SATELLITE-BASED IDENTIFICATION OF AQUACULTURE FARMING USING NEURAL NETWORK METHOD OVER COASTAL AREAS AROUND BHITARKANIKA, ODISHA

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Introduction

- Aquaculture is a method that is used to produce food and other commercial products that are extracted from fishes, prawns, shrimps, mussels and other marine life.
- In India, the annual fisheries and aquaculture production has increased from 0.75 million tonnes in 1950-51 to 9.6 million tonnes in 2013-14. Globally now country takes 2nd position, after China, with regard to annual fisheries and aquaculture production. [1]
- Odisha is a coastal state of India with a coastline of 480.4 km. There are 13 ports and 57 fish landing centers in Odisha. [2]
- There are plans such as 'Fish Pond Yojna', 'Odisha fisheries policies, 2015' etc. [3] These government plans are promoting aquaculture practices in Odisha.

Source: www.cifa.nic.in

Why neural network technique for delineation of Aquaculture?

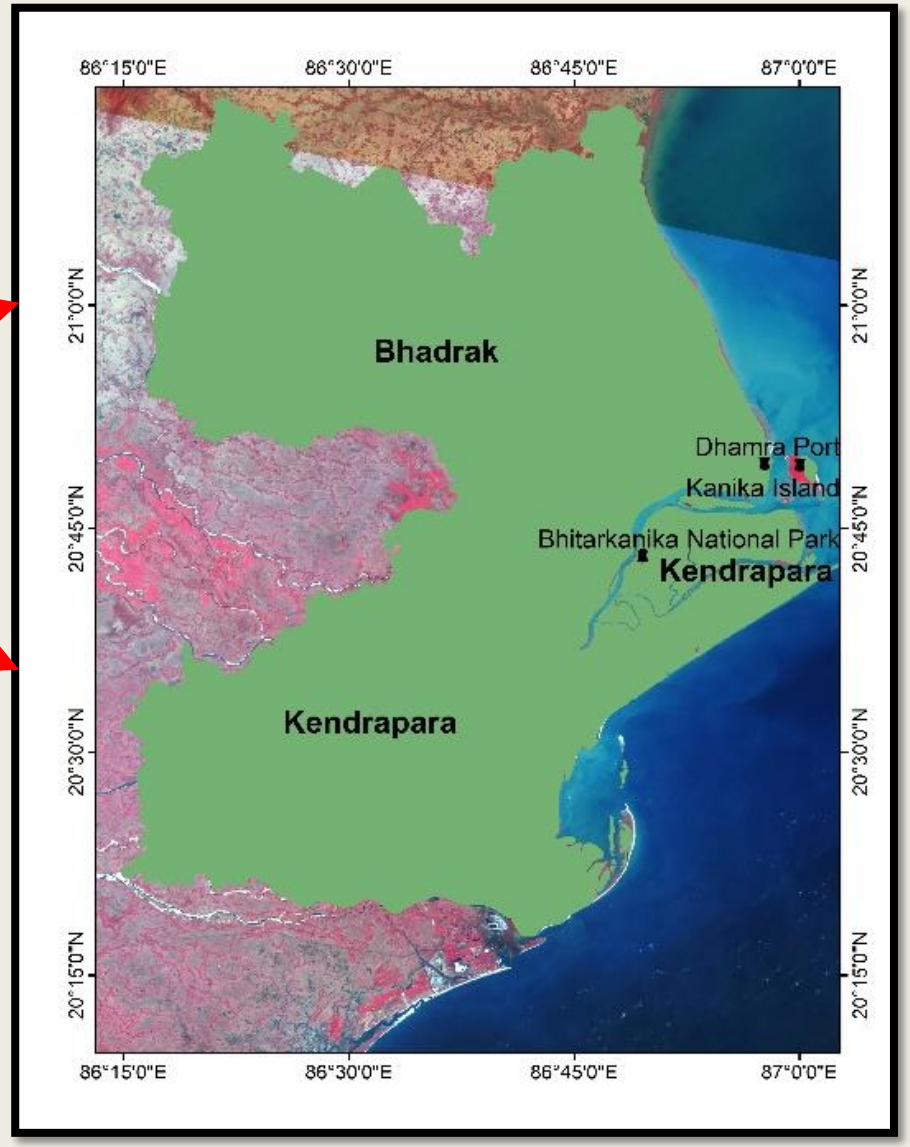
- Popular methods of satellite image classification are mainly based on DN value of example data set.
- Neural network classification method focuses on DN values as well as their pattern i.e. how they are arranged.
- River, ocean, lagoon and aquaculture all these features give similar reflectance in satellite image, the only difference between all these features is aquaculture is in regular shapes with division between them. Other features such as river, ocean etc. are in irregular pattern.

Figure 1 Appearance of aquaculture in satellite imagery

Study Area

- The present study area is two districts of Odisha, India namely Bhadrak and Kendrapara.
- Both the districts are situated in coastal region, around the vicinity of Bhitarkanika National Park.
- The area of Bhadrak district is 2,505 km^2. Its location is 21.0667°N & 86.500°E. Its population is 1,506,522 km^2. Dhamra Port is also there on the banks of the river Baitarani.
- The location of Kendrapara district is 20°20’ N & 86°14’ E. Its area is 2,644 km^2. Bhitarkanika National Park is also there. It’s population is 1,439,891.

Location of Study Area



Data Used:-

- In this study Landsat series images are used to view the temporal changes over the study area from year 2002 to 2017.
- **Year 2002 - Landsat ETM+**

  No. of Bands – 8

  Spatial Resolution- 30m

  Bands Used- Blue, Green, Red, NIR

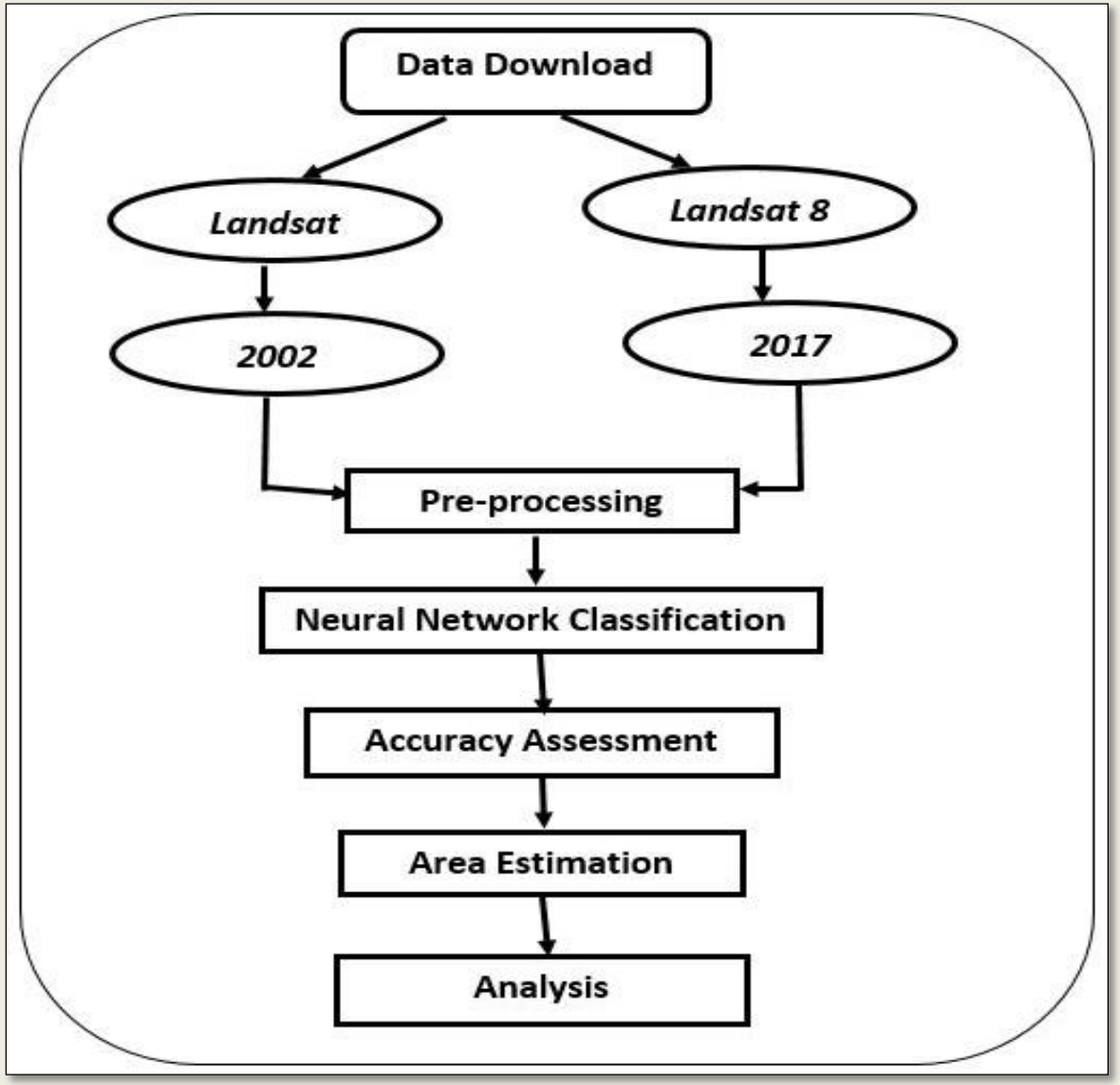
- **Year 2017 – Landsat 8 OLI**

  No. of Bands- 11

  Spatial Resolution-30m

  Bands Used- Blue, Green Red, NIR

Methodology



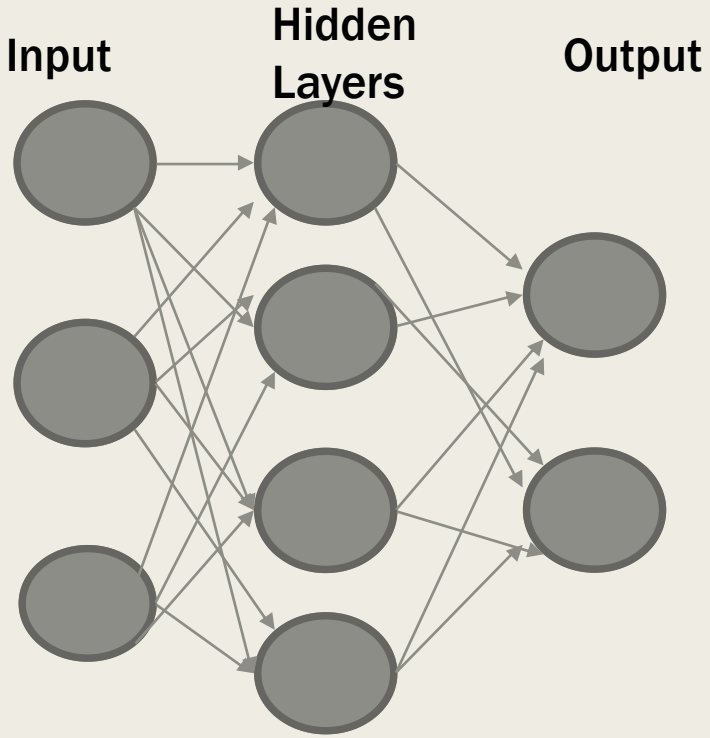
Methodology Flow Chart

Table 1 Specifications of neural network classifications

Parameter	Value
Training threshold contribution	0.900
Training rate	0.2
Training RMS exit criteria	0.1
No. of hidden layers	1
No. of training iterations	1000

Methods

- For pre-processing , radiometric calibration by applying FLAASH settings. Then dark pixel subtraction method is also applied to the images.
- Neural net classification method is used for classifying the images into 5 classes i.e. Aqua-culture, River, Mangrove, Wet land & others.
- Neural network method uses feedforward backpropagation algorithm.



Equations used in Neural Network backpropagation

It is a method used to calculate error contribution of each neuron.

For each neuron j, its output o_j is defined as:

$$o_j = \varphi(net_j) = \sum_{k=1}^{n} w_{kj} O_k$$

Change in Weight w_{ij} which is added to the old weight

$$\Delta w i_j = -\eta \frac{\delta E}{\delta w_{ij}} = -\eta o_i \delta_j$$

Derivative of error, $\frac{\delta E}{\delta wij} = o_i \delta_j$,

with $\delta_j = \frac{\delta E}{\delta oj} \frac{\delta oj}{\delta netj} = \begin{cases} (o_j - tj) o_j (1 - oj) & if\ j\ is\ an\ output\ neuron, \\ (\sum_{l \in L} \delta_l w_{jl}) oj (1 - oj) & if\ j\ is\ an\ inner\ neuron \end{cases}$ [4]

Where:-

O_k= input layer

n= input units to the neuron

w_{kj} = weight between neurons k and j

φ = Activation function which is non linear and differentiable

η = Learning rate

Result

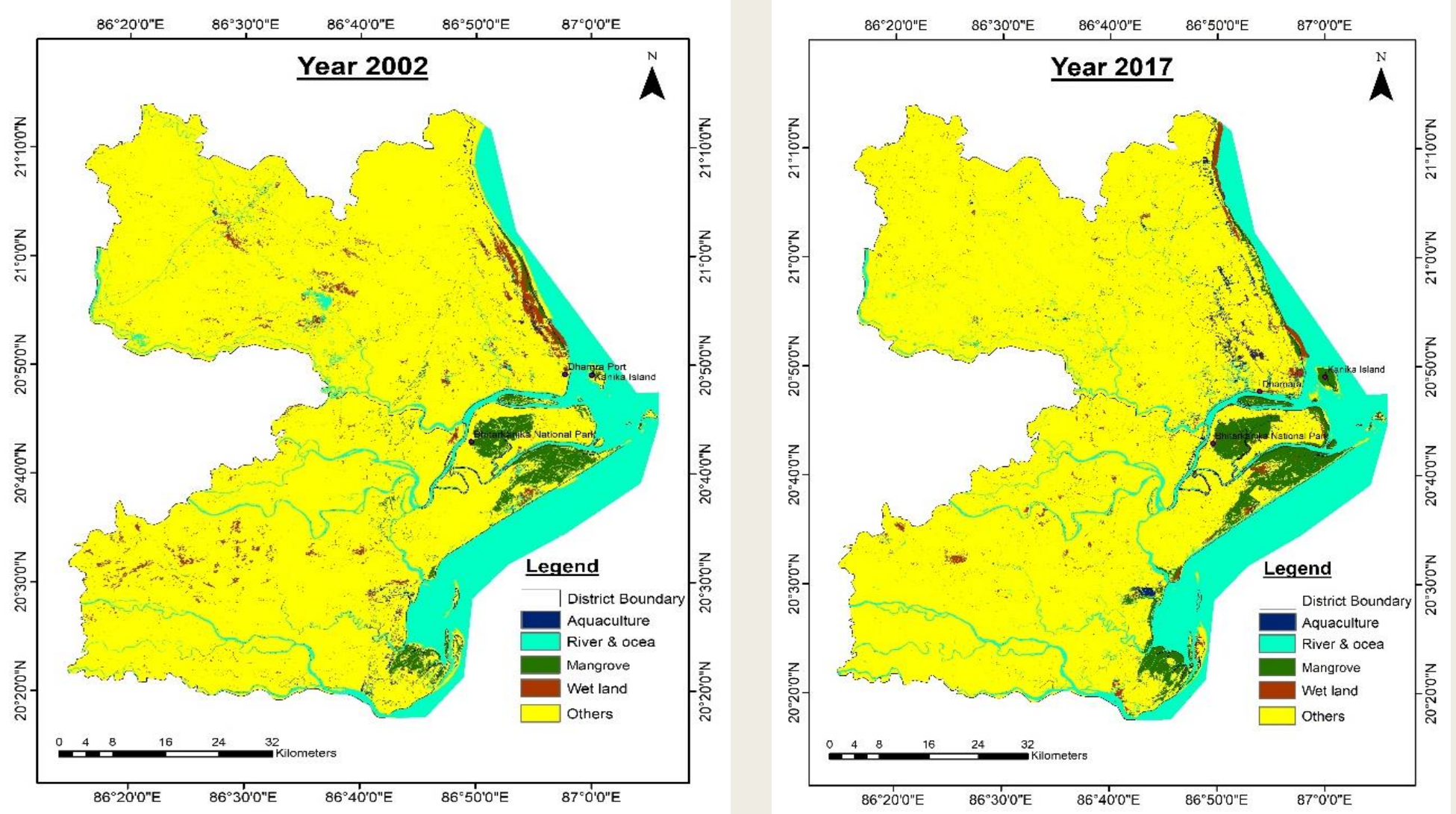


Figure 3 Classified maps of Bhadrak and Kendrapara districts in year 2002 & 2007

Result

- The satellite images are classified into five classes using neural network method. i.e. Aquaculture, River, Mangrove, Wet land, & Others.
- More attention was given towards the ROI selection for aquaculture and river.
- Area under aquaculture have increased from 0.36% to 0.79% in year 2017. It does not appear much but when we compare the area statistics of aquaculture we see there is large increase in area under aquaculture activities. 24.1km^2 area have increased from year 2002 to 2017.
- In Bhadrak district there is large increase in aquaculture activities in comparison to Kendrapara district.

Table 2 Calculated area from the classified images

Type	2002		2017	
	Area(in km^2)	Percentage(%)	Area(in km^2)	Percentage(%)
Aquaculture	20.76	0.363	44.86	0.79
River	832.37	14.68	863.19	15.23
Mangrove	155.10	2.74	212.16	3.74
Wet land	135.92	2.38	100.63	1.77
Others	4523.914	79.81	4447.28	78.46

Table 3 Accuracy assessment of classified image

Type	2002		2017	
	Percentage	Kappa	Percentage	Kappa
Aquaculture	77.42	0.72	86.11	0.82
River	88.57	0.84	87.10	0.84
Mangrove	79.41	0.74	85.71	0.82
Wet land	75.00	0.73	85.71	0.83
Others	80.95	0.74	82.61	0.76
Overall	81.17	0.75	85.21	0.81

Discussion

- Area under aquaculture have increased from 0.36% to 0.79% in year 2017.
- 24.1km^2 area have increased from year 2002 to 2017
- The overall accuracy of classification in year 2002 is 81.17% and accuracy of classification of year 2017 image is 85.21%.
- Accuracy of aquaculture is 77.42% in year 2002 as various aquaculture were classified as river. Accuracy of aquaculture increases up to 86.11% in 2017.
- Wide streams and ocean are accurately classified but narrow streams are classified into some other classes.
- In Bhadrak district there is large increase in aquaculture activities in comparison to Kendrapara district.

Conclusion

- Neural network (NN) classification method have been very helpful in delineation of aquaculture. Other popular classification methods such as nearest neighborhood, parallel piped methods won't give even 60% accuracy while classification.
- NN classification method has given up to 86% accurate results when it comes to extraction of aquaculture.
- There is problem with narrow streams, higher resolution satellite images will resolve these errors also.
- NN method takes more time for training but when it comes to differentiation between similar textured features when only shape or pattern is different, this method gives satisfying results.

- There is increase in aquaculture up to 216.08% over the years 2002 to 2017.
- This is the source of good income as well as government policies are also supporting aquaculture activities, thus these practices are taking high rise.
- Since the products from aquaculture are exported to other countries which is beneficial for government also.
- It provides good source of income and livelihood to people.
- Remote sensing and GIS has been very helpful in estimating the increase in aquaculture. Through this a faster estimation can be done as field survey can take months.

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