

GEOSPATIAL TECHNOLOGIES FOR IDENTIFICATION OF POTENTIAL AQUACULTURE AREAS IN ANDHRA PRADESH, A CASE STUDY OF KRISHNA DISTRICT

Raghuveer Naidu K¹, V.V.R.M.Narayana Rao², Dr.K.V.Ramana³

Author for Correspondence E-mail:: raghukonanki@gmail.com

Andhra Pradesh Space Applications Centre (APSAC), Planning Dept., Govt.of.A.P, Vijayawada-520010

Abstract

Aquaculture is a highly profitable venture in India also it has increased the availability of nutritive food for the growing population, the government of Andhra Pradesh has identified the fisheries sector as a Growth Engine for Socio Economic Development of the new state of Andhra Pradesh. At the same time A.P Government accords top priority to enhance the fish production to 42 lakh tones in the next five years from the present level of 19.64 lakh tones and to double the exports value from the present level of Rs.16000 crores. Remote Sensing and Geospatial Information System can be effectively used for identification of existing aquaculture and map the Potential aquaculture area. The study was conducted in coastal district of Krishna in Andhra Pradesh for identification of aquaculture potential areas and existing/dry/abandon aquaculture ponds using high resolution IRS LISS-IV satellite data (March-April 2014-15). The aqua pond farmer and management details were collected through enumeration in the field. Study was carried out Mandal/Village/Creek/Cluster/FPO (Farmer Producer Organization) wise for identification of potential aquaculture areas in Krishna district, using visual Interpretation approach. In Krishna district, 60,171 ha were existing as aquaculture ponds and another 23,088 ha was found to be Potential aquaculture areas. The parcel boundaries (Cadastral layer) were superimposed on the Aqua Ponds. The area in Krishna district equals to 37 percent of the total aquaculture in Andhra Pradesh, and Machilipatnam mandal 6,049.ha highest aqua potential area was found.

Keywords: Potential Aquaculture, LISS-IV, Remote Sensing, GIS, Andhra Pradesh.

Introduction

Aquaculture is a highly profitable venture in India. Also, it has increased the availability of nutritive food for the growing population. The advent of aquaculture is mainly due to depletion or standstill of capture fishery since the seventies, and availability of vast stretches of brackish water lands (1.2 million sq. km). The industry has grown enormously, leading to purchase of agricultural and fallow lands by entrepreneurs for setting up small and large-scale aqua farms in Tamilnadu and Andhra Pradesh.

Aquaculture plays a significant role in the development of the country economy as well as state economy. So from the past two decades aquaculture has been fast growth in the study area. Since the 1990s, under the reform policies of Central and state government driven by the economic benefits, the rapid development of India's both in fresh water aquaculture, Brackish water aquaculture and marine water aquaculture has been the focus of the world's trade. Now India is also one of the world's largest fishery production country, a position it has maintained continuously after 1990s. Andhra Pradesh stands first in total fish and prawn/shrimp production in India since 2013-14 both in terms of production and value. The contribution of fisheries sector is 6.01 % in A.P's. GSDP, whereas the fisheries contribution is about 0.83% of GDP of the nation. The overall fish production has more than doubled in the past one decade from 8.14 lakh tons in 2005-06 to 19.64 lakh tones in 2014-15. The share of Andhra Pradesh in India's sea food exports has increased from about 20% in 2009-10 to about 40% in 2013-14. During 2009-10 the exports from Andhra Pradesh was Rs. 2,100 crores but by 2013-14 exports have increased to Rs. 12,100 crores. During 2014-15, the marine exports have been increased to an estimated value of Rs.16,000 Crores.

In Andhra Pradesh, pond culture was initiated in the Kolleru lake region in 1976. Initially, 133 fish ponds covering an area of 2040 ha were constructed by the State Government. The initial successes that as achieved by a few private farmers encouraged large numbers of people in Krishna and West Godavari districts to take up commercial fish farming in and around Kolleru lake. Other factors that contributed to the rapid development of the sector included the frequent flooding of the agricultural land, increased labour costs, and a concomitant low return from traditional paddy crops. By 1981, several fish farms ranging from 2 to 100 ha were operating in the region (Gopal Rao, 1987). Since 1981, the area under aquaculture has continued to expand. This has resulted in the conversion of about 5 000 ha of flood-prone fallow land to pond farming, and in some areas, agricultural fields have also been converted for this purpose. Most of the carp culture in Andhra Pradesh is located in and around Kolleru Lake (Nandeesh and Gopal Rao, 1989). By 1985, fish culture had expanded to other irrigated areas in Krishna and Godavari districts, and on a smaller scale to Nellore, Guntur, Prakasam and East Godavari districts.

The Government of Andhra Pradesh has identified the Fisheries sector as a Growth Engine for social economic

development of the new State of Andhra Pradesh. The Vision 2029 Programme promotes the rational exploitation and utilization of the State's fishery resources in a manner consistent with the overall goal of sustainable development.

The AP state Government also supported to the Aquaculture. Some of the departments also play a major role for this Aquaculture Industry. Marine product development authority (MPEDA), Coastal aquaculture authority (CAA), The national fisheries development board (NFDB), The national bureau of fish genetic resources (NBFGR), state fisheries department (SIFT), CSA etc are the Supported Government organizations.

The Government of Andhra Pradesh accords top priority to Fisheries Development and its intervention for marine, brackish water, Inland fisheries, reservoirs development and ornamental fishery trade, with a view to enhance the fish production to 42 lakh tones in the next five years from the present level of 19.64 lakh tones and to double the exports value from the present level of about Rs.16000 Crores.

Scope / Objective of the Study

- Increase fish production and ensure sustainable development.
- Develop fisheries value chain and boost exports.
- Promote investment to create infrastructure.
- Promotion of Andhra Pradesh as the 'Aqua Hub' of India
- Ensure Sustainable socio economic development of people involved in fisheries
- Put in place appropriate mechanisms to ensure sustainable fisheries and aquaculture to ensure ecological integrity and biodiversity.
- Modernize the fisheries sector by importing new technologies.
- Promote innovation and encourage technology up gradation through Research and Development
- Enhance Human Resource Development to make the fisheries sector an efficient and professionally managed sector.

The project envisages developed a dynamic GIS database for aquaculture ponds in coastal districts of Andhra Pradesh and identified Existing, and Potential aquaculture areas including Dry/Abandoned aquaculture ponds in coastal wetlands using high resolution IRS LISS-IV satellite data and aqua ponds farmer and management details has been collected through enumeration in the field, locations of hatcheries, feed factories and processing plants has collected using GPS.

Database and Methodology

- Extraction of Aqua ponds (existing) and Potential aquaculture area's in on screen interpretation from high resolution satellite image using Visual Interpretation techniques of Size, Shape, Tone, Texture, Pattern etc.

- Village wise Aqua and potential areas calculated.
- Rectified Village Parcel boundaries (Cadastral layer) overlaid on aqua ponds
- Extraction of survey numbers from cadastral map and assigning to pond layer.
- Verification of archive shrimp / scampi data with present ponds layer
- Preparation of plot maps for field data collection.
- Integration of field data into standard database format and generation of geo-database of ponds layer in GIS environment with joining of recent farmers information and management practices.
- Preparation of Aquaculture distributed maps with Creek/Cluster/FPO (Farmer Producer organization) wise.

Data Used:

1. Recent IRS Satellite LISS- IV digital data of March-April 2014-15 year (single season data) and available archive satellite data of different years on different resolutions and sensors.
2. Recent attribute data of the ponds collected by Fisheries Dept Govt. of A. P used for preparation of different maps.
3. Details of Locations of hatcheries, feed factories and Processing plants collected by Fisheries Dept Govt. of A.P.

Professional software used:

The following professional software will be used in this project:

1. ERDAS IMAGINE
2. Desktop Arc GIS Software
3. Arc GIS Enterprises Server Software

Study area:



Fig.1 Location Map of the Study Area.

The study area of Krishna district is an administrative district in the Coastal andhra region of the Indian state of Andhra Pradesh, it is geographically lying in between 80° 0' and 81° 33' of E. longitude and 15° 43' N and 17° 10' N latitude and It has an area of 8,727 km² and had a population of 45,29,009 as per 2011 census of India, it has 88 km's of long Coastal Line and It is bounded by West Godavari on the east, Bay of Bengal on the South, Guntur and Nalgonda istricts in the west and a portion of it also borders with the state of Telangana, Krishna river is the third longest river in India flowing in this district and Krishna river flows through the state of Andhra Pradesh before it empties itself into Bay of Bengal, near Hamsaladevi village of Krishna district, the study area is shown in Fig: 1

Results and Discussions

Krishna District is strategically located on the South-Eastern coast of India and is the natural gateway to East and South East Asia. Krishna District has fertile river basins, extensive canal system and conducive agro climatic conditions for fishery promotion. The District has 125 kms of coastline out of 972 kms of Andhra Pradesh coastal line and is one of the largest producers of marine products.

In this study high resolution Satellite data (IRS LISS-IV) is used and extracted aquaculture (existing), dry/abandoned ponds and potential aqua areas in Andhra Pradesh, and area statistics has been generated, current existing aquaculture area in Andhra Pradesh is 1,63,307 Hectares, dry/abandon/potential area is 88,542 hectares and Salt pans covering 4,103 hectares and total is 2,55,952 hectares. Highest Aquaculture area is identified in West Godavari district i.e. 62,449 hectares existing aquaculture, 22,261 hectares Dry/Abandoned/Potential area, and total is 84,799 hectares, after West Godavari District, highest aquaculture area is identified in Krishna District i.e. 60171 ha existing aquaculture, 23088 ha dry/abandoned/potential and 718 ha salt pans and total is 83977 ha and lowest aquaculture area is identified in Vizianagaram District that is 31 ha aquaculture, 105 ha dry/abandoned/potential area as shown in Table 1.

Table.1.District wise Aquaculture statistics in Andhra Pradesh

District wise Aquaculture distribution in Andhra Pradesh (areas in Hectares)				
District Name	Aqua culture	Dry/Aban don/ Potential	Salt Pans	Total
Srikakulam	966	4326	495	5787
Vizianagaram	31	105	0	136
Visakhapatnam	523	2449	359	3331
East Godavari	15531	7773	27	23331
West Godavari	62449	22261	89	84799

Krishna	60171	23088	718	83977
Guntur	6114	5099	0	11213
Nellore	14107	14299	464	28870
Prakasam	3415	9142	1951	14508
Total	16,3307	88,542	4,103	2,55,952



Fig.2.Aquaculture distribution in Andhra Pradesh

As shown in Table.1 75 % of the aquaculture area is distributed West Godavari and Krishna Districts in Andhra Pradesh. In West Godavari district 38 % aqua, dry, abandon and potential area is distributed. Next Krishna district 37 %, Nellore and East Godavari 9 %, Guntur 4 %, Prakasam 2%,Srikakulam 1 %, and remaining aquaculture area distributed in Vizianagaram and Visakhapatnam district respectively, at the same time 88,542 ha aquaculture potential area has been identified in this study area. In District wise highest aqua potential area has been identified in Krishna district i.e. 23,088 hectares, it is equals to 26 % of the total state, after Krishna, West Godavari district 22,261 hectares (25 %),Nellore 14,299 hectares (16 %),Prakasam 9,144 hectares (10 %),East Godavari 7773 ha (9 %),Guntur 5,099 hectares (6 %), Srikakulam 4,326 (5 %),Visakhapatnam 2,449 ha (3 %) and Vizianagaram 105 hectares (0.1 %) of Aquaculture potential area identified.

Case study of Krishna District

The area accounts for approximately 37 per cent of the total aqua farm area of Andhra Pradesh distributed in the Krishna district. Many paddy cultivators have shifted to shrimp culture, attracted by the tremendous difference in profitability, apart from this, in Krishna district, where water salinity is a problem, many agriculturists shifted to aquaculture, because farmers at the tail end of the irrigation canals had little access to fresh water, and were forced to use saline water. In their situation, shrimp culture was a promising option. The profits made in the first year were used to buy or lease more land for the second season, so that area under aqua farms increased manifold.

Table. 2. Mandal wise Aquaculture statistics in Krishna district.

Mandal wise Aquaculture Distribution -Krishna District (Area in Hectares)					
SN	Mandal name	Aqua culture (Existing)	Dry/Abandoned / Potential	Salt Pans	Total
1	Avanigadda	27	52		79
2	Bantumilli	3450	156		3606
3	Bapulapadu	997	28		1025
4	Challapalle	59	0		59
5	Ghantasala	36	0		36
6	Gudivada	698	0		698
7	Gudlavalleru	151	0		151
8	Kaikalur	7077	5262		12339
9	Kalidindi	11442	1424		12866
10	Koduru13	2162	2773		4934
11	Kruthivenu	5277	1752	159	7188
12	Machilipatnam	4358	6049	559	10966
13	Mandavalli	8529	2400		10929
14	Mopidevi	111	38		148
15	Mudinepalle	4080	131		4211
16	Nagayalanka	2286	2458		4744
17	Nandivada	8150	377		8527
18	Nandiwada	291	22		313
19	Pedana	636	150		786
20	Pedaparupudi	284	9		293
21	Unguturu	13	0		79
22	Total	60171	23088	718	83,977

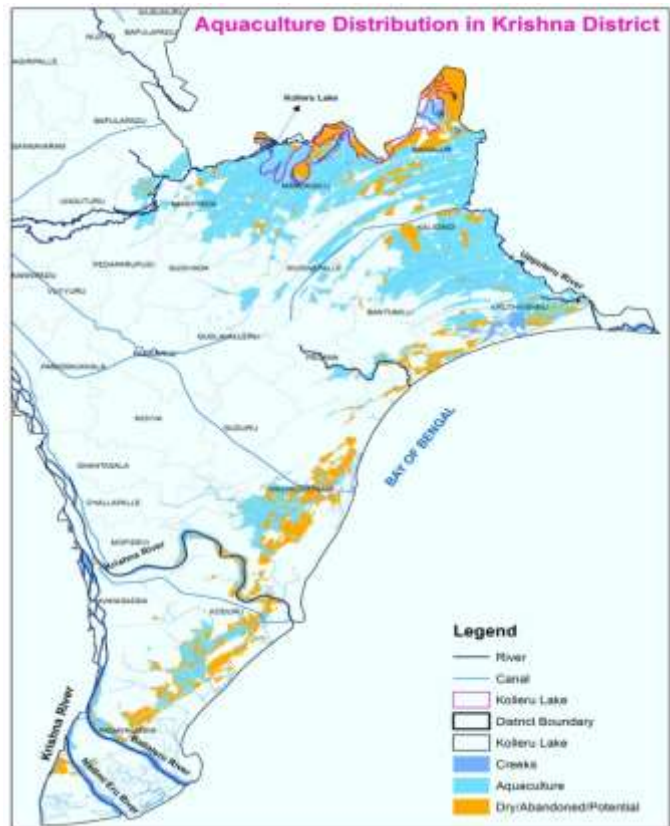


Fig.3. Aquaculture Distributed Area in Krishna District



Fig.4. Aquaculture ponds showing in LISS-IV Satellite Image near Uppureru river area

Andhra Pradesh highest aquaculture area has been distributed in Krishna district along with Krishna, Upputeru and other rivers, streams and drains and in and around Kolleru lake. 60,171 ha existing aquaculture, 23,088 hectares abandoned/dry/potential area occupied. In Krishna district, highest aquaculture area is distributed in Kalidindi Mandal, 11,442 hectares aquaculture existing, 1,424 hectares abandon/dry/potential area is distributed and lowest is Ghantasala mandal, only 36 ha aquaculture (existing) area is distributed as shown in the Table 2.



Fig.5. Aquaculture & Potential area with cadastral boundary as shown in classified image in Krishna District

Creek wise Aquaculture distribution

Creek wise Aquaculture areas identified based on the water source of Krishna river, Upputeru, Utukuru drain, Pedalanka drain, Gunderu nala and Ballaleru etc. rivers, drains and creeks in Krishna district, based on this around 55 creek maps prepared, Upputeru river (part) creek map can shown in Fig.10 for the reference.



Fig.6. Cadastral Layer (Survey Numbers) superimposed on Aquaculture ponds in Krishna district as seen on IRS LISS-IV Satellite Image (Date-12th June 2014)

As shown in Table no.3 highest aquaculture area distributed in Upputeruv river basin that is 22,779 hectares aquaculture (existing), 6,661 ha dry/abandoned/potential area and total

Table. 3. Creek wise Aquaculture Statistics in Krishna district

Creek wise Aquaculture distribution in Krishna District (Area in Hectares)					
SN	Creek Name	Aqua culture	Dry/Abandoned/Potential	Salt Pans	Total
1	Ballaleru River East	517	755		1273
2	Budameru River	915	28		943
3	Campbell Canal	531	25		556
4	Chandrayya Drain	9022	1061		10083
5	Dosapadu Bhumikodu Channel	4227	250		4476
6	Goguleru Creek	3118	2214		5332
7	Gudivada Canal	353			353
8	Gumu Channel Part	127	239		366
9	Gunderu Nala Part	1866	3408		5274
10	Komaravolu Drain	574			574
11	Kreek Near Bandar Port Rf	397	575		972
12	Krishna River East And Nidameru River West	1	396		396
13	Krishna River North	970	901		1871
14	Krishna River South	558	909		1467
15	Lazzabanda Drain	740	170		911
16	Mangaleru And Uppukaluva River	909	983		1892
17	Nadimeru River East And Ballaleru River West	188	60		248
18	Pedda Kommileru Drain Campbell Canal	704	9		712
19	Pedalanka Drain	776	14		790
20	Peddapadu Chinki Part	1065	144		1209
21	Peddatumaidi Drain Part	486	57		543

22	Polraju Canal Kaikalur Channel	5391	1597		6988
23	Ratna Kodu Drain	2265	2195		4460
24	Sitanapalle Channel	1060	332		1392
25	Upputeru River Part	22779	6661		29439
26	Other Small rivers and Backish water of Bay of Bengal	631	108	718	1456
27	Total	60171	23088	718	83977

Kruthivennu-2 FPO covered highest number of villages i.e. 10 villages.

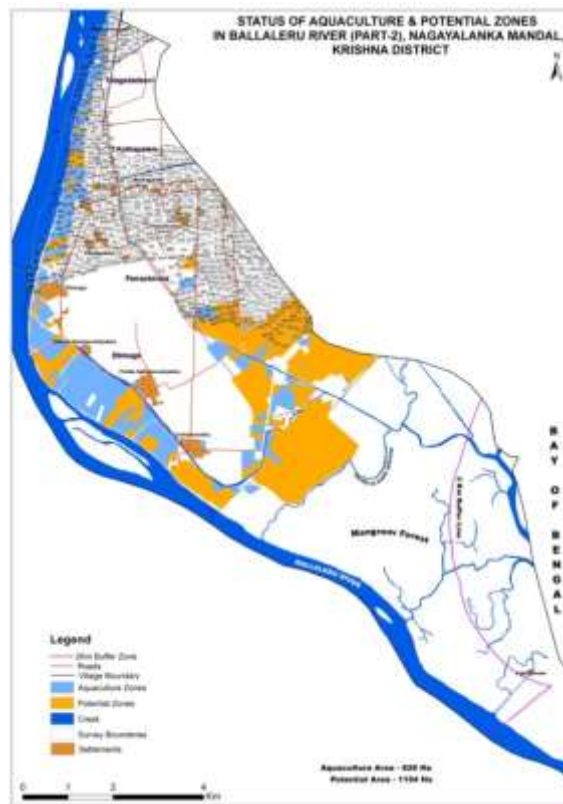


Fig.7. Ballaleru River (part) Creek Map in Krishna district

Village wise Aquaculture distribution: Aquaculture has been distributed in 219 villages in Krishna districts, highest aquaculture area is found in Kolleru lake area that is 2,261 hectares aquaculture ,2,312 hectares Dry/Abandon/Potential, 101 hectares Potential and total aquaculture area is 4,676 hectares next Pedalanka village in Kalidindi mandal aquaculture area is 3216 hectares, 23hectares Dry/Abandon/Potential and total aqua area is 3239 hectares, in Kolletikota village 668 hectares aquaculture, 2420 hectares Dry/Abandon/Potential and total aqua area is 3088 hectares, highest potential area find in Kolletikota village of Kaikalur mandal Krishna district. Next Ramakrishnapuram village 884 hectares Aqua, 1579 hectares dry/abandon/potential,26 hectares potential area and total 2490 hectares aquaculture has been distributed, then Kona village 1339 hectares aquaculture, 562 hectares dry/abandon/potential,66 hectares potential area and total 1968 hectares aqua area distributed in this village. And lowest aquaculture area that is below 10 hectares find in Mellamaru village (0.43 hectares) in Mopidevi mandal, Machavaram village (0.49 hectares) in Koduru mandal, Chinatummidi village (0.69 hectares)in Bantumilli mandal, Avanigadda village (1.07 hectares) in Krishna mandal, Chilakamudi village (1.85 hectares) in Gudivada mandal, Vadali (2.5 hectares) and Sankarshana puram (2.71 hectares) villages in Mudinepalli

aqua area is 29,439 ha were distributed and second highest aquaculture area distributed in Chandraiah drain basin area, i.e. located in south western side of Kolleru lake, 9,022 ha aquaculture (existing), 1,061 hectares dry/abandoned/potential area and total aqua is 10,083 hectares, in Polaraju canal of Kaikalur channel, 5,391 hectares aquaculture (existing), 1597 hectares dr/abandon/potential area is distributed, next Goguleru creek 3,118 hectares aquaculture (existing), 2214 hectares dry/abandoned/potential area is distributed then Gunderu nala 1,866 hectares aquaculture (existing),3,408 hectares dry/abandoned/potential, Ratna koduru drain 2265 hectares aquaculture (existing),2195 hectares dry/abandoned/potential, Krishna river part is 1,530 hectares aquaculture (existing),2205 ha dry/abandoned/potential and Dosapadu Bhunikodu channel is 4,227 hectares aquaculture existing, 250 hectares dry/abandon/potential area is distributed. and lowest aquaculture area is distributed creeks in Krishna district namely Nadimeru river east and Ballaleru river west 248 hectares, Gudiwada canal 353 hectares, Gummu channel part is 366 hectares, pedatummidi drain is 543 ha and.

kommaravolu drain is 574 hectares of aquaculture(existing) and dry/abandoned/potential area respectively.

FPO (Farmer Producer Organization) wise Aquaculture distribution

Farmer producer Organization (FPO) wise aquaculture and dry/abandoned/potential areas is identified in Krishna district, total 19 FPO identified and same maps prepared as shown in Table.5.and aquaculture, dry/abandoned and potential areas were calculated as FPO wise and same shown in the FPO maps. Cadastral layer overlaid in this maps as shown in the fig.10. Each FPO covering group of villages for example

mandal, Talagadadevi village (4.88 hectares), Nagayalanka Mandal, Angaluru village (8.73 ha), Chandrala village (8.97 ha) in Gudlavalleru mandal.

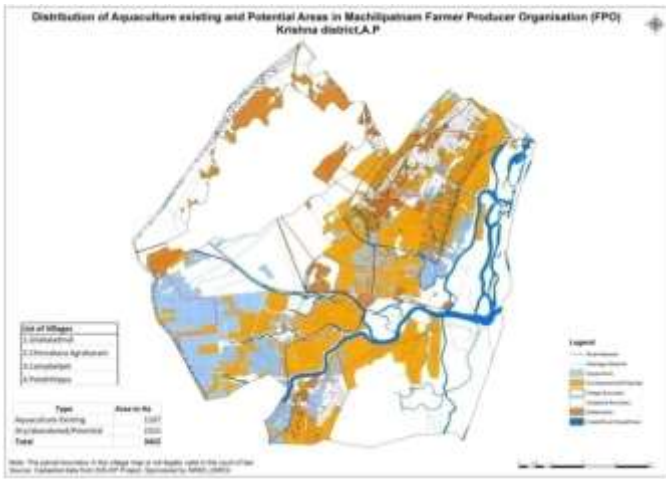


Fig.8. Machilipatnam Farmer Producer Organization (FPO) Map

Ground Truthing

At the time of Image Interpretation, doubtful areas has been identified, which is aquaculture distributed mandals of Krishna district and ground truth exercise has been completed, as shown in the fig.no13, Krishna district field points seen in the high resolution image of LISS-IV (2014-15-March), in the area of Machilipatnam Mandal and filed photos of Aquaculture ponds, dry/abandoned, aqua potential and salt pans also can be seen in the below figures.

10	Machilipatnam & pedana	3066	3917	200	7183
11	Nandivada 1	4189	345		4534
12	Mandavalli	2069	450		2519
13	Kruthivennu 1	1955	806	159	2920
14	Kalidindi 1	5432	757		6189
15	Kaikaluru 1	2103	973		3076
16	Bapulapadu	980	43		1023
17	Machilipatnam 2	2067	2679	159	4905
18	Nagayalanka	2068	2382		4450
19	Mudinepalli	971	80		1051
20	Total	60171	23088	718	8397

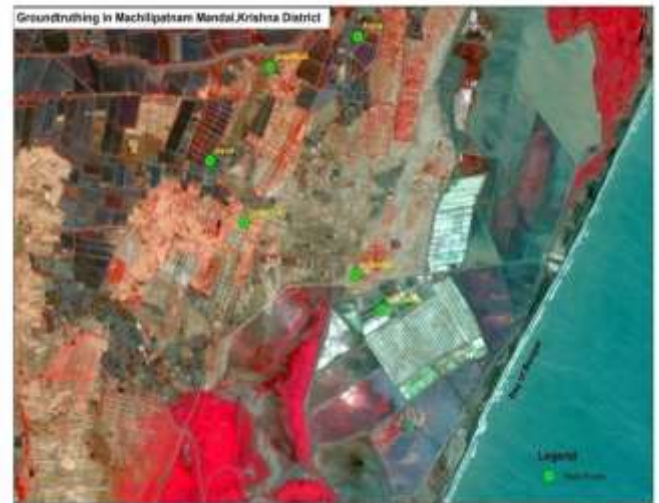


Fig.9. Field points of Krishna district

Table 4. FPO wise Aquaculture statistics in Krishna District

FPO wise aquaculture in Krishna District (Area in Hectares)					
S.No	FPO Name	Aquaculture	Potential	Salt Pans	Total
1	Machilipatnam 1	851	1474	200	2525
2	Kruthivennu 2	3150	551		3701
3	Nagayalanka and Koduru 2	2195	2963		5158
4	Nagayalanka and Koduru 1	1991	2222		4213
5	Kalidindi_2	7055	581		7636
6	Machilipatnam -3	1107	2315		3422
7	Kaikaluru	13667	414		14081
8	Bantumill	2929	80		3009
9	Nandiwada	2326	56		2382



Fig 10. Field Photo of Dry/Abandoned/Potential area in Machilipatnam mandal Krishna District

Conclusion

Growth and Developments

As shown in Fig.14, highest aquaculture potential area identified in Machilipatnam mandal, 6049 ha (26 %), Kaikaluru mandal 5262 ha (23%) and Nagayalanka 2464 ha (11 %) mandal and total 23,088 ha of the highest aquaculture potential area is available in Krishna in Andhra Pradesh. If this vast potential area will develop into aquaculture, aqua production will be increased into double as of now and this aqua production is one of the rich sources for double digit growth of Andhra Pradesh state economy.

The Government of Andhra Pradesh has identified the Fisheries sector as a Growth Engine for social economic development of the new State of Andhra Pradesh. The Vision 2029 Programme promotes the rational exploitation and utilization of the State's fishery resources in a manner consistent with the overall goal of sustainable development.



Fig.11. Field Photo of Aquaculture Pond in Machilipatnam mandal Krishna District

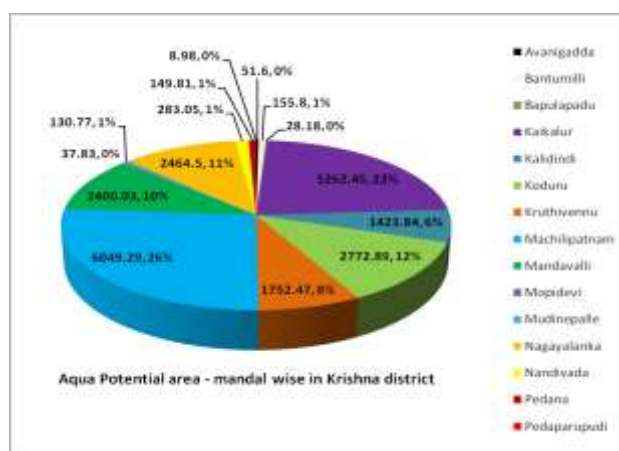


Fig.No.12. Mandal wise Potential Aquaculture area in Krishna district

The Government of Andhra Pradesh accords top priority to Fisheries Development and its intervention for marine, brackish water, Inland fisheries, reservoirs development and ornamental fishery trade, with a view to enhance the fish production to 42 lakh tones in the next five years from the present level of 19.64 lakh tones and to double the exports value from the present level of about Rs.16,000 Crores. 3. Government with a view to make Andhra Pradesh, a hub of Fisheries, hereby introduces the Fisheries Policy 2015-2020. 4. Under the Fisheries Policy 2015-2020, the Government approved the following fiscal benefits covering the categories of (a) Processing Units (b) Aquaculture Pond/ Farm (c) Feed Manufacturing Units/Fishery related Equipments Manufacturing (d) Aqua Labs/ Disease diagnostic Labs Promotion.

The state has 4 fishing harbours – Visakhapatnam, Kakinada, Nizampatnam and Krishnapatnam. One major port at Visakhapatnam and 14 non major ports offering vast opportunity for exporting fish products. There is scope for establishment of new fishing harbours/ fish landing centers and 12 other post-harvest and market infrastructure to give value addition to the produce.

The fisheries and aquaculture play a significant role in providing employment, reducing poverty and promoting health. Fish is an extremely nutritious – a vital source of protein and essential nutrients. The sector provides employment opportunities to nearly 14.5 lakhs people directly and indirectly. Sustainable fisheries can generate lasting benefits for nutritional security and economic growth. Good governance and Good Aquaculture Practices can enable fisheries to thrive sustainably. Therefore the Government of Andhra Pradesh is unveiling this policy to create a suitable eco-system for the rapid growth of fisheries and aquaculture for the next Five years (2015-2020).

Benefits of the Aquaculture development in Andhra Pradesh

- (i) Increased production and productivity by 20-30% increasing the GSDP contribution of Fisheries Sector.
- (iii) Better infrastructure and logistics facilities in the sector ensuing the availability of fish products in all the days.
- (iv) Increased marine exports and domestic trade thereby increase in foreign exchange earnings.- Target is to double the value of marine exports in next five areas Better infrastructure facilities in the sector.
- (vii) Gainful employment in fisheries and allied ancillary industries. – Additional employment opportunities to 1.4 lakhs fishers directly and 2.8 lakhs indirectly.
- (ix) Promote research in frontier areas of aquaculture.
- (x) Better fish farmers' welfare.
- (xii) Promote Sustainable fishery in the State.

References

- [1] Feeding and feed management of Indian major carps in Andhra Pradesh, India, Ramakrishna, R.; Shipton, T.A.; Hasan, M.R. 2013, FAO Fisheries and Aquaculture Technical Paper No. 578. Rome, FAO. 90 pp.
- [2] Break-even Analysis and Profitability of Aquaculture Practices in India, R. Sathiadhas^{1*}, T. M. Najmudeen¹ and Sangeetha Prathap¹ Central Marine Fisheries Research Institute, P. B. No. 1603, Cochin - 682 018, Kerala, India.
- [3] Aquaculture and its impact on ground water in East Godavari District Andhra Pradesh, India, A Case Study, A.R.K. Raju Penmetsa, S.R. Reddy Muppidi, Raghuram Popuri, Suri Babu Golla and Rambabu Tenneti, International Research Journal of Environment Sciences, ISSN 2319-1414, Vol. 2(10), 101-106, October (2013).
- [4] Advances in geographic information systems and remote sensing for fisheries and aquaculture, Technical Paper-Geoffery J. Meaden, FAO consultant, Canterbury, United Kingdom of Great Britain and Northern Ireland and José Aguilar-Manjarrez Aquaculture Officer Aquaculture Branch, FAO Fisheries and Aquaculture Department, Rome, Italy.
- [5] Delineation and monitoring of aquaculture areas using multi-temporal space-borne multispectral data, R. S. Dwivedi* and Sreenivas Kandrika National Remote Sensing Agency, current science, vol. 89, no. 8, 25 october 2005.
- [6] Government Of Andhra Pradesh, Abstract, Fisheries Department – Fisheries Policy of Andhra Pradesh 2015-2020 - Orders – Issued, Animal Husbandry, Dairy Development & Fisheries (Fish) Department.
- [7] Ground Truth Sampling to Support Remote Sensing Research and Development: Submersed Aquatic Vegetation Species Discrimination Using an Airborne, Hyper spectral/Lidar System, by Molly Reif¹, Candice Piercy², Jessie Jarvis³, Bruce Sabol², Chris Macon⁴, Richard Loyd⁵, Phil Colarus⁶, Heidi Diers⁷, and Jen Aitken, ERDC TN-DOER-E30 January 2012.
- [8] Impacts of aquaculture on water resources utilization and land resources of Krishna district using with Remote Sensing and GIS techniques, P. Mynar Babu¹, Prof. G. Jai Sankar², and Prof.V.Sreenivasulu³, International Journal of Engineering Trends and Technology (IJETT) - Volume4 Issue7- July 2013.
- [9] Environmental and Social Conflicts of Aquaculture in Tamilnadu and Andhra Pradesh, I. Emerson Kagoo and N. Rajalakshmi, Journal of Social and Economic Development Jan. - June 2002.

Biographies

1. Dr.K. Raghuvveer Naidu, Msc, PhD, PGDTCP, is working as a Team Leader in Andhra Pradesh Space Applications Centre (APSAC), Planning Department, Govt. of Andhra Pradesh, Vijayawada-520010.
Email id: raghukonanki@gmail.com
2. V.V.R.M.Narayana Rao, Be Civil Engineering, is working as a Scientist-SE in Andhra Pradesh Space Applications Centre (APSAC), Planning Department, Govt. of Andhra Pradesh, Vijayawada-520010
Email: vattinrao@yahoo.co.in
3. Dr.K.V.Ramana, M.sc, PhD, PGDPPM, is currently working as a Vice Chairman in Andhra Pradesh Space Applications Centre (APSAC), Planning Department, Govt. of Andhra Pradesh, Vijayawada-520010 and he is a Scientist-SG in National Remote Sensing Centre (NRSC), ISRO, Dept. of Space, Balanagar, Hyderabad-500037.
Email: ramanakv.apsac@gmail.com, ramanakv.nrsc@gmail.com