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

Ecosystem CO_2 Exchange in Croplands of South Korea

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Introduction:

Agricultural landscapes occupy ca. 48% of South Korea, and they play an important role in the global budget of greenhouse gases via the release of carbon dioxide, methane and N_2O. Agricultural management practices significantly influence cropland carbon balances and, thereby, exchange of CO_2 with the atmosphere. Quantifying long-term net ecosystem CO_2 exchange (NEE) and identifying sub-processes that contribute to overall CO_2 fluxes will help us understand how CO_2 exchange may be influenced by climate change. In this study, we examine the NEE and ecosystem respiration of cabbage, radish, potato, bean and rice agro-ecosystems in the Haean catchment managed conventionally or as organic farms, using a closed chamber that has provided good comparisons with studies applying eddy covariance techniques. The study focuses on the relation of CO_2 fluxes to accumulated biomass in the field. It is a first-step in the determination of parameters for the PIXGRO landscape model, which will be used to estimate carbon balance and emission of greenhouse gases by vegetation in the entire catchment.

Methods and Metarials:

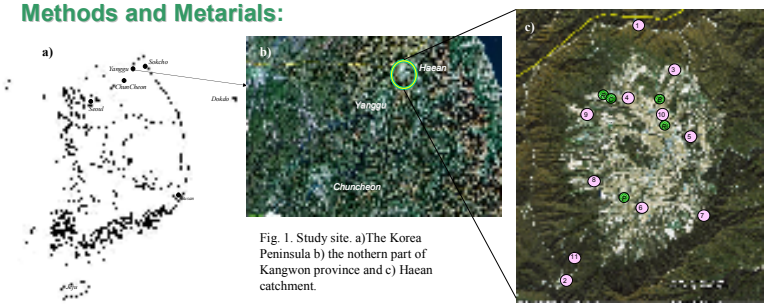


Fig. 1. Study site. a)The Korea Peninsula b) the nothern part of Kangwon province and c) Haean catchment.

Auto Weather Station (AWS):

Weather data was recorded at Automatic Weather Stations set up in the Haean catchment since May 2009. We installed 11 AWS at locations shown in fig. 1.c. AWS data includs air temperature, relative humidity, solar radiation, wind direction, wind speed and rainfall. Data were measured every 1 min, averaged and recorded every 30 min.

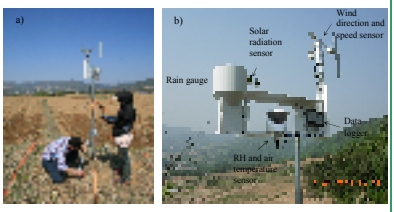
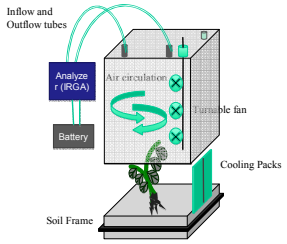


Fig. 2. Auto-Weather Station. a) installation of AWS and b) AWS components

CO_2 Flux Measurement:

Net ecosystem exchange of CO_2 (NEE) and ecosystem respiration (Reco) were measured using a closed chamber system. The 38cm * 38cm * 54cm light chamber (for measuring NEE, Fig. 4. a) was constructed of transparent plexiglass, dark chamber was constructed of opaque PVC and covered with an opaque insulation layer and reflective aluminum foil (for measuring Reco, Fig. 4.d). Chambers were placed on the plastic frame (Fig. 3).



Net Ecosystem Exchange (NEE)

= Phosynthesis – Respiration

Ecosystem Respiration (R_{eco})

= R_{plant} + R_{soil} + R_{root}

Fig. 3. Chamber components. The chamber is connected by a flexible inflow and outflow tube to an gas analyzer (IRGA; Licor-820). The air within the chamber was circulated by turnable fans. By the cooling packs, temperature during measurements could be maintained.

We measured 5 crops using chambers at Haean catchment. During each measurement, two soil plots without any vegetation, four crop plots and three weed plots monitored. Each crop locations are green circles in Fig. 1.c.

R: Radish (Kang, Kyeongwan)
C: Cabbage (Kang, Kyeongwan)
B: Bean (Jun, Keonsu)
Ri: Rice (Kang, Chunkwon)
P: Potato (Kim, Wonbae)

Fig. 4. CO_2 chamber measurement.
a) light chamber b) measuring of daily NEE and Reco using chamber c) installed soil frame in the rice paddy and d) dark chamber

Biomass:

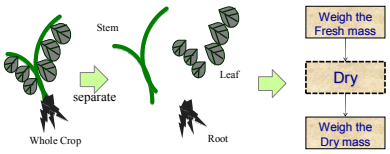
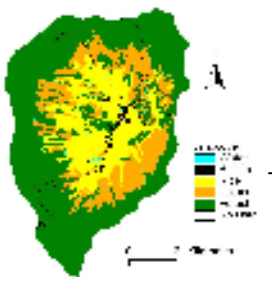
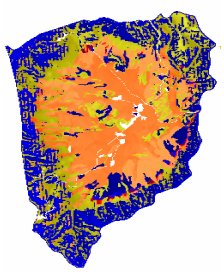


Fig. 5. Progress of biomass measurement.

At the end of the each CO_2 chamber measurements, all of the biomass including root on each of plots was harvested. Biomass was determined separately for leaf dry weight , stem dry weight and root dry weight.

Simulation Modeling:





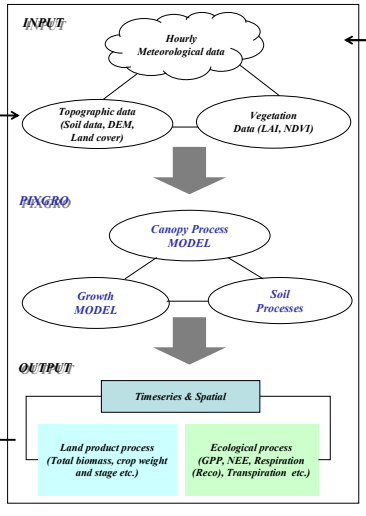
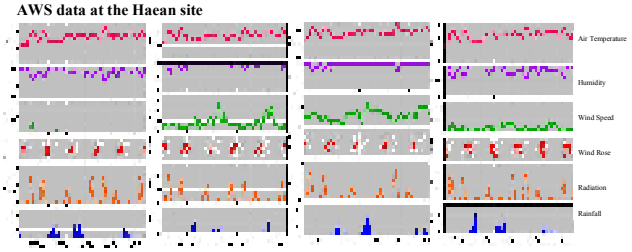


Fig. 6. Framework of simulation modeling

AWS data at the Haean site



PIXGRO, process-based model is being used to estimate net ecosystem CO_2 exchange, ecosystem respiration, gross primary production and water balance at landscape scale. The framework of PIXGRO is illustrated in Fig.6. Gas exchange using chambers in a closed system can be applied to calibration of PIXGRO. Hourly meteorological data for simulation model are provided by kriging of information from 11 AWS at the Haean catchment. The model output will be used to estimate agricultural ecosystem services based on current and with projections, future land use. By linking the modelling with an an economic agricultural sector model, the change in returns with various management methods will be estimated.

References:

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