# Prospective upscaling of quantification of non-rainfall water inputs to regional scale

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In drylands, the annual amount of non-rainfall water inputs (NRWIs), i.e., a gain of water to the surface soil layer that is not caused by rainfall, can exceed that of rainfall. NRWIs contribution to the water cycle and to biogeochemical dynamics is thus significant. However, the small magnitude of the fluxes involved in the formation and evaporation of NRWIs challenges their measurement.

Various methods exist to assess amounts and duration of NRWIs at local or point scale. Given the large heterogeneity of soils, both at local and regional scales, quantification of NRWIs at larger scales is necessary in order to fully understand the environmental factors controlling NRWIs and the role of NRWIs in dryland ecosystems. Numerous remote sensing-based models have been developed to assess spatially distributed latent heat fluxes, greatly varying in complexity. Unfortunately, the magnitude of diurnal latent heat fluxes due to NRWIs is too small to be detected by any of the existing models.

Hypothesizing that soil surface emissivity is sensitive to very small changes in water content at the topsoil layer, **our objective was to quantify NRWIs by analyzing the temporal changes in land surface emissivity over bare loess soil in the Negev desert, Israel.** Proven successful, this can be utilized over large areas.

Measurements were conducted over the summer of 2019 at Wadi Mashash Experimental Farm ($31^{\circ}08'$N, $34^{\circ}53'$E). Four microlysimeters (Fig. 1) provided direct measurements of NRWIs.

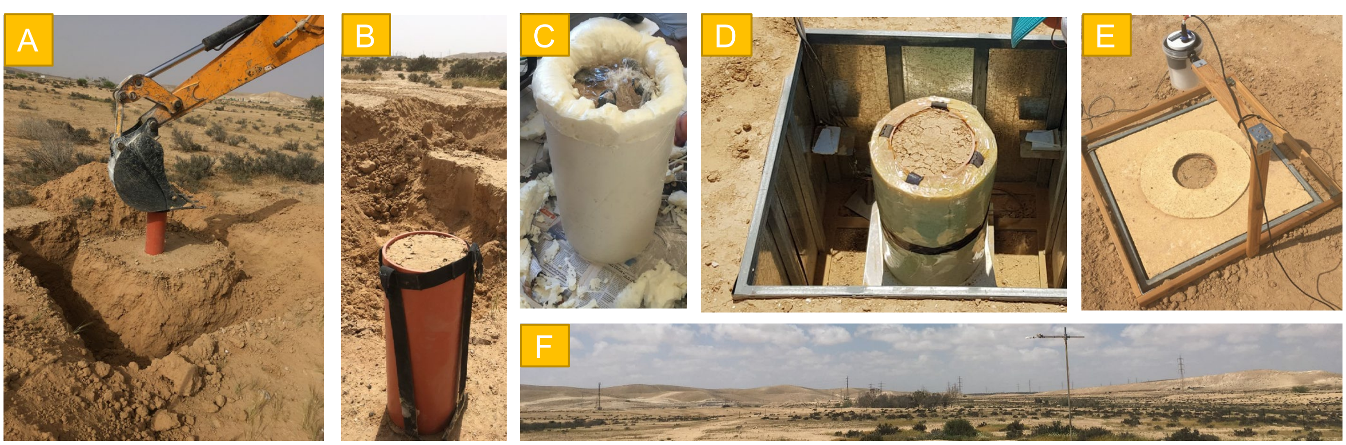


Fig. 1. Microlysimeters were 50 cm long undisturbed soil columns; excavated (A), sealed (B), insulated (C), and placed on an automated balance (D), flush with the soil surface (E) at the research site (F).

Radiance and temperature measurements were obtained for selected 24-h periods for a broad band (8.01-13.34 µm) and 5 sub-bands using a longwave infrared radiometer (CLIMAT 312-2n ASTER, Cimel Electronique, Paris, France). The radiometer was mounted 0.5 m directly above one of the microlysimeters (Fig. 1E). Data were collected at 15-minute intervals.

Emissivity $\varepsilon_j$ for effective wavelengths $j$ was calculated by

$$\varepsilon_j = \frac{L_j}{L_{j,BB}},$$

where $L_j$ is measured longwave radiation leaving the surface. Soil surface temperature was estimated using soil temperature profile data to compute blackbody longwave radiation $L_{j.BB}$. Emissivities for all wavelengths show a similar diurnal pattern. Emissivities increase when microlysimeter mass increases (Figs. 2,3).

Initial results indicate an agreement between the daily accumulation of NRWIs detected by the microlysimeters and cumulative changes in emissivity (Fig. 4, $r^2$ of 0.63-0.72). Highest correlation was found for an effective wavelength of 8.42 µm. These preliminary results show the potential to upscale quantifying NRWIs to regional scale.

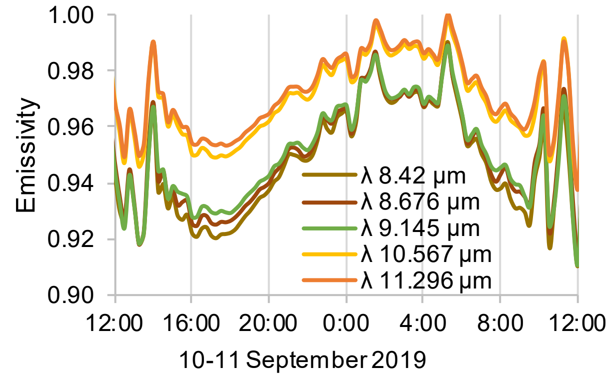


Fig. 2. Emissivity $\varepsilon_j$ for effective wavelengths λ.

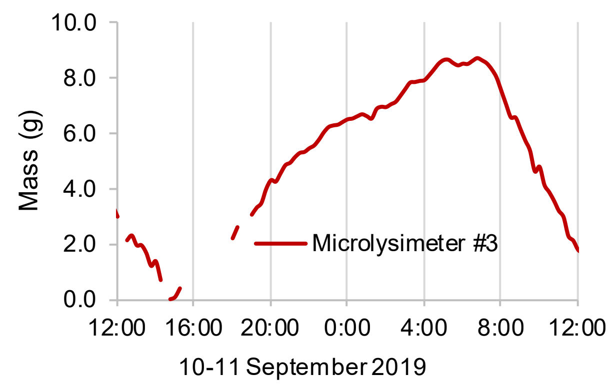


Fig. 3. Microlysimeter mass zeroed at 15:00.

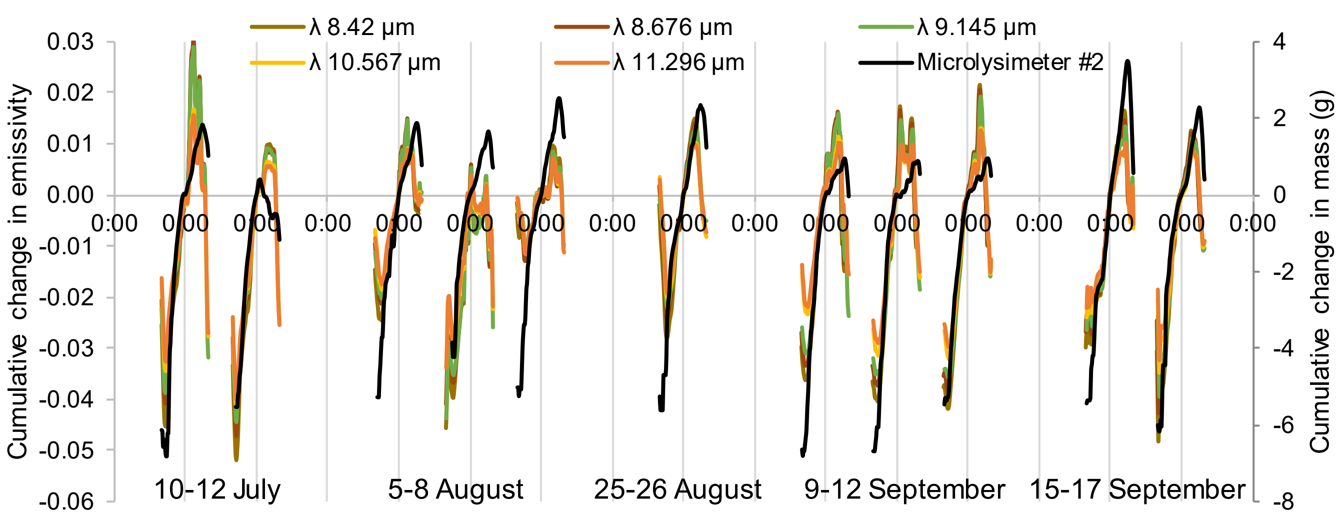


Fig. 4. Nighttime cumulative water uptake and changes in emissivity.