Preliminary assessment, restoration and aquaculture support for a small wetland

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Abstract

In line with the strategy of regional wetland datasets integration to a common national digital platform, map of small wetlands less than 2.2 ha in Kochi Taluk was prepared. A representative small wetland at Edakochi village of Kerala was selected through maps and field visits for preliminary assessment and restoration. Shuttle Radar Topography Mission's Digital Elevation Model (DEM) was used to assess the general elevation, slope and flow accumulation pattern of the selected wetland along with assessment of the catchment area and drainage pattern. Restoration works of the selected wetland was carried out *vis-a-vis* side bund strengthening and sluice gate fortification. The comparative analysis of water quality assessment of wetland before and after restoration revealed improvement in water quality parameters as well as increase in water level. The Dissolved Oxygen level of the aquatic system was found to have increased substantially along with other several favourable changes in water parameters due to the restoration activities. The restored wetland at Edakochi was further utilised for multispecies farming of prawns, Pearl spot, Milk fish and Grey mullet and the harvest indicated sustainable yield. Aquaculture practice in wetlands with real time scientific advisories could ensure continuous data generation and village level climate resilience.

Keywords: *Small wetland, Geospatial, Restoration, Aquaculture, Climate resilience*

Introduction

Climate variability induced rainfalls, runoffs, floods and storm water drastically changes the physico-chemical, hydrological, biodiversity and microbial profile of wetland eco-systems. Enhancing village level nutritional security being a national priority, small regional wetlands can contribute significantly as a key habitat for aquaculture production. In view of the significance of ecological and economic functions of wetlands and the threats they face, their monitoring and protection is needed. Regional wetland restoration has been identified as among the prospective climate resilient strategies, with farming of stress tolerant fish species as well as native species, so as to maintain the regional biodiversity profile (Rojith and Zacharia, 2015). The impact on the regional wetland could be cumulative of climatic and non-climatic factors. Scavia *et al.* 2002 states that the most important non-climatic factors comprise drainage of wetlands, overharvesting, discharge of sewage, deforestation, land reclamation, habitat fragmentation, eutrophication, pollution and the introduction of invasive alien species. The hydrology of surface layer of wetlands gets affected by atmospheric inputs such as ratio of precipitation to evapotranspiration (Ferrati *et al*., 2005). An effective eco restoration requires knowledge about wetland dynamics and the factors associated to wetland system, along with the support of regional stakeholders. The study area selected was located at 9.9065° N latitude and 76.2895° E longitude covering an area about 2.115 ha in Kochi Taluk of Ernakulam district, Kerala.

Wetland Dynamics

The shape file data which consists of water shed data and drainage pattern of Ernakulam district and wetland data of Kochi Taluk was procured from Kerala State Land Use Board (KSLUB). The map of wetland < 2.25ha in Kochi Taluk was prepared by QGIS software and based on this and a field survey, a degraded wetland < 2.25 ha was identified for restoration at Edakochi village. Field visits to assess the degradation status, pollutant source and depth of the wetland, followed by geospatial and water quality analysis were carried out. Shuttle Radar Topography Mission (SRTM) was used in the assessment of general elevation, slope and flow accumulation of the study area. The 30 m Digital Elevation Model (DEM) data was obtained from USGS's Earth Explorer. Slope of the study area was attained by Terrine Analysis Tool and Flow accumulation and drainage was found out. Restoration of the wetland was carried out by side bund construction and fortification of sluice gate, followed by multi-species aquaculture. Water samples from the wetland were analysed for six weeks each before and after restoration. The temperature, salinity and turbidity of the water samples were measured with standard mercury-in-glass thermometer, refractometer and turbidity meter respectively, while pH was determined using the pH meter. The dissolved oxygen, alkalinity, total dissolved solids, ammonia, hardness was determined by standard APHA methods (APHA, 2005).

Fig. 1. Catchment Area of the study area

Geospatial analysis revealed the total area of the wetland as 2.115 ha. Initial field visits revealed that the wetland was in degraded state with shallowness, inflow of drainage water and dumpage of solid wastes, which cumulatively made the wetland unfit for aquaculture. The elevation, catchment area, slope, flow accumulation and drainage pattern of the wetland were documented. The general elevation of the wetland region was estimated to range between 0 to 5 meters above mean sea level with highest elevations towards southern sides. The catchment of the water body was 437 acres (Fig.1). Slope for the region was between 0 and 5, while the estimated slope within the catchment area was below 5%. Since the elevation data of high resolution was not accessible, demarcating the catchment area for small wetland was tedious.

The area includes *Pokkali* fields with paddy prawn cultivation, aquaculture ponds, river, settlements and marshy lands with a river nearby. Flow accumulation was found to be high at the southern part of the wetland, while the northern portion showed a slight accumulation pattern from which Drainage network was generated. This showed two inlets into the field, through which polluted water and household wastes influxes into the wetland. As a remedy, the side bund construction prevented the drainage influx as well as increased the water level of the wetland, whereas fortification of sluice gate facilitated the water exchange for aquaculture.

Water quality analysis indicated water temperature of the wetland around six weeks before restoration within the range of 25°–27°C, whereas it decreased after restoration, which could be attributed to the increase in the water level. The optimum temperature required for good aquaculture and fish growth is between 24 °

C–27 º C (Santhosh and Singh, 2007) and the restoration efforts could bring a water temperature more suitable for aquaculture. The decrease in pH observed after restoration could be attributed to the acid leach from the sediments dredged and used for the strengthening of the side bunds. Reduction in pH was anticipated as it is common in case of restoration activities involving sediment removal. The optimum pH for aquaculture was attained during the operational phase. The salinity range observed before restoration was 20-27 ppt with the highest observed during the last week (26.5 ppt) and the lowest salinity observed during the first week (20 ppt). Maximum salinity was observed in the pre monsoon season in Kochi taluk. However salinity was found to drop rapidly after restoration which could be attributed mainly to the rainfall. Wetlands with seasonal salinity variations could prefer saline tolerant fish species for aquaculture. Turbidity, which is an indicator of wetland health showed normal variation during the pre-restoration phase, whereas the first week after restoration showed an increase in the turbidity level, which may have been caused by the restoration activities with stable turbidity levels exhibited in later weeks. The dissolved oxygen (DO) before restoration ranged between 3.4 and 4.4 and after restoration increased to the desirable limit (5.0 mg/l O_2–6.0 mg/l O_2) for aquaculture. This increase was mainly due to the increase in water spread as well as reduction in water temperature.

The water alkalinity of medium range (40.0-90.0 ppm) indicates high productivity of water body and the levels before and after restoration was found to be within the desirable limit. The total hardness before restoration was mostly higher, whereas after restoration it is observed to be lowered. High hardness value is detected during the pre-monsoon season, while the reduction is observed after rainfall. Overall decrease in ammonia was also observed after restoration activities, with the range of ammonia prior to restoration as above 0.25 (mg/litre) got reduced to around 0.2 (mg/litre). Due to pollution influx and

Table 1: Water Quality before restoration

Parameters	Week-1	Week-2	Week-3	Week-4	Week-5	Week-6
Temperature (ºC)	26	25	27	25.5	25	26.7
pH	8.7	8.02	7.5	7.3	7.5	7.5
Salinity (ppt)	20	27	26	26.5	27	26.8
Turbidity (NTU)	17.64	17.24	17.14	17.02	16.5	17.39
DO (mg/l O_2)	3.7	3.4	3.3	3.6	3.7	4.4
Alkalinity (mg/l $CaCO_3$)	76	72.8	76.07	72.9	73	77
Total Hardness (mg/l $CaCO_3$)	57	56.7	55	55.5	54	57
Ammonia (mg/l L)	0.3	0.3	0.27	0.23	0.3	0.2
TDS (mg/l solids)	278	370	340	347.3	354	349
Total plate count (cfu/ml)	Nil	Nil	Nil	Nil	Nil	Nil

Table 2: Water Quality after restoration

Parameters	Week-1	Week-2	Week-3	Week-4	Week-5	Week-6
Temperature (ºC)	24	23	23.6	22	23	23.3
pH	7.7	7.4	7.4	7.3	7.3	7.3
Salinity (ppt)	25	20	19	22	17	10
Turbidity (NTU)	24.54	16.76	16.34	15.12	14.14	15.2
DO (mg/l O_2)	4.3	4.7	4.8	5.3	5.7	5.6
Alkalinity (mg/l $CaCO_3$)	72	72	72.4	72.03	72.6	73
Total Hardness (mg/l $CaCO_3$)	56.6	55.9	56	56	54	54.2
Ammonia (mg/l L)	0.34	0.2	0.22	0.23	0.2	0.2
TDS (mg/l solids)	441.2	360.6	330	314.2	260	208.1
Total plate count (cfu/ml)	Nil	Nil	Nil	Nil	Nil	Nil

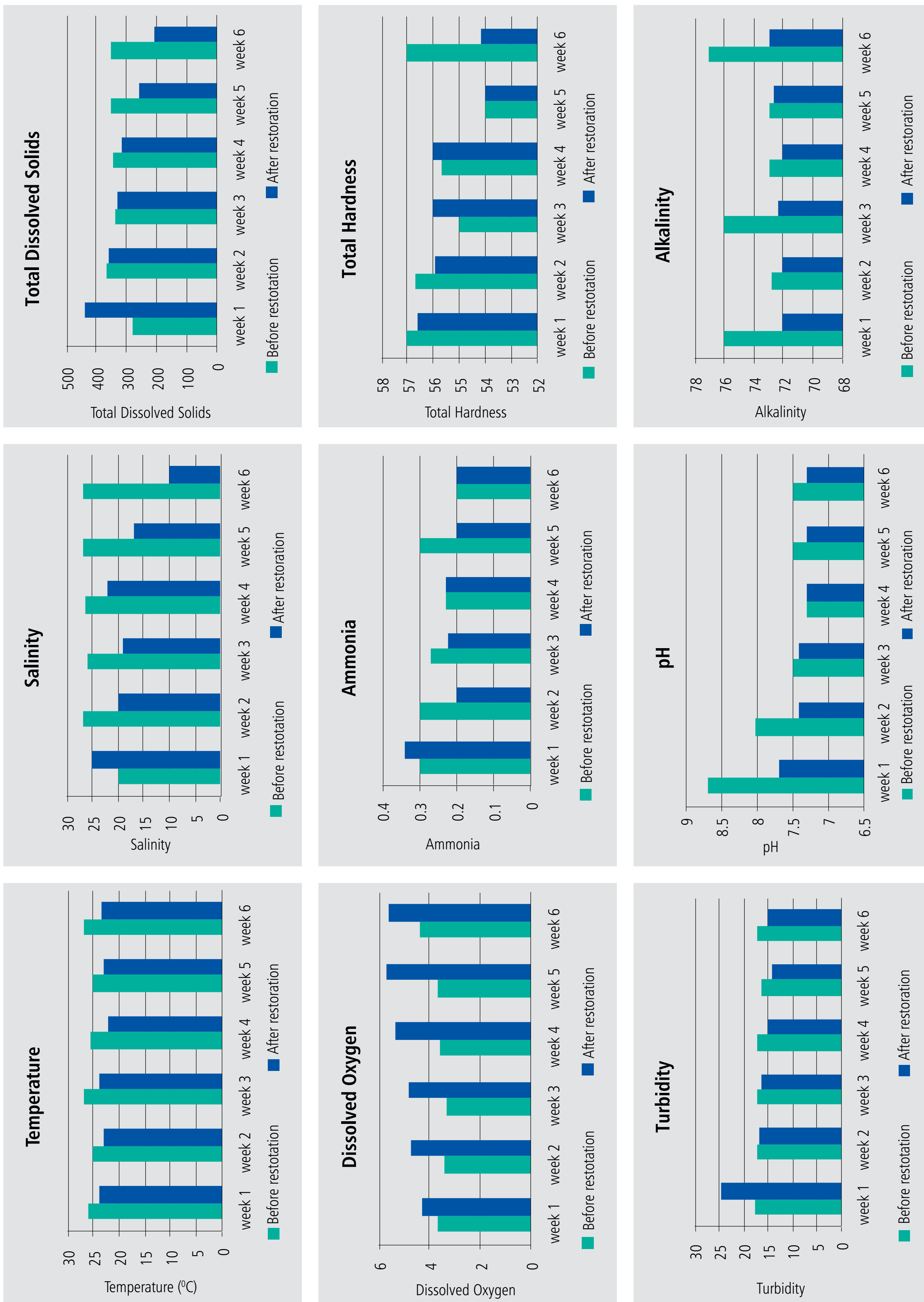

Fig. 2. Water Quality variation before and after restoration

siltation, Total dissolved solids (TDS) value was initially higher, and decreased to a stable desirable value after restoration, after the first week. TDS value in the range of 278-370 before restoration reached 441-208.1 after restoration. No colony of *E. coli* and coliform bacteria was found from the water. The restored wetland is being further utilised for multispecies aquaculture of prawns, pearl spot, milk fish, grey mullet with moderate yields during partial harvest.

Conclusion

A representative degraded small wetland could be successfully restored with generation of water quality and geospatial datasets. The eco-restoration increases the value and potential of regional aquaculture, which can be carried out by private owners, local self-help groups or through lease to stakeholders. The generated data sets such as wetland real images, geospatial profile and periodic water quality parameters are envisaged as inputs to be integrated to the e-platform, developed in collaboration with SAC-ISRO for continuous monitoring and sustenance of the regional wetland ecosystem. The work paves way for real time advisories and continuous monitoring system for regional small wetlands in the country as a competent climate resilient strategy.

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