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Hydrogeochemical evidence of seawater intrusion: a case study in Venice farmland

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Saltwater contamination seriously affects groundwater quality and land productivity of coastal farmland along the Venice lagoon, Italy. Characterizing seawater intrusion dynamics represents a fundamental step to better understand its effect on soil and groundwater quality and in turn, conceive mitigation strategies. To this end, a three-year study was conducted in an experimental field bounding the southern Venice Lagoon. Volumetric water content, soil matric potential and apparent electrical conductivity (ECa) were monitored by five automatic monitoring stations at four depths (0.1, 0.3, 0.5 and 0.7 m). Groundwater electrical conductivity (EC) and depth to the water table were measured at the five stations. In addition, soil pore water at the four depths and borehole groundwater samples were collected periodically and analyzed for chemical composition. Physical and chemical analyses of the soil profiles were also carried out. Relationships between Cl^-, Na^+, Mg^{2+}, Ca^{2+}, K^+, SO_4^{2-}, Br^- ionic concentrations, EC and soil characteristics (e.g. texture, EC1:2, exchangeable cations) were calculated by Pearson and Spearman correlation. Kruskal Wallis test was performed to test the five monitoring stations. Moreover, specific molar ratios (Cl/Br, Br/Cl, Na/Cl and K/Cl) were calculated in order to identify the main drivers affecting salinity in the field. EC and ionic concentrations showed high variability across the monitoring stations and between the different sampling dates (e.g. groundwater EC ranged between 0.33 and 17.46 dS/m). Higher EC and ionic concentration values were observed during upward soil water movement, while values were lower during percolation events (e.g. maximum Cl^- concentrations were 9227.3 mg/l and 3436.1 mg/l, respectively). An high correlation resulted between Na^+ and Cl^- ionic concentrations and EC data in four out of the five monitoring stations (r values between 0.82 and 0.92). In addition, Kruskal Wallis test showed a significant difference between EC and chemical data sampled at the five monitoring stations and different soil depths. These results allow to conclude that soil and water salinity originated from different processes such as seawater intrusion and deep brines upcoming. Understanding salinization sources would enable the definition of a mitigation strategy able to enhance land productivity and water quality.