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Modeling the effects of salinity and vegetation salt-tolerance on plant-water interactions

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Ecohydrological models have been extensively used to investigate the role of abiotic stress in shaping plant-water interactions and ecosystems productivity. In this context, the research effort has mainly focused on water-limited ecosystems under the hypothesis that water scarcity is the main source of stress. However, a number of ecological and plant physiological studies have pointed out how soil salinity represents a crucial stress factor for vegetation in salt-affected soils – estimated to cover already over 9 billion ha worldwide – and coastal ecosystems.

The objective of this study is to model the effects of salinity on plant-water relations in order to better understand the interplay of soil hyperosmotic conditions and osmoregulation strategies in determining different transpiration patterns. Salinity reduces the water potential, therefore is expected to reduce stomatal and plant conductance (eventually leading to cavitation for very high salt concentrations). Also, plant adaptation to short and long-term exposure to salinity comes into the picture to maintain an efficient water and nutrients uptake.

We introduce a parsimonious soil-plant-atmosphere continuum (SPAC) model accounting for both salt-exclusion at the root level and osmoregulation - i.e. the adjustment of internal water potential in response to salt-stress. The model is used to interpret a paradox observed in salt-tolerant species where maximum transpiration occurs at an intermediate value of salinity ($C_{Tr,max}$), and is lower in more fresh (C<$C_{Tr,max}$) and more saline (C>$C_{Tr,max}$) conditions. Such non-monotonic transpiration-salt concentration patterns can be largely explained by plant osmoregulation, while the peak of transpiration at $C_{Tr,max}$ tends to disappear over longer time scales, when ionic stress appears and morphological adaptations become predominant.

Osmoregulation emerges here as a water-saving behavior similar to the strategies that *xerophytes* use to cope with aridity. The maximum of transpiration at $C_{Tr,max}$ is thus the result of a trade-off between the enhancement of salt-tolerance and optimal carbon assimilation.