

# INDIAN CARTOGRAPHER



**Volume 28, 2008**

**Collaborative Mapping  
& Space Technology**



**XXVIII INCA International Congress  
Gandhinagar, Gujarat, November 4-6, 2008  
Journal of the Indian National  
Cartographic Association**

## Embedding GIS Application into Geo-spatial Mapping of Shrimp Farming in Coastal States of India

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### ABSTRACT

In the age of information and technological advancements, location-awareness is becoming a key feature in management of natural resources. Geospatial mapping is a location based study and is a part of intelligence GIS which is expected to be a useful tool for fisheries scientists, aquatic resource managers and policy planners in developing countries. Intensive shrimp farming has developed rapidly in response to the ever increasing seafood demand coupled with depleting catch and landings from the capture fisheries sector. It has become a lucrative business in many of the developing countries including India. In this paper, an attempt has been made to map the extent, potential and prospects of shrimp farming by using modern GIS tools. The data on the coastal state of India was brought in tabular form through Microsoft Access and then joined to Map Info Professional version 9.5 GIS software with the digitized Map of India to enable mapping. This was further synchronized and integrated to generate five thematic maps searchable on several criteria. Map 1 contains the searchable criteria as regards to the shrimp fish farming for the years 1996-2004 with two components. Map 2 contains status of shrimp and scampi fish farming with three components. Map 3 contains shrimp farming production and culture area for the year 2003-04 with three components. Map 4 contains status of brackish water and its production with two components. Map 5 contains infrastructure facilities for shrimp farming in India.. This type of spatial analysis will provide managers and policy makers with the tools to evaluate the relative importance of various aquatic resources and to prioritize areas that need to be conserved as well as to implement development plans in eco-friendly sustainable manner.

### Introduction :

India is endowed with a long coastline of 8118 km covering ten coastal states and four union territories viz; West Bengal, Orissa, Andhra Pradesh, Tamil Nadu, Pondicherry,

Kerala, Karnataka, Goa, Maharashtra and Gujarat. It has a wide variety of natural coastal ecosystems like eastern coast topography is low-laying with lagoons, marshes, beaches and deltas, while western coast is dominated by rocky shores. The Islands of Lakshadweep are composed of atolls, while Andaman and Nicobar Islands are volcanic in origin, arising from a submerged mountain chain. These coastal areas are productive and rich in natural resources and support significant proportion of India's populations. There are 14 major river systems in the country which leads to the formation of wide network of creeks and estuaries in coastal areas and thus facilitating coastal aquaculture. The Ministry of Environment and Forests, Government of India, estimated that, India has a total estuarine area of 3.9 million ha and backwaters of 3.5 million ha. Mangroves contribute about 0.4 million ha area. The estimated brackish water area suitable for undertaking shrimp cultivation in India is around 1.2 m ha spread over 10 states and union territories. Of this only around 1.2 lakhs ha. are under shrimp farming now and hence lot of scope exists for entrepreneurs to venture into this field of activity. It is commonly said that after Green and White Revolution in India, it is time for Blue Revolution to exploit the huge potential in fisheries sector. Shrimps are called the "Pinkish Gold" of the sea because of its universal appeal, unique taste, high unit value and increasing demand in the world market.

Shrimp culture, which started a century ago as a traditional practice in the form of trapping, holding and harvesting, has undergone a revolutionary changes in the past two decades. It has become a luxury food items and has created a sensation in the world sea food with share of 20% (\$11 billion) of it. This industry has set an example to open up a huge hidden potential of aquaculture as a giant food producing center providing gainful rural employment to millions and revolutionizing rural economy along the coastal zones.

In India, shrimp earns nearly 67 percent of the total value of marine product exports for the (Rs.6, 881.31 crores) during 2002-2003. Out of total aquaculture production of 2.2 million tones at present, brackish water shrimp production contributes about 5%. Modern and scientific method of shrimp farming had shown phenomenal growth since early nineties and presents about 1, 50,000 ha area under shrimp farming which is about 15% of the total potential brackish water area available in the country.

Geospatial mapping is a location based study and is a part of intelligence GIS which is expected to be a useful tool for fisheries scientists, aquatic resource managers and policy planners in developing countries. It is being increasingly used as a decision support system for management of fisheries and aquaculture. In this context, present study reveals information based on the secondary data of coastal state of India.

**Material and Methodology of the Study :**

Geospatial mapping of coastal states data is performed through GIS technology having critical geographic dimensions on potential and prospects of shrimp farming in India. Each aspect of the map has a different component involved. For this purpose, state wise secondary data had been collected from 'Handbook of Fisheries Statistics, 2004' Govt. of India, over the period 1994- 2004 and brought in tabular form through Microsoft Excel by allotting a LC number to each state. This data have been used for GIS-analysis and preparation of different thematic maps for shrimp farming area and its production over the different states. For analysis and preparation of various thematic maps of shrimp farming in coastal states, MapInfo Professional Version 8.0 GIS software was used. Firstly, digitization of geo-registered India's map was done and each state ID number was allotted a LC number. After this, the excel sheet was joined to India's digitized map in Map Info Profession. After joining of the excel sheet, geocoding process is adopted. In geocoding, all the state ID and digitized maps are matched to state wise excel location code. This was further synchronized and integrated to generate five thematic maps by adopting customized layering system in the GIS-Software Map Info Professional Version 8.0 searchable on several criteria.

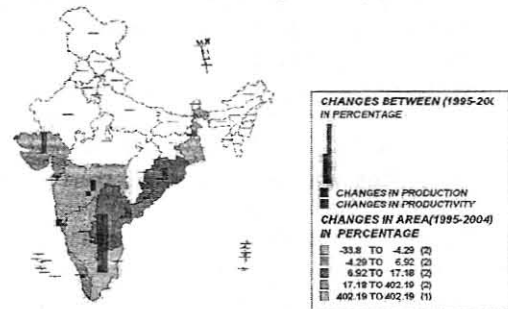
Accordingly, map 1 contains the searchable criteria of pattern of Shrimp / Prawn Farming in Coastal States of India during the year

1995-2004. Map 2 contains Shrimp and Scampi Farming in Coastal States of India. Map 3 contains Shrimp Farming Production and Culture area for the year (2003-04). Map 4 contains Status of Brackish water and it's Production. Map 5 contains information on Fishing Crafts in coastal states of India These mapping provide managers and policy makers with the tools to evaluate the relative importance of various aquatic resources and to prioritize areas that need to be conserved as well as to implement development plans in eco-friendly sustainable manner.

**Results and Discussions:**

**Map1** : Series pattern of Shrimp / Prawn Farming in Coastal States of India during the year 1995-2004.

MAP1: CHANGES PATTERN OF SHRIMP/PRAWN FARMING IN COASTAL STATES OF INDIA (1995-2004)



Map1 represents percentage of shrimp/prawn production over the period 1995-2004 comprising of three components viz; (i) Changes in production, (ii) Changes in culture area and (iii) Changes of productivity.

Geospatial mapping of coastal states reveals that some of the coastal states had procured better technology for production, their production rate had enhanced every year. Whereas states like Kerala and Karnataka, shrimp production had decreased over the years due to the non adaptation of suitable technology. Coastal state, Tamilnadu was the first ranker holder in production touching the highest figure 437.64% followed by Gujarat state holding the second rank with production rate 163.99%. Maharashtra's production rate was 87.57% and comes at third rank. This was followed by Orissa (82.07%) and Andhra Pradesh (73.74%) occupying fourth and fifth positions as per their production rate. West Bengal shrimp production rate was 48.95% followed by Goa with production rate 20.69%.

The second component of this map represents changes in areas for shrimp farming, i.e., brackish water area during 1995-2004. Decreases in the areas are shown in

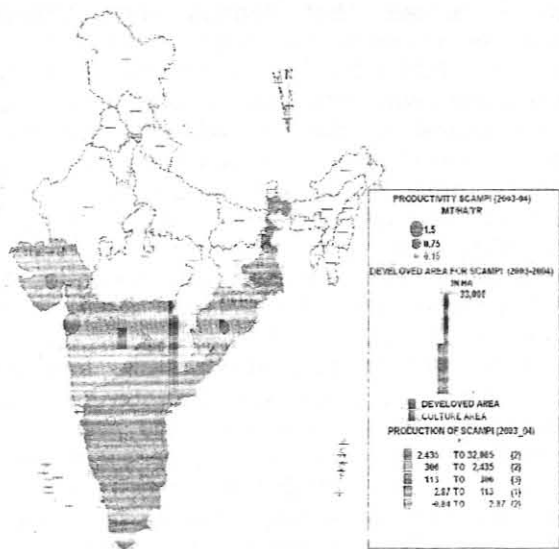


Maharashtra with 33.80%, Karnataka with 11.86% and Kerala with 4.29%. Stagnation of fresh water aquifers was the main cause of decrease in brackish water areas of coastal states of Maharashtra and Kerala. In Karnataka state, seepage from shrimp farms is a site-specific problem which can be taken care of by providing mandatory buffer zones between farms and fresh water sources. Coastal state like Tamilnadu had shown tremendous increases in brackish water area with 402.19% followed by Goa with 48.15% and West Bengal with 17.18%. Coastal state Andhra Pradesh which leads in fish production had also shown an increase of area with 1.58%.

As far as third component of productivity is concern, Maharashtra and Gujarat are leading states showing high productivity rate with 183.34% and 159.82% respectively. This was followed by Orissa and Andhra Pradesh comprising 70.29% and 50.31% respectively. Mapping of this component represents negative productivity in Kerala with 17.92% and Goa with 18.54%. Productivity rate is very high in coastal state Maharashtra and Gujarat because of high demand and export from Mumbai and Gujarat ports.

**Map 2 : Shrimp and Scampi Farming in Coastal States of India**

MAP 2 : SCAMPI AND SHRIMP FARMING IN COASTAL STATES OF INDIA (2003\_04)



Map 2 is Geo-spatial thematic map comprising of three components viz., (i) Developed and culture areas are shown by bar diagram in the map, (ii) Production in metric tonnes are shown by different colours and (iii) Productivity rate in coastal states of India.

Map 2 reveals that Andhra Pradesh is the leading coastal state in shrimp and scampi farming in India. In the year 2003-04, Andhra Pradesh contains 96,924 ha area out of total culture area 111,360 ha producing about 85,209 metric tonnes of shrimp. The second rank is the Kerala which is containing 14915 ha out of 19209 ha. The total production in 2003-04 from Kerala is 6,699 metric tonnes. Orissa has got third place in area and production. Here area is 12586 ha out of 15880 ha and total production is 12,810 metric tonnes.

According to the map 2, Andhra Pradesh has maximum developed and cultured area among all the coastal states. Developed area is around 79.27 thousand ha, out of which 53.17 thousand ha used for Shrimp and Scampi culture. Second position is taken by Maharashtra state by holding 7,000 ha developed area and 6,980 ha as culture area. Third position is taken by West Bengal state occupying 4,530 ha developed area and 4,450 ha as culture area.

In Map 2, second component gives information about scampi production (2003-04). According to the map, Andhra Pradesh and West Bengal occupies first position in scampi production whereas Maharashtra occupies second and Orissa occupies third position in scampi production. Coastal states like Tamilnadu, Karnataka and Kerala begged fourth position in scampi production. Gujarat is the only coastal state where scampi production is less as compared to other fish production.

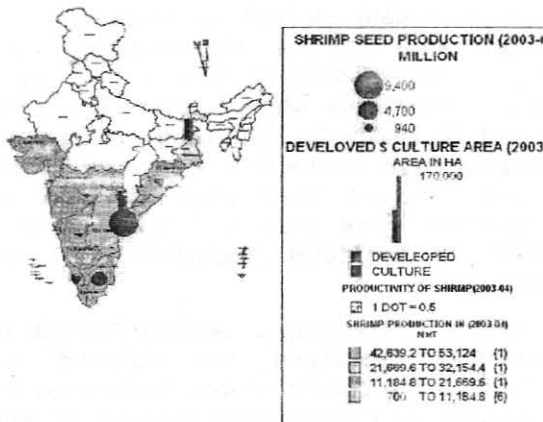
For the third component of productivity rate in the coastal states, scenario was entirely different. Tamilnadu state was having maximum productivity rate (1.84%) followed by Orissa with productivity rate (1.02%) and Andhra Pradesh with productivity rate (0.88). Goa, Gujarat and Karnataka states were having only 0.73%, 0.66% and 0.59% productivity rate in the year 2003-04. Higher shrimp and scampi productivity rate in Tamilnadu and Orissa shows that fish farmers in these states were taking lot of interest in prawn fish farming.

**Map 3 : Shrimp Farming Production and Culture area for the year (2003-04)**

Map 3 also contains three components viz., (i) Area developed for farming and culture area, (ii) Production and (iii) Shrimp seed production.



MAP 3: SHRIMP FARMING COASTAL STATES OF INDIA (2003-04)



According to Geo-spatial map 3, Andhra Pradesh was the leading coastal state in the year 2003-04 for developed and cultured area. Here total developed area was about 79, 270 ha and out of it 69, 630 ha area was used as culture area. West Bengal holds second rank for the developed and cultured area with the figure 50, 405 ha and 49, 925 ha respectively. This state is followed by Kerala with developed area 16, 329 ha and culture area 14, 029 ha. Likewise, coastal states Orissa, Tamilnadu and Kerala were followed by these.

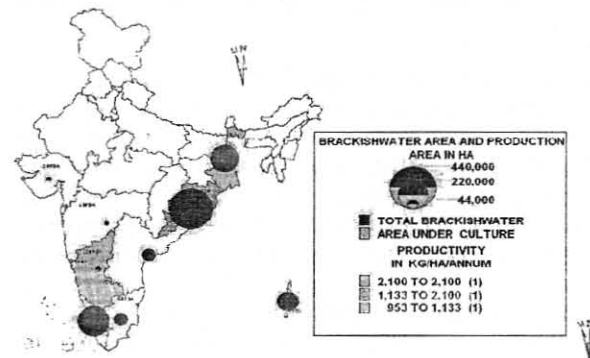
Second component of Map 3 is shrimp production for the year (2003-2004). Map 3 reveals that in the year 2003-04, Andhra Pradesh tops in shrimp production with figure 53, 124 metric tones. West Bengal comes next with total shrimp production 29714 metric tones and was followed by Orissa state with production 12, 390 metric tones. Tamilnadu with production 6, 461 metric tones and Kerala with production 6, 070 metric tones were on much lower side as far as production was concern. During late eighties, shrimp culture and its production in India were totally dependent on the wild seed whereas in nineties, planned hatcheries were set up in coastal states and wild seed collections were reduced. Later, trades on natural seeds were also banned to avoid destruction of natural resources. Further due to viral disease menace, farmers were advised to have disease free hatchery and produced seed. Exploitation of natural seeds was highest in West Bengal. Orissa and Andhra Pradesh during course of collection of cultivable shrimp seed and large number of other shrimp and fish seeds were caught and destroyed, which cause a serious concern.

For productivity of shrimp in the year 2003-04, the scenario was entirely different.

Tamilnadu was the state having highest productivity 1.89%. Maharashtra was second state with productivity 1.60%. Gujarat was the third state with productivity 1.49%. Orissa, Andhra Pradesh and West Bengal were followed by these states, where productivity was only 1.02%, 0.76% and 0.60% respectively. Overall productivity rate for all coastal states was achieved 0.73%.

Map 4 : Status of Brackish water and its Production

MAP 4: BRAKISHWATER AREA AND PRODUCTION COSTAL STATES OF INDIA



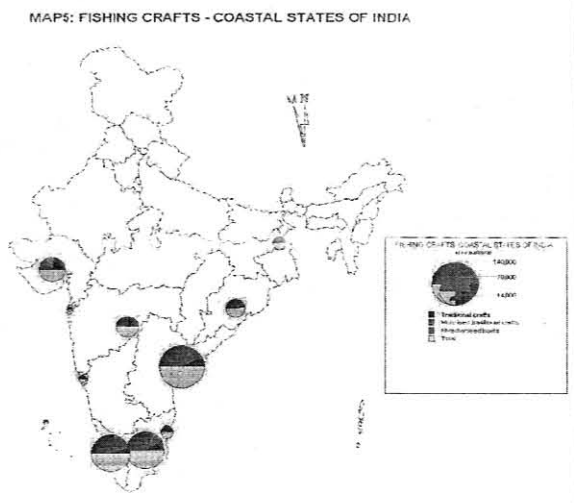
This map represents three major components viz,, (i) Total brackish water area, (ii) Area brought under culture through BFDA's (ha) and (iii) Productivity (kg/ha/annum).

Map 4 reveals that coastal state Orissa possessed maximum brackish water area of about 4, 30,000 ha but availability of under culture area was very less i.e. only 3, 041 ha as compared to this. Productivity for this brackish water area in this state is only 1,133 ka/ha/annum. Kerala got second maximum brackish water area of about 2, 40,000 ha but availability of under culture area is only 3,162 ha by BFDA. Third position was occupied by West Bengal state by holding approx. 2, 10,000 ha brackish water area and out of these 6, 092 ha is under culture and its productivity rate is 953 kg/ha/annum. This is followed by Andaman and Nicobar occupying 1, 20,000 ha brackish water area but figures for culture and productivity rate is not available. Coastal states Gujarat, Tamilnadu and Maharashtra occupies 1, 00,000 ha, 60,000 ha and 10,000 ha as brackish water area.

Brackish water area for India as a whole was 12, 40,000 ha and available culture area was 22, 627 ha and its productivity rate was found to be 6, 686 kg/ha/annum. This map also implicit number of Brackish water Fish Farmers Development Agency (BFDA's). Coastal state Orissa contains 7, Kerala

contains 7, Andhra Pradesh contains 6, Tamilnadu contains 5, Maharashtra contains 4, Goa and Andaman & Nicobar Islands contains 1 BFDA's. According to Hand book on Fisheries Statistics, 2004. Govt. of India, total number of BFDAs in India was 39.

**Map 5:** Fishing Crafts ± Coastal States of India



Map 5 reveals information about four components in one legend. That is (i) Total, (ii) Traditional crafts, (iii) Motorized traditional crafts and (iv) Mechanized boats.

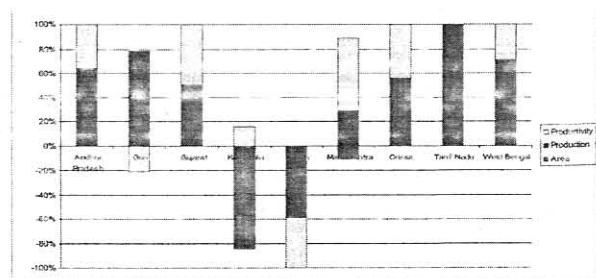
According to this map, Andhra Pradesh was found to be the leading state for occupying fishing crafts. Tamilnadu comes at the second position and Kerala holds third position, where fishing crafts are more as compared to other coastal states. Other coastal state Gujarat, Karnataka and Maharashtra were followed by these.

Andhra Pradesh	-66659	-	I
Tamilnadu	-52433	-	II
Kerala	-50024	-	III
Gujarat	-25985	-	IV
Karnataka	-25610	-	V
Maharashtra	-19441	-	VI

All the leading coastal states they have maximum number of traditional boats but Andhra Pradesh have maximum number of Mechanized boats as compared to other leading coastal states. Total boat in Andhra Pradesh are about 66, 659 and out of this only 8, 642 are the mechanized and 4, 164 are motorized traditional and rest 53, 853 are traditional boats. Likewise Tamilnadu had

more number of mechanized boats (9896) as compared to Andhra Pradesh (8642). In Gujarat State, number boat are about 25, 985 and out of these there are only 11, 372 mechanized boats in coastal states of India.

**Conclusion :**



The pattern of shrimp / prawn farming in coastal states in India is highly variables during the period 1995-2004 but recent trends indicate that potentially developed area has converted to culture area. Data indicates that Andhra Pradesh and West Bengal are leading coastal state for developed and culture area as well as shrimp / prawn production. For fishing crafts, Gujarat had got the recognition of advance coastal state where mechanized boats are more as compared to traditional boats. Increased shrimp farming have created some negative impacts also due to improper resource use and uncontrolled development of the sector but it can be rectified by proper planning and adequate control by the coastal states. Thus present study Geo spatial mapping will be a very useful tool for state fisheries department, central fisheries department, researchers, fish traders as well as fishermen.

**Acknowledgement**

The authors are grateful to Director, Central Institute of Fisheries Education, Mumbai for providing necessary facilities and encouragement to carry out this work. The authors express their thanks to Mrs. S. S. Gajbhiye for her technical support for preparation of manuscript

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