Effects of Aquaculture on Water Quality in Gudivada Region

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Abstract. In the Gudivada region, surface and ground water are important sources for drinking, agriculture, and aquaculture. The environment and human health gets depleted as the water and groundwater become contaminated as a result of man-made activities. The objective of this study is to provide a brief overview of the environmental impact of aquaculture as well as an assessment of ground water quality in the Gudivada Krishna District of Andhra Pradesh. Aquaculture activities have a substantial physical, chemical, and biological influence on water supplies. Physical pressure is exerted on the water; chemically, the water and land are polluted; and biologically, foreign species, infections, and diseases are introduced. For daily change activities, these aquaculture ponds require the mixing of bore-well or creek waters with fresh water; as a result of this practise, the upstream ponds discharging the polluted water into the channels, and the downstream ponds are utilising the same. This is attributed to increase of pollution in the aquatic environment. Over exploitation of water also leads to salt water intrusion, usage of ground water and conversion of land use to aquaculture. Pollution, damage of delicate coastal ecosystems, dangers to aquatic biodiversity, and significant socioeconomic costs are all factors to consider. Change in land distribution data over a period of 2005 to 2021 is collected and water quality parameters are collected and water quality index is assessed at three locations of gudivada region.

1 Introduction

Global fish production has increased notably over a period, with an annual growth of 3.2 percent from 1961 to 2011. Production of aquaculture annually rose to 154 million tonnes from 8 million tonnes during the period of 1985 to 2011 [1]. In the state of Andhra Pradesh's (AP) farming of shrimp has increased drastically to 84,951 hectares from 6000 hectares over a period of 1990 to 2012 and by the end of 2012, the state led India in production, with 1.6 lakh tonnes out of a total of 2.0 lakh tonnes. [2].

Number of fish ponds increased drastically and the conversion of agriculture fields to aquaculture has aloes increased rapidly in Gudivada, Krishna district, Andhra Pradesh, has

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been a major source of concern for many. Farmers are turning to fish farming because paddy yields are dwindling. More farmers turned to aquaculture rather than paddy cultivation due to high yield in aquaculture. This led to reduction of paddy cultivation drastically. The aquaculture wastes are being discharged to channels and nearby agriculture fields results in reduction of water quality. As a result more agriculture fields are turning to fish ponds. Due to usage of salt water in aquaculture, the ground water salinity in the surrounding areas is increased.

1.1 Algal Blooms varieties

There are three types of algal bloom:

- Fresh Water Algal Bloom (Green Tides): Due to deposition of extra nutrients especially phosphates these are formed. In fresh water, higher nutrient concentrations result in algal bloom formation.
- Ocean Bloom: These are formed in large reservoirs and oceans and they kill aquatic organisms. They will reduce the oxygen levels in the oceans and create negative impact to aquatic organisms in the oceans.
- Harmful Algal Bloom: They will have negative impact on aquatic life due to depletion of oxygen and leads to death also [9].

2 Objective

The major objective of this paper is to analyze the ground water quality at study area due to rapid increase in growth of aquaculture. The likely reasons for impact on quality of water include sea water intrusion, increase in salinity levels in underground water are to be assessed which are important for aquaculture and drinking water sources.

3 Study area

On India's east coast the current study area Gudivada, Andhra Pradesh is located. The latitude of 16.441025 and a longitude of 80.992630. It is a town having GPS coordinates 16° 26' 27.6900" N and 80° 59' 33.4680" E. We discovered that the algal blooms formed in the study area are Fresh Water Algal Blooms, which form as a result of extra nutrient deposition.

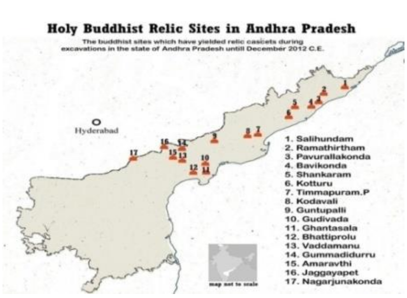

Fig. 1. Source: Holy_relic_sites_map_of_Andhra_Pradesh.jpg

Fig. 2. Source:study area –Gudivada, Krishna district

4 Literature Review

A literature study was conducted and presented below

4.1 Effects of fish feed on the water quality

Beatriz Torres-Beristain, Marc Verdegem, and MaciejPilarcyk
Formulated feed elements like as fish meal, earthworms, snails, and so on are employed in intensive and semi-intensive pond cultivation. Shrimp, salmon and cod are fed feed that has a high protein content ranging from 30 to 60%. High-protein feeds are used to provide optimum nutrition, avoid disease, and maximise animal growth. The targeted species often do not consume a large amount of the feed provided, which increases the organic deposits to settle on water leading to pollution. The combination of high-protein feeds and high-intensity production might lead to water quality issues if not adequately controlled.

4.2 Organic matter decomposition

Because uneaten feed and expelled metabolic products and faeces collect in bottom sediments with dead plankton, organic matter accumulation increases as the production cycle advances. The dissolved oxygen levels reduce due to disintegration of organic waste. In these settings, aerobic decomposition takes over. As a result, breakdown of stored organic matter occurs in both aerobic and anaerobic settings in aquaculture ponds, rotating between the two depending on oxygen supply.

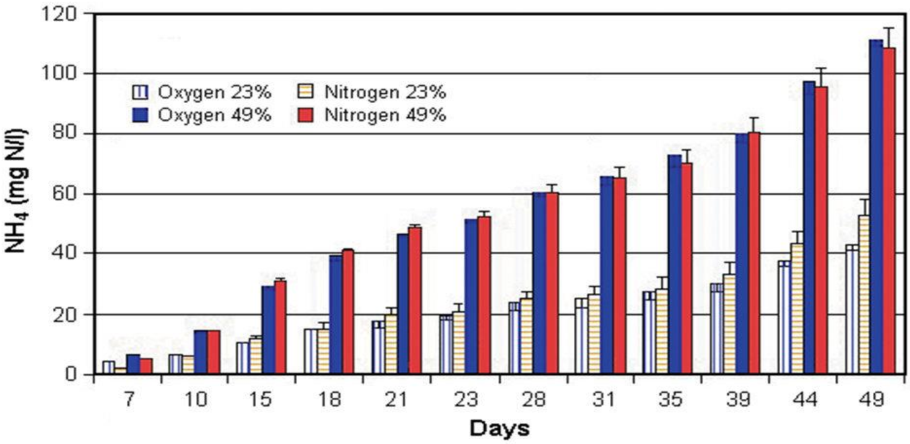

Fig. 3. Ammonia concentration. Percentage of protein content is shown next to the gas treatment

The COD content in all treatments rose over the course of the experiment. The highest COD level remaining in the anaerobic system revealed that the durability of organic matter such as fish feed in aerobic systems is short and immediately oxidised, leaving the system as carbon dioxide. At greater concentrations, the anaerobic treatments created hydrogen sulphide, which is hazardous.

4.3 Aquaculture Effluents

Claude E .Boyd, Auburn University ,September 2011

- Fertilisers and feeds which have high nitrogen phosphorus, organic matter and suspended solids are used to increase the production.
- From harvested fish and shrimp the nitrogen and phosphorus is recovered. Atleast 20 to 40% from fish and 15% from shrimp is recovered respectively.
- Denitrification and ammonia volatilization happens in fish ponds whereas Phosphorus is absorbed by bottom soils. In most cases, it ends up as effluents.

4.4 Impact of Aquaculture on The Environment

Brianna Healey, Will Dell'Erba, Kurt Leavitt
Overfeeding fish in aquaculture can also have impact on the environment negatively. A lack of regulation, lack of feed plan has a wide range of negative effects on the environment. Open net cage farming is common practices which is one of the most harmful aquaculture systems. The waste cannot escape into water during fishing as he farmed fish are held in large mesh fishing nets. This waste contains large amount of antibiotics, pesticides and even fish feces (2013).

4.5 Aquaculture waste

Brianna Healey, Will Dell'Erba, Kurt Leavitt
Aquaculture waste, specifically carbon, nitrogen, and phosphorous, can be separated into two forms both solid and dissolved. Solid waste is made up of uneaten and/or spilled feed as well as fish faces. The majority of dissolved wastes are from fish excretes. These two pollutants grow in a specific location and sooner or later degrade the water quality, as well as causing an influx of disease-carrying fish.Algal blooms formation is one of the most considerable effects. They are toxic and can have much negative impact on many aspects. The blooms have the likely effect to make water unsafe for drinking and recreation.

Fig. 4. Aquaculture waste

4.6 Solid wastes

Department of Fisheries and Aquaculture, Federal University Dutsinma, Katsina State, Nigeria
Solid waste consists primarily of inedible feed and farmed fish feces. Solid waste is further divided into suspended solids and sediments. Suspended solids are most difficult to remove from the system unless coagulation or sedimentation methods are used.

4.7 Dissolved wastes

Dissolved waste from fish metabolism or inedible decaying feed. Nitrogen and phosphorus are the two primary components of dissolved waste. These two elements are required for protein, which is the primary component of fish meal. All fish require a high crude protein content in their diet, ranging from 25 to 50%. Fish retain varied levels of nitrogen and phosphorus, with nitrogen retention ranging from 25 to 30 percent to 10 to 49 percent and phosphorus retention ranging from 17 to 40 percent on average. Nitrogen is expelled primarily as dissolved ammonia, while phosphorus is excreted as particulate matter.

Table 1. Suggested water-quality criteria for pond water fishery for getting high yield [10]

S.No	Test Parameter	Desirable range	Stress	Acceptable range
1.	Temperature (^{0}C)	20-30	<12,>35	15-35
2	Alkalinity(mgL^{-1})	25-100	<20, >300	50-200
3.	Watercolor	Light green to Light brown	Clear water, Green &Brown	Pale to light green
4.	Dissolved oxygen (mgL^{-1})	5	<5, >8	3-5
5.	BOD(mgL^{-1})	1-2	>10	3-6
6.	CO_2(mgL^{-1})	<5,5-8	>12	0-10
7.	pH	6.5-9	<4, >11	7-9.5
8.	Turbidity(cm)	30-80	<12,>80	
9.	Hardness(mgL^{-1})	75-150	<20,>300	>20
10.	Calcium(mgL^{-1})	25-100	<10, >250	4-160
11.	Ammonia(mgL^{-1})	0-<0.025	>0.3	0-0.05
12.	Plankton(No.L^{-1})	3000-4500	<3000, >7000	2000-6000
13.	Nitrite(mgL^{-1})	<0.02	>0.2	0.02-2
14.	Nitrate(mgL^{-1})	0.1-4.5	>100, <0.01	0-100
15.	Phosphorus(mgL^{-1})	0.01-3	>3	0.03-2
16.	H_2S(mgL^{-1})	0.002	Any detectable level	0-0.02
17.	Primary productivity ($C_L{}^{-1}$ D^{-1})	1.6-9.14	<1.6, >20.3	1-15

5 Problem Statement

With increase in aquaculture in the past years and its impact on surface water and ground water quality

6 Methodology

It entails both fieldwork and laboratory analysis. The field work entails collecting water samples from wells in the study area over a seven-year period. Wells and pumps are examples of underground water sources. Using analytical methods chemical analysis of water samples can be done. All the quality parameters are assessed from the collected water in the study area using standard methods.

6.1 Effect on ground water quality:

Recent increases in aquaculture in Krishna and West Goda Bali have turned fertile lands into water bodies and increased salinity in the water table, according to the report. Brackish water area doubled from 20,000 hectares to 56,094 hectares between 2014 and 2017, and its area could reach 10,000 hectares, taking into account illegal cultivation, according to government data from the Ministry of Fisheries.According to experts, one of the major concerns about rising groundwater levels is their impact on the mangrove forests of the Krishna Estuary. For the past decade, the second-largest mangrove forest in India, which provides at least 25% of the oxygen for the entire district, has been suffering from stunted growth. However, thanks to river water flow to the estuary, water quality in the region has improved significantly so far this monsoon season [5].

Table 2. Total land distribution for Aquaculture and Agriculture in acres

Year	Aquaculture Land(in acres)	Agriculture Land(in acres)	Total Land (in acres)
2021	1400	700	2100
2020	1392	718	2110
2019	1376	754	2130
2018	1350	789	2139
2017	1339	806	2145
2016	1296	842	2138
2015	1253	904	2157
2014	1197	989	2186
2013	1142	1024	2166
2012	1094	1093	2187
2011	1038	1158	2196
2010	1026	1247	2273
2009	963	1294	2257
2008	898	1325	2223
2007	834	1374	2208
2006	772	1465	2237
2005	696	1529	2225

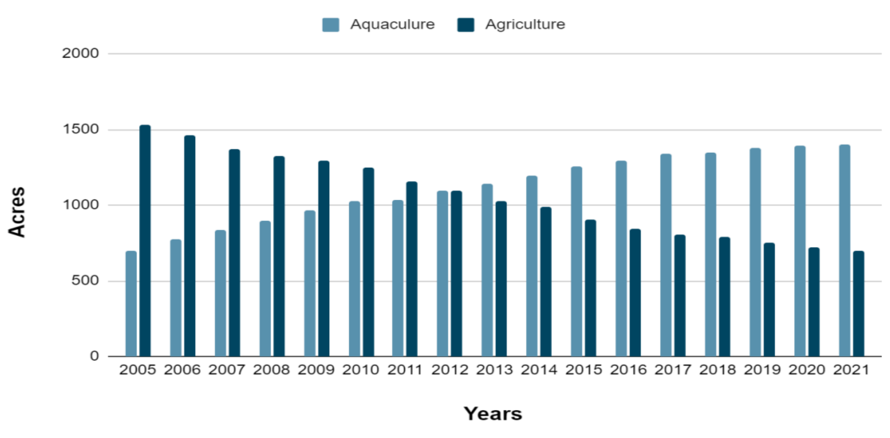

Fig.5. Variation of land distribution for aquaculture and agriculture in acres

Table 3. Data of water quality at three locations

Locations inGudivada	**Year**	**pH**	**TDS (ppm)**	**EC (µS/cm)**	**Chlorides (ppm)**	**Phosphates(ppm)**	**Sulphat-es (ppm)**	**TotalAlkalinity (ppm)**	**TotalHardness (ppm)**	**Salinity (ppt)**
Autonagar	2015	7.7	300	410	21.4	0.0	0.0	258.3	25.0	0.0
	2016	7.9	500	435	35.6	0.0	0.0	279.0	25.0	0.0
	2017	7.7	700	462	59.4	0.0	0.0	312.6	29.3	0.0
	2018	8.0	820	496	87.9	0.0	0.0	395.0	32.6	0.0
	2019	8.2	950	530	109.2	0.1	0.0	412	34	0.0
	2020	7.9	1066	595	124.5	0.0	0.0	472.5	42	0.0
	2021	8.1	1300	613	186.4	0.1	0.0	544.4	56	1.0
Jonnapadu	2015	7.5	1830	1850	340.3	0.0	74.6	626.7	180.2	1.0
	2016	7.6	1900	2000	423.4	0.0	107.3	738.2	230	1.0
	2017	8.1	2300	2800	489.5	0.1	131.9	830.4	252	3.0
	2018	7.7	3100	3450	523.5	0.0	140	1028	285	3.0
	2019	7.6	3600	5230	606.8	0.1	153.7	1186.5	300	3.0
	2020	7.9	4200	5800	682.4	0.1	165.8	1274.8	323	5.0
	2021	7.6	5300	6600	789.6	0.1	185.7	1536.6	395.2	8.0
Teachers colony	2015	8.0	400	482	33.4	0.0	0.0	285.0	36.8	0.0
	2016	8.2	800	521	45.9	0.0	0.0	310.0	40.4	0.0
	2017	8.1	940	602	72.5	0.0	0.0	356.6	48	0.0
	2018	7.8	1053	718	105.8	0.0	0.0	402.9	54	0.0
	2019	8.3	1269	800	164.9	0.0	0.0	493	59.4	1.0
	2020	7.7	1390	910	205.9	0.1	0.0	520.8	64.2	0.0
	2021	8.0	1600	1030	309.2	0.0	0.0	604.0	72	1.0

Source: municipal office water department, machilipatnam, Krishna district

7 Calculation of Water Quality Index

Water quality index is calculated based on weighted arithmetic WQI method.

Table 4. WQI Calculation Results

Year	Autonagar	Jonnapadu	Teachers colony
2015	37.22	52.12	51.35
2016	46.84	60.52	61.57
2017	39.52	93.29	58.98
2018	54.33	85.02	47.97
2019	63.96	95.95	73.81
2020	52.61	118.92	48.23
2021	65.08	123.12	65.89

Table 5. Water quality classification using weighted arithmetic WQI method

WQI Value	Water Quality rating	Grading
0 to 25	water quality is Excellent	A
26 to 50	water quality is Good	B
51 to 75	water quality is Poor	C
76 to 100	water quality is Very poor	D
> 100	Unsuitable for drinking purpose	E

Source: Brown et al (1972), chatterji and Raziuddin (2002)

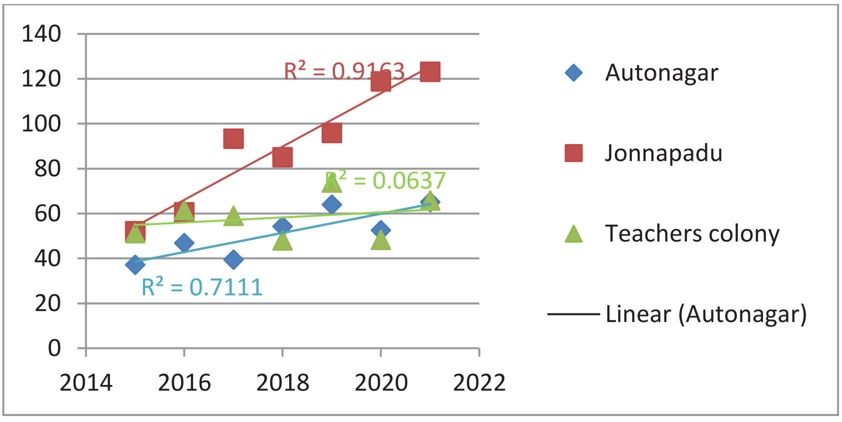

Fig. 6. Five years series plot of WQI for Autonagar, Jonnapadu, and Teachers colony

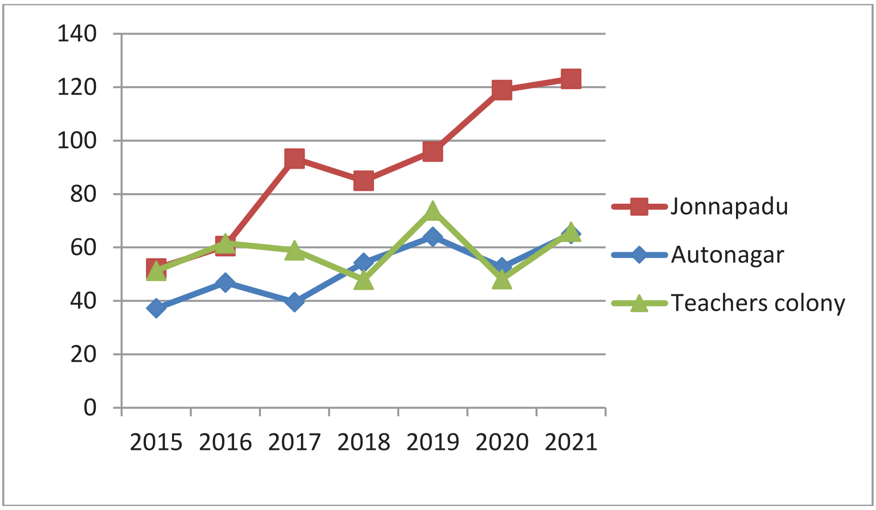

Fig. 7. Assessing the Water Pollution of Jonnapadu, Autonagar, Teachers colony Using Water Quality Indexes

8 Conclusions

The index is used as a tool for communicating water quality information. The WQI for seven years were compared, it was found that the WQI mostly increasing from year to year that means the water quality is dwindling day by day by increase in the aquaculture in all three study locations.

The WQI uniformly increase (reduction in quality) in case of Autonagar, Jonnapadu but in case of Teachers colony the WQI is not uniform.

Various methods can be adopted to improve the quality of water are by the Cyanobacteria, Algae eaters, by changing water, by reducing the feeding of fish, Ultra violet sterilization, Bio clean clarifier, and by the alternatives of fish feed

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