

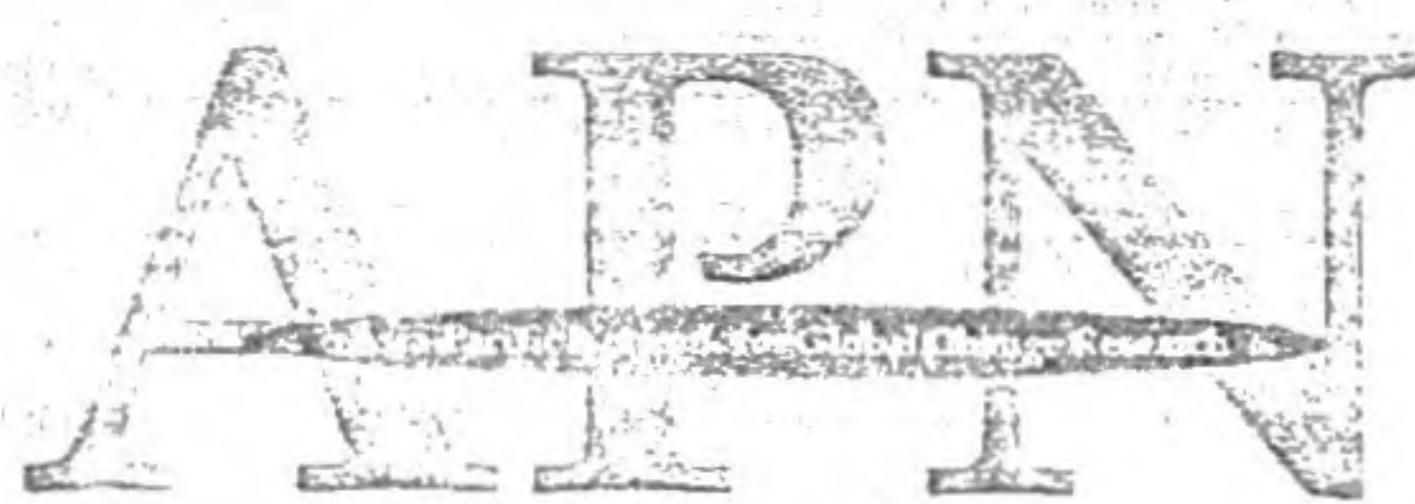
SOUTH ASIA REGIONAL WORKSHOP ON

ASSESSMENT OF MATERIAL FLUXES TO  
THE COASTAL ZONE IN SOUTH ASIA  
AND THEIR IMPACTS

A JOINT APN/SASCOM/LOICZ WORKSHOP  
08-11 December, 2002, Negombo, Sri Lanka



Sri Lanka National Committee of IGBP  
Sri Lanka Association for the Advancement of Science  
120/10, Vidya Mawatha, Colombo 07, Sri Lanka





## Recent trends in environmental degradation in the coastal areas developed for shrimp culture

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### Abstract

Shrimp industry in Sri Lanka developed rapidly during the last decade resulting in rapid degradation of the coastal environment in the North Western province. The land allocation for shrimp culture was less than 500ha in 1985 and increased to over 4000ha by 2000.

Reduction of environmentally sensitive areas has caused a reduction in Biodiversity. The mangrove cover has reduced by 41% due to shrimp culture activities. Migratory bird populations visiting the Mundel area have reduced by 48%. The species diversity in the lagoon fishery has reduced from 19 species in 1991 with catches dominated by *Nematolosa nasus* to 14 species in 2000 with catches dominated by *Arius* species. The only shrimp species caught in the Mundel lagoon is *Peneaus monodon* in small numbers while there was a good fishery for *Peneaus indicus* and *Peneaus semisulcatus* in the past.

The Mundel lagoon area has been reduced by 9%. Construction of dykes obstructing natural water drainage has increased the incidence of floods in the area. The water quality deterioration caused by direct discharge of effluents to the surrounding water bodies, has resulted in elevation of BOD levels, Nitrite, Ammonia and sulphide levels as well as the water pH and Suspended solid concentrations.

Populations of several pathogenic viral and bacterial species in the coastal area have increased even threatening the wild crustaceans in the natural environment. Use of probiotics to treat water as well as use of chlorine and lime without any technical guidance has resulted in further aggravating the problems.

Importance of introducing a monitoring system and educating farmers and their technical consultants could help in enhancing production with lesser impacts on the environment.

*Keywords: coastal environment, shrimp, aquaculture, water quality*

### Introduction

Shrimp farming industry expanded rapidly in the north western province during the past decade. Most of the farms are located in the North western province and is distributed along a narrow coastal belt extending about 120Km. (Fig1) The land developed for shrimp culture were mainly intertidal virgin areas while some of the agricultural lands were also converted for shrimp culture.

Conversion of lands for shrimp culture caused several environmental impacts in the region. No assessments of the expected impacts were carried out prior to development at the early stages of the industry. The impacts caused included severe siltation of water ways, reduction of biodiversity and loading of nutrients and toxic waste products to the surrounding water bodies degrading the water quality.



The paper investigates the recent trends in the environmental degradation in the coastal areas developed for shrimp culture with special attention on water quality degradation and impacts on bio-diversity.

### Methodology

Information was collected from farmers and government departments on land allocation, land use change, present regulations, and present management practices. Water quality data was collected from the many studies done in this region within the past 15 years carried out by the same team under different research projects.

### Results

Conversion of environmentally sensitive areas for shrimp culture included mangroves, salt marshes, agricultural land shrubland and mudflats bordering lagoons and estuaries. (Fig2) The farm development showed a rapid increase during the period from 1991 to 1996 and the most vulnerable areas were Arachchikattuwa Divisional secretariat, Mundel Divisional secretariat and the Wanathawilluwa Divisional secretariat.(fig 3)

The bio diversity reduction thus effected is clearly shown in the Mundel and Mi Oya estuarine areas where the mangrove species, bird populations specially the migratory species and the fish populations decreased after the expansion of shrimp industry.(fig4) The Mundel lagoon fishery have been adversely affected due to the discharge of farm effluents containing high loads of dissolved and suspended materials as well as lack of opportunity for recruitment due to closing of lagoon mouths. Destruction of nursery areas caused by shrimp culture activities have aggravated the situation. However the species diversity has changed within the last decade and it is noted that no shrimp species except for *Penaeus monodon* are recorded during recent times in this area and that again is mostly during floods or during disease situations in farms.

A survey carried out in 1996 showed a 9% area reduction in the Mundel Lake while the water volume had been reduced by 4%. The total area of the lake as at 1996 was.... The depth reduction had affected mainly areas less than 1m in depth. Mundel region has experienced severe floods during the recent past and within the year 1995 this area was affected by floods twice. Development of sensitive areas such as lagoon mud flats and mangrove buffer zones are common in this area.

The water quality degradation caused by the shrimp culture activities include elevated BOD levels, nutrient levels and toxic metabolite levels specially ammonia and sulphide levels to which are elevated to higher than normally acceptable levels for aquatic life. (table 1) The release of more toxic materials during farm reclamation activities includes high levels of aluminium, manganese and ferric compounds. The suspended particle concentrations washed out during the reclamation activities are over .... The use of lime and chlorine to treat water during culture practices vary between farms and have a direct effect on the water pH as well as micro organisms (fig5).

The water movement and tidal exchange are minimal in this Dutch canal Mundel lake system with a very high residence time. During dry seasons the residence time was as high as 160 days. There are no sea openings in this area and the system is connected to the Puttalam estuary and opens out at the estuary mouth north of Puttalam.



The use of probiotics in high concentrations during recent times also has created many problems. Most commercially available probiotics have not been tested for their activity in Sri Lankan conditions. The application practices for these also vary from farm to farm and no definite guidelines are followed (fig). Finally the water exchange practices which also vary between farms affect the Mundel Puttalam estuarine system as it loads the effluents in to the same system which acts as the water source for shrimp culture.(fig)

Pathogen populations released to the environment through discharge of contaminated pond water with infected shrimp has resulted in introducing the viral diseases to the wild populations. (fig. )

### **Discussion**

Shrimp culture industry originated in the early 1990's during a period when government patronage for aquaculture activities had been withdrawn. Shrimp aquaculture therefore was introduced to Sri Lanka by the private sector entrepreneurs. Large scale (>50ha) or medium scale (10 - 50 ha) farms were set up on government lands obtained on lease or on private lands. No special regulations were formulated to mitigate the environmental impacts or even to study the environmental impacts. The lands converted for this purpose were mostly intertidal areas and consisted of mainly mangroves. Since the North -western coastal areas contained large uninhabited areas of mangroves and salt marshes and few development activities had taken place, this area was considered ideal for location of shrimp farms which showed good prospects for the development of the area.

However as the profits gained through shrimp culture were exceptional during the early years, this induced more entrepreneurs to venture into this new industry. Some village folk employed labor jobs in large farms also were enticed to try their luck in this industry in the hope of getting good profits which they may never get in any other traditional industry. The rapid development thus occurred had no concern for the environment and the environment quality degradation was inevitable as the number of farms increased.

Disputes over land use as well as effluent discharge and rights to the water bodies formally used for traditional industries (ie. Fishing and coir production) created an outcry against shrimp culture, while environmentalists supported the villagers in this cause, with the hope of halting the damage caused to the coastal environment. This created a situation where the government had to intervene not only by providing a license or just granting approval for an application for shrimp culture, but by bringing in regulations to mitigate the environmental impacts and conflicts. However since no monitoring was carried out these regulations were limited to the books and the Initial environmental examination (IEE) reports or environmental impact assessment (EIA) reports often did not provide the expected outcome. With political power or financial power many farms were constructed overnight without any approvals and with no concern for the environment. Mangroves, salt marshes, mud flats or even areas of the lagoons exposed during dry seasons were converted into shrimp culture ponds overnight. As more people got involved in the industry agricultural lands including paddy and coconut lands were also vulnerable. Rapid development continued until 1996 till the white spot disease brought disastrous results to the industry. Since then the industry has been struggling with disease and using different remedial measures, some causing further damage to the environment, however with little results.



The bio-diversity reduction thus affected was clearly visible from the migration bird populations that visited the Mundel area. A 48% reduction was observed in 1998-1999 compared to that of the period 1992-1993. The mangrove coverage had been reduced by 41% in the areas between Chilaw lake and the Puttalam estuary. Although the reduction of bird populations have no effect on the human population, the reduction of mangroves did affect them directly and indirectly, as mangroves were used for fishery activities as well as firewood and as breeding and nursery grounds for commercially important fish species. The reduction of fish populations affected the lagoon fishing community directly and the adverse effects of water quality degradation resulted in mass fish kills as well as some human health problems. The shrimp species diversity in the estuarine system has caused a reduction in profits from fishery industry as shrimp were the high value species caught by lagoon fishermen. The commonest high value species found presently is *Penaeus monodon* and that again is during floods or disease periods as shrimps are released from farms.

Construction of farms in lagoon mud flats as well as water retention areas have increased the incidence of floods in the area, and the problem is further aggravated by construction of dykes obstructing free passage of water. Salination of drinking water and siltation caused by shrimp farming activities, conflicts on traditional industries like coir and fishery, floods with damage to property and health problems all have created the situation for villagers to protest against shrimp culture.

The water quality degradation including elevation of pH levels, ammonia and nitrite levels and sulphide levels have caused further problems to the coastal Bio-diversity. The loads of suspended particles which cause siltation in lagoons have affected the benthic populations as well as seagrass beds further reducing the feeding and nursery grounds for aquatic larval forms. High levels of ammonia with elevated pH levels have created toxic conditions to many organisms while species adapted for polluted waters have invaded the system. Use of lime for water treatment irrespective of the prevailing water pH has caused problems not only to the estuarine species after water is released but has also affected the cultured shrimp from time to time. Use of chlorine to treat incoming water in the hope of disease eradication has not served its purpose since most farms treated with chlorine has been affected by disease. However use of chlorine also has no guide lines and each farmer uses a different quantity which has only resulted in adding more chlorine to the environment. High use of chlorine has inhibited algal growth in ponds as well as in the estuarine system. Mass fish kills have been attributed to various chemicals released from shrimp farms including tea seed cake which is used for killing fish in shrimp ponds. Use of chemicals to eradicate crabs from farming areas also have become a common practice in recent times as crabs are considered carriers of the dreaded white spot disease in shrimps.

Water discharge from farms vary between farms and the usual practice was to discharge daily. However with disease problems and unavailability of good quality water for shrimp culture, water exchange has reduced in recent times and use of probiotics in the hope of maintaining water quality is becoming popular. However no instructions are followed on the use and this again is carried out as the farmer thinks is necessary. Therefore the amount of bacterial cultures added may not be sufficient or could be too much. In the same way the time interval between additions depends on the farmer and that again may not be appropriate for water quality maintenance. However it has been found that the water from ponds with probiotics have little or no difference from the quality of water from ponds without probiotic use. Water exchange after using probiotics also depend on the farmer or his technical adviser who may or may not be a qualified person for this purpose, and therefore some farmers

release water immediately after using the probiotics. This has only resulted in adding more materials to the surrounding water bodies. Release of probiotics could have harmful effects as well since some bacterial cultures commercially available does not seem to have any effect on water quality , which creates suspicion whether they actually contain any bacterial culture or whether it is just the base material only. Therefore releasing probiotics not only releases a live component but also other base materials used to store these bacteria.

From the studies carried out through the past decade it is obvious that most of the environmental damage caused by shrimp culture could have been prevented. However for this purpose educating the farmers as well as law enforcement personnel is necessary together with regulations to protect the environment and a monitoring system to make sure that the regulations are carried out and not limited to paper.



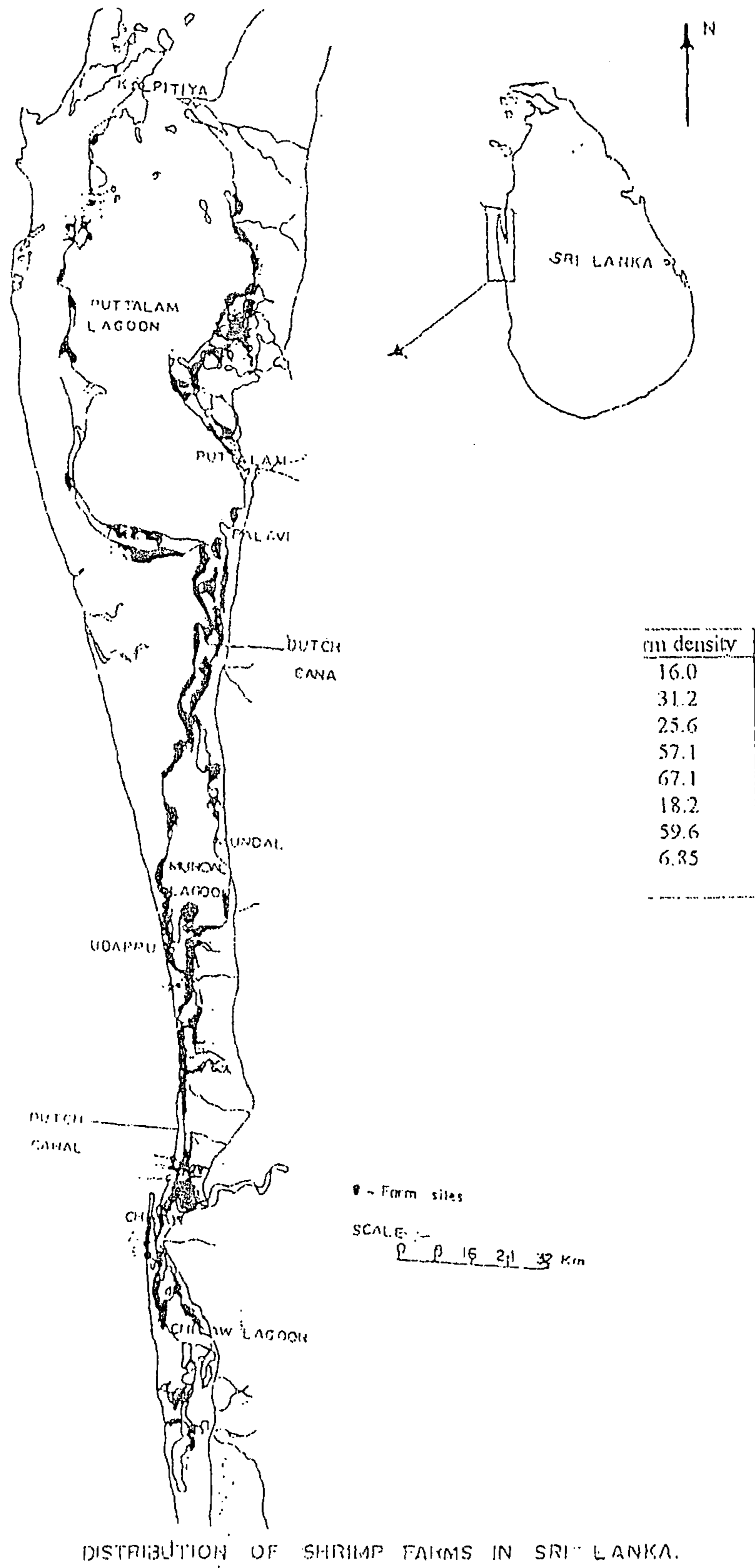


Fig. 1

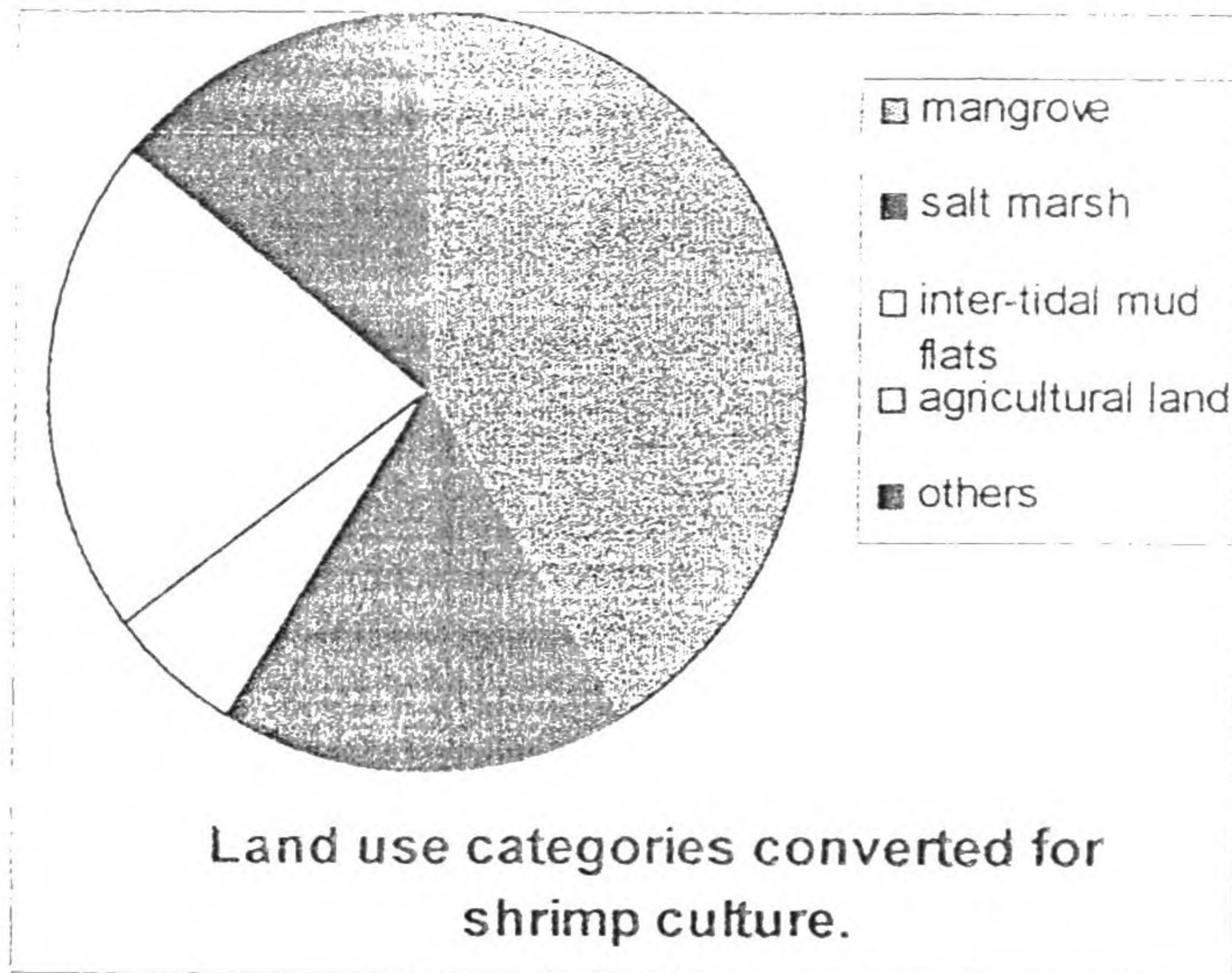


Fig. 2 Land use converted for shrimp aquaculture