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An experimental field for studying soil-atmosphere interaction in soft soils

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The city of Bogotá, Colombia rests on top of a soft soil deposit that is highly compressible and has low permeability. This deposit is more than 500 m deep in some places. As a consequence of the high compressibility, many buildings suffer differential settlement over time. Soil properties such as water content, suction and volume changes are greatly influenced by environmental variations which determine the flux of liquid water and water vapor within the soil thereby influencing the thickness of the unsaturated zone and the position of the water table with respect to the surface. The soil's behavior is very complex as a consequence of this coupled mechanism within which processes of mass, heat transfer and volume changes interact.
For this research, an experimental field was established for studying the effect of environmental variables on water content, matric suction and soil profile and their relation to resulting changes in volume. In-situ measurements were made to ensure that real soil responses were recorded as atmospheric conditions varied. The results obtained from this experimental work cannot be correctly reproduced in laboratory conditions because of the difficulty of simulating environmental variables and the state of stress of the soil deposit. The experimental field has an area of 4m2. Surface materials were removed to reach the soil of interest which is located at 1.40 m below the surface. The field was instrumented with many measuring devices including water content sensors, thermocouples, a relative humidity sensor, and a wind velocity sensor. This instrumentation allowed us to register simultaneous variations of atmospheric variables and soil properties. In addition, a rain meter was installed to measure the quantity of rain, an evaporation tank was placed to determine the potential evaporation rate, and a water pump was used to extract unfiltered water. At the depth of interest, the soil is classified as a high plasticity silt (MH) according to USCS, has a very low permeability of ks = 1.75 x 10-10 m/s, and develops higher suction as water content decreases. For example, for ω= 25% found in a natural state, matric suction is s=1.1 MPa. This value was obtained from the Soil Water Characteristic Curve (SWCC).
This study presents the results obtained over three months of recordings. The evolution of environmental conditions and associated changes of soil properties such as the variation of the water content, suction, and volumetric changes were analyzed. As a result, higher values of suction were obtained in the period considered which was a dry season in Bogotá.