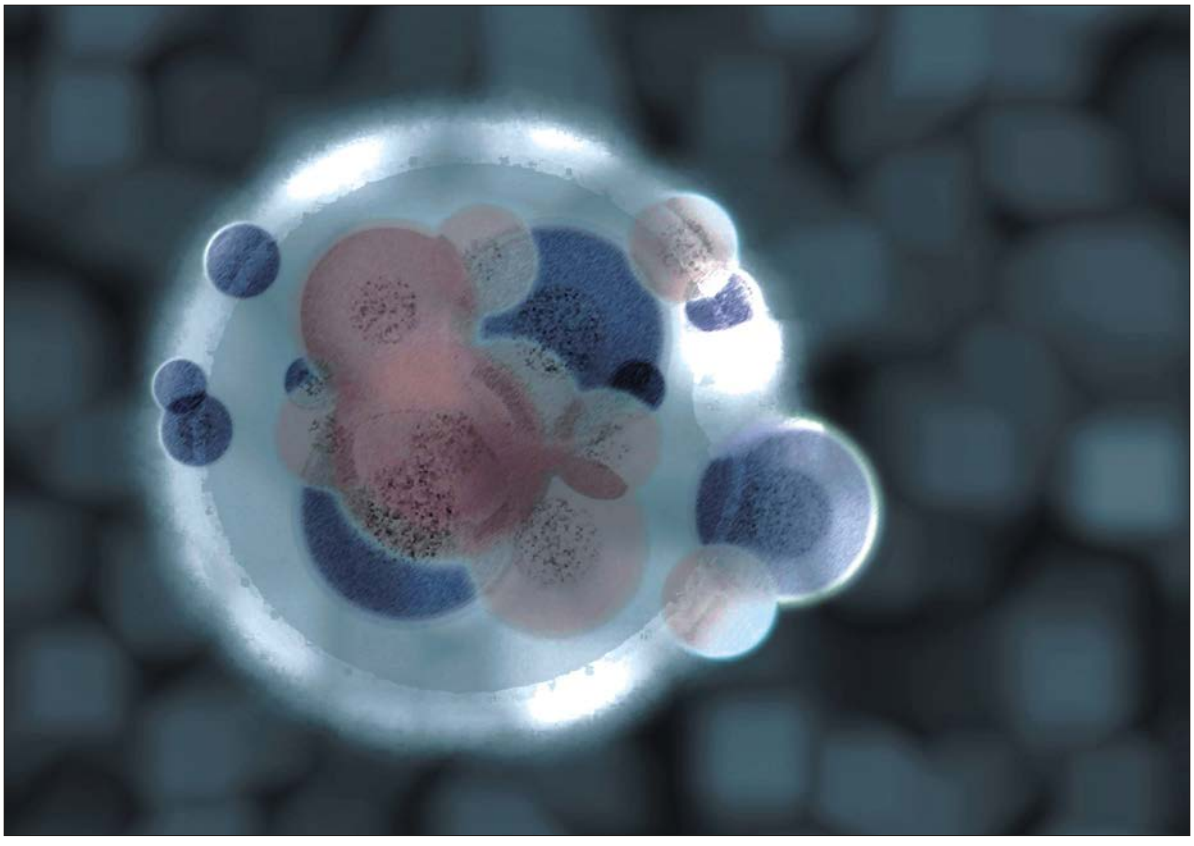

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Tree Species Survival in the Homestead Forests of Salt Affected Areas: A Perception Analysis for Bangladesh

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Abstract: One of the major problems in the coastal zone of developing countries is salinity intrusion. It is increasing in those countries due to natural and anthropogenic reasons. Soil salinity is causing decline in soil productivity and crop yield, which result in severe degradation of bio-environment and ecology. The effect of salinity on the agriculture crop is well understood even in developing countries but the effect on ecology is less explored. So in Bangladesh a perception analysis has been made on the effect of soil salinity on the homestead gardens of the worst salinity affected district Satkhira (21°36'-22°54' N and 88°54'-89°20' E). It has been found that the people have recognized salinity as a problem and construction of shrimp enclosures and maritime influence as the main reasons. Salinity increase results in reduction of crop production (2.50% per year), tree growth (2% per year) and vegetation coverage (1.87% per year). Tree species are disappearing due to salinity (three main species are *Swietenia macrophylla* King>*Achras zapota* Linn.>*Spondias pinnata* (Linn. f.) Kurz). The remaining trees are affected by diseases, like, top dying, leaf shedding and root rot. The main salt tolerant species are *Acacia nilotica* (Linn.) Willd. *ex* Del., *Cocos nucifera* Linn. and *Phoenix sylvestris* Roxb.

Key words: Shrimp enclosure, soil salinity, top dying, vegetation coverage

INTRODUCTION

Bangladesh is a tropical developing country with high population density, low per capita forest and high tree species diversity[1,2]. It is endowed with favorable climate to support tropical evergreen, semi-evergreen, deciduous, mangrove and homestead forest[3]. The homestead forests are the most highly productive (growing stock is > 200 m^3 ha^{-1}) forest and meet most of the demand of timber and fuelwood of the country[4,5]. But this over dependency is resulting in stock depletion in the homestead forests[6]. Moreover, in some parts of country it is degrading due to environmental reasons. Salinity intrusion in the coastal zone is one of such problem[7].

It has been recognized that in the coastal zone 8,142 sq km (5.5% of the country) land is salt affected and it is increasing at the rate of 146 sq km per year[8]. This is altering the chemical composition of the soil and making the environment non-conducive for tree growth[9]. In different literature the effect of salinity on bio-environment has been mentioned[10-13]. But in most of the cases they are sporadic and do not contain people's perception on this growing problem[1]. So this study was undertaken with the following objectives:

- Assess people's perception on the present trend of salinity
- Assess people's perception on the trend of vegetation
- Assess people's perception on the effect of salinity on vegetation

MATERIALS AND METHODS

Selection of the study area: The study was carried out in the Satkhira district (21°36'-22°54' N and 88°54'-89°20' E) of Bangladesh, as it is one of the worst salinity affected district (38% of the area is affected by different level of salinity and in the soil salinity map produced by SRDI[8] it is placed under highest saline zone) of the country. Of the total area (3858 sq km) of the district 40% area is under forest and 1% is riverine[14]. It is divided into seven upazilas (administrative unit) and out of them Shyamnagar

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upazila was chosen as the study area. It is situated beside the Sundarbans forest (Fig. 1) and the total area of the upazila is under different degree of salinity. Of the total area (368 sq km) of the upazila 80% land is agriculture land. Rest of the area is under homestead (11%), water bodies (8%) and forest (1%). Presently 8% area is used for shrimp cultivation.

The upazila consists of 13 unions (administrative unit under upazila) and 216 villages. The study was carried out in 22 villages covering 11 unions, selected through random sampling. From each village 12 households were purposively chosen among the households who have been living in the place for more than twenty years. This criterion was set to obtain proper information on past vegetation and salinity trends. A general description of the study area has been presented in Table 1.

Data collection and analysis: The respondents were interviewed with a pre-formulated questionnaire. Pre-testing of the questionnaire was done through a reconnaissance survey in Shyamnagar union. The final survey was done in November 2000-January 2001. Different descriptive techniques (Mean, Standard deviation) have been used to present the data. One-way ANOVA and correlation test have been used to compare the data. For analysis MS EXCEL, SPSSwin version 6 have been used.

RESULTS AND DISCUSSION

Perception of the people on the salinity level and trend: Majority of the people have thought that salinity level at their dwelling place/village is very high (57%) and most of them are the inhabitants of the unions of south-central (Munshiganj, Ramjannagar) part. But a considerable portion of the respondents thinks that salinity level at their locality is medium (33%). Whereas very few people think that salinity level is low (10%). The respondents' opinion mentioning high salinity shows negative relationship (r = -0.11) with the average salinity of the unions whereas the sequencing of the opinions mentioning medium and low salinity show positive relationship (r = 0.46 and 1; Table 2). But as a general remark they all have recognized that salinity is increasing.

It has been recognized by major portion of the respondents that salinity level in their locality has increased in last ten years (80%). Few have opined that the trend of salinity has been raised for the last 15 years (Table 3) for different reasons. The respondents from the south-west and south-central parts (Munshiganj, Iswaripur, Burigoalini union) have identified that salinity has been started to increase 5-10 years before whereas

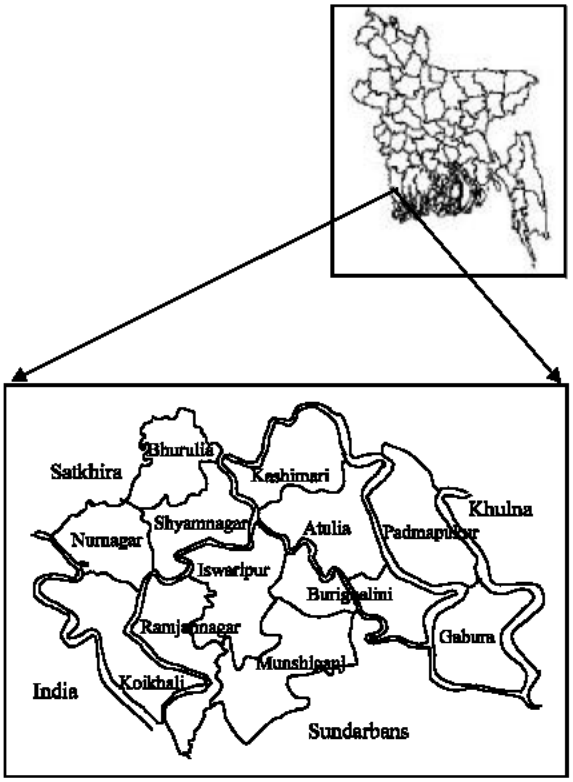

Fig. 1: Location of study area

inhabitants of northwest and north-central part have identified that salinity increment has started in last five years.

Cause of salinity increment: The main reasons of salinity increment as has been identified by the respondents are construction of shrimp enclosure, nearness to the sea, tidal water inundation and reduction in tree cover (Table 4). Opinions of the respondents varied significantly (F=52.97; d.f.=3, 84; P=2.56E-19) on the importance of these causes. The opinions have also varied in different unions. The inhabitants of middle portion (Burigoalini, Iswaripur) have emphasized on the construction of shrimp enclosures and inhabitants of the unions beside the Sundarbans forest (Gabura, Koikhali) have emphasized on the influence of sea as major factor for salinity increase.

Sequencing of the opinion on the effect of shrimp enclosures have positive relationship (r = 0.42) with the average salinity value of the unions. This could be substantiated by another fact that in the last twenty years 8% of the total area of the Upazila has been brought under shrimp cultivation and it is increasing.

Effect of salinity

Reduction in vegetation growth: In general the respondents have recognized that salinity exerts negative

Table 1: General features of the unions and distribution of the studied villages

	General feature*				
Union	Area (sq km)	Population	Major soil type	Soil salinity (average dSm^{-1})	Selected village**
Atulia	422	25025	Jhalokati Barisal	28.63	Noabeki (18), Bairshing (19)
Bhumlia	249	16165	Bazoa Jhalokati	27.80	Rudrapur (20), Durgapur (22), Begumpur (21)
Burigoalini	436	20481	Barisal Jhalokati	28.29	Pankhali (7), Datnakhali (9)
Gabura	411	26026	Barisal Kamal Kati	25.02	Sora (13)
Iswaripur	422	27812	Barisal Kamal Kati	25.36	Iswaripur (6)
Kaikhali	446	22265	Bazoa Jhalokati	27.97	Kaikhali (12), Jadoppur (14)
Kashimari	334	21503	Barisal Jhalokati	28.64	Kashimari (16)
Munshiganj	491	28395	Barisal Jhalokati	27.05	Jatindra nagar (3), Mirgang (2), Shinghortali (1), Dhanakhali (5), Munshiganj (4)
Padmapukur	411	19205	Barisal Kamal Kati	24.34	Chandipur (8)
Ramjaunagar	370	19247	Bazoa Jhalokati	27.99	Tangrakhali (11), Ramjannagar (15)
Shyamnagar	307	21104	Bazoa Jhalokati	28.20	Kashipur (10), Nakipur (17)

* After SRDI[8] ** Numbers in parentheses indicate village code

Table 2: People's opinion on the salinity level at their dwelling place

	Opinion (%) on salinity level			
Union	High	Medium	Low	Average soil salinity (dSm^{-1})
Kashimari	50	42	8	28.64
Atulia	59	38	3	28.63
Burigoalini	63	30	7	28.29
Shyamnagar	50	33	17	28.20
Ramjaunagar	63	25	12	27.99
Koikhali	55	38	7	27.97
Bhurulia	44	42	14	27.80
Munshiganj	67	28	5	27.05
Iswaripur	50	33	17	25.36
Gabura	50	33	17	25.02
Padmapukur	67	25	8	24.34

Table 3: People's opinion on the trend of salinity increment

	< 5 yrs	5-10 yrs	10-15 yrs	>15 yrs
Opinion (%)	43.0	41.0	11.0	5.0
Standard deviation	4.7	3.9	2.9	3.1

Table 4: People's opinion on the causes of salinity increment

Causes	Opinion (%)	S.D.
Shrimp enclosure	53.78	14.49
Nearness to the sea	25.41	10.64
Tidal water inundation	20.83	10.87
Reduction in tree coverage	15.27	12.73

Table 5: People's opinion on the reduction (%) in crop production, tree growth and vegetation proportion in last 15 years due to salinity

	Crop production	Tree growth	Vegetation production
Reduction (%)	36.86	30.16	26.33
Standard deviation	2.33	2.01	2.07

effect on the growth of crop and tree species. The reduction in the growth of tree species also contributes in the overall reduction of vegetation coverage. Table 5 presents opinion of the people on the effect of salinity on vegetation for last 15 years and the opinion vary significantly for different unions ($F=4.95$; d.f.=10, 22; $P=0.0009$). The inhabitants of Burigoalini and Padmapukur union have expressed highest reduction in vegetation due to salinity, whereas respondents of Shyamnagar, Iswaripur and Bhurulia have opined lowest.

The sequencing of the people's opinion about the salinity level has positive relationship with sequencing of opinion regarding the reduction of crop production ($r = 0.76$), tree growth reduction ($r = 0.59$) and vegetation coverage ($r = 0.65$). Considering the high soil salinity (measured value ranges between 24.34-28.64 dSm^{-1}) of the unions all the places are unsuitable for proper vegetation growth.

Reduction in tree vigor: The tree species are affected by different kind of diseases due to salinity, like, top dying, leaf shedding and root rot. The people's observation on the diseases affected by tree due to salinity has been presented in Table 6. It has been found that *Achras zapota* Linn., *Cocos nucifera* Linn., *Psidium guajava* Linn., *Swietenia macrophylla* King are dying due to these diseases at a larger rate than other species.

Similar types of observations have been made by different authors for these species (*Spondius* spp.[15], *Acacia* sp.[16], *Eucalyptus* sp.[17,18], *Leucaena* sp.[19], *Dalbergia* sp.[20]) in other areas.

Reduction in species diversity: The trees are affected by different diseases and gradually disappearing from the villages. Table 7 shows the rate of disappearances of species from the villages. It has been seen that *Mangifera indica* Linn., *Borassus flabellifer* Linn., *Swietenia macrophylla* King, *Syzygium cumini* (Linn.) Skeels, *Psidium guajava* Linn., *Achras zapota* Linn. are

Table 6: Prevalence of diseases (%) in different species due to salinity

Species	Prevalence of diseases (%) in different villages		
	Top dying	Leaf shedding	Root rot
Achras zapota Linn.	23	9	36
Phoenix sylvestris Roxb.	18	5	0
Cocos nucifera Linn.	23	5	5
Bombax ceiba Linn.	14	5	0
Artocarpus heterophyllus Lamk.	14	0	0
Acacia nilotica (Linn.) Willd. *ex* Del.	9	5	0
Psidium guajava Linn.	9	23	5
Tamarindus indica Linn.	14	0	0
Swietenia macrophylla King	14	27	0
Azadirachta indica A. Juss.	5	0	0
Albizia procera (Roxb.) Benth.	5	32	0
Mangifera indica Linn.	0	9	0
Samanea saman (Jacq.) Merrill	0	5	0
Spondias pinnata (Linn. f.) Kurz	0	5	5
Dalbergia sissoo Roxb. ex DC.	0	9	0
Syzygium cumini (Linn.) Skeels	0	0	5

Table 7: People's observation on the disappearance of tree species

Species	Reduction in last 15 years (%)
Swietenia macrophylla	79
Spondias pinnata	73
Achras zapota	73
Artocarpus heterophyllus	72
Azadirachta indica	32
Bombax ceiba	23
Ziziphus mauritiana	14
Tamarindus indica	9
Cassia siamea	5
Albizia procera	5

Table 8: People's observation on the tree coverage at different time interval

Village code	Tree coverage (%) in different year			
	1985	1990	1995	2000
1	78	61	49	34
2	76	68	43	31
3	76	69	48	33
4	79	55	44	36
5	74	56	39	29
6	77	61	40	28
7	70	63	41	30
8	81	62	43	31
9	68	63	45	36
10	70	60	55	41
11	72	64	57	43
12	71	59	43	26
13	89	73	60	49
14	82	69	58	48
15	84	74	66	51
16	88	70	61	53
17	86	72	59	43
18	87	79	62	53
19	79	64	51	43
20	72	64	58	53
21	69	64	60	51
22	73	60	53	45

disappearing from the villages at a higher rate than other species.

Reduction in vegetation coverage: The opinion of the respondents on the vegetation coverage of the study area in 1985, 1990, 1995, 2000 are given in Table 8. From Table 8 it could be seen that the vegetation coverage of the studied villages have been reduced at varying rate, which is significantly different for different years (F= 96.74; d.f.=3,84; P=3.65E-27). People's opinion on the vegetation reduction shows positive relation with salinity (r=0.48) and highest reduction is observed in Munshiganj, Padmapukr, Gabura and Iswaripur unions.

It has been observed in different countries (Ghana, Kenya, Tanzania, China, Pakistan, Indonesia, Vietnam, Thailand, Hungary, Turkey, Argentina, Cuba, Egypt, Australia, etc.) that due to soil salinity increase vegetation coverage is reducing[9].

Table 9: Species survival (%) in the study area

Species	Village (%)
Acacia nilotica	16
Phoenix sylvestris	16
Cocos nucifera	16
Eucalyptus camalduleusis	15
Dalbergia sissoo	9
Leucaena leucocephala	8
Samanea saman	6
Emblica officinalis	1
Butea monosperma	1
Acacia anriculiformis	1

Identifying salt tolerant species: Even when vegetation coverage is reducing at such rapid rate some species are growing well in saline condition. The respondents have ranked the species according to their performance in saline condition and this has been presented in Table 9. According to the opinion of the respondents *Acacia nilotica* (Linn.) Willd. *ex* Del., *Phoenix sylvestris* Roxb., *Cocos nucifera* Linn. and *Eucalyptus camaldulensis* Dehn are more salt tolerant than other species.

The people's observation shows similarity with the information available on the salt tolerant capacity of the species. In comparing the biological tolerance to salinity Parkash[21] have ranked the species in following order *Acacia nilotica>Eucalyptus camaldulensis>*

Azadirachta indica>*Acacia auriculiformis*> *Dalbergia sissoo*>*Albizia lebbek*>*Leucaena leucocephala*.

Thus it could be seen that vegetation coverage is reducing at an alarming rate due to species depletion resulting from salinity intrusion. On the verge of more shrimp enclosure construction and climate change there is huge possibility the rate of depletion will increase and new areas will be affected. So to arrest further depletion plantation with the salt tolerant species as identified by the respondents are recommended after proper trial.

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