# Impacts of aquaculture on water resources utilization and land resources of Krishna district using with Remote Sensing and GIS techniques

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*Abstract—* **Aquaculture activities are major impact on water resources both physical and chemical. Physically there is a lot of pressure on water; chemically it's polluted the water as well as land degraded. It is due to poor planning of land and water resources management in the study area. On the other hand in the coastal areas farmers getting low income output from agricultural activities, liable flooded areas, and mud flats, open scrubs areas are largely converted in to Aquaculture ponds. These are good significance for the economic growth. Fresh water Aquaculture practices are more in the study area when compared to marine water aquaculture, majority of the Aquaculture ponds are situated near to the Kolleru Lake region. Those Aquaculture ponds are required large amount of fresh water for daily change activities, due this practices the polluted water discharged in to the channels from the upstream Aquaculture ponds that same water used by downstream Aquaculture ponds, this is the main cause for increasing pollution in many folds aquaculture environment. So GIS and Remote sensing techniques are very efficient to present situation and required to maintain the water resources, to control the pollution in the study area.**

*Keywords—* **Aquaculture ponds, Water resources, Land, GIS and Remote Sensing.**

INTRODUCTION

Aquaculture has been a fast-growing industry because of significant increases in demand for fish and seafood throughout the world. It is growing more rapidly than any other segment of the animal culture industry (Gang et al. 2005). Aquaculture in India has a long history; there are references to fish culture in Kautilya's *Arthashastra* (321–300 B.C.) and King Someswara's *Manasoltara* (1127 A.D.). The traditional practice of fish culture in small ponds in eastern India is known to have existed for hundreds of years; significant advances were made in the state of West Bengal in the early nineteenth century with the controlled breeding of carpin *bundhs* (tanks or impoundments where river conditions are simulated). Fish culture received notable attention in Tamil Nadu (formerly the state of Madras) as early as 1911,subsequently, states such as Bengal, Punjab, Uttar Pradesh, Baroda, Mysore and Hyderabad initiated fish culture through the establishment of Fisheries Departments. 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 the world's largest fishery production country, a position it has maintained continuously after 1990s. 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.

*Study area:* The study area is located in central and southern part of Krishna district, Andhra Pradesh. The area covered in this investigation is about 3420 sq.km. The area is geographically lying in between $80^0 48^{'} 0^{''}$ and $81^0 35^{'} 0^{''}$E longitude and $15^0 42^{'} 0^{''}$ and $16^0 45^{'} 0^{''}$ N latitude, the study area is shown in given below Fig: 1
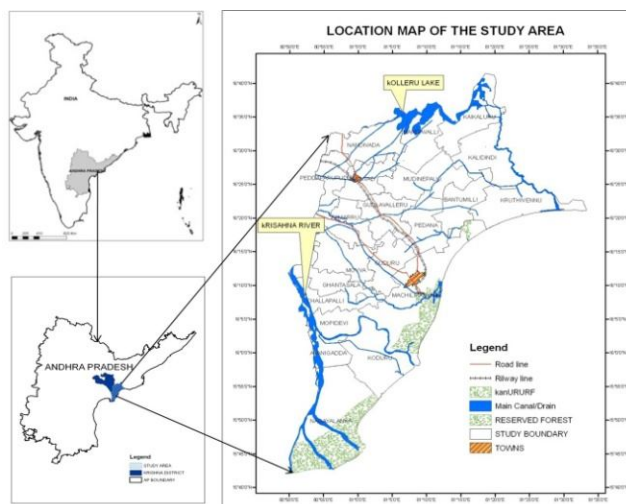


Fig. 1 Location map of the study Area

*DATA USED*

For Identifying aquaculture increasing activities in the study area Landsat ETM 1990, 2000 and IRS-1D-LISS-III 2010 satellite data sets have been used. The Survey of India (SOI) topographical maps 65D/14, 65D/15, 65D/16, 65E1&E2,

65H/2, 65H/3, 65H/4, 65H/6, 65H/7, 65H/11, 66A/13 and 66A/14 published on a scale 1:50,000 have been used along with other collateral data

### MATERIALS AND METHODS:

To fulfill the objectives of this study, three types of approaches have been attempted, such as (1)Pre-field work stage (2) Fieldwork stage (3) Post-fieldwork stage:

Pre-field work stage: 1) Preparation of base maps 2) Digitization of the drainage network3) Generation of slope maps 4) Land use / Land cover analysis 5) Preparation of Geomorphological map

Fieldwork stage: Extracting ground truth information 2) Visiting places in the study area for classifications 3) Topological error rectification of all the coverage's 4) Collection of Hydro geological data

Post-fieldwork stage: 1) Editing and Topology creation 2) Creation of attributes to all the coverages 3) GIS analysis 4) Generation of output maps

Interpretation of multi-date optical remote sensing data for the purpose of study of Aqua culture activities in the study area .ARC GIS 9.3 and ERDAS IMAGINE 9.1 are powerful tools for extracting the Aqua culture development in the Study Area in mandal wise, These are from SOI toposheets and satellite imageries from 1990 to 2010 including 2000

*Aquaculture Development in World:* The World distribution of aquaculture production in 2010 across the continents and countries of different economic development levels remains imbalanced. In that the Asia producing 89% of world aquaculture. After that Americas producing 4.3%, Europe with 4.2%, Africa with 2.2%, and Oceania with 03%.Top ten countries of all continents accounted for 87.6 percent by quantity and 81.9 percent by value of the world's farmed food fish. The country China is occupied first place with 61.4% in the total world and this was dominated by the contribution of China, Other major producers in Asia are India, Viet Nam, Indonesia, Bangladesh, Thailand, Myanmar, the Philippines and Japan. In Asia, the share of freshwater aquaculture has been gradually increasing, up to 65.6 percent in 2010 from around 60 percent in the 1990s. In terms of volume, Asian aquaculture is dominated by finfishes (64.6 percent), followed by molluscs (24.2 percent), crustaceans (9.7 percent) and miscellaneous species (1.5 percent). The share of non-fed species farmed in Asia was 35 percent (18.6 million tonnes). The details of World and Asian aquaculture has shown in Table 1, 2&3 and also shown in Fig 2, 3&4

| | | | |
|---|---|---|---|
| Near East | 40599 | 56665 | 278061 |
| **Africa** | **81015** | **399676** | **1288320** |
| Sub-saharan Africa | 17184 | 55690 | 359790 |
| North africa | 63831 | 343986 | 928530 |
| **Americas** | **548479** | **1423433** | **2576428** |
| Caribbean | 12169 | 39704 | 36871 |
| LatinAmerica | 179367 | 799234 | 1883134 |
| North America | 356943 | 584495 | 656423 |
| **Europe** | **1601524** | **2050958** | **2523179** |
| Europeanunion (27) | 1033982 | 1395669 | 1261592 |
| Non-European union countries | 567667 | 657167 | 1265703 |
| **Oceania** | **42005** | **121482** | **183516** |
| **World** | 13074379 | 32417738 | 59872600 |

**Table No: 1: Aquaculture production in World (Tonnes)**

| | Percentage (In 1990) | Percentage (In 2000) | Percentage (In 2010) |
|---|---|---|---|
| **Asia** | **82.60** | **87.7** | **89** |
| Asia(excluding China ) | 32.7 | 21.1 | 27.2 |
| China | 49.6 | 66.40 | 61.40 |
| Near East | 0.3 | 0.2 | 0.5 |
| **Africa** | **0.60** | **1.2** | **2.2** |
| Sub-saharan Africa | 0.1 | 0.2 | 0.6 |
| North africa | 0.5 | 1.1 | 1.6 |
| **Americas** | **4.2** | **4.4** | **4.3** |
| Caribbean | 0.1 | 0.1 | 0.1 |
| LatinAmerica | 1.4 | 2.5 | 3.1 |
| North America | 2.7 | 1.8 | 1.1 |
| **Europe** | **12.2** | **6.3** | **4.2** |
| Eurounion (27) | 7.9 | 4.3 | 2.1 |
| Non- European union countries | 4.3 | 2.0 | 2.1 |
| **Oceania** | **0.3** | **0.4** | **0.3** |
| **World** | **100** | **100** | **100** |

Table No: 2: Aquaculture production in World (% of Tonnes)
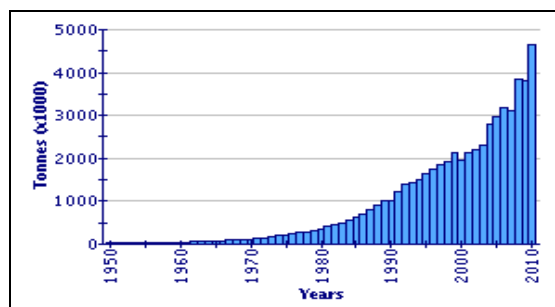


Fig No: 2 Aquaculture report from 1950 to 2010 (FAO Fishery Statistics)



**Fig No: 3:**
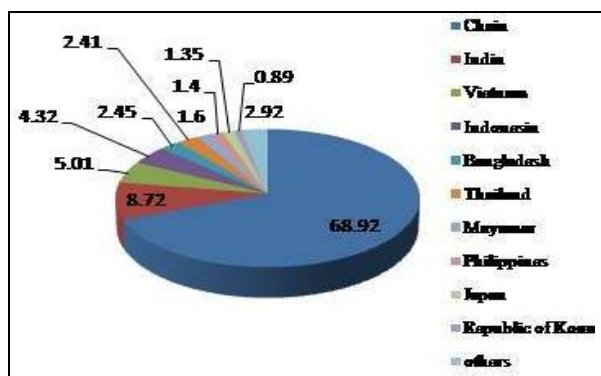
**Aquaculture production o f Asia in 2010**

### Aquaculture Production in World:

| | 1990 (Tonnes) | 2000(Tonnes) | 2010(Tonnes) |
|---|---|---|---|
| **Asia** | **10801.356** | **28422189** | **53301157** |
| Asia(excludingChina &NE) | 4278.355 | 6843.429 | 16288.881 |
| China | 6482.402 | 21522.095 | 36734.215 |
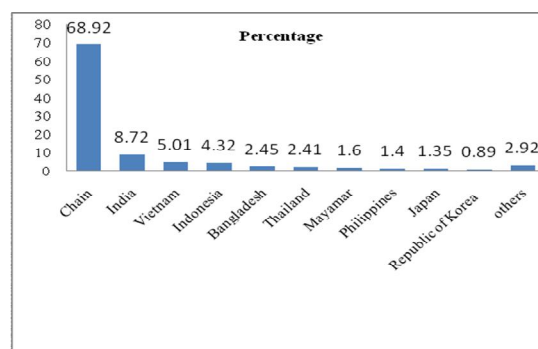
**Fig No: 4: Aquaculture production o f Asia in 2010**

| | | | |
|---|---|---|---|
| 5 | Guntur | 765 | 317 |
| 6 | Khammam | 633 | 463 |
| 7 | Prakasam | 257 | 75 |
| 8 | Mahabubnagar | 110 | 86 |
| 9 | Srikakulam | 105 | 16 |
| 10 | Nalgonda | 95 | 55 |
| 11 | kharimnagar | 76 | 57 |
| 12 | Adilabad | 40 | 40 |
| 13 | Karnool | 34 | 17 |
| 14 | Visakhapatnam | 29 | 21 |
| 15 | Anathpur | 27 | 34 |
| 16 | Chittore | 20 | 31 |
| 17 | Kadapa | 16 | 17 |
| 18 | Waragal | 12 | 10 |
| 19 | Nizamabad | 11 | 9 |
| 20 | Medak | 2 | 3 |
| 21 | Rangareddy | 1 | 1 |
| | TOTAL | 55341 | 24284 |

Table No: 4: AP District wise Aquaculture Area and number of Farmers

*Aquaculture Development in Andhra Pradesh*: The area accounts for approximately 70 per cent of the total aqua farm area of Andhra Pradesh. Especially in the Krishna district, many paddy cultivators have en masse 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. Most of these farms are five or 10 acres in size, with the smallest ones being around two acres and the largest ones going up to 20 acres. Only extensive aquaculture is practiced and the investment in farms has been meager-only Rs 10,000 to Rs 15,000 per acre for conversion from paddy land.

The details of district-wise fresh water aquaculture area and number of farmers engaged in culture are as Shown in Table No.4

| S.No | Name of the District | Extent under culture in Ha | No.of Farmers |
|---|---|---|---|
| 1 | Krishna | 20647 | 7249 |
| 2 | West Godavari | 28566 | 12626 |
| 3 | East Godavari | 2055 | 1855 |
| 4 | Nellore | 1840 | 1302 |



**Fig No: 6: Aqua culture (1990) in the study area**

*Aqua culture development in the Study Area*: In the study area there was no aquaculture activities at the time of topo maps preparation by survey of India i.e., in the year 1968. But in the year 1990 the satellite data of LANDSAT shows, there was enormous amount of land has been converted as aquaculture ponds. That total aquaculture in the study area was245.41 sq.km.

In the year of 2000, the total aquaculture observed in the study area was735.16 sq.km and in the year of 2010, the total aquaculture in the study area was810.36 sq.km. The details are shown in Table 5, and also shown in Fig 5, 6, 7, 8, 9&10
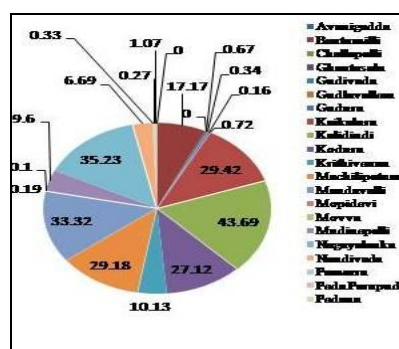


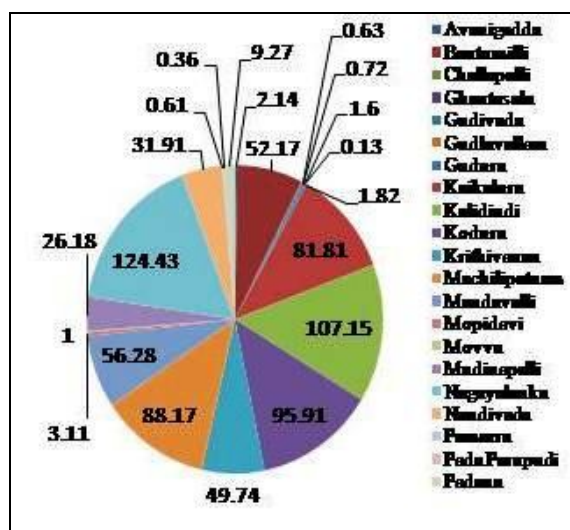**Fig No: 5: Aqua culture (1990) in the study area was in sq.km**



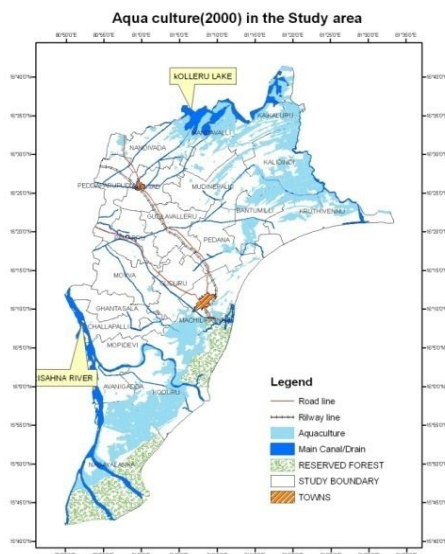**Fig No: 7: Aqua culture (2000) in the study area was in sq.km**
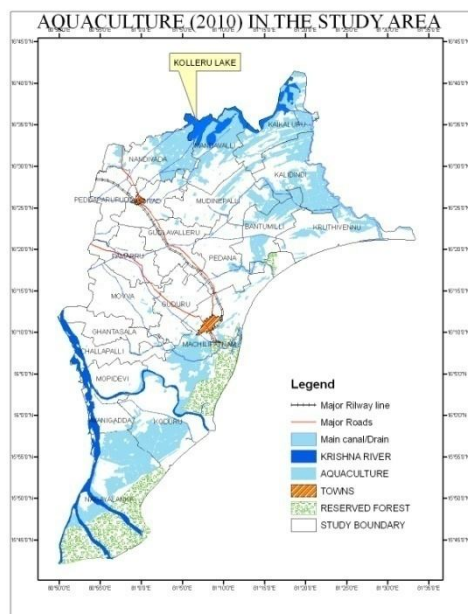
Fig No: 8: Aqua culture (2000) in the study area


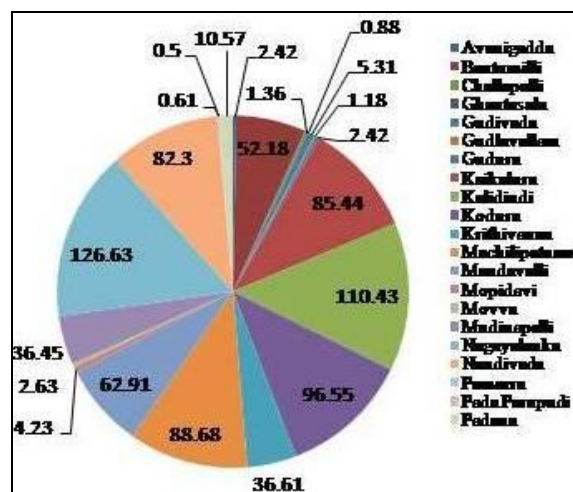
Fig No: 9: Aqua culture (2010) in the study area was in sq.km



Fig No: 10: Aqua culture (2010) in the study area

**Results and discussions:**

**1)** *Aquaculture Impact on Drinking Water resources***:** In the study area the panchathy drinking water tanks were given for lease in some of the villages for aquaculture. The panchathy depends on the ground water only,but the ground water is not suitable for drinking. In the study area this type of villages observed are   ventrapragada village in Peddaparupudi mandal.In this study area village people in the Kolleru lake region area  are forced to travel for distances as long as 5 km to fetch a pot of drinking water crossing the Upputeru rivulet and  from the neighbouring West Godavari district. About 20,000 people are living in and around villages of Pandiripalligudem, Gummalapadu, Srungavarappadu villages on Kolleru lake bed and Penchikalamarru, Kottada, Alapadu, Pallevada in the surrounding areas in Kaikaluru mandal in Krishna district.

Large number of other villages, including Sunnampudi village of Kalidindi mandal Dakshinachirulanka and Yedlanka of Avanigadda mandal, Kammanamola, Yedurumondi of Nagayalanka mandal and Hamsaladeevi and Palakoderu of Koduru mandal too face the same problem.

**2)** *Aquaculture Impact on Ground Water resources***:** Due to the aquaculture practices in the study area some of the villages are facing the high nitrate concentration values in natural water. The high Nitrate values are observed at in Mandavalli mandal villages .It is very near to Kolleru Lake.

 **3)** *Aquaculture Impact on Kolleru Lake premises***:**  In the study area the Kolleru Lake is situated in two mandals i.e., Mandavalli and kaikaluru . The lake is dry in summer seasons due to the water utilized by the upland areas for purpose of aqua culture. In the beginning there was no aquaculture

practices were found when geological surveys of India topo sheets were prepared. The total area occupied by Kolleru Lake is about 63.21sq km. Out of that Mandavalli mandal was 41.82 7sq.km and Kaikaluru mandal was 21.384 sq.km .

In 1990's geographical occupation of Kolleru lake is 45.2 sq.km and aquaculture activities were spread in 17.97 sq.km. Out of that the Kolleru lake occupy 26.84sq.km in Mandavalli mandal and aquaculture activities spread in 14.99 sqkm where as in Kaikaluru mandal Kolleru lake occupy 18.4 sq.km and aquaculture activities spread in 2.99 sq.km only.

In 2000's geographical occupation of Kolleru lake is 26.63 sq.km and aquaculture has been increase to 38.36 7sq.km. Out of that the Kolleru lake occupy 15.876sq.km in Mandavalli mandal and aquaculture activities were spread in 14.99 sqkm where as in Kaikaluru mandal Kolleru lake occupy 10.76 sq.km and aquaculture activities increase to 10.624 sq.km. In the year 2006 the govt.of A.P took the decision to protect the Kolleru Lake and initiative to impede any further encroachments by ordering the demolition of aquaponds that were in the +5 ft contour of Lake area and declared it as a wildlife sanctuary area (Nagabhatla et al. 2009; Pattanaik et al. 2008). Studies have been conducted in the period of years 1977 to 2007 to monitor the status of the lake after demolition and dynamics of aquaculture and wetlands (Nagabhatla and Sellamuttu 2008; Nagabhatla et al. 2009; Pattanaik et al. 2008) and also qualitative analysis with a social science perspective for the sustenance of the Lake (S.Irrinki and N.Irrinki 2006-2007). According to a report produced by Wetlands International (2008), there still are some seeming human encroachments. So In the time of 2010 largely aquaculture is decreased in Kolleru Lake.

4) *Impact on canal Net work*: In the study area the aquaculture practices were concentrated in all banks of canals and disturb irrigation system as well. The required water is taken from the canals and released back to the canals, Mainly these type of aquaculture tanks are observed surroundings of the Avanigadda, Koduru,Nagayalanka mandals.

5) *Impact of Channel/sub-channels net work on water quality*: In the study area rural village's people were diverted water to drinking water tanks from existing channels, which were contaminated by pollutants generally add from discharge water of the aqua ponds. so the channel water is not used for drinking purpose. These are observed at villages of Tamirisa,Anamanpudi villagesin Nandivada mandal, The villagers are purchasing water for drinking.

6) *Impact on Drainage Net work*: In the study almost all farmers started their activities at the same time so lot of pressure applied on the drainage network. Some of the channels or Sub channels are very close to the drainage, at that time drainage is not working properly, the drainage water is leaked to the channel or sub channel. These are observed at Polukonda village in Nandivada mandal.

7) *Impact on Agricultural land*: In the study area some of the mandals nearest to the Kolleru Lake agricultural lands are largely converted to aquaculture tanks. So it is directly increase pressure on water resources. Some of the agricultural lands situated near to the aquaculture tanks facing the waterlogging problems. So that crop output comes very low. The agricultural lands are largely converted to aquaculture tanks in the mandals Mandavalli, Kaikaluru, Nandivada, kruthivennu, Bantumilli, Kalidindi,and Partially in the mandal Mudinepalli, Gudlavalleru. Challapalli,Avanigadda,

8) *Impact on Soils*: The pumping of sea water into aquaculture tanks and its long contact with these fertile soil results the conversion these land into saline soils which is evident in some places of the study area, these are observed in, Bantumalli, Kruthivennu, Koduru,Machiliptnam, Nagayalanka mandals.

9) *Impact on Mangrove Forest*
In the study area some of the Mangrove forest conversion to shrimp ponds in Nachugunta reserved forest, yellichattladibba reserved forest, Sorlagondi reserved forest, Bandar reserved forest has contributed to the negative press received by aquaculture. This transformation results in loss of essential ecosystem services generated by mangroves, including the provision of fish/crustacean nurseries, wildlife habitat, coastal protection, flood control, sediment trapping and water treatment. Fish pens and cages also degrade near shore habitats through their physical installations on sea grass beds and sediment communities, or through deposits of uneaten feeds (Primavera 2006).

10) *Impact on Liable flooded area*: In the study area some of the liable flooded areas in Bantumiili, Kruthivennu mandals are converted in to Aquaculture ponds.

11) *Impact on open scrub*: In the study area some of the open scrub areas in Avanigadda, Bantumilli, Challapalli, Ghantasala, Guduru,Kalidindi,Koduru, Kruthivennu, Mudinepalli, Machilipatnam mandals largely converted in to Aquaculture ponds

12) *Impact on mud flats area*: In the study area some of the mud flat areas Bantumiili, Kalidindi,Koduru, Kruthivennu, Movva, Mudinepalli,Pedana, Machilipatnam, Nagayalanka mandals are converted in to Aquaculture ponds

**Conclusions**:
Extensive aquaculture may lead to excessive use of ground water thus it may be cause depletion in ground water in the study area.
For the practice of aquaculture salt water is used from the nearby creaks and also pumping from ground water. The water quality in these aquaculture tanks is usually saline, which slowly infiltrates and reaches the water table, it cause to salinity intrusion to ground water

The practice of aquaculture has been observed to increase in recent time in the study area; the majority of the Agricultural lands are converted to aquaculture lands.

GIS and Remote sensing Techniques are used for the identification of how much land is converted, canals, channels and drainage network is located near to that Aquaculture surrounding areas.

Arranged for the Village level based Channel network for inlet to tanks, drainage net work for the outlet to tanks and regulating for proper management of water.

## Recommendations:

**1) *Integrated aquaculture system:***
In Chain there is already practiced these type of integrated (both agriculture and aquaculture) recently this type of culture is practiced in East Godavari district by ATMA. It has more benefits compare with individual crops. So proposed for the both cultivation of aquaculture and paddy crop

**2) *Government regulations*:** Government regulations are required for proper management for controlling the pollution, for providing the proffer water supply,

**3) *Engineering aspects of Design*:** Proper design required for construction the Aquaculture ponds, to maintain the inlet and outlets.

**4) *Arrangements of the Inlet for Canals/Channels or Sub ways*:** Modify the Village level based canal/Channel network for inlet to Drinking water tanks and Aquaculture ponds.

**5) *Arrangements of outlets for Drainage or Drainage sub ways*:** Modify the Village level based Drainage network for outlet to Aquaculture ponds and other domestic wastes.

**6) *Polluted Treatment plants*:** a) Physical methods b) Chemical methods c) Biological methods are required for treatment.

**7) *Re cycling of water*:** In the drought seasons providing proper planning to re use the same water for aquaculture.

**8) *Provide good water facility*:** water facility is also important for the fresh water aquaculture. So provide good quantity and quality of water.

**9) *Promote investments to create Infrastructure.***

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