427.7–662.4 (µg/g.fresh), at My Giang and 60-80 (µg/g.fresh) at Mui Du in 2005. Cu content is

from 246.06–273.76 (µg/g.fresh), and Mui Du at 98.64–99.98 (µg/g.fresh) in 2009, exceeding from 2-4 times as Vietnamese Health Ministry standards.[3]. There is the local pollution status about BOD in the gulf. Most of the gulf locations have BOD >4 mgO_2/l (year 2008); BOD> 4 mgO_2/l at Ben Goi, My Giang, Hon Khoi, Ninh Tinh… (2009-2013). COD in most locations in the gulf exceeds the critical value of Vietnamese regulations in the phase of 2002-2013. Nitrate, phosphor, ammonia content are not simultaneous, but approximate or exceed the critical value of Vietnamese regulations from 1994-2013. TSS (Total of Suspended Solids) average value in the gulf from 20-50 mg/l and exceeds the critical value of Vietnamese regulations and causes the local pollution in many locations in the gulf: Dam Mon, Hon Gom, Ben Goi, Hon Khoi, My Giang, Ninh Tinh…(2007-2013).[3]. Constructing, operating the seaport decreases DO, blows water abyss, specifically water layer close to bottom declines the zoobenthos… There is the organic substance pollution, nutrients, TSS in the gulf and particularly Western and Southwestern of the gulf (Ben Goi, My Giang, Hon Khoi, Ninh Tinh…), there is the clear decrease about density, weight, and kind of the zoobenthos (Fig.3, Table 1).

4.2.3 Excessive exploration:

In the gulf of the phase of 1990-1991, there are many zoobenthos such as Penaeus merguiensis, lobster, Stenopus hispidus, cuttle-fish, Haliotis ovina Gmelin, Atrina vexillum, Pinna vexillum, P. pumata, P. nigra, Conaptopallium redina, Area navicularis, Some sea cucumber kinds, Trchus niloticus Linnacus, T.m ulatus, Turbo marmratus Linnacus, Cassis cornuta Linnacus, strombus spp., Charonia tritonis Linnacus, Lutraria sieboldii, oyster, Pinetada margartifera, Tridacna spp.,… with numerous amount, but spontaneously excessively exploited (for food and fine arts… fair common) up to now, mostly there is no more or very little (0-0.3 individuals/$100m^2$) or only surprising few individuals, very low catching products (excluding the sea reservation area with the restore and management process). The density of the spineless zoobenthos with the big sizes are fair low, average 53 individuals/400 m^2 down to 43.5 individuals/$400m^2$ (Lach Co Co region without any individual). On the hard bottom region of the gulf, the spineless zoobenthos kinds exhausting and not able to restore. The useful zoobenthos for coral reefs (Atrina vexillum, Pinna vexillum, P. pumata, P. nigra, Lutraria sieboldii, Lambis lambis, Strompus Luhuanus linnaeus, 1758 mostly absent.[3].

4.2.4 Destruction exploitation:

Seafood exploitation means digging sea grass, raking arca when exhausting flood, harmful chemicals, dynamites, net with small mesh,… destroying, losing the great amount of creatures of the seafood kinds with the high value in the coral reefs, seagrasses in the gulf, carving water, stirring toxic substances in the sediments (heavy metals…) creating the film sticking on the filter screen of the creature and dying, coral (withering coral reefs in the gulf, most remaining Porites, Gonipora high carving (surveyed 2005-2008).[3]; disording and burying the bottom creature (crustacean, polychaeta, amphipoda) as food for other economic seafood kinds; breaking the individuals stuck of most infants sticking into the bottom. Most of crustacean kinds (shrimp, crabs), soft body (oyster, shellfish, arca) living in the sea grass. In the process of catching the soft body animals, such as arca, snail, exhausting the creature profit with bivalvia, some sea cucumber kinds, holothurians (variety in the sea grass) rare, regressing heavily the sea grass, size of seagrass beds of the gulf remaining 1/3 than previously. Western of the gulf down greatly zoobenthos and other locations (1991-2005).[4](Figs.1-6, Table1). In Southwestern of the gulf, crustacea down to 3 times, polychaeta down to 3.3 times, bivalvia down to 8 times (1972-1995).

4.2.5 Motive power and sediment deposit elements:

In March (dry season), Northeastern wind direction, flow with the moving trend to Southwestern to the matters (organic, TSS,…), matter content concentrates in channel of inshore of Xuan Tu, shore of Western of the gulf. When flood up, the matters are pushed out of shore, when flood down, the matters go along the shore path and to Southwestern and direction to the gulf door. In September (rain season), Southeastern main wind direction, so the flow with the moving trend to Northeastern to circulation at the gulf cape, the matters move to Northeastern through the gulf cape and to Southwestern direction, so the matter content at gulf cape- Trau Nam pool (with the weak effect wave) high, creating one of the converging regions, matter assembling. Other converging regions in the gulf such as Ben Goi, Bac Hon Sang, Vung Trau Nam with the density and weight of lowest zoobenthos in the gulf, density 102.34 individuals/m^2 (weight 2.47g/m^2) and down to 59 individuals/m^2 (2008)…. In the gulf, there are the regions without being covered and greatly affected by the sea, heat, and salt index no different through the rain and dry seasons (Bai Dai, Hon Doi, Hon Tai…) with the low zoobenthos weight 14.8g/m^2.[3]. River water flow into the gulf, life wastes, production, seaport, tourist, aquaculture, mineral exploitation, inshore sites, … and by the motive process of the water region (one of the main sources causing TSS), Western inshore of the gulf with the high indecisive content, low salt index and causing the mud status in the region, invading mud outside of coral reefs as the common bottom. There is argo chemistry by the aquaculture wastes (Dam Mon, Ben Goi…). Extending and improving the seaport such as dredging frequently Hyundai port burying 20ha with the sea in My Giang and surrounding in many latest years… These elements contribute to make sediments, down the clear zoobenthos density in these regions.[3] (Figs.1-7, Table 1).

5 CONCLUSIONS:

Declining the zoobenthos can affect to the seafood profits, biodiversity level and organic disintegrating process. Retrospective risk assessment of zoobenthos shows that there are the declines for the zoobenthos in Van Phong bay: Declining the zoobenthos density; Declining the zoobenthos kinds; Declining quantities creature, zoobenthos amount on the soft bottom regions and on the coral reefs. Big reasons affecting the zoobenthos: Declining the coral roeefs, seagrass beds, mangrove forest; Exploiting the seafood excessively; Destroying exploitation for seafood profits; The pollution of oil and grease, heavy metals, organic substances, nutrients, suspended solids and the motive elements of the gulf and sediment with the important affecting uselessly to the zoobenthos life. The results have used to manage the agents with application of GIS technique for database management, and minimizing the harm for the zoobenthos.

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