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Research Paper

Influence of Brackish water aquaculture on Soil Salinisation

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Abstract-*Brackish water aquaculture has been debated severely for its environmental consequences. Mushrooming of such farms on reclaimed mangrove lands and converted agricultural land leads to salinisation of agricultural fields of vicinity. In this study around Bhitarkanika National Park of Orissa, significant correlation between aquaculture farming and high soil salinity has been found. The impact was predominant within a distance of 500 m of the aquaculture pond. The villages having higher aquaculture density were also reported to have tendency of high soil salinity, unsuitable especially for production of paddy – the only crop of the region. Considering other environmental conditions the findings strongly suggest that aquaculture farms play predominant roles in soil salinisation.*

Key words: Bhitarkanika, Brackishwater Aquaculture, Soil salinity.etc.

Introduction

The coastal agricultural lands or soils are exposed to some specific competitive interactions in terms of land conversion, which often directly impact the soil quality. Reclamation of mangroves or swampy areas adds on the areal extent of agricultural soil. On the other hand conversion of agricultural lands to brackish water fisheries and/or shrimp aquaculture has been a major threat to the coastal agriculture in tropical countries. Rice farms are favoured site for conversion to shrimp ponds because they pose several characteristics well suited for aquaculture [1].

It is generally accepted that the extent of salt affected soil in coastal areas of tropics is increasing. Salinity reduces osmotic potential and limits water uptake by plants. Salinity may also cause specific ion toxicity or upset the nutrient balance in the soil [2]. However, in our study area of coastal Orissa, in and around Bhitrakanika Wildlife Sanctuary, both the mangrove and agricultural lands remain in close vicinity, as in most of the cases, agricultural lands have been reclaimed of the mangroves [3]. Such kind of reclaimed lands suffer spatial and temporal variability in soil salinity and acidity posing threat to the agriculture [4]. The problem seems to be pronounced due to lack of irrigation facilities.

Mushrooming aquaculture farms intermittently situated with agricultural lands have been claimed to be another major cause of soil salinization in the area. Seepage of saltwater into the adjacent agricultural lands from aquaculture ponds is well documented and sometimes it makes cultivations impossible [5 – 7]. The seepage may take place through saltwater leakage, aquaculture pond overflow and leaching from sludge pile during rainfall [8]. Indirect soil salinization can occur as a result of irrigation of rice field and orchards from freshwater canal contaminated with the aquaculture farm effluent [9].

In the study area the chances of soil salinisation due to overtopping of river water is ruled out as no such occurrence was reported by the local people and the earthen embankments were found to be mostly intact [10]. Hence, a predominant role of seepage in soil salinisation should not be overlooked.

Khan et al. (2000) showed direct correlations between soil salinity and distance of aquaculture [7]. The salinity and sodicity of soil were found directly proportionate to the distance from the sea and aquaculture ponds [11]. A buffer of 60 m around aquaculture was suggested to protect such salinization of soil [7]. Taking all those facts under consideration, the effects of brackish water aquaculture on adjacent agricultural fields have been assessed for coastal areas of Bhitarkanika.

Methodology

Salinisation of soil at coastal areas may have several factors involved. Hence, for assessment of particular impact of brackish water aquaculture one needs to be very specific. Seepage being the major cause of salinisation, more salinity is expected near aquaculture. With this consideration, the soil salinity and distance of the sampling point from any aquaculture have been regressed.

The sampling of agricultural soil was done at 50 sampling points spread over the area and their distance from nearest aquaculture farm was recorded. However, one of the sampling was discarded afterwards and kept away from the final analysis as a few sampling snag were found with that.

The number of aquaculture farms present in the village under study was also recorded for further estimation of farm density. The farm density had been considered as a factor of general soil health of the region and regressed over the salinity distribution data. Soil salinity was estimated in the soil collected from a depth of 15 cm. The salinity of soil was expressed as Electrical Conductivity of 1:5 soil extract (EC_e) in dS m^{-1}. Based on previous experiments [12, 13] the soils were classified as normal (salinity <1.9 dS m^{-1}), saline soil (salinity ranges between 1.9 dS m^{-1} and 3.4 dS m^{-1}) and highly saline (salinity > 3.4 dS m^{-1}).

Results and Discussion

The salinity or EC_e of agricultural soil in villages around Bhitarkanika ranges between 0.275 and 6.18 dS m^{-1} with 76% of the samples represented the saline soil regime. Among those 49% (of the total) fall under the high salinity zones i.e. electrical conductivity is greater than 3.4 dS m^{-1}. However, based on the agricultural land salinity threshold (3dS m^{-1}) suggested by FAO (1999) [14] 55% of the sampled agricultural soils were found to be non-suitable for paddy cultivation.

Villages at and around Bhitarkanika National Park are delimited by earthen embankments, which have been found mostly intact throughout. Infrequent flooding however is reported in a few places without much significance. It is however presumed that the current trend of land conversion to brackish water aquaculture may have a strong hold on soil salinization process. Introduction of aquaculture farms within the sanctuary area require saline water transport to the aquaculture ponds through feeder channels. These, in turn, are the carrier of irrigation water for the agricultural fields of the area. Not only the irrigated water but also the salt water seepage into the field makes the soil saline even resulting salt encrustations at times. The soil salinity of the non-agricultural and non-mangrove lands of the area varied between 2.305 and 3.50 dS m^{-1}, which included soils from different areas of community and infrastructural utility [15]. In contrast, soils from mangrove forest or degraded mangrove vegetation area showed salinity between 6.24 and 11.925 dS m^{-1}.

Presence of aquaculture in vicinity was correlated with soil salinity in agricultural fields, as most of the brackish water shrimp aquaculture farms have been established in expense of agricultural lands and are situated intermittent within those.

Significant correlations ($p < 0.001$) are found among the soil salinity and distance of sampling point from the aquaculture farms. However, salinisaing trend up to a distance of 500 m from aquaculture was noticed.

Software generated salinity zonation suggests that the high salinity zones are situated mostly at the areas with higher density of aquaculture farms. While all the villages with more than 5 aquaculture farms per square kilometre have been found to fall in the high salinity zones, on the other hand only 6.25 per cent villages with an aquaculture density more than 3 per square kilometre represented low saline soil (Table 1). With reducing aquaculture density the percentage of high salinity villages decreased and subsequently the same for low salinity villages enhanced (Figure 1).

Conclusion

Salinisation is a problem of the coastal area due to rapid land conversion practices. The finding clearly indicates that introduction and storage of saline water in the aquaculture farm influence salinity of soil in nearby agricultural fields. Although salt content may not be the sole factor of soil infertility, but it has bearing on the productivity. The extent of soil salinity at vicinity of the aquaculture farms in the study area shows a similar result obtained for low salinity shrimp culture, but even this level of soil salinity may render the soil unsuitable for production [16]. In the study area 94 times increase in aqua farming was reported after 1989, most of which are intermingled within the agricultural fields [10]. Finally, inland shrimp farming represents a situation where significant short-term economic benefits may be obtained, but at the risk of creating long-term cumulative environmental impacts. The particular area of coastal Orissa is facing an economical crunch due to strict forest conservation practices promoting economic instability [17]. The tendency of people for land conversion to saline aqua farming practices seems making the existing coastal agriculture further vulnerable.

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Table 1 Relationship among aquaculture density and soil salinity.

Soil salinity Zone	Percentage of Villages (with different aquaculture farm density)					
	Aquaculture Farm density (km^{-2})					
	0 ≤ 1	**>1**	**>2**	**>3**	**>4**	**>5**
High salinity (>3.4dS m^{-1})	59.9%	69.38%	68.96%	68.75%	77.78%	100%
Moderate salinity (1.9 to 3.4dS m^{-1})	22.72%	18.36%	20.69%	25%	22.22%	0%
Low salinity (<1.9dS m^{-1})	18.18%	12.24%	10.34%	6.25%	0%	0%

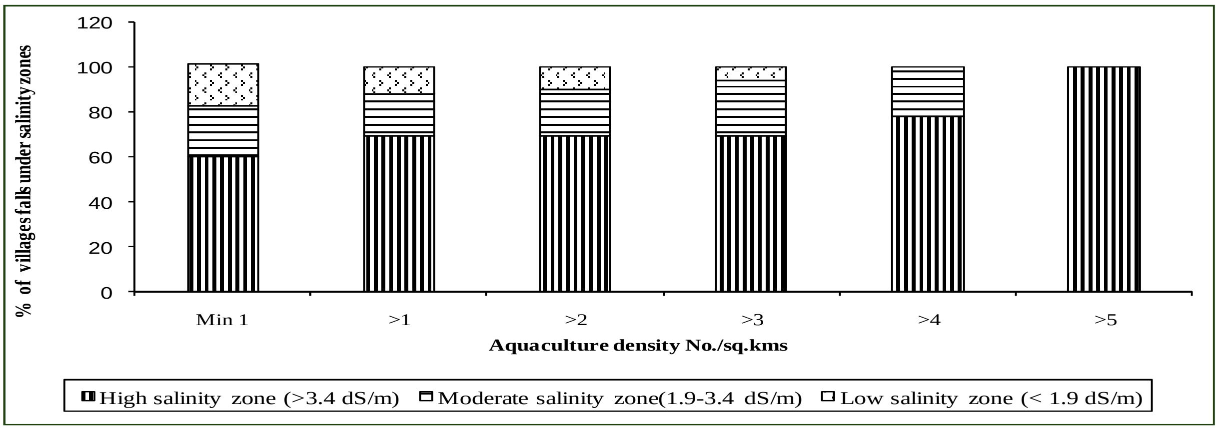

Figure 1: The proportion of villages in different salinity zones on the basis of aquaculture density per square kilometre.