Salinity risk mapping using an integrate approach and land cover in semi-arid area, Morocco

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INTRODUCTION

Salt-affected soils are increasingly gaining global attention due to pressure of growing population and the ever-increasing food demands in many parts of the world. Soil salinization is a multifactorial and complex process that occurs following primary (natural) or secondary (anthropogenic) factors, or the combination of both. Natural salt accumulation as a process is associated with and accelerated by a number of physical factors, such as soil properties, geological features, depth of water table, topography, climate conditions, water use, and groundwater. Additionally, management practices can influence strongly the process of salt accumulation. For instance, land cover has a crucial impact on local hydrology and the distribution of salt in the landscape. In this research we are proposing a modified version of the soil salinity risk index (mSSRI) that includes land cover. The first goal of this investigation is to map soil salinity risk in Tadla plain using the mSSRI. The second goal is to integrate land cover as a dynamic component into the mSSRI, in order to assess the impact of agricultural practices (i.e., land cover) on soil salinity risk.

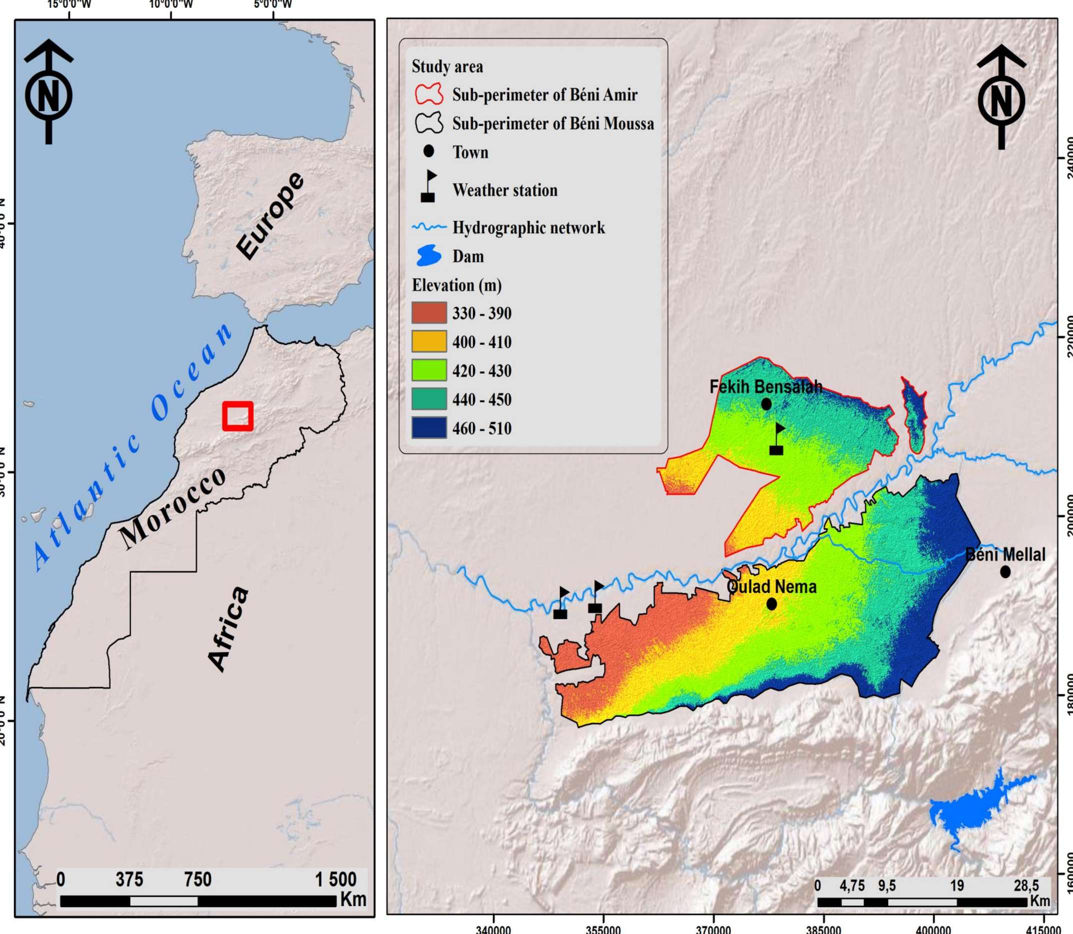

Fig 1. Geographic location of the study area

METHODOLOGY

The soil salinization risk index (SSRI) is an additive method (Chaaou et al., 2020), which includes nine factors for its computation. SSRI is based on a 5 X 9 matrix with two weighting levels (1 and 2).

Five risk classes of salinization, ranging from zero risk to very severe risk and nine factors including electrical conductivity (EC) of groundwater, EC of surface water, EC of soil, depth of groundwater, aridity index, climate type, topography, soil texture and substratum. Each factor is assigned a weight (Wi) to represent its relative contribution on the accumulation of salt in a given soil.

The calculation of the modified Soil Salinity Risk Index (mSSRI) includes the abovementioned factors in addition to land cover factor. Land cover mapping has been based on a time series of satellite images from Sentinel-2A sensor.

Land cover classes have been classified according to their contribution to the risk of salinization. The weighted values for each factor are added together to estimate mSSRI. The modified index ranges from 10 "very low" to 50 "very high" depending on the risk class (Table 1). The approach used to develop the mSSRI map is summarized in Figure 2.

Table 1. Severity Classes of Salinity Risk (Chaaou et al., 2020)

Class	None	Slight	Moderate	Severe	Very severe
Risk score	10-15	16-25	26-35	36-45	46-50

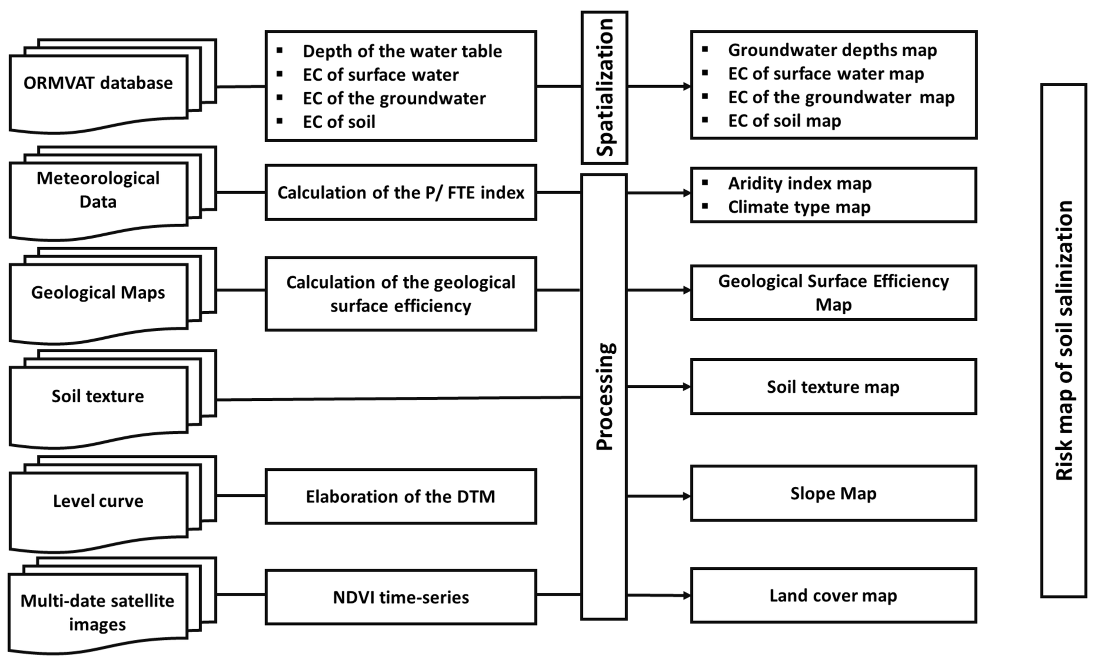

Fig 2. Approach used to develop the mSSRI map

RESULTS

The spatial distribution of the soil salinity risk (Figure 3) delineates four classes that are moderate potential risk, low potential risk, moderate current risk and severe current risk. The results show the predominance of moderate potential risk class (%). It is also noteworthy to mention that the area of severe potential risk (mainly in the sub-perimeter of Béni Amir) corresponds to soils that are highly sensitive to salinity (Figure 4). The severe risk class lies in areas where the salinity of both groundwater and soil is high. In addition, the variability of salinity risk shows a strong relationship with topography in Tadla plain. The perimeter downstream is characterized by a severe risk class.

According to these results, the Béni Amir sub-perimeter displays a higher salinity risk compared to the Béni Moussa sub-perimeter. The contrast between these two sub-perimeters is due to a number of factors, particularly the use of saline water for irrigation and the intensification of agricultural practices associated with excessive use of fertilizers. It should also be emphasized that the increase in irrigated areas and the persistent demand for water have forced farmers to over-exploit groundwater despite its poor quality.

In the light of the results achieved, it can be concluded that land cover can be a key variable in the prediction of soil salinity risk in line with its effect on soil water status. The more water- and fertilizer-demanding the crops are, the more they impair the accumulation of salts in the soil.

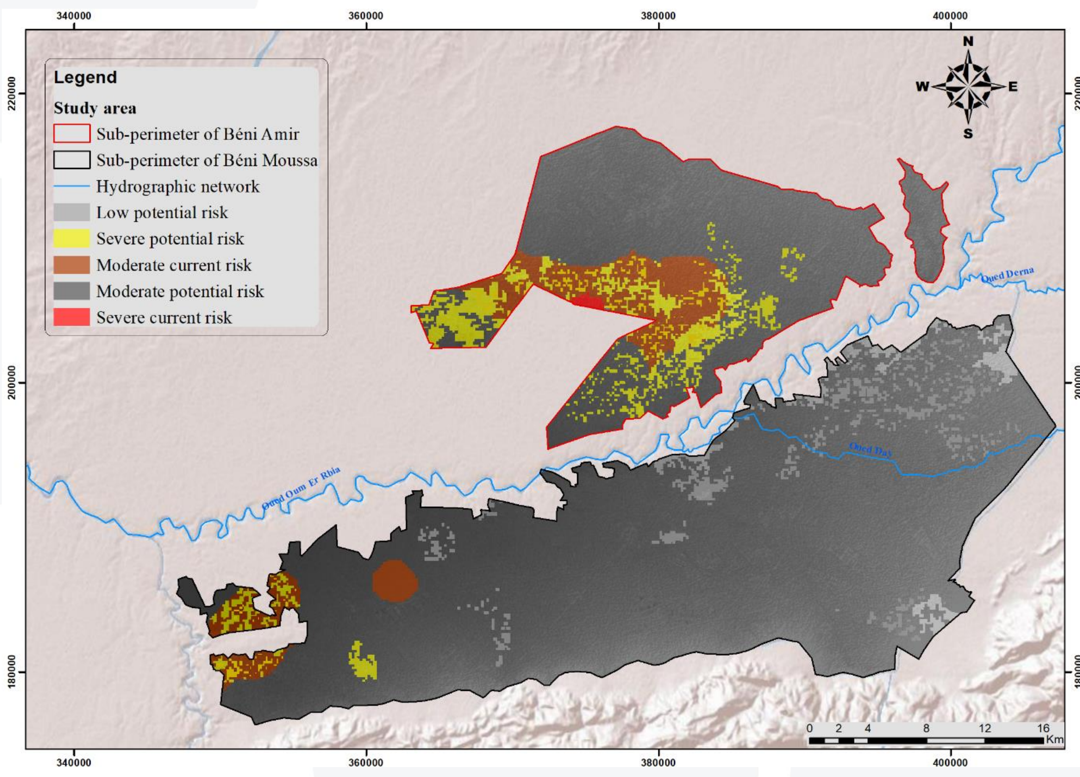

Fig 3. Soil salinity risk map using mSSRI

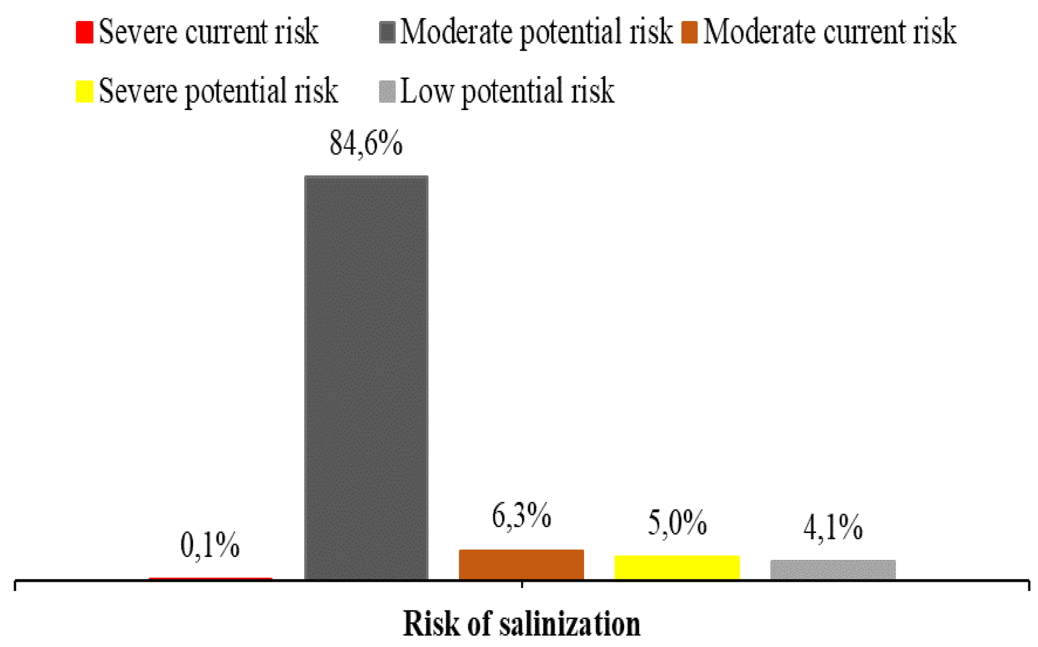

Fig 4. Soil salinity risk classes using mSSRI

CONCLUSIONS

Morocco faces many challenges related to the extent of salt-induced land. To monitor the progress of this degradation process, the mSSRI, an approach that combines multi-source data and land cover allowed us to spatially map current and potential risk classes of soil salinity in Tadla plain and take the appropriate actions to minimize the treat. The use of this approach is also justified by its simplicity and ease of implementation in a GIS environment. The improvement of the index by integrating land cover in the original model made it possible to properly evaluate the soil salinization risks in Tadla plain, and to enhance soil salinization prediction.

To preserve soil quality and control the risk of soil salinity, it is recommended that consideration be given to crop selection, tillage practices, irrigation systems and nutrient management. Additionally, the installation of suitable drainage system is highly recommended.

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