A merging framework for improving field scale root-zone soil moisture measurement with Cosmic-ray neutron probe over Korean Peninsula

Hoang Hai Nguyen*, Minha Choi**

Abstract
Characterization of reliable field-scale root-zone soil moisture (RZSM) variability contribute to effective hydro-meterological monitoring. Although a promising cosmic-ray neutron probe (CRNP) holds the potential for field-scale RZSM measurement, it is often restricted at deeper depths due to the non-unique sensitivity of CRNP-measured fast neutron signal to other hydrogen pools. In this study, a merging framework relied on coupling cosmic-ray soil moisture with a representative additional RZSM, was introduced to scale shallower CRNP effective depth to represent root-zone layer. We tested our proposed framework over a densely vegetated region in South Korea covering a network of one CRNP and nine in-situ point measurements. In particular, cosmic-ray soil moisture and ancillary RZSM retrieved from the most time stable location were considered as input datasets; whereas the remaining point locations were used to generate a reference RZSM product. The errors between these two input datasets and the reference were forecasted by a linear autoregressive model. A linear combination of forecasts was then employed to compute a suitable weight for merging two input products from the predicted errors. The performance of merging framework was evaluated against reference RZSM in comparison to the two original products and a commonly used exponential filter technique. The results of this study showed that merging framework outperformed other products, demonstrating its robustness in improving field-scale RZSM. Moreover, a strong relationship between the quality of input data and the performance merging framework in light of CRNP effective depth variation has been also underlined via the merging framework.

Keywords: Cosmic-ray neutron probe, Root-zone soil moisture, Temporal stability analysis, Merging technique

Acknowledgment
This research was supported by Space Core Technology Development Program through the National Research Foundation of Korea (NRF) funded by the Ministry of Science and ICT (NRF-2014M1A3A3A02034789). This work was supported by the National Research Foundation of Korea (NRF) grant funded by the Korea government (MSIT) (NRF-2016R1A2B4008312).

* Member · Graduate student, Dept. of Water Resources, Sungkyunkwan University · E-mail: hainh@skku.edu
** Professor, Dept. of Water Resources, Sungkyunkwan University · E-mail: mhchoi@skku.edu