Development of salt-affected lands in Southern Sri Lanka with special reference to Hambantota district

S. Subasinghe
Department of Crop Science, Faculty of Agriculture, University of Ruhuna, Mapalana, Kamburupitiya, Sri Lanka

Abstract

A detailed soil survey was conducted throughout the Hambantota district to determine the soil pH and Electrical Conductivity (EC) of the soils. The data points were taken by using GPS. The soil salinity map was drawn by using GIS and Remote Sensing technique. Results revealed that no strongly saline areas were found where soil EC was more than 16ds/m while 24.8sq.km or 1.2% of strongly saline areas where soil EC was from 8-16ds/m, 433.5 sq.km or 20.5% of moderately saline areas where soil EC was from 4-8ds/m, 806 sq.km or 38% of slightly saline areas where soil EC was from 2-4 ds/m and 855.2sq.km or 40.4% of non-saline areas where soil EC was from 0-2ds/m were found in the district.

A series of pot experiments were also conducted to screen the salt-tolerant tree species (i.e (Katuandara (Acacia leucoploea), Kottamba (Terminalia catappa), Ipil-Ipil (Leucenea leucocephala), Castor (Ricimus communis), Ranawara (Acasia auriculata L), Wood Apple (Feronia limonia), Tamarind (Tamarindus indica), Kathurumurunga (Sesbania grandiflora) and Cashew (Anacardium occidentale L)) available in the district. Plant height, Number of leaves, dry weight of above ground biomass, root depth and root biomass) were taken once a month up to 4 months of transplanting in polythene bags.

According to the results, the tree species used for the experiments could be ranked in order of tolerance to salinity levels as follows.

Katuandara > Tamarind > Wood Apple > Kottamba >Ipil-Ipil > Ranawara > Kathurumurunga > Castor >Cashew.

These selected tree species (i.e. Katuandara, Tamarind, Wood Apple, Kottamba and Kathurumurunga were established in the salt affected areas in Hambantota district and growth performances and soil salinity were monitored up to one year. Results revealed that even though site was strongly saline (salinity was 9.5ds/m), several tree species (Katuandara, Kottamba, Kathurumurunga etc.) were able to grow successfully and soil salinity was reduced in top and second 10cm soil layers form 1.6-2ds/m and 1.0-1.2ds/m respectively.

Keywords: Soil salinity, salt tolerant species, GIS and Remote Sensing

Introduction

Soil that contains excess salts so as to impair its productivity is called salt-affected soil. Soil salinity is a serious problem in areas where groundwater with high salt content is used for irrigation and soil salinization has been identified as a major process of land degradation.

Salinity affects 7% of the world's land area, which amounts to 930 million ha (Szabolcs, 1994). It has been estimated that the world is losing at least three hectares of arable land every minute due to

soil salinity. As the soil is subjected to degradation, the cost of reclaiming becomes higher, rising sharply until the threshold is passed, beyond which reclamation is no longer economically feasible

The salt-affected lands in Sri Lanka is about 223,000 hectares or about 3 percent of land area of the island, mainly found in the dry zone which receives an annual rainfall between 500 – 800mm during the North-East monsoon (Oct. – Dec.) with a moisture deficit period (drought) of 6 to 8 months. In the eastern seaboard alone stretching from Jaffna to Galle, it is estimated that there are about 100,000 hectares, which can be made use for planting tree species, which are salt-tolerant (Vivekanandan, 1989).

Therefore it is a very important and urgent need to restore these lands for agricultural production. In this regard, identification of salt-affected lands and taking necessary steps to restore these lands seems to be a national priority.

Materials and Methods

A series of experiments were conducted in pots and field to identify salt affected lands in the Hambantota district, screen salt-tolerant tree species available in the district and restore the salt-affected lands by growing selected salt-tolerant tree species.

The study was conducted in the Hambanthota district in southern Sri Lanka between latitude 5° 50′ to 6° 50′ N and longitude 80° 20′ to 81° 50′ E., belonging to the south western dry zone of Sri Lanka with annual rainfall of 1074 mm. The rainfall pattern of the district is bimodal, which received rains in two monsoons, such as N-E (November – March) and S-W (May – September). The main rainy season is from North-East monsoon which received more than 25% of annual rain. There is a long drought spell of 3 – 4 months. Mean annual temperature is 27°C.

The major crop cultivated in the district is paddy. Apart from paddy, several other vegetables and fruits are cultivated. The other major cropping system in the area is Chena cultivation. The major source of irrigation is rainfall. A part of Hambantota district is provided with irrigation water. The major irrigation schemes are Lunugam vehera, Udawalawa and Kiridi Oya.

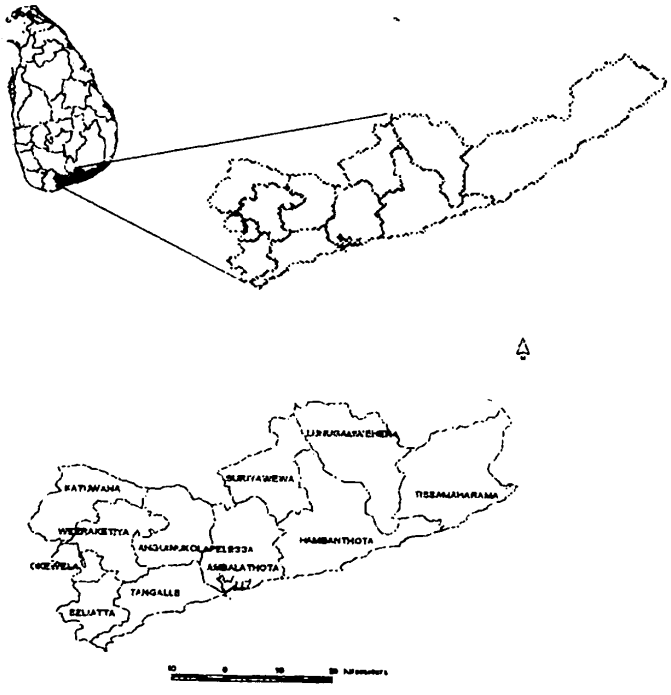

Fig. 1 The study area (Hambantota district)

Soil sampling

An extensive soil survey was conducted to collect soil samples throughout the district. The sampling was done at different depths (i.e. 0-10cm, 10-20cm, 20-30cm, 30-40cm and 40-50cm) by using a soil auger. The distance between sampling sites was approximately 3 to 5 km.

The exact position of sampling points in latitude and longitude was identified by GPS (Global Positioning System).

Topographic and digital maps

Topographic maps of Department of Survey of Sri Lanka used in the study were Timbolketiya (82), Kataragama (83), Yala (84), Hambantota (88) and Tissamaharama (89) of scale 1:50,000. Digital thematic maps of same map sheets and scale of 1:25000 digital maps were also used. In addition, Satalite maps were also used when preparing the salinity maps.

ArcView 3.2a and ILWIS 3.2 for Windows system have been used for all remote sensing and GIS analysis. Information about soil quality, soil types, agricultural practices and necessary ground truth data of the study area were obtained and used. The samples were taken to the laboratory, where EC and pH measurements were taken using EC and pH meters and created salinity maps using GIS and Remote Sensing Technique.

Identification of the Salt-tolerant tree species

A series of pot experiments were conducted to select salt-tolerant tree species (i.e (Katuandara , Kottamba, Ipil-Ipil, Castor, Ranawara, Wood Apple, Tamarind, Kathurumurunga Cashew, which were available in the district. Different salinity levels from 0.03 mc/cm (normal water), 4, 8, 12, 16, 20, 24, 30 and to sea water (40 ms/cm) were used as treatments. Poly bag seedlings of different species were used for the experiments. Different levels of saline water as assigned in different treatments were applied for each and every plant twice a week . 50 ml of saline water was applied each time up to 2 months and thereafter 100 ml of saline water was applied twice a week. All experiments were arranged in a Completely Randomized Design with four replicates. Growth parameters (Number of leaves, plant height, shoot dry weight, root dry weight and root depth etc.) were taken once a month by destructive methods and therefore four sets of treatments were maintained to collect data up to four months.

Establishment of selected tree species in the field

In this step, 2 months old selected tree species ((Katuandara *(Acacia leucoploea)*, Tamarind (*Tamarindus indica)*, Wood Apple *(Feronia limonia)*, Kottamba (*Terminalia catappa*) and Kathurumurunga *(Sesbania grandiflora)* in poly bags were established in the salt affected lands in the Hambantota district and growth performances of trees and salinity level of the soil were monitored for one year.

Results and Discussion

Identification of salt-affected areas of the district

Results of the preliminary study (De Alwis and Panabokke, 1972) showed that more salinity concentration was in the coastal belt. Therefore, when collecting soil samples throughout the district,

more priority has been given to the coastal belt. Therefore, distribution of sample sites was not in a regular form. All the locational data were taken using GPS system, entered into a database which was created using MS-ACCESS. EC and pH data also been entered to the database. Using Arc View software, a point map was drawn using all the locational data and each point has the EC and pH values for every sampling depth as attributes (Figure 3).

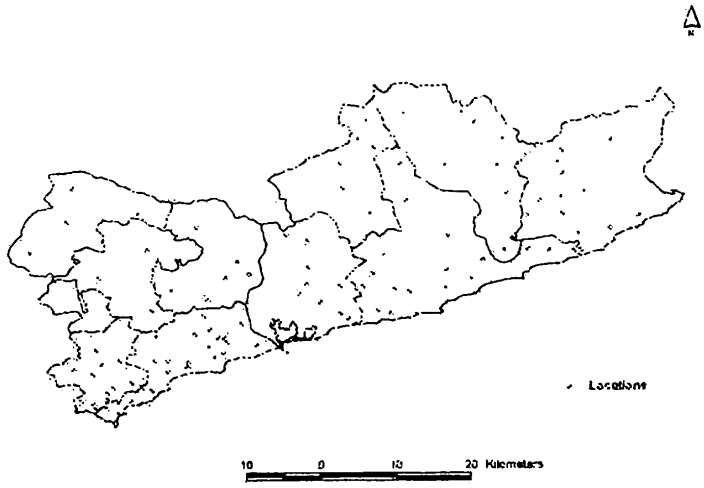

Fig 2: Distribution of the sampling points over the study area

When considering Divisional Secretariats in Hambantota district, EC values were lower in Katuwana, Okewela and Weeraketiya D.S. divisions. Tangalle, Ambalantota, Hambantota, Lunugamvehera and Tissamaharama D.S. divisions had high values of EC while Beliatta, Angunukolapalassa and Sooriyawewa D.S. divisions had moderate values of EC. The salinity levels in different layers of soil in different D.S. Divisions varied greatly. Salinity of deeper soil layers was higher in Sooriyawewa and Tangalle D.S. Divisions than surface soil, which may be due to ground water salinity (Gunasena and Subasinghe, 2004).

With regard to Beliatta and Angunukolapalassa D.S. Divisions, salinity in both, surface and deeper soils was higher, may be due to both ground water salinity and irrigation water and sea water especially for some parts of Angunukolapelassa D.S. Division close to Sea. Ambalantota and Hambantota D.S. Divisions showed the presence of ground water salinity because salinity in deeper soil layers was higher than surface soil layers, while Lunugamwehera and Tissamaharama D.S. Divisions showed higher surface salinity, may be due to irrigation water.

After creating the interpolated grid theme, it was classified in to 5 groups based on the classification done by Chhabra, 1996 (Table 3) and the salinity map was generated (Fig. 4).

Table 3: Salinity classes and respective EC values.

EC values (dSm^{-1})	Soil Salinity Class
<2	Non saline
02 - 04	Slightly saline
04 - 08	Moderately saline
08 - 16	Strongly saline
>16	Very strongly saline

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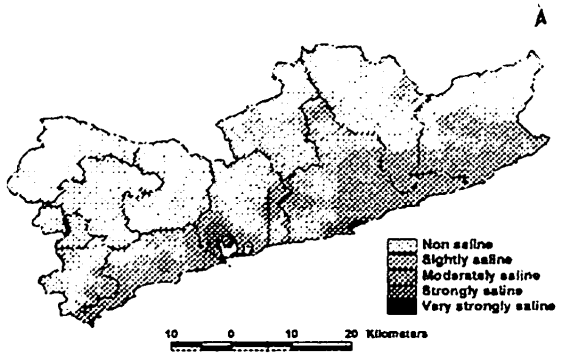

Fig 3. Salinity map of 0-10cm soil depth (Gunasena and Subasinghe, 2004)

Fi.7: Salinity map of 40-50cm soil depth

Area calculations for each saline categories through the study area has been done as shown in Table 4.

Table 4: Salinity distribution in Hambantota district

Salinity class	Area (Sq. Km)	%
Non saline	855.1	40.4
Slightly saline	806.0	38.0
Moderately saline	433.5	20.5
Strongly Saline	24.8	1.2
Very Strongly Saline		0.0
Total	2119.5	

As shown in Table 4, the total land area (including inland water resources) was 2119.5 square kilometers. From the total area, 40.4% was non saline areas and 38.0% slightly saline areas. There were 20.5 % of moderately saline areas and 1.2% of strongly saline areas in Hambantota district.

The data obtained from the ground surveys showed that *Acacia leucophloea* and *Acacia leucophloea* associates, identified as salt tolerant species (Subasinghe and Aruna, 2002; Subasinghe and Liyanarachchi, 2001,2002), were the most prominent vegetation over the salt-affected areas in Hambantota district.

Because of the higher tolerance of *Acacia leucophloea* to salinity, this species has become prominent and grow as healthy vegetation over the area when compared to other vegetation. *Acacia leucophloea* was more pronounced especially near lagoons and salterns in the district.

Screening of salt-tolerant tree species

Results of the screening trials are summarized in Table 5.

Table 5: Effect of different levels of salinity on growth performances of the tree species

Tree species	Salinity level of salt tolerance (mmohs/cm)	Source
Katuandara *(Acacia leucoploea)*	Close to sea water (>30)	Subasinghe and Liyana Arachchi, 2002
Tamarind (*Tamarindus indica)*	>30	Subasinghe and Liyana Arachchi, 2002
Castor *(Ricinus communis)*	up to 1	Subasinghe and Liyana Arachchi, 2001
Ranawara (*Acasia auriculata* L)	up to 12	Subasinghe and Liyana Arachchi, 2001
Wood Apple *(Feronia limonia)*	up to 12	Subasinghe and Liyana Arachchi, 2001
Kathurumurunga *(Sesbania grandiflora)*	up to 9.5	Subasinghe and Aruna Kumara, 2002
Kottamba (*Terminalia catappa)*	up to9.5	Subasinghe and Aruna Kumara, 2002
Cashew *(Anacardium occidentale* L)	<8.0	Subasinghe and Liyana Arachchi, 2003

Field establishment of salt-tolerant tree species and their performances

Selected tree species from the screening trials were established in the salt affected areas in Hambantota district and growth performances and soil salinity were monitored up to one year. Results revealed that eventhough site was strongly saline (salinity was 9.5ds/m), several tree species (Katuandara, Kottamba, Kathurumurunga etc.) were able to grow successfully and soil salinity was reduced in top and second 10cm soil layers form 1.6-2ds/m and 1.0-1.2ds/m respectively.

Conclusion

From the total land area (including inland water resources) of2119.5 square kilometers, total non saline area was 855.1 square kilometers (40.4%). Area of806.0 square kilometers (38.0%) was slightly prone to saline areas. There were 433.5 square kilometers (20.5%) of land area of moderate salinity which need improvement. From the total area of the district, there were 24.8 square kilometers (1.2%) of land of strongly saline areas.

Selected tree species could be ranked in order of salinity as follows.

Katuandara>Ipil-Ipil>Maliththa>Ranawara>Tamarind>Wood Apple>Kathurumurunga>Castor >Cashew.

Results proved that even in strongly saline areas (salinity was 9.5ds/m), several tree species (i.e. Katuandara, Kottamba, Kathurumurunga etc.) can be grown successfully and soil salinity can be reduced substantially. Therefore, there is a strong possibility to restore the salt-affected lands in the Hambantota district by cultivating salt-tolerant tree species.

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Acknowledgement

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