Analyses on salt-marsh vegetation composition changes in the Venice lagoon in the last twenty years

Zhicheng Yang1, Sonia Silvestri2, Marco Marani3, and Andrea D’Alpaos1

1University of Padova, Department of Geosciences, Italy (zhicheng.yang@phd.unipd.it; andrea.dalpaos@unipd.it)
2University of Bologna, Department of Biological, Geological, and Environmental Sciences, Italy (sonia.silvestri5@unibo.it)
3University of Padova, Department ICEA, Italy (marco.marani@unipd.it)

Coastal salt-marshes are important eco-geomorphic features of coastal landscapes providing valuable ecosystem services, but unfortunately, they are among the most vulnerable ecosystems around the world. Their survival is mainly threatened by sea-level rise, wave erosion and human pressure. Halophytic vegetation distribution and dynamics control salt-marsh erosional and depositional patterns, critically determining marsh survival through complex bio-morphodynamic feedbacks. Although a number of studies have proposed species-classification methods and analyzed halophytic vegetation species distribution, our knowledge of the temporal evolution of species composition remains limited. To fill these gaps and better describe vegetation composition changes in time, we developed a novel classification method which is based on the Random Forest soft classification algorithm, and applied the method to two multi-spectral images of the San Felice marsh in the Venice lagoon (Italy) acquired in 2001 and 2019. The Random Forest soft classification achieves high accuracy (0.60 < $R^2$ < 0.96) in the estimation of the fractional abundance of each species in both images. We also determined the local dominant species, i.e. the species with the highest fractional abundance in each pixel. Our observations on the dominant species in 2001 and 2019 show that: 1) the area dominated by Juncus and Spartina decreased dramatically in such period; 2) the area dominated by Limonium almost maintained constant; 3) a noticeable decrease in the bare-soil area occurred due to the encroachment of Salicornia between 2001 and 2019. We also noticed that the probability distribution of the dominant patch area of each species is consistent with a power-law distribution, with different slopes for different vegetation species at different times. We suggest that vegetation composition changes are related to sea-level rise and to the species-specific inundation tolerance.