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Measurements of effective non-rainfall in soil with the use of time-domain reflectometry technique

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The non-rainfall vectors are fog, dew, hoarfrost and vapour adsorption directly from the atmosphere. The measurements of the amount of water supplied to the soil due to their temporary existence are essential, because in dry areas such water uptake can exceed that of rainfall. Although several devices and methods were proposed for estimating the effective non-rainfall input into the soil, the measurement standard has not yet been established. This is mainly due to obstacles in measuring small water additions to the medium, problems with taking readings in actual soil samples and atmospheric disturbances during their course in natural environment. There still exists the need for automated devices capable of measuring water deposition on real-world soil surfaces, whose resolution is high enough to measure the non-rainfall intensity and increase rate, which are usually very low.

In order to achieve the desirable resolution and accuracy of the effective non-rainfall measurements the time-domain reflectometry (TDR) technique was employed. The TDR sensor designed and made especially for the purpose was an untypical waveguide. It consisted of a base made of laminate covered with copper, which served as a bottom of a cuboidal open container in which the examined materials were placed, and a copper signal wire placed on the top of the container. The wire adhered along its entire length to the tested material in order to eliminate the formation of air gaps between the two, what enhanced the accuracy of the measurements.

The tested porous materials were glass beads, rinsed sand and three soil samples, which were collected in south-eastern Poland. The diameter ranges of their constituent particles were measured with the use of the laser diffraction technique.

The sensor filled with the wetted material was placed on a scale and connected to the TDR meter. The automated readings of mass and TDR time were collected simultaneously every minute. The TDR time was correlated with the mass loss, which was a measure of the amount of water that evaporated from the porous medium. Preliminary measurements demonstrated that the temperature control is dispensable for the conducted laboratory studies, because small temperature variations do not influence the results noticeably. However, field measurements would definitely require advanced temperature calibration.

The aim of the research was to test the designed sensor for the effective non-rainfall intensity measurements in actual soil samples. It turned out that the device is highly sensitive to the amount of water present in the investigated medium. The geometry of the sensor allowed obtaining satisfactory resolution, which in the case of soil samples did not exceed 0.015 mm of water. Moreover, the direct translation of the TDR time into the water amount present in the examined media is straightforward and workable among the tested materials, which is the main advantage of the presented measurement method. Hence, both the applied TDR technique and the construction of the sensor proved to be adequate for the planned measurements of the effective non-rainfall intensity.