CHAPTER 8

INTEGRATION OF RESULTS

A. Situation of Kung Krabaen Bay

Before the Present Study

Kung Krabaen Bay Royal Development Center was founded in 1981 by the initiation of the King to raise the standard living for the local residents by introducing marine shrimp farming to the area and for demonstrating study in sustainable use of nature concerning the conservation of environment. Shrimp farming had been installed to this area as a main activity for local villagers as an alternative profession besides other agricultural and the capture fisheries. It is evidence that shrimp diseases and low qualified seawater problems on shrimp culture causes minimal yield production of cultured shrimps and resulted farms abandonment. These occurrences were agreed with the deteriorated environment nearby shrimp farms. Unsuccessful shrimp farming in Kung Krabaen Bay area have been practically implied with the seawater irrigation system from the government from 1999.

The environmental degradation is the most important issue which needed a solution not only in Kung Krabaen Bay but also in many countries over Southeast Asia (Phillips, 1995). Large shrimp effluents discharged during pond cleaning created eutrophic condition to environment (Boonsong, 1997: Tookwinas, *et al.*, 1996). Although, shrimp culture areas in this area obviously small comparing to southern part of Thailand, the large amount of discharged effluents may affect the coastal environment, due to its small bay area or poor flushing. Phillips (1995) suggested that the discharge of nutrients from shrimp ponds may contribute to eutrophication, with increased primary productivity and possible to phytoplankton blooms. But there was yet no evidence that this had happened in Kung Krabaen Bay. Tookwinas, *et al.* (1996) reported an occurrence of plankton blooms in the drainage canals of Kung Krabaen Bay. Though the water qualities in Kung Krabaen Bay routinely monitored and revealed that the water quality of Kung Krabaen Bay was still in good condition for coastal aquaculture according to the Water Quality Control Division.

Phillips (1995) reported that the potential to degrade the environment was much less with the pond effluents during normal pond operation in comparison of shrimp pond effluents, domestic wastewater, and fish processing effluent. Although number of researches had invested in this bay on the water qualities and nutrient loadings (Tookwinas, et al., 1996; Boonsong, 1977; Songsangjinda, et all, 2000). The impact of organic loading on benthic communities in Thailand was rarely studied, especially for the Kung Krabaen Bay.

After the Present Study

The present study of chapter 3 reviewed the evolution of shrimp farming area around the Kung krabaen Bay by modifying into 3 periods of land development. The variation of initial landuse for shrimp culture activities was evidently affected by several factors while the invasion of shrimp diseases and low water quality for growing shrimp were the major factors (Boonsong, 1997; KKBRDSC, 2000). It was concluded that there was positive correlation between the number of shrimp ponds operated and the nutrients loading in drainage canals and the bay during the same period, in particular inorganic and organic nitrogen forms.

From chapter 4, the budget models of water, salt and nutrients were determined in 1994-2000 for wet and dry season dividing and grouped into before and after period of the seawater irrigation operation (in late May, 2000). It was found that during dry season the net source phosphorus and nitrogen both inorganic and organic forms appeared in the bay system and also showed as net source carbon in term of organic production in period before the seawater irrigation. Net source inorganic nitrogen appeared in period after the seawater irrigation

significantly lower than the period before the seawater irrigation system operated. In wet season, net sources phosphorus of both forms appeared in the bay system while net source carbon in term of organic production was as sink in the period after the period of the seawater irrigation system operation. Inorganic and organic nitrogen was transferred from the system in the period after the seawater irrigation operated. These findings revealed that there was a difference on nutrients circulation between wet and dry season in the periods before and after the irrigation system installation. It is also found that the retention time for water circulated in the system was rather short less than 1 day in dry season and about 2 days in wet season. These nutrients could be removed off the system within 1-2 days during one or two tidal cycles. In addition, the water volume of about 83-86% would be exchanged on daily basis (Sasaki and Inoue, 1985: Boonsong, 1997). Regarding the above expressions and annual reports in KKBRDSC (1998-2000), it was concluded that the Kung Krabaen Bay water was in good qualities for aquaculture. It is not clearly mentioned that the seawater irrigation was effectively served as the improvement of water quality in this area.

B. Benthic Community of Kung Krabaen Bay

Water quality situation of Kung Krabaen Bay was concerned with configurations of various factors. There are the hydrological characteristics, area of shrimp farming operation, quantity of nutrient sources input, strictly regulation on utilizing the settle pond, mangrove forests, seagrass beds, seawater irrigation system and enforcement. The change of any factors can impact the situation of water condition of the bay.

Chapter 5 presents the benthic environment factors conducted in annual year. Some limiting factors, organic content, dissolved oxygen, temperature, sediment, salinity, pH, hydrogen sulfide, were determined. Temperature and dissolved oxygen showed the temporal variations. Low dissolved oxygen appeared in the drainage canals while there was not indicated the deficient to critical anoxia or hypoxia. The stagnant water in the drainage canals, particular dredging man-made canals, might result the hypoxia or anoxia during the night time in the period of neap tide. Salinity changes were also observed. Salinity of 2 psu was recorded in rainy season in the drainage canals while high salinity was found in the bay. The high content of organic matter occurred in the drainage canals and at the mouth of canals and some stations (TE2) closed to fish cages. High content of hydrogen sulfide also appeared in high mud content often found in the drainage canals and some stations on seagrass beds, indicating of rotten roots and plant parts. Temporal change also occured in bottom sediment composition particular inside the bay which affected by turbulent wave action during rainy season or the southwest monsoon period. During this season, the fine particle, silt-clay, of entire bay was re-suspended and transported to coastline and canals, partly moved outside the bay. The bottom sediment in the drainage canals were less affected and still dominated of mud, except the natural canals in transect A and B dominated by coarser sediment.

The finding of organic content in the present study agrees with Sangrungruang (1997) that high organic content appeared in drainage canals and gradually low toward the bay. A gradient organic content showed relationships with the benthic communities and opportunistic polychaete species occurring in this study area as mentioned in chapter 6.

Chapter 6 reveals the results of the benthic communities and the polychaete assemblage structure relating to the environmental parameters. Polychaetes were dominant group in the benthic communities of Kung krabaen Bay. Determination of the polychaete assemblage structure shows that there was spatial distribution with low species diversity in the drainage canals while the higher diversity occured in the bay. Species diversity of polychaete was distinctly low in enriched organic sediment in the drainage canals. High diversity appeared in the bay and coastal area. The analysis of the polychaete assemblage using the cluster analysis reveals that there are two distinctively different polychaete assemblage boundaries, the drainage canals boundary and dominated by the opportunistic spionid *Prionospio (Minuspio) japonica* and the bay boundary with unclear dominant species of *Lumbrineris* sp.B, *Mediomastus* sp.A, *S. (Leodamus)* sp.A. It is coincided that the drainage boundary is a homogeneity association while the bay is heterogeneity association. This result is also reconfirmed with the species-abundane-biomass curves or SAB curves demonstrated by Pearson and Rosenberg (1978).

A further evaluation of organic enriched stage using the abundance-biomass curves (ABC curves) suggested by Warwick (1986) in comparison to 3 sites, namely, the drainage canals, the entire bay and coastal area during the two seasons. The result revealed that the entire bay was moderately enriched stage in dry season. However in wet season, the bay was in normal condition. It was concluded that Kung Krabaen Bay was still in good condition. The dominance of polychaetes in the benthic communities reflected the organic enrichment condition in the bottom sediment.

Chapter 7 focused on the taxonomic study on polychaete diversity of Kung Krabaen Bay. The study involves the identification with the description of each species and drawings. A total of 27 families and 78 species of polychaete in this area were described. The objective of this chapter was to provide the guide-manual in the polychaete identification for the further marine researches in Kung Krabaen Bay and its vicinity. Polychaete taxonomy is still limited in Thailand.

C. Suggestions

The present study illustrated the situation of Kung Krabaen Bay by relating landuse for shrimp culture area which affected coastal environment. It also showed the disturbances on the benthic community, particular the polychaetes. This study conducted during the decline of shrimp farming activity due to the outbreak of shrimp diseases and low water quality period. The situation of Kung Krabaen Bay in this present period was indicated as normal condition, except in dry season showing a moderately organic enriched condition. The trend in shrimp farming in this area might be increasing in the future due to the seawater irrigation system. Monitoring program will be important to assess the environmental impact. The results in this study showed that routinely monitoring on water quality in this area was not enough to evaluate the impact. Changes in benthic community should be added to the monitoring program in order to assess the real situation of the bay.

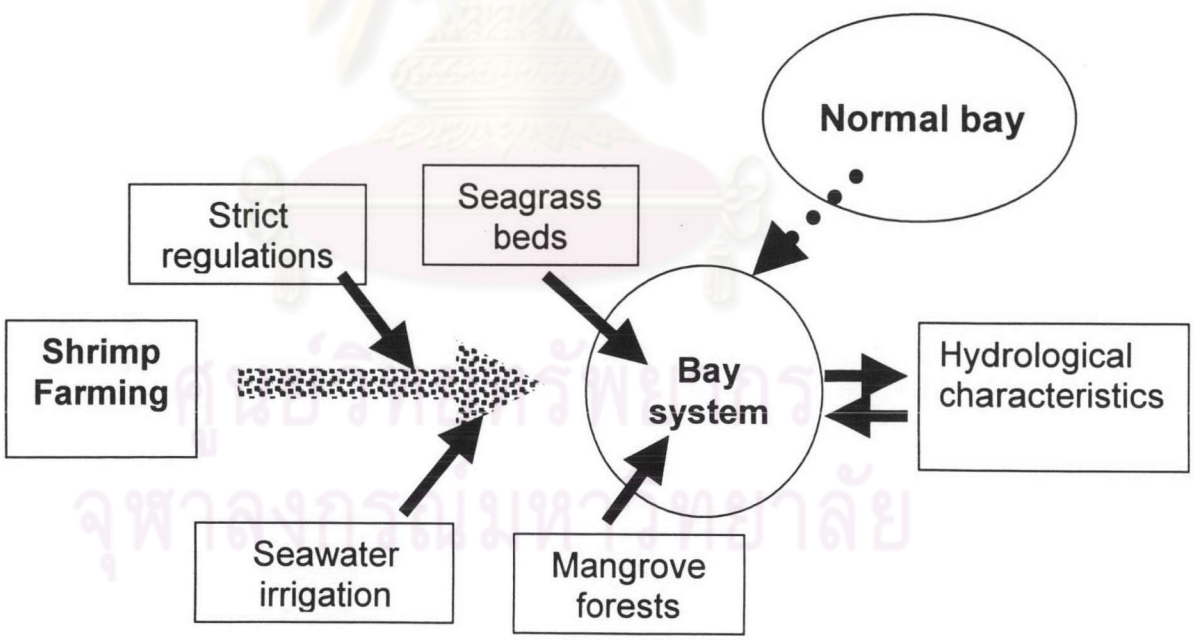

Figure 8.1 Factors determining the environmental condition in Kung Krabaen Bay

The present results reconfirmed that Kung Krabaen Bay's environment was in normal condition. The bay consisted of various natural habitats for example, the flourish mangrove forest

fringed along shoreline and sea-grass beds on the intertidal and subtidal flats. These habitats played the important roles of absorbents which help to lessen the nutrient inputs in this bay. Since 1999 the seawater irrigation system has already been installed and operated. This system transported the fresh seawater from offshore outside the bay directly to shrimp farming areas directly. The result of hydrographic study showed that the seawater irrigation system could reduce the effluents concentration circulated in the bay, particular the dissolved organic and inorganic nitrogen. The result also showed that the retention time of water exchanges were less than 1 day in dry season and 2 days in wet season. This indicated that the nutrients loaded could be transported to the coastal area in short period. The strict regulations in shrimp farm management provided by the KKBRDSC were still necessary. Large amount of waste water had to be treated in settling ponds before releasing into the environment. During this system can regulate the high organic waste by trapping these waste in the system.

The weakness of any factors may influence to change to the bay's environment while the number of shrimp ponds tends increasing near future. The findings of the present study were concluded in the declining period of shrimp farming development and also in the early period of seawater irrigation system installation. Lacking of strict enforcement of shrimp farm management such as the establishment of settling ponds prior the release of effluents, strict control of sedimentation and enforcement on the seawater irrigation system, the problems on environmental impacts would not be solved. Mangroves and seagrass beds inside the Kung Krabaen Bay acted as the nutrient absorbents. These would help lessen the organic enrichment problems. Changes in any of these factors would have pronounced impacts on the environmental conditions in this area.

D. Conclusions

1. Shrimp farming is the major activities contributing organic loading in Kung Krabaen Bay. This shows impacts on water quality. The level of eutrophication in the Kung Krabaen Bay system depended on the level of shrimp farm activities.

2. Water and salt budget models show the short water retention time in Kung Krabaen Bay related to low concentration of nutrients accumulated in the system.

3. The period before the seawater irrigation installation Kung Krabaen Bay was autotrophic especially in dry season. Dissolved inorganic phosphorus (DIP) was in the biological processes and recycled; Nitrogen was in the biological processes (denitrification). After the irrigation system installation, Kung Krabaen Bay is net heterotrophic in both seasons.

4. The result from budget models indicates that the seawater irrigation may enhance the improvement by decreasing nitrogen concentrations in particular dissolved organic nitrogen when compared to the period before the installation of seawater irrigation.

5. A total of 27 families and 78 species of benthic polychaete are recorded in Kung Krabaen Bay.The gradients in organic content showed relationship with the polychaetes assemblage and opportunistic polychaete species.

6. There were two distinctive polychaetes assemblages found in Kung Krabaen Bay.Two different benthic communities were found in Kung Krabaen Bay

6.1 The first group was the benthic community associated with high organic content consisted of *Prionospio (Minuspio) japonica, Mediomastus* sp.A and *Glycinde* sp.A as the major species. They were common in mud and very fine sediment in the drainage canals and the mouth of canals.

6.2 The second group consisted of *Lumbrineris* sp.B, *Mediomastus* sp.A and *Sigambra* cf. *tentaculata*, and associated with low organic content sediment in the bay. They were common in mud and very fine sediment in the bay.

7. A spionid polychaete, *Prionospio (Minuspio) japonica*, performs an indicator polychaete for moderated organic polluted in the drainage canal and shoreline boundary.

8. The bay was in normal condition except in dry season showing a moderately oganic enriched condition. The dominance of polychaetes in the benthic communities reflected the organic benthic enrichment condition in bottom sediment. Thus it is necessary to monitor the changes in benthic communities as well as the water quality to assess the real situation of the bay.