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Soil Moisture Retrievals from Unmanned Aerial Systems (UAS)

ruodan zhuang[1], Salvatore Manfreda[2], Yijian Zeng[3], Zhongbo Su[3,4], Nunzio Romano[5,6], Eyal Ben Dor[7], Antonino Maltese[8], Fulvio Capodici[8], Antonio Paruta[8], Paolo Nasta[5], Nicolas Francos[7], Giuseppe Ciraolo[8], Brigitta Szabó[9], János Mészáros[9], and George P. Petropoulos[10]

[1]Department of European and Mediterranean Cultures, Architecture, Environment, Cultural Heritage, University of Basilicata, 75100 Matera, Italy (ruodan.zhuang@unibas.it)
[2]Department of Civil, Architectural and Environmental Engineering, Federico II University, via Claudio 21, 80125 Napoli, Italy (salvatore.manfreda@unibas.it)
[3]Faculty of Geo-Information Science and Earth Observation, University of Twente, Hengelosestraat 99, Enschede 7514 AE, The Netherlands (y.zeng@utwente.nl; z.su@utwente.nl)
[4]Key Laboratory of Subsurface Hydrology and Ecological Effect in Arid Region of Ministry of Education, School of Water and Environment, Chang'an University, Xi'an, 710054, China (z.su@utwente.nl)
[5]Department of Agricultural Sciences, AFBE Division, University of Napoli Federico II, Portici (Napoli), Italy (nunzio.romano@unina.it; paolo.nasta@unina.it)
[6]Interdepartmental Center for Environmental Research (C.I.R.AM.), University of Napoli Federico II, Napoli, Italy (nunzio.romano@unina.it)
[7]Department of Geography and Human Environment, Tel Aviv University (TAU), Tel Aviv 6997801, Israel (bendor@tauex.tau.ac.il)
[8]Department of Engineering, University of Palermo, 90128 Palermo, Italy (antonino.maltese@unipa.it)
[9]Institute for Soil Sciences and Agricultural Chemistry, Centre for Agricultural Research, H-1022 Budapest, Hungary (toth.brigitta@agrar.mta.hu; messer.janos@gmail.com)
[10]School of Mineral Resources Engineering, Technical University of Crete, Kounoupidiana Campus, 73100, Chania, Greece (petropoulos.george@gmail.com)

Quantification of the spatial and temporal behavior of soil moisture is vital for understanding water availability in agriculture, ecosystems research, river basin hydrology and water resources management. Unmanned Aerial Systems (UAS) offer a great potential in monitoring this parameter at sub-meter level and at relatively low cost. The standardization of operational procedures for soil moisture monitoring with UAS can be beneficial to understanding and quantify the quality of retrieved soil moisture (e.g., from different platforms and sensors).

In this study, soil moisture retrieved from UAS using different retrieval algorithms was compared to collocated ground measurements. The thermal inertia model builds upon the dependence of the thermal diffusion on soil moisture. The soil thermal inertia is quantified by processing visible and near-infrared (VIS-NIR) and thermal infrared (TIR) images, acquired at two different times of a day. The temperature–vegetation trapezoidal model is also used to map soil moisture over vegetated pixels. This trapezoidal model depicts the soil moisture dependence of the surface energy balance. The comparison of the two algorithms helps define a preliminary standard procedure for retrieving soil moisture with UAS.

As a case study, a typical cropland area with olive orchard, cherry and walnut trees in the region of Monteforte Cilento (Italy, Salerno) is used, where optical and thermal images and in situ data were simultaneously acquired. In the Alento observatory, long-term studies on vadose zone hydrology have been conducting across a range of spatial scales. Our findings provide an important contribution towards improving our knowledge on evaluating the ability of UAS to map soil moisture, in support of sustainable natural resources management and climate change studies.

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Keywords: soil moisture, Unmanned Aerial Systems, thermal inertia, HARMONIOUS