Linking Canopy Reflectance to Water Use Efficiency of Rice: Scaling from Leaves to the Landscape via Stable Isotopes and Remote Sensing

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1. Introduction

Water represents one of the key factors constraining ecosystem productivity in many systems. Thus, a mechanistic understanding of the linkage between carbon and water cycles is needed to identify land-use change effects on ecosystem functioning and productivity. Plants couple global carbon and water cycles via photosynthesis (A) and evapotranspiration (ET), which are intrinsically related to water-use-efficiency (WUE=A/ET). Still, there is an ongoing debate about methodology and approaches to correctly assess WUE, which is partially a question of the scale under consideration and of water fluxes from the soil. Here, a multi-scale WUE analysis will be carried out.

2. Objectives of the Study

- To analyze ecosystem WUE of rice along gradients in water and nutrient availability at the leaf, stand, field and landscape scale by combining innovative stable isotope analysis with remote sensing and measurements of gas exchange
- To analyze ecohydrological processes within paddy rice dominant farming systems in the Haean Catchment, contributing to extrapolation methods (production models PIXGRO and CERES) for assessing ecosystem services from agricultural landscapes.

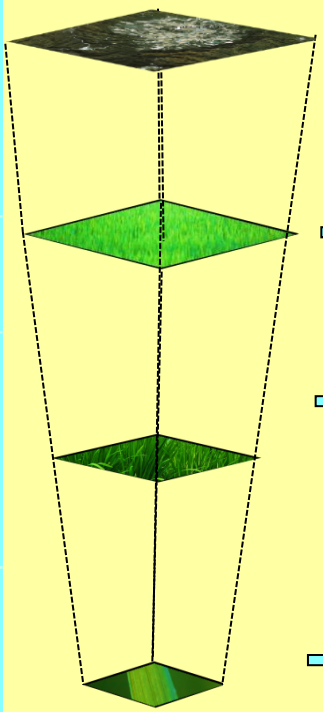
3. Motivation of the Study

Understanding the ecohydrological process of paddy rice production is of major importance since rice, the second largest produced cereal in the world, is one of the most important crops in the Haean Catchment and in Korea. Clear understanding of ecohydrological processes of paddy rice production will help us understand atmosphere-water-crop-soil interactions in the Haean Catch-ment. The understanding gained will allow for improved ET esti-mates in models used in TERRECO.

4. Multi-Scale Analysis of Ecosystem WUE of Paddy Rice

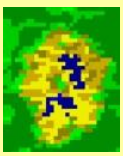
WUE will be analyzed by:

Macro	Landscape	Remote sensing of spatial patterns in WUE by Unmanned Aerial Vehicle (UAV)
Meso	Field	Ecosystem water and carbon fluxes from eddy-covariance
	Canopy	Canopy evapo-transpiration partitioning and chamber carbon fluxes by stable isotope $\delta^{18}O$ laser spectro-scopy and $\delta^{13}C$
Micro	Leaf	Leaf carbon isotope discrimination (ΔC^{13}) and gas exchange (Assimilation / Transpiration)

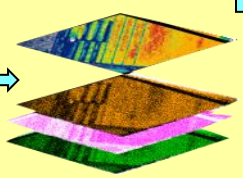


Fieldwork | **Data Analysis** | **Output**

Satellite

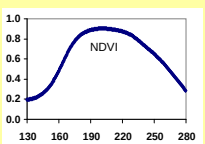


UAV



Eddy Tower

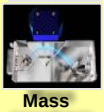
Crop Scan



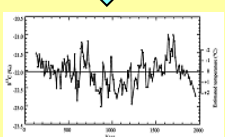
Chamber

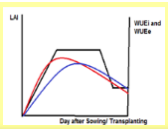
Laser

Gas analyzer



Mass spectrometer





Multi-scale assessment of WUE, water fluxes and carbon fluxes of rice which is important to validate the rice crop models of TERRECO

New technology for multi-scale water fluxes analysis which is important for global water and carbon cycle analysis

Sustainable crop management / Climate change mitigation and adaptation

5. Expected Results

- An almost complete ecosystem WUE scenario of rice will be established identifying processes and driving factors from the leaf to the landscape scale
- Water fluxes and (possibly) carbon fluxes of paddy rice dominant ecosystem will be added to TERRECO's ecosystem fluxes database.
- New methods: by linking remote sensing data and the functional information from isotope analysis, WUE can be scaled up to landscape level and contribute to assessment of water balances.