

Non-invasive high-resolution investigations of marshland processes

Salt marshes are vegetated landforms periodically inundated by the tide and represent a fragile transition zone between water and terrestrial environments. Among other things, salt marshes function as a buffer zone against coastal storms, provide essential ecosystem services, and act as an indicator of environmental change and impact [e.g., Silliman et al., 2009]. The fate of these vitally important ecosystems is of great concern, because their extent worldwide has dramatically decreased in the last century [Gedan et al., 2009], threatened as they are by climate change and human interference. Salt marsh dynamics are governed by interacting physical and biological processes, and their temporal evolution emerges from the mutual interaction and adjustment between ecological, hydrological, and geomorphological components [e.g., Marani et al., 2007; D'Alpaos, 2011]. These landforms are populated by halophytic vegetation species, adapted to live in frequently inundated and hypersaline soils (characterized by salt concentrations even higher than seawater due to evapotranspiration [see e.g. Cronk and Fennessy, 2001]). Marshland evolution processes are controlled by a dynamic equilibrium between sedimentation, margin erosion and stabilization processes driven by vegetation. Channel evolution and margin erosion are relatively fast processes, that manifests themselves in the range of decades and lend themselves to the study via historical records. However a full understanding of the processes requires high resolution subsurface investigations, that can only be achieved by a combination of invasive and innovative non-invasive techniques. The field “hydrogeophysics” emerged in the 1990s as a multi-disciplinary subject that focuses on the use of geophysical methods for characterising subsurface features, determining hydrogeological properties and monitoring processes relevant to soil and groundwater processes. Hydrogeophysical methods can allow large scale aquifer characterization, previously unobtainable through conventional hydrogeological techniques. In addition, time-lapse deployment of appropriate methods can give useful insight into complex subsurface processes, aiding hydrological model development and the assessment of groundwater restoration strategies. A number of geophysical methods can have useful hydrogeophysical application, particularly in terms of structure characterization. However, some techniques have a more specific link to hydrological properties and to the presence/motion of water: these are listed above. In particular, the physical quantities more specifically affected by water presence or motion are, among the ones most commonly measured, electrical conductivity via ERT (Binley and Kemna, 2005) and EM methods, and dielectric constant via GPR (Annan, 2005). Some of these techniques have already been applied successfully in the marshland environment. In this PhD project it is expected that the candidate will develop, test and validate techniques to improve the understanding of basic physical and biological processes affecting stability and evolution of marshlands, with particular emphasis on the Venetian Lagoon.

References

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