Saline soils and salinity assessment in western Golestan Province

Holm Voigt [1], Martin Kehl [2] and Farhad Khormali[3]

[1]: Department of Geography, University of Bonn, Meckenheimer Allee 166, 53115 Bonn, Germany, holm@uni-bonn.de

[2]: INRES-Soil Science, University of Bonn, Nussallee 13, 53115 Bonn, Germany, mkehl@uni-bonn.de

[3]: Department of Soil Science, Gorgan University of Agricultural Sciences and Natural Resources, Shahid Beheshti Avenue, Gorgan, Iran, khormali@gau.ac.ir

Introduction

Soil salinization adversely affects soil fertility and can lead to severe land degradation. Accumulations of soluble salts in the soil increase the osmotic potential of the soil which aggravates the water uptake for plants, an imbalanced ionic adsorption is a second effect. (VAN HOORN & VAN ALPHEN, 1994). Since soil salinization causes yield depression, it is a massive problem for farmers in the lower alluvial plains of Gorgan and Atrak rivers located in the north-western part of Golestan Province.

This area is characterised by a steep climatic gradient: hot, dry climate in the north with mean annual temperatures of about 19°C and 250mm annual rainfall whereas at the northern slopes of the Alborz Mountains in the south, there are slightly lower annual temperatures of about 17°C with higher rainfall of more than 600mm. The depth to water table oscillates from 300 to less then 80 cm below surface due to spatial and temporal variability. The slope of the land surface ranges between 0-1° (MINISTRY OF AGRUCULTURE, 1969), so it is rising very gently from -26m below sea level at the Caspian Sea to -6m below sea level at the town of Incheboron located in about forty kilometres distance to the coastline. The plains are covered by fine-grained calcareous alluvium (EHLERS, 1980).

The aim of this investigation was to characterize salt affected soil profiles of the area and to assess the degree of soil salinization as a basis for further investigations and modelling of soil salinity.

Materials and Methods

The sampling area is located in the west of Golestan Province with the settlements of Incheboron and Agh Ghala designating the easternmost points. Soil profiles of Pahlavidej soil series, Ariadasht soil series saline phase, Aghtappeh soil series solonchak, Kavous soil series and Khazar soil series (MINISTRY OF AGRICULTURE, NO DATE) , located along a N-S and E-W transect, were investigated. The distance of the soil profiles to the Caspian Sea varies from approximately four to forty kilometres. Profiles 1 and 4 are located in non-cultivated areas whereas profile 2, 3 & 5 were under rain-fed farming. Only the field of profile 3 was equipped with an underground drainage system.

Nine additional auger samples were taken from in between the profiles in order to receive a higher spatial resolution. Sampling from the profiles was according to soil horizons detected, whereas the auger samples were taken at defined depths of 0-30, 30-60 and 60-90cm.

The soil samples were dried and sieved on a standard mesh sieve set. The soil texture was determined by a combined sieving and pipette method after destroying organic matter by H_2O_2, dissolving carbonates by $HCl_{(aq)}$ and adding 0,1M $Na_4P_2O_7$ as a dispersion agent. The percentage of carbonates was identified by the volumetric method (SCHEIBLER). Electric conductivity (EC) and pH of the soil saturation extract were measured according to standard laboratory methods (SCHLICHTING ET AL. 1995). The ionic composition of the saturation extract was measured by atomic absorption spectrometry (Na, K, Mg and Ca) and ion exchange chromatography (Cl, SO_4^{3-}, NO_3^- and PO_4^{3-}). Concentration of HCO_3^- was estimated from the ion balance. ESP was estimated according to VAN REEUWIJK (2002).

Results and discussion

The profiles are classified as a sodic Haplogypsid, sodic Haplocalcids and one sodic Haplocambid. The texture is silt loam or loam. The soils were found to be mostly saline sodic or sodic with EC_{SSE} (25°C-normalized) reaching values up to 21,5 mS/cm in the northernmost profile. The soluble salts are mainly dominated by sodium with the sodium adsorption ratio (SAR) ranging from 7,79 to 137,92 mmol/kg and the exchangeable sodium percentage (ESP) estimated from 9,17 to 66,91%. Soil $pH_{(H2O)}$ ranges from 7,76 to 8,87. Table 1 gives an overview on

Parameters	Min	Max	Mean	S.D.	C.V. [%]
Sand [%]	0,0	30,1	4,9	6,2	125,2
Silt [%]	62,7	96,5	84,0	6,5	7,8
Clay [%]	2,0	29,9	11,1	6,5	58,5
pH	7,8	8,9	8,4	0,3	3,2
EC [mS/cm]	0,7	21,5	7,1	5,2	72,5
K+ [$mmol_{eq}$/kg]	0	26	3	4,1	154,3
Ca2+ [$mmol_{eq}$/kg]	6	79	29	16,3	56,6
Mg2+ [$mmol_{eq}$/kg]	13	513	124	104,9	84,9
Na+ [$mmol_{eq}$/kg]	24	1879	547	447,4	81,8
Cl^- [$mmol_{eq}$/kg]	27	2361	606	589,4	97,2
NO_3^- [$mmol_{eq}$/kg]	0	15	4	4,1	96,3
PO_4^{3-} [$mmol_{eq}$/kg]	0	0	0	0,0	177,5
SO_4^{2-} [$mmol_{eq}$/kg]	13	264	99	46,5	47,1
HCO_3^- [$mmol_{eq}$/kg]	0	102	26	26,0	101,8
Total soluble salts [%]	0,05	2,22	0,66	0,4	65,7
Gypsum [%]	0,02	10,04	3,96	3,1	78,8
Carbonates [%]	10,74	35,38	16,98	5,5	32,3
SAR [mmol/kg]	7,7	137,9	59,2	30,0	50,7
ESP [%]	9,2	66,9	43,3	13,3	30,7

Table 1: The mean values, Standard Deviation (S.D.) and Coefficient of Variation (C.V.) of soil physical and chemical properties of the soils investigated

the measured and estimated values of physical and chemical properties of the soils investigated. Sodium concentrations tend to decrease with depth below surface whereas carbonate concentrations slightly increase in most profiles. This indicates an upward directed soil water flux. Salinity and sodicity increase towards the northern part of the sampling area and towards the Caspian Sea. A spatial pattern of salinity seems to become apparent.

Outlook

Further investigations with higher spatial sample resolution will be done to understand the operating processes of soil salinization in that area and to verify the spatial pattern of soil salinization which is assumed. In a second step, the numerical computermodel SAHYSMOD will be applied to the data collected and adjusted to the local conditions to simulate and predict soil salinization.

References

EHLERS, E. (1980): Iran: Grundzüge einer geographischen Landeskunde, Wissenschaftliche Buchgesellschaft (Darmstadt).

MINISTRY OF AGRICULTURE AND RURAL DEVELOPMENT – SOIL INSTITUTE (NO DATE): Reconnaissance soil map of Gorgan Rud north bank area – west part Gomishan, 1:100,000.

MINISTRY OF AGRICULTURE – SOIL INSTITUTE (1969)[2]: Regional map of land resources and potentialities, Gorgan region – east Mazandaran, 1:250,000.

SCHLICHTING, E., BLUME, H.P. AND K. STAHR (1995)[2]: Bodenkundliches Praktikum, Blackwell Wissenschafts Verlag (Berlin).

SOIL SURVEY STAFF (2006)[10]: Keys to soil taxonomy, United States Department of Agriculture (Washington).

VAN REEUWIJK, L.P. (2002)[6]: Procedures for soil analysis, in: ISRIC technical papares (9), ISRIC publications (Wageningen).

VAN HOORN, J.W. AND J.G. VAN ALPHEN (1994)[2]: Salinity Control, in: Drainage Principles and Applications, ILRI Publications 16 (Wageningen).