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A conceptual model for landscape evolution and agricultural land salinization in coastal area

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Soil salinization is a major threat to agricultural lands. Among salt-affected lands, coastal areas could be considered as highly complex systems, where salinization degradation due to anthropogenic pressure and climate-induced changes could significantly alter system functioning. In order to preserve land resources and crop production potential, a possible solution to salinization is the promotion of sustainable land management practices that sustainably reduce salinity. To this end, modelling is an appropriate method for simulating and testing the evolution of soil salinity according to different land management scenarios. However, the use of numerical models presumes the ability of users to produce quantitative data and to have hypotheses on system functioning and complexity. A preliminary step prior to this numerical work could be to use a conceptual model as an evaluation tool, allowing the reduction of complexity.

This study aimed to propose a conceptual model for water fluxes in a coastal vineyard area affected by salinity, which can help to identify the relationships between agricultural landscape evolution and actual salinity. First, we conducted field investigations from 2012 to 2016, mainly based on both soil (EC1/5) and water (ECw) electrical conductivity survey. Subsequently, we proposed and used a conceptual model for water fluxes and conducted a time analysis (1962–2012) for three of its main constitutive elements, namely climate, river, and land systems.

Investigations of both soil and water electrical conductivity of agricultural lands allowed us to characterize spatial structures of soil and water salinity affecting vine production and to identify the river as a preponderant factor in land salinization. We subsequently proposed a conceptual model for water fluxes in the coastal agricultural area. Main landscape elements (sea, river, atmosphere, land use and cover, soil, water table, and humans) and processes constitute this simple model. This model, when coupled with time analyses of climate, river, and land systems since 1960, helped us to understand the main evolutionary processes responsible for the disruption of system equilibrium, favouring overall salt accumulation in the soil root zone: (i) a decrease of freshwater influx due to river discharge evolution, (ii) an increase of freshwater outflow due to climate evolution, (iii) an increase in saline water influx due to seawater intrusions into the river, and (iv) a decrease in saline water outflow due to ditch network evolution.

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