Complex Terrain and Ecological Heterogeneity (TERRECO): Evaluating Ecosystem Services in Mountainous Landscapes

Energy and matter exchange in an atmosphere-ecosystem over a complex terrain in Korea

Peng Zhao[1](peng.zhao@uni-bayreuth.de), Johannes Lüers[1], Chong Bum Lee[2], John Tenhunen[1], Thomas Foken[1]

[1]University of Bayreuth, Germany [2]Kangwon National University, South Korea

Introduction

Increasing anthropogenic impacts on natural and managed ecosystems have been modifying ecosystem functions and having an apparent influence on ecosystem services. A joint education and research activity between Germany and South Korea, called Complex TERRain and ECOlogical Heterogeneity (TERRECO), is running to evaluate ecosystem services in production versus water yield and water quality in mountainous landscapes.

As a sub-program of TERRECO, this study is focused on a better understanding of the energy and matter exchange above farmlands (both flooded and dry) during the whole growing period including the monsoon season in a complex terrain in Korea. Field work was conducted at a potato field and a rice field from May 12th to November 8th, 2010, at Haean-myun Catchment, Yanggu-gun, Kangwon-do, South Korea (대한민국 강원도 양구군 해안면, 大韓民國江原道楊口郡亥安面).

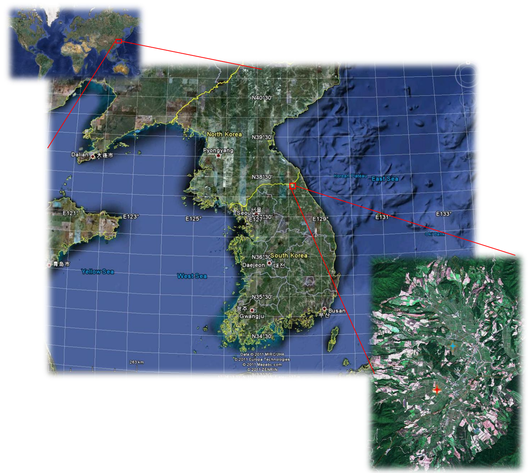

Figure 1: Locations of the measurement sites during TERRECO-WP1-02 campaign in 2010 at Haean, South Korea (128 °07'E, 38 °17'N; red star: a potato field; blue star: a rice field)

Figure 2 Calendar of the campaign in 2010 (blue: rice field; brown: potato filed)

Methods

Eddy covariance method was used to measure CO_2 flux, sensible and latent heat flux at a height of 2.5 m at the potato field and 2.8 m at the rice field above ground. The measurement complex was equipped with a sonic anemometer (METEK USA-1) and an open-path gas analyzer (LI-7500). The sampling frequency was 20 Hz. The instruments were moved between the two sites and biomass was sampled every other half a month. The Leaf Area Index (LAI) and weights of different plant parts were measured too. Basic meteorological parameter and the net radiation were recorded by an automatic weather station and a net radiometer.

The high frequency data were post-processed, corrected, and quality controlled by a software packages called TK2 developed by University of Bayreuth. Footprint analyses were performed to check the influence from target and surrounding areas. The results will be used as driving factors or for comparisons for related models.

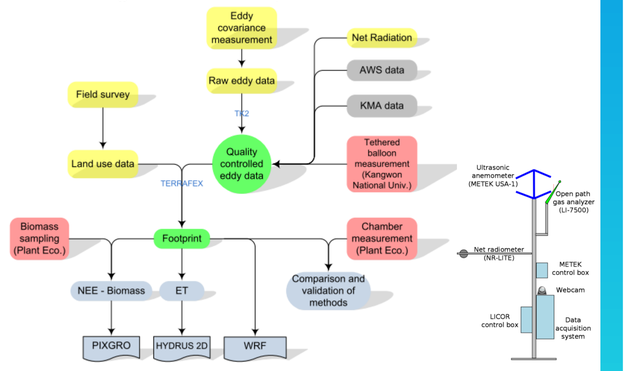

Figure 3: Method of the research (right: installation of the instruments)

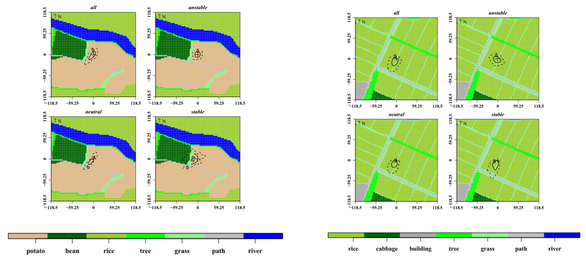

Figure 4: Footprint (left: from 2010-07-06 to 2010-07-22 at the potato field; right: from 2010-07-22 to 2010-08-11 at the rice field)

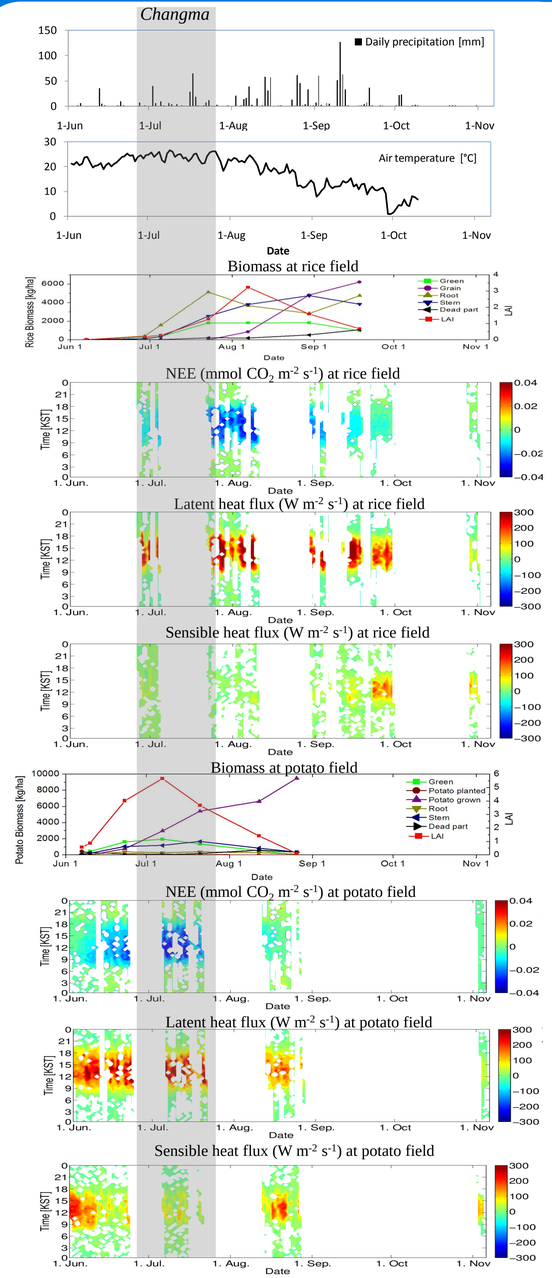

Figure 5: Precipitation, air temperature, biomass, NEE, sensible and latent heat flux

Results

The prevailing wind direction at both sites during the measurement was southwest. There was intensive precipitation in July during *Changma* (an intensive rainy period of the Asian summer monsoon) and typhoons in August and September.

The footprint model showed that both the target potato filed and rice field contributed about 95% of the related area during unstable and neutral stratification conditions. The potato site was influenced by the adjacent cabbage field and the rice site was slightly influenced by the adjacent field road and the grass verge during stable conditions.

The net ecosystem CO_2 exchange (NEE) at both sites was negative during daytime (sink) and positive during nighttime (source) as a results of photosynthesis and respiration respectively. The daily pattern of NEE was mainly controlled by solar radiation, and the day-to-day pattern was controlled by the growing stages of the crops. CO_2 fluxes reached the peak simultaneously with the maximum of LAI during mid-day. A mid-season depression in NEE during *Changma* was reported in literature, but it was not observed in this study possibly because of the exclusion of data with bad quality during rain events.

The sensible heat flux had two peaks one at the beginning and one at the end of the potato growing period, while only one peak was observed at the rice field before harvest. These peaks were apparently due to a small LAI when there was much bare soil surface exposed to the air. The latent heat flux had similar patterns like the NEE at both sites, indicating that it was controlled by plant transpiration .

References

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