Salt-affected soils in Colombia: modelling study case in CAR zone

Rosalina Gonzalez[1]*, Julian Avila[2], Karina Ariza[2], Rocio Afanador[2] [1]La Salle University, rogonzalez@unisalle.edu.co Environmental Studies Research Line Coordinator – Agroscience PhD Program,
[2]La Salle University, Environmental and Sanitary Engineering Student

INTRODUCTION

The soil degradation is a worldwide problem, and the environmental authorities are facing different ways to determine the impact on this natural resource. This project looked for a salinity degradation model for soils of the CAR (Regional Autonomous Corporation) area in Colombia. This corporation is the biggest regional Environmental Authority of the country. To do that a multiple linear regression model was tested, using the physicochemical soil characteristics of the soils studied.

METHODOLOGY

This project use the physicochemical soil characteristics of CAR places and The Agustin Codazzi Geographical Institute (IGAC) as baseline. The procedure use was:

1. Municipalities recognition of CAR places and the physicochemical characteristics information of soils in this area.
2. Analysis of the CAR and IGAC physicochemical characteristics information and determine their impact on the soil salinity, according to the soil use.
3. Look for soil salinity models based on physicochemical information. And comparison the variables of the models with the information provided by authorities.
4. Select the model and propose some scenarios based on the physicochemical properties and program them in R.
5. Make the statistical analysis of the results (R^2 the mean square error RMSE) and determine the effectiveness of the models.

RESULTS

Results indicate that CAR and IGAC data are different; they do not measure the same variables at the same places. An interesting fact is that the electrical conductivity that is very important to determine soil salinity is measure by CAR and not by IGAC. The last one is the national reference laboratory and is important to improve the protocols to include environmental variables on it.
Figures 1 and 2 show the geographical position of samples by CAR and IGAC. It is important to note that there are more than 10 years of difference by both data; so, using all the information in the model did not generate an adequate correlation output.

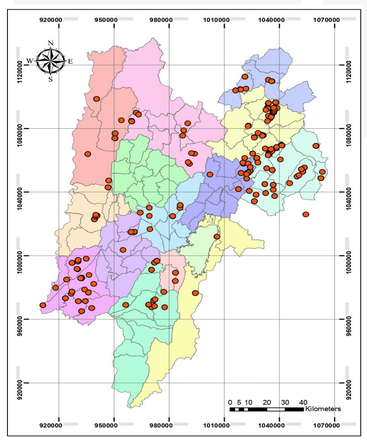

Fig 1. Spatial location of sampling sites of CAR data (Own elaboration, 2020)

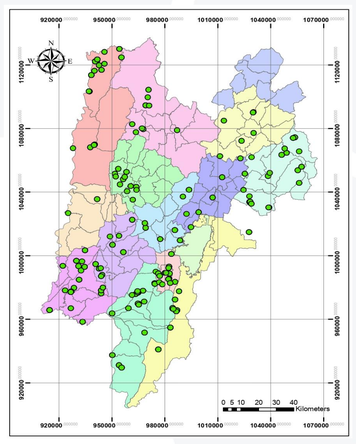

Fig 2. Spatial location of sampling sites ok IGAC data (Own elaboration, 2020)

Salinity data according to the Protocol for saline soils of IDEAM, 2018, and the FAO Handbook for saline soil management.

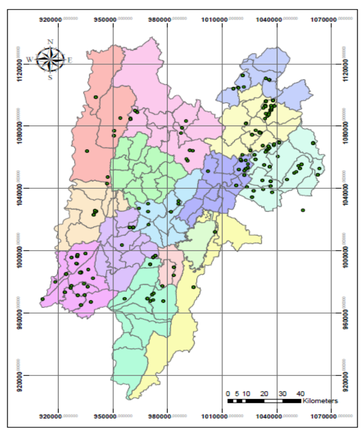

Fig 3. Salinization degree according FAO criteria (Own elaboration, 2020)

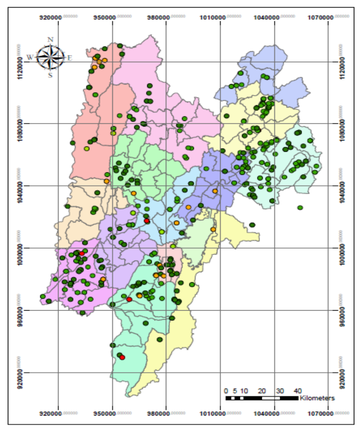

Fig 4. Salinization degree according to Soil Salinity Protocol (Own elaboration, 2020)

The mathematical models obtained are described as in equation 1:

$$\mathbf{Y = a + bX_i + cX_{i+1} + dX_{i+2} + dX_{i+n} + e_i}$$

Y = electrical conductivity or dependent variable
X_i = Independent variable
a = Regression constant
b, c, d = Angular coefficients of the variable
e = Random error

As was seen in figures 1 and 2, not all regional places have physicochemical data, so, it is necessary to get new and complete information to validate the models. Tables 1, 2 and 3 show the best models according to R^2 and the RSME values.

Table 1. Most optimal models for scenario 1 (Own elaboration, 2020)

Regional Directions	Scenario 1	
	R^2	RMSE
Almeidas	0,87	0,0131
Alto Magdalena	0,94	0,1237
Bogota and La Calera	0,98	0,0057
Chiquinquirá	0,98	0,0004
Ubaté	0,74	0,4571

Table 2. Most optimal models for scenario 2 (Own elaboration, 2020)

Regional Directions	Scenario 2	
	R^2	RMSE
Almeidas	0,81	0,0165
Alto Magdalena	0,79	0,2193
Bajo Magdalena	0,71	0,0074
Bogotá and La Calera	0,96	0,0078
Sabana Centro	0,70	0,0263
Sumapaz	0,99	0,0001
Ubaté	0,52	0,6367

Table 3. Most optimal models for scenario 3 (Own elaboration, 2020)

Regional Directions	Scenario 3	
	R^2	RMSE
Almeidas	0,77	0,017
Magdalena Centro	0,83	0,002
Sabana Centro	0,77	0,028
Soacha	0,99	0,00004

As the sodium soil content is important in the salinity degradation measures. It was determined this content in the CAR and IGAC data

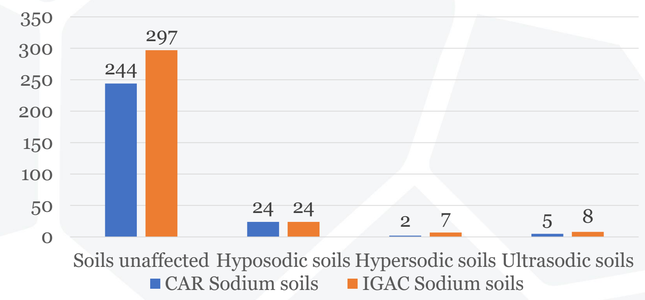

Fig 5. Quantitative distribution of saline soils sampled in the CAR jurisdiction (Own elaboration, 2020)

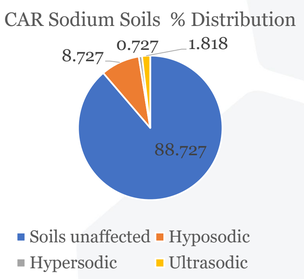

Fig 6. % Distribution of CAR saline soils in CAR area (Own elaboration, 2020)

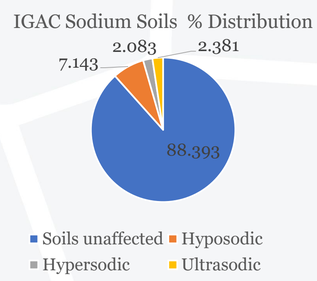

Fig 7. % Distribution of IGAC saline soils in CAR area (Own elaboration, 2020)

CONCLUSIONS

In Colombia, many institutions have participated in salinity measures, but they used different methods in different places; so, is not easy make good comparison. Is necessary a complete monitoring campaign to the CAR territory. In addition, more detailed physicochemical analyzes of the specific areas are required for the development of the most complex salinity models; such as meteorological parameters, irrigation water, evapotranspiration, among others and with a wide temporal trajectory.

Most of the soils in CAR Jurisdiction do not present high conductivity values that show salinity; however, the number of samples is not enough related to the area of CAR territory. This represents a challenge of CAR in terms of soil sampling to feed the geographic visualization record and the multiple linear regression model carried out. These results can be used for continuous improvement processes of CAR.

ACKNOWLEDGEMENTS

CAR (Environmental Authority)
La Salle University

GLOBAL SYMPOSIUM ON
SALT-AFFECTED SOILS
20 - 22 October, 2021