Sea-level rise: a big push to increase plant root zone's subsurface water salinity level

In coastal east-central Florida (ECF) in the U.S. (Fig. 1), plant root zone's (PRZ) subsurface water salinity level is crucial to the survival of various vegetation species because it is one of the dominant factors controlling seed germination, plant growth, and water and nutrient uptake. Its increase can create problems for plant growth and reproduction by altering vegetation's metabolic pathways and rates, preventing water in soil moving to plant roots, and interfering nitrogen uptake. A continuous high salinity level can cause: (1) reduction of plant growth and re-productivity; (2) dieback and limited recovery of plant species; (3) shift in plant species composition from less salt-tolerant to more salt-tolerant; and (4) degradation of bio-diversity and deterioration of natural habitat, posing a great threaten to coastal ECF's ecosystem at small or large scales dependent on its magnitude.

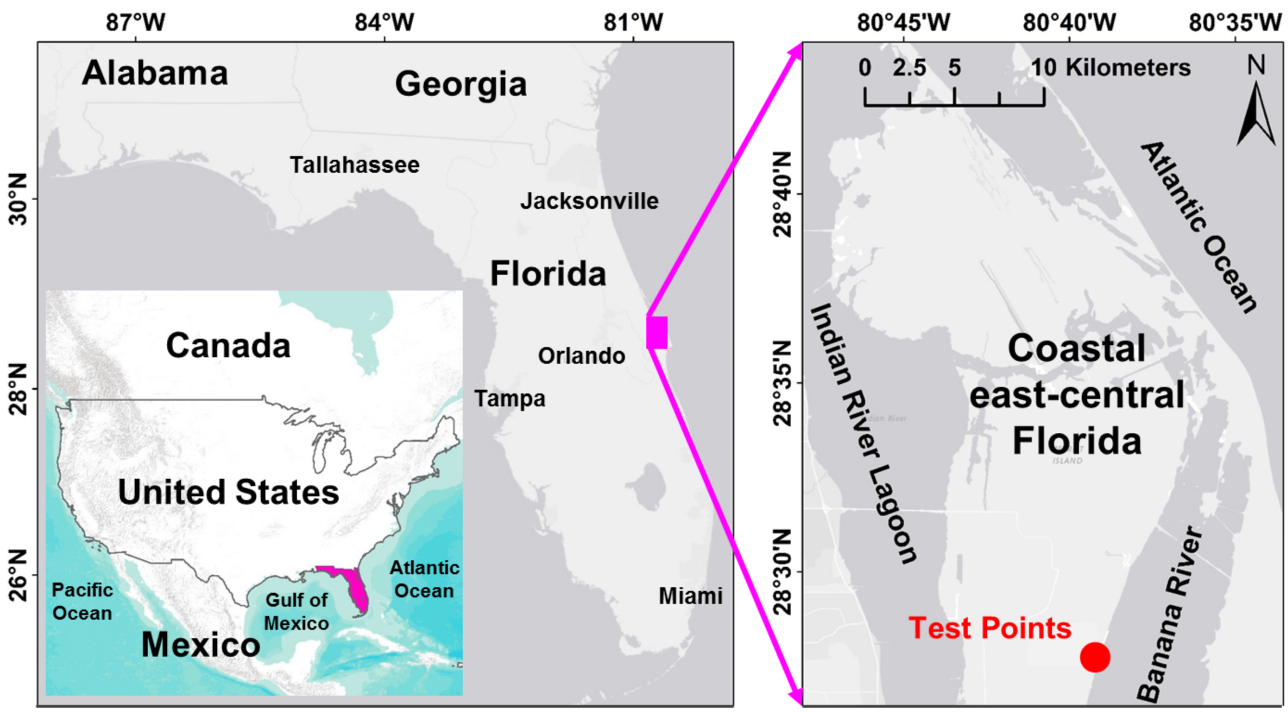

Fig. 1. Location of coastal east-central Florida in the U.S.

In coastal ECF, sea-level rise (SLR) has been highlighted as one of the major impact factors resulting in deep subsurface water salinity level increasing, while its impacts on shallow subsurface water, especially PRZ's salinity level are still unknown. A research question is proposed herein: how will PRZ's subsurface water salinity level vary under various SLR scenarios? Widely recognized as an efficient and effective tool capable of delineating real-time dynamics of coastal subsurface water salinity level, numerical method is adopted as the research technique in this study, and numerical models based on FEMWATER computer code are developed to simulate the dynamical changes of PRZ's subsurface water salinity level with respect to various SLR scenarios in coastal ECF.

The variation of PRZ's subsurface water salinity level (measured by total dissolved solids (TDS) concentration) with respect to various SLR scenarios at the test points (Fig. 1) located 5 m, 10 m, 15 m, 20 m, 25 m, 30 m, 35 m, 40 m, 45 m, and 50 m from the coastline are visualized in Figure 2. In general, PRZ's subsurface water salinity level increases with the rising sea-level. According to the National Ground Water Association's definition, subsurface water is identified as: (1) fresh and suitable for plant growth if TDS concentration is lower than 1 kg/m^3; and (2) saline and not suitable for plant growth if TDS concentration is greater than 1 kg/m^3. From Figure 2, subsurface water of PRZ located within 40 m from coastline is not suitable for plant growth even if SLR does not occur. Therefore, it goes without saying that intensification of PRZ's subsurface water salinity level increasing due to SLR is inevitable in future.

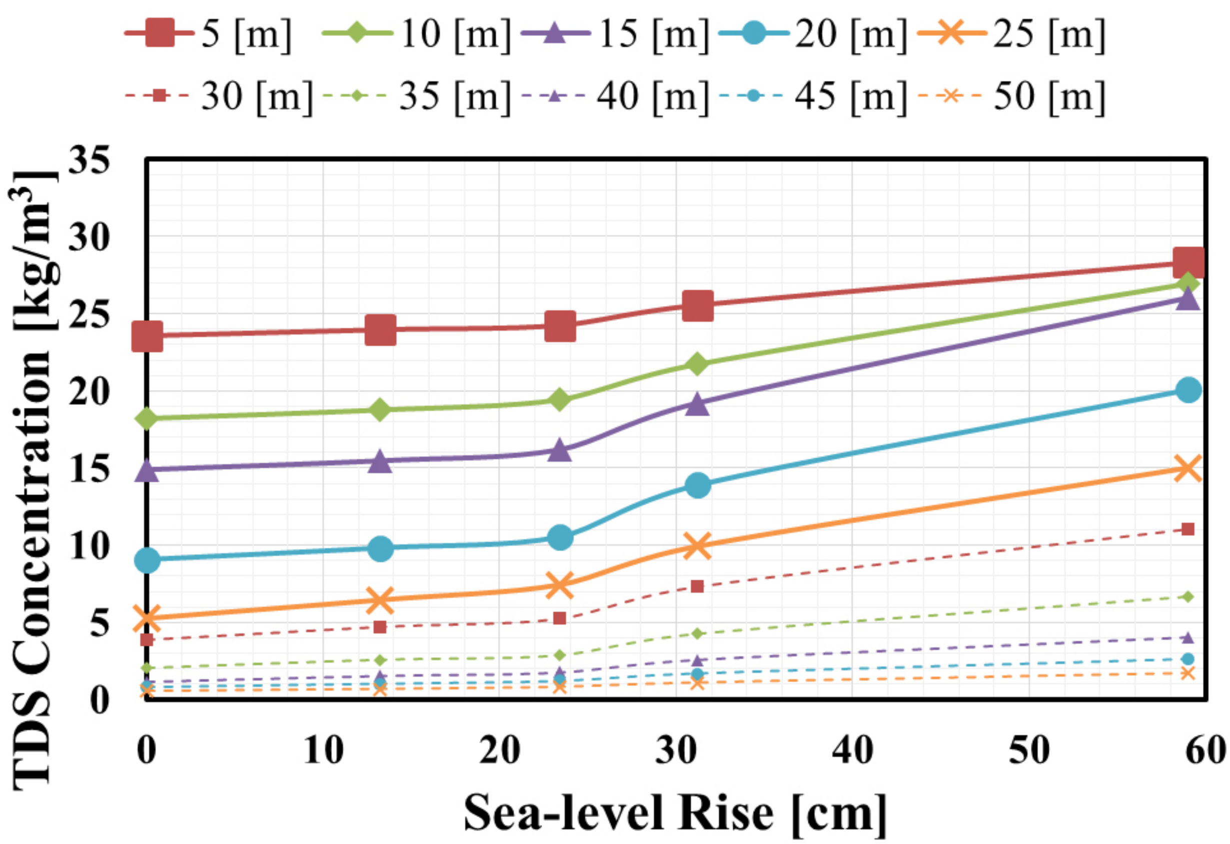

Fig. 2. Variation of PRZ's subsurface water salinity level with respect to various SLR scenarios.

Simulation results answer the research question of this study by assessing the responses of PRZ's subsurface water salinity level to various SLR scenarios in coastal ECF. The outcome demonstrates the importance and significance of taking immediate engineering measures to weaken the impacts of SLR on increasing PRZ's subsurface water salinity level, including heightening and strengthening sand dunes and construction and maintenance of artificial coastal defense structures such as seawalls if sand dunes do not exist to: (1) stabilize beach and shoreline; and (2) prevent seawater overtopping if waves run up and pass over the crest of sand dunes or coastal defense structures due to SLR.

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Publication

Assessing sea-level rise impact on saltwater intrusion into the root zone of a geo-typical area in coastal east-central Florida.
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