

Natural resources and environment in Cam Ranh bay and sustainable development orientation

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Abstract. Locating in Khanh Hoa province, Cam Ranh bay is a typical bay for Southern Middle of Vietnam. The system of Cam Ranh bay has a plentiful natural resources, that divides into non-biotic resources and biotic resources because of interaction between climate, hydrology, geology, and topography conditions. The first one includes position, wetland, mineral and geotope resources. The second one involves the diversity of ecosystems such as mangrove, seagrass, coral reef and tidal wetland. However, all of them have been over exploiting for development of local economic, therefore, make them being degraded. The pressure of economical development are threatening to the sustainable of natural environment. Water has been contaminated by oil and liable to contaminate by Pb, Hg, Mn, Sb. Sediment has been contaminated by As, PCBs, DDT and liable to contaminate by Hg. Therefore, it is necessary to orient for sustainable use of natural resources and environment system of Cam Ranh bay. Base on characteristics of natural resources and environments in Cam Ranh bay, solutions in sustainable use of natural resources for the development of economies such as tourism, marine harbours, fisheries, national security, industrial zone, mineral exploiting has been proposed. Apart from the natural resources exploiting, solutions in natural resources protection has also been considered such as to establish of protection areas; to protect sensitive ecosystems, fisheries resources and to prevent environmental pollution and natural hazards.

Keywords: Bay, geotope, position resource, over exploited, sustainable development.

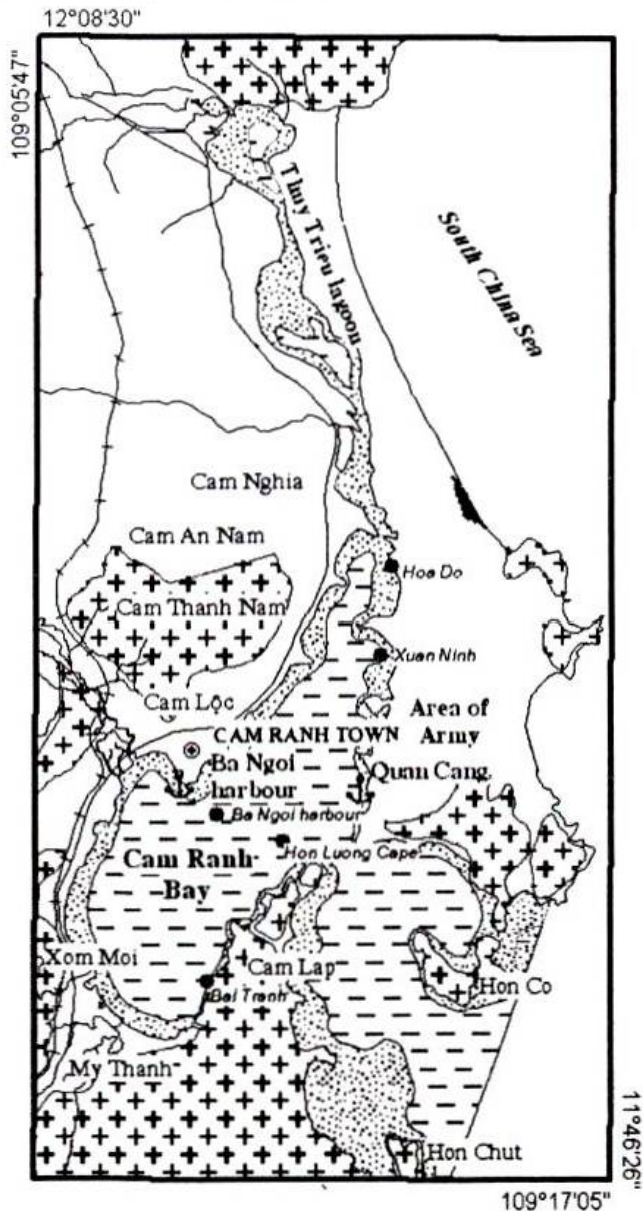
Introduction

There are some definitions on bay [1-3] but the main ideas that bay is a part of a sea indenting the shoreline between two capes. The bay is larger than a cove but smaller than a gulf. Cam Ranh Bay is a depth bay located on the southern coast of Khanh Hoa Province,

Vietnam, and its mouth opens into the South China Sea. According to the definition, Cam Ranh Bay does not include Thuy Trieu lagoon that is on the northern. Thuy Trieu lagoon, however, is the sources to support freshwater, nutrients, minerals to the bay, furthermore is a spawn area and habitat for many species in the Cam Ranh bay, therefore it should not separate from the Cam Ranh bay. Those are considered a unified area and the term Cam Ranh Bay in this

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paper will involves Thuy Trieu lagoon. The location of this region is from 11°05' to 12°10' Northern latitude and from 109° to 109°20' Eastern longitude (Fig. 1).



Legend




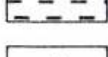
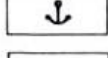
-  Magma intrusion
-  Low toxic elements storage capacity sediments
-  Medium-high toxic elements storage capacity sediments
-  Harbour
-  Station to collect sedimental samples for PCBs and OCBs

Fig. 1. Map showing study area.

The Cam Ranh bay has an abundant biotic resources that is a good basis for development of aquaculture and production of aquatic. Other natural resources in this area are minerals, tourism, especially with the position resources, Cam Ranh bay is a good place for fishing vessels storm shelter areas, for sea-port building and for military. Because of those, Cam Ranh Bay plays an important role in social - economical development and security of national defence. However, these resources have been over exploiting, therefore, protection of biodiversity and environmental should be considered for a sustainable development.

1. Natural conditions

Cam Ranh Bay covering 119 km², is about 19 km in length, 8 - 10 km in wide, and 16 m in depth [4]. The bay reciprocates to the sea with a big mouth of 3.5 km in wide at the southern part of Binh Ba Island and a smaller mouth of 250 m in wide at the northern part of Binh Ba Island. Thuy Trieu lagoon is about 18 km in length from Cam Hoa to My Ca bridge. The lagoon is characterized by a narrow width, shallow water and a large tidal flat at the top (Fig. 1).

The topography of the studying area is diversify and strong differentia. Low mountains and hills mainly distribute along the national road 1A at the Western. Coastal sandy dunes locate at the Cam Ranh peninsula. Western coastline is quite simple in shape, straight at the top and arc shape at the end. Eastern coastline is more complicated. It is separated by uplifting block to form headlands between narrow sandy beach. Furthermore, the mouth of the bay is protected by igneous rocks islands such as Co Trong, Co Ngoai, Chut. Coastline developing on unconsolidated sediment is quite even and

flat. Topography of the bottom where coastline developing on hard rock is changeable in depth.

Geological formations in this area could be divided into three groups base on physical properties and capacity of storable toxic. The first group is a bedrock, that can be strong loading and low toxic element storable capacity belongs to La Nga formation (J_2ln), Nha Trang formation (Knt); Dinh Quan complex, phase 2 (GDi/J_3dq_2); Deo Ca complex, phase 2 (GSy/Kdc_2); Ca Na complex, phase 1 (G/K_2cn_1). The second one is *Unconsolidated sediment that can be weak loading and low toxic element storable capacity* includes sandy sediments formed in Pleistocene, Holocene. These sediments range from the North of Thuy Trieu lagoon to the Bai Can beach in the western, and distribute only at Cam Ranh peninsula in the eastern. This group involves also sandy, gravelly sand sediments at the bottom of the bay. The third one is *Unconsolidated sediment that can be weak loading and medium to high toxic element storable Capacity* including fields of muddy sand, sandy mud at the center of the bay (Fig. 1).

The Cam Ranh bay lies in the tropical monsoon belt and experiences considerable seasonal variation. Annual rainy season stretches from May to December and the rest time is dry season. Annual precipitation is below 1,200 mm/year, mainly in rainy season (80 %). Annual mean temperature at this area is about 25 – 26 °C. With a lot of sunny days, annual total sunny hours is about 2,400 - 2,500 h/year. Annual mean humidity is about 80 %.

The Bay is influenced by two rivers: Can river and Trau river. The valley of these rivers is small and steep consequently water in the rainy season contributes to 80 % of annual total flow. This area is characterized by irregular semi-diurnal tide with mean amplitude is about 1.5m. Due to the Bay is quite close, the wave's

energy is fairly weak consequent the wave's height is usually low. The distribution of surface currents in the bay is quite complicated in direction, but the velocity of current ranges usually in 6-46 cm/s at the center of the bay.

2. Distribution and current uses of natural resources

2.1. Position resources

First of all, no military experts can negate the strategical values of the Cam Ranh bay. Vietnam coastline is long, therefore it is necessary to protect the coasts. This area is ideal place to make a military area that can be separated the mainland into two distinct regions and from this site naval forces can control whole territorial sea of Central Vietnam.

In addition to the strategical role, the Cam Ranh bay is also known as a good place for building sea-port. Cam Ranh Bay locates at the center in the international seaway to Singapore, Hong Kong, Shanghai, Yokohama. In comparison to the other sea-ports of Vietnam, the distance from Cam Ranh Bay to the international seaway is shortest. Together with other islands, the Binh Ba Island locating at the Southern of the bay, served as a screen for the bay. The island systems, mainly is a convenient place for building lighthouse and maritime radar. The flat bottom of the bay, mainly composed of sand mix with mud, is very convenient for dropping anchor.

2.2. Wetland resources

Wetland in the Cam Ranh bay that involves nine types cover 15,584 ha except mangrove forest and coral reef. The widest wetland types is Bays (Ab) with 6,907 ha; and the next in turn are Salty/brackish aquaculture ponds (1a) with

3,159 ha; Beaches (Ea) with 1,968 ha; lagoons (J) with 1,522 ha, Marine sub-tidal aquatic beds, includes kelp beds, sea grass beds, tropical marine meadows (B) with 800 ha [5] by the Vietnamese Wetland Classification System [6]. Wetland is not only valid in ecological aspect, in environmental protection and disaster prevention but also good basis for fishing & aquaculture, marine transportation, tourism...

2.3. Minerals resources

There are several mines and mineral deposit, that have been exploited, distribution around Cam Ranh bay such as peat in Ba Ngoi Town, molybden in Hon San and Hon Rong, ilmenite in Cam Ranh mine and hot mineral water in Ba Ngoi. Glass sand is the most common mineral being exploited, mainly from several mines including Cam Ranh and Thuy Trieu with total capacity of about 42 millions of tons. Besides, anomaly of heavy minerals including ilmenite, rutil, anataz, zircon, monazite, casiterite was also discovered at the bottom of the bay.

2.4. Geotope

There are a lot of famous landscape at the Cam Ranh bay such as Hon Rong, Hon Qui, Cam Linh mountain, Cam Ranh lake... The beauty of Bai Dai beach is neglected with 16 km long of smooth white sandy beach. Sandy bars are characterized by special interesting structures and strange shapes of granite hill resulted from weathering. These geotopes together with their ecological and humanity values contribute to the development of marine tourism, ecological tourism ...

2.5. Biological resources

The review of researches, investigations and the result of survey in 2007, 2008 shows a

diversified and abundant sources of biological income at the Cam Ranh Bay. 217 species of phytoplankton, 60 species of seaweed, 6 species of seagrass, 30 species of mangrove, 129 species of zooplankton, 234 species of benthos, 117 species of coral, 147 species of coral reef fishes and 87 species of fish in seagrass. Mangrove forest, coral reef and seagrass are typical ecosystems of the bay. Coral reef mainly distributes at Chuong beach (7.3 ha), Giai Nanh headland (4.4 ha) and Hon Noi (5.4 ha), but associated with low coverage rate, in average the coverage rate only figured 12% for hard coral and 1% for soft coral. The area of undamage mangrove forest at My Ca coastal line is about 60 ha and new planted forest of *Rhizophora* sp. is about 0.5 ha at Thuy Trieu lagoon and Nuoc Ngot hamlet (Cam Lap). Seagrass well develops at Thuy Trieu lagoon with total area of 800 ha. Seagrass ecosystem at Thuy Trieu lagoon contains of 87 species of marine fish, 13 species of crustacean, 12 species of echinoderm, 31 species of mollusca.

2.6. Distribution and using status of natural resources

Total annual aquacultural productivity in the bay area is about 3,000 tons/year, among which 337 ha for lobster, 180 ha for seaweed (*Kappaphycus alvarezii*). Within the small area of the Cam Ranh bay, there are 17 different exploitation types. The highest productivity is white herring surrounding and the lowest productivity is exploitation of cuttle-fish, crab. Total annual productivity of seafood exploitation is 6,044.7 tons/year. The main means in exploitation are handicraft, fishing equipment and low capacity ship. Exploitation productivity of glass sand at Thuy Trieu mine by the FICO glass sand enterprise is about 150,000 tons/year.

Enterprises of agricultural, silvicultural and aquatic product processing are strongly developed in the system of Cam Ranh Bay. The other developed industries are crafts, sewing, shipbuilding. Sugar refinery (Cam Thanh Bac), shipbuilding yard (Cam Phuc Nam, Cam Phu), cement plant (Cam Thinh Dong), aqua-product processing enterprises and fruit processing enterprises (along the western coast) are some large factories operating in this area. Together with Cam Ranh port and Ba Ngoi port, two major ports for marine transportation and military, smaller ports are exploited for fishery. Marine transportation mainly takes place at Ba Ngoi port. Development of military activities are being priorly invested at the South of Cam Ranh peninsula in the fields of seagoing vessel rescue, military shipbuilding and repairing...

3. Environmental status

3.1. Oil pollution

Oil content in the all of twelve water samples collected over the bay is about 0.15 - 0.22 mg/l with the mean content of 0.16 mg/l. Three days monitoring results at a fixed station shows the presentation of oil in the sea water with content-range from 0.14 to 0.17 mg/l. In comparison to Vietnam Standard on Environment 5943 - 1995, water in the Cam Ranh bay is polluted to all using purposes by oil.

3.2. Metallic pollution risk

Heavy metal analysis of water samples in the Cam Ranh bay shows that water has not polluted by heavy metals (in comparison to Vietnam Standard on Environment 5943 - 1995) but pollution potential is implicit (> 3 times of average content of heavy metal in coastal water of the world) by Pb, Hg and Mn.

Pb content in water ranges from 0.2 to $0.5 \cdot 10^{-3}$ mg/l, about 6.7-16.7 times of the average content of Pb in coastal water of the world ($0.03 \cdot 10^{-3}$ mg/l (Table 1)).

Table 1. Pollution risk of sea water by Pb

Region	Content (10-3mg/l)	Intensity (Ttc)
From Xuan Ninh to Cam Linh (0-15m)	0.41 - 0.5	4.6 - 5.6
Cam Ranh port (0-5m)	0.41 - 0.45	4.6 - 5.0
Can beach (0 - 5m)	0.41 - 0.43	4.6 - 4.8
Thuy Trieu lagoon	0.40 - 0.45	4.4 - 5.0

Note: $T(tc) = \text{measured content} / \text{risk content or polluted content}$

Hg was strongly accumulated in the water with mean content of $0.07 \cdot 10^{-3}$ mg/l. The highest content of Hg was measured at some places is about $0.09 \cdot 10^{-3}$ mg/l (3 times of the average content of Hg in coastal water of the world) (Table 2), the warning level causing potential pollution by Hg in water. In the Cam Ninh coast, Mn content in water ranges from $0.8 \cdot 10^{-3}$ to $10.0 \cdot 10^{-3}$ mg/l while average content of Mn in coastal water all over world is only $0.2 \cdot 10^{-3}$ mg/l. In conclusion, water in the Cam Ranh Bay is not only polluted by Pb and Hg on a large scale but also is in potential pollution by Mn in Cam Ninh area.

3.3. Heavy metallic pollution and risk in sediment

Environmental quality of sediment in the Cam Ranh bay is assessed on the basis of comparison to the Canadian Environmental Standard on Sediment. Heavy metal analysis that surface sediment in the bay was polluted by As and was potentially polluted by Hg. The pollution by As was found at several areas including from Cam Linh to military port; Cam Ranh port; Hon Luong headland with pollution level from weak to medium (Table 3). Mean

content of Hg in the sediment is about 0.7 ppm. Concentrated coefficient of Hg is 2.6 demonstrates that means content of Hg in this area higher than that in the coastal sea all over the world and that Hg is strongly concentrated. High concentration of Hg causes potential pollution in the sediment at several areas including from Cam Linh to military port; Cam Ranh port; Hon Luong headland (Table 4).

Table 2. Pollution risk of sea water by Hg

Region	Content (10^{-3} mg/l)	Intensity (Ttc)
Hon Trung island (20m water depth)		
Ca Tien headland (25m water depth)	0.09	1
Xuan Ninh (8m water depth)		
Thuy Trieu lagoon		

Table 3. Pollution of sediment by As

Region	Content (ppm)	Intensity (Ttc)
Cam Linh to military port (5-10m water depth)	8.6 - 9.2	1.2-1.3
Cam Ranh port (5-8m water depth)	12.8	1.8
Hon Luong headland (5-20m water depth)	9.4 - 12.6	1.3-1.8
Xung islet (0.5-1m water depth)	10.6	1.5

Table 4. Pollution risk of sediment by Hg

Region	Content (ppm)	Intensity (Ttc)
Cam Linh to military port (5-10m water depth)	0.09	1.0
Cam Ranh port (5-8m water depth)	0.10	1.1
Hon Luong headland (5-20m water depth)	0.09-0.10	1.0-1.1
Xung islet (0.5-1m water depth)	0.09	1.0

3.4. Pollution of Polychloro byphenyl (PCBs) and (OCPs) in the sediment

Sixteen selected constituents of PCBs for analysis were identified in all sediment samples of the Cam Ranh bay except in Xuan Ninh and Eastern of the Ba Ngoi port only $\Sigma 10\text{Cl}$ was not identified. Total content of PCBs, ranging from 8.91 to 29.10 ppb decreases from the North (29.20 ppb in Hoa Do) to the South (8.91 ppb in the south of Bai Tranh beach) (table 5). However, the composition of constituents is variation in different sediment cores. The most common constituents in analyzed samples are constituents with fewer Cl element in the formula. This demonstrates that the main source of these PCBs is lubricating oil from marine transportation. In comparison to TEL (21.5 ppb) of the Canadian Standard, the surface sediment at the Hoa Do was polluted by PCBs (29.1 ppb). Besides, pollution by PCBs was also found at the Ba Ngoi port at the depth of 38 - 40 cm with total content of 22.1 ppb.

All of seven selected OCPs (α BHC, β BHC, γ BHC, δ BHC, DDE, DDD, DDT) were identified in three points (in total 5 collected sample points). At the eastern of the Ba Ngoi and Hon Luong headland, only δ BHC was not identified. The total content of OCPs is below 1 ppb except the Xuan Ninh area with total content of OCPs reaches 2.51 ppb (table 6). The trend indicates that there has been a decrease (1.44-3.92 times) in total content of OCPs from the North (Hoa Do, Xuan Ninh) to the center of the bay (the east of the Ba Ngoi port, Hon Luong headland) and the south of the bay (Bai Tranh). The total content of OCPs at the shallow water area (Hoa Do, Xuan Ninh, Tranh beach) is higher than that at the center of the Bay (the eastern of the Ba Ngoi and Hon Luong headland). Among all constituent, content of DDT is always the highest (50 % of total content of OCPs), and content of δ BHC is always the smallest. The highest of DDT

content is 1.34 ppb in the sediment sample collected at Xuan Ninh indicate the pollution of the sediment by DDT at this area in

comparison to TEL (1.19 ppb). The sources of DDT and DDD comes from pesticide restricted for use.

Table 5. Distribution of PCBs in the surface sediment of the Cam Ranh bay

Constituent	Hoa Do	Xuan Ninh	Ba Ngoi port	Hon Luong headland	Tranh beach
2,4,4',4'-trichlorobiphenyl	1.31	0.29	0.20	0.12	0.13
2,2',5,5'-tetrachlorobiphenyl	2.54	0.20	0.49	0.10	0.53
2,2',4,5,5'-pentachlorobiphenyl	0.42	1.03	0.40	0.40	0.46
2,3,4,4',5-Pentachlorobiphenyl	0.66	2.44	0.78	1.13	0.43
2,2',3,4,5,6'-Hexachlorobiphenyl	0.96	7.26	1.77	4.96	2.56
2,2',3,4,4',5 hexachlorobiphenyl	0.71	0.65	0.07	0.12	0.14
2,2',3,4,4',5,5' heptachlorobiphenyl	2.28	1.14	8.57	4.64	3.81
∑ 2Cl	7.16	0.22	0.12	0.06	0.01
∑ 3Cl	1.31	0.29	0.20	0.12	0.13
∑ 4Cl	3.61	0.34	0.62	0.11	0.56
∑ 5Cl	11.80	3.92	1.24	1.98	1.19
∑ 6Cl	1.92	8.27	1.91	5.22	2.88
∑ 7Cl	3.13	1.71	8.58	4.71	3.89
∑ 8Cl	0.04	0.01	0.25	0.05	0.08
∑ 9Cl	0.11	0.08	0.03	0.06	0.14
∑ 10Cl	0.01	-	-	0.02	0.01
∑ PCB	29.10	14.84	12.96	12.33	8.91

Table 6. Content (ppb) of OCPs in the surface sediment (0 - 5 cm) of the Cam Ranh bay

Area	αBHC	γBHC	βBHC	δBHC	DDE	DDD	DDT	Total
Hoa Do	0.12	0.20	0.03	0.04	0.05	0.16	0.32	0.92
Xuan Ninh	0.11	0.17	0.04	0.02	0.07	0.76	1.34	2.51
Ba Ngoi port	0.05	0.06	0.01	-	0.04	0.12	0.23	0.51
Hon Luong headland	0.04	0.05	0.01	-	0.06	0.11	0.22	0.49
Tranh beach	0.07	0.09	0.01	0.01	0.04	0.13	0.29	0.64

4. Orientation in sustainable use of natural resources and environment at Cam Ranh bay

4.1. Developmental orientation on the basis of sustainable use of natural resources and environment

Base on characteristics on natural resources and environment, socio-economical developmental orientation on the basis of sustainable use of natural resources and environment at the Cam Ranh bay was proposed as follow:

Development of tourism, involves ecological tourism and adventurous tourism, should be exploited at Bai Dai beach, granite hill along the coast, Rong island, Giang island, Tai island, coral reefs, mangrove forest at Thuy Trieu lagoon, Sop island, Nhan island. Some main business including building the Center for tourism and relax at Bai Dai beach, Center for trade and international conferences at the North of Cam Ranh peninsula, service center of hot mineral water at Ba Ngoi and improvement of the fourth bathing beach should be focused.

Development of maritime economics should be based on advantages of the bay, especially concentrate on the system of sea-ports by upgrading the Ba Ngoi port. Besides, building harbours for fishery at Cam Lap, Binh Ba island and south of Bai Dai beach also should be paid attention.

Fisheries development based on exploitation of resources in the tidal flats and within the bay. It is recommended to implement the limited measures for fishing in the tidal areas at the North of Thuy Trieu lagoon, since these are the habitats and spawn-place of varied species. In addition it is recommended to promote offshore fisheries beyond the Cam Ranh bay to avoid the degradation of the resources inside the bay. Provide more investment for shrimp hatcheries and maintain the good environment conditions for these areas beside the development intensive shrimp farming areas at Cam Loc, Cam Hai Dong, Cam Thinh Dong.... The cage culture of shrimp

raising also should be developed at the Thuy Trieu lagoon with reasonable intensification and to ensure not exceed the environment capacity of the lagoon.

Building and strengthening constructions of navy including military port, Cam Ranh airport and corresponding services for ensuring security.

Economic zone, industrial zone and export processing zone should be built and developed together with development of urban zone. Industrial zone should be located in Ba Ngoi and Cam Thinh Dong, especially Ba Ngoi aqua-product processing factory for exporting and Cam Thinh Dong foodstuff processing factory for shrimp and fish also should be upgraded. Besides, the system of electric wires and drainage should be built and upgraded. Economic, industrial and urban zone should not plan to develop at sensitive wetland area such as the North of Thuy Trieu lagoon, mangrove forest.

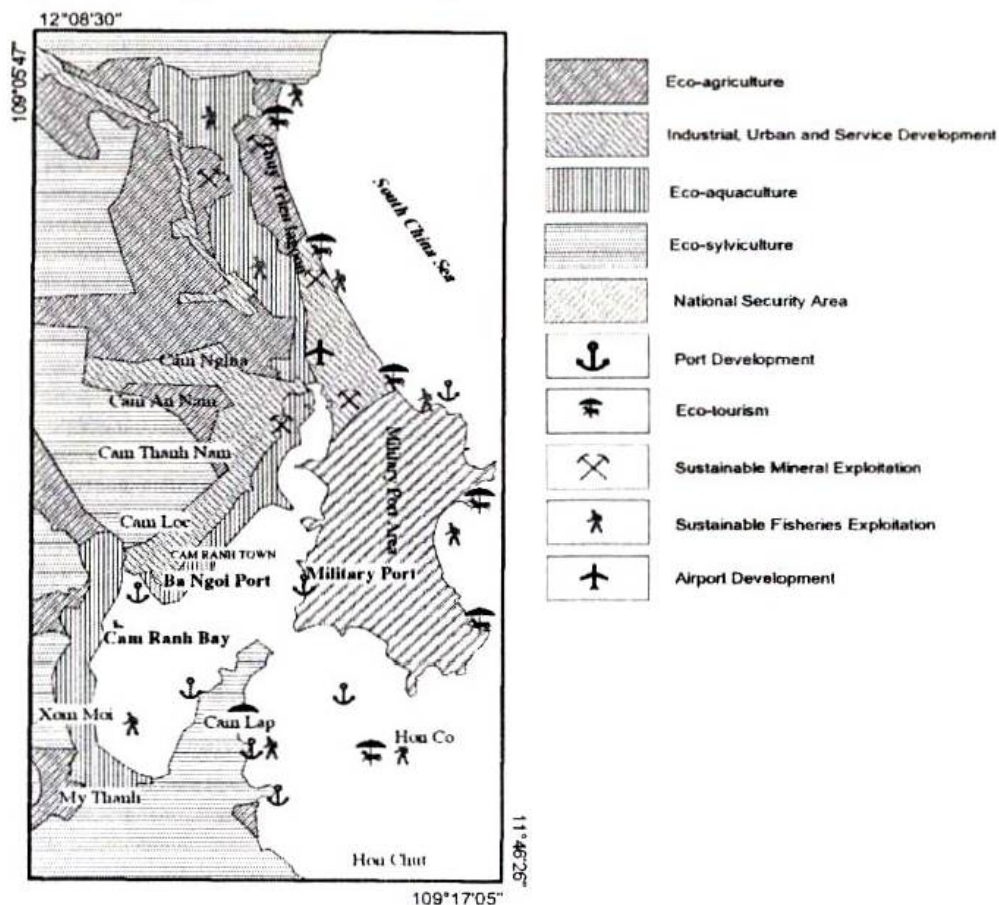


Fig. 1. Map showing the orientation in sustainable use of natural resources and environment at Cam Ranh bay.

About *minerals exploitation and processing*, besides continuing of glass sand exploitation at several mines including Cam Hai, Thuy Trieu, Cam Ranh, Cam Thuan glass factory also should be developed. However, survey, assessment and application of modern technology should be done in natural resources exploration. Protection of ecological environment, reducing of environmental pollution and landscape destruction must be carried out at the same time with exploration.

4.2. *Resources conservation and protection*

Conservation area of wetland landscape in the Cam Ranh Bay, conservation area for species in Thuy Trieu lagoon should be established.

Protection of sensitive ecosystems, including coral reef at Sop Island, Nhan Island, Co Trong Island, and Co Ngoai Island; sea grass at Thuy Trieu Lagoon; mangrove forest at the North of Thuy Trieu Lagoon and around the Cam Ranh Bay should be strengthen and restored.

Protection and development of fisheries resources in the Cam Ranh Bay should be conducted. The development of planning, program for exploitation of aquatic resources should be suitable to the development of sectorial planning according to modernization direction. Detail plan for protection of natural re-production areas of species, conservation of natural seed resources of aqua-products should be built. Addition and re-generation of marine seed resources by artificial methods including indigenous species related to traditional livelihood of local community should be promoted. Exploitation of aqua-product by destroyed fishing gears must be restricted. Fishing by low capacity vessels and fisheries exploitation in Thuy Trieu lagoon and the Cam Ranh Bay should also be limited.

4.3. *Environmental protection, disaster prevention*

Degradation of environmental at sensitive area such as Thuy Trieu lagoon should be prevented and reduced. Environmental work at pollution sites, industrial, economic, export processing zones and sea-ports especially in Cam Ranh town should be promoted by environmental sanction. Potential degradation of ecosystems because of rapid deposition in the North of the Cam Ranh bay by effective solutions such as cut off sources of sedimentary materials.

Constructions for coastal protection such as defending from erosion at Xuan Ninh and deposition at the North and South of the Cam Ranh Bay should be considered.

Monitoring system for environment and biodiversity at Thuy Trieu lagoon, south of the Cam Ranh Bay and the area around the Ba Ngoi port should be established.

Sewage collection systems from urban, industrial, economic and export processing zones such as the Cam Ranh town, Cam Think Dong and Ba Ngoi industrial zone should be built for processing.

Long-term solutions for global sea level rise at high potentially affected areas such as Bai Dai beach, aquaculture areas, My Thanh lowland area, the Cam Ranh peninsula also should be found.

5. Conclusions

The Cam Ranh Bay has diverse natural resources, including space, eleven wetland types, mineral mines, geotope and biological resources. Currently, natural resources and environment of the system are being extensively exploited and used for

socioeconomic development in unsustainable and degraded status.

The unsustainable development caused the pollution and degradation of water and sediment. Water was polluted by oil and potentially polluted by Pb, Hg, Mn and Sb. Sediment was polluted by As, Polychloro byphenyl, DDT and potentially polluted by Hg.

On the basis of characteristics of natural resources and environment, the orientation in sustainable use of natural resources and environment at Cam Ranh was proposed including tourism, marine transportation, aquaculture and fishery, security of national defence, industry and minerals exploitation. For a sustainable development, conservation of natural resources including establishing of nature conservation, protection of sensitive ecosystems and prevention of environmental pollution and disasters also should be step up.

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