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RAISE project: summary for the first three years' activities

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I Introduction

In the northeastern Asia including Mongolia and the northeastern China, a climatic shift from humid condition in the northern part to arid condition in the southern part can be found in a relatively narrow, boundary zone. As a consequence of the steep gradient in climatic conditions, a distinct "ecotone" (*i.e.*, forest-grassland-desert) is formed in the northeastern Asia. Such a ecotone is sensitive to changes in external environment (*e.g.*, global warming) even though those changes are very small. For instance, changes in external environment may result in desertification in this region. In reality, it has been reported that air temperature in winter and spring gradually has increased and precipitation amount has decreased in the last four decade. A possibility can be pointed out that the warming and drying of the atmosphere induce drastic changes in plant growth and vegetation distribution through changes in hydrological cycle. In addition, changes in human activity as an external forcing can affect natural environments in this region. Overgrazing and inappropriate water use might have already disturbed ecosystem and hydrological cycle of this region.

In the light of above discussion, the main focus of this research project, RAISE (the Rangelands Atmosphere-Hydrosphere-Biosphere Interaction Study Experiment in Northeastern Asian) have been set to the evaluation of the effects of these changes on the rangeland ecosystem with emphasis on the role of hydrologic cycle in northeastern Asia. The strategy of the project includes field observations for the understanding of the current status of the ecosystem and the modeling of the atmosphere, hydrosphere and biosphere in this area. The models to be produced and optimized for the area will then be used for the prediction of the possible changes of the area in response to likely scenarios of future climate and land use changes.

In the first three years', the main focus of the RAISE activities have been observations to obtain basic information for the subsequent analysis as well as for the model inputs. In this article, the such RAISE activities are summarized and some of the findings are presented.

II Study area

Kherlen River basin in northeastern part of Mongolia, and its surrounding regions have been selected as the observation target. The basin has the area of 122,500 km^2 (total area in Mongolia), 71,500 km^2 (upriver part of Choybalsan) or 39,400 km^2 (upriver part of Undorhaan). Khelren River has its headwater source at Henty mountain in the northeast of Ulaanbaatar and runs eastward through moderately hilly plane.

III Observation stations

Within Kherlen River basin, two flux stations, four automatic weather stations (AWSs), two GPS stations, two hillslope observation sites have been set up (Fig. 1). Most of the stations have been in operation since March of 2003. In addition, an intensive observations were carried out in the following schedule 1) 6/13-29, 2) 7/16-8/1, 3) 8/18-9/1, 4) 9/25-10/12 to make special measurements (*e.g.*, leaf area index, multi-spectral radiance data, *etc*.) that are not available from routine observations by AWSs and flux stations.

IV Aircraft observations

In addition to the surface observations, special observation by means of MIAT aircraft AN-2 was carried out. The sensors and equipment for the special observations on board include 1) turbulence sensors of humidity and temperature, 2) a multi spectral radiometer, 3) an infrared radiometer, 4) an air sampling device, 5) digital video camera. A GPS system allowed a determination of the exact position. Fig. 2 indicates typical flight pattern during the observations. From June 17 through October 4, a total of 11 flights with total flight hours of 66 was carried out.

V Results

Based on the analysis of the observed results, some interesting findings have been obtained. Details will be presented as a separate paper in this workshop, but briefly, the following lists some highlights of the results. The reference numbers indicate presentation number listed below.

1. Surface and ground water hydrology

-Water of the Khelren River originated fromprecipitation mainly at upper part of the watershed. 1), 2), 13)

-River water flows Khelren River with only alimited water exchange between groundwater. The horizontal extent of such region is limited within 10^1 km scale from the river. In these areas there is a flow from groundwater to river. At the same time river loses water through evaporation. Net result is more or less same discharge from upper stream to downstream. 1), 10)

- Shallow groundwater is mostly circulated within a relatively small local watershed. As a result, continued aridity and/or extensive use of well water would result in loss of well water. 1), 2), 13)
- Watershed under grazing pressure produced more sediment output as a result of active erosion. 9)

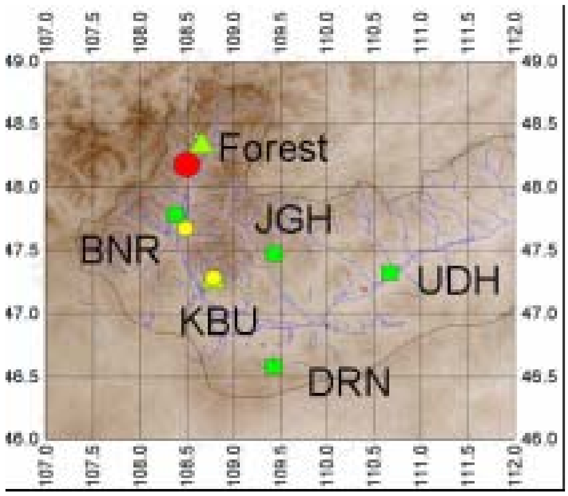

Fig. 1 Observation stations in upper Kherlen River basin. Triangles denote flux stations, rectangular AWSs, small circles hillslope observation sites, larger circle the GPS station.
JGH: Jargalthaan, BNR: Baganuur, KBU: Khereen Bayan-Ulaan, UDH: Underhaan, DRN: Darhan.

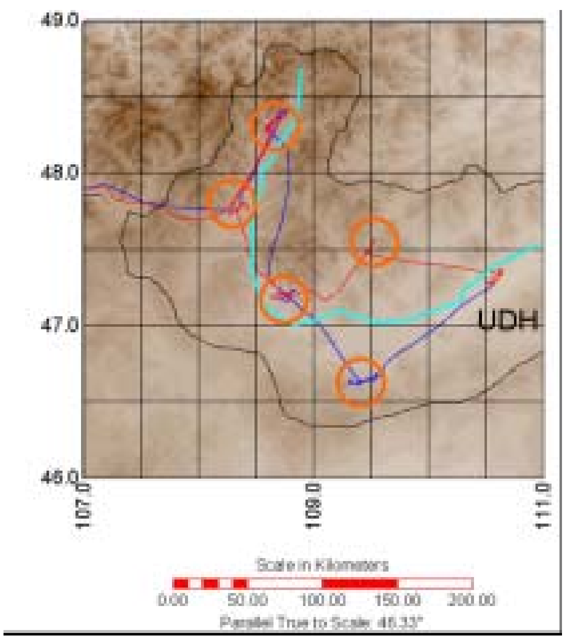

Fig. 2 Flight pattern by AN-2 aircraft.

2. Atmosphere-surface interaction

-There is a distinctive difference of the interactionfeatures between the larch forest in upper watershed and the steppe grassland, although the general seasonal trend is essentially the same with active fluxes observed in vegetation season and dormant flux rest of the seasons. 20)

-In general fluxes are larger in forested area, withannual evaporation 225 mm in forest and 163 mm in grassland. Similarly, CO_2 fluxes amount to 164 g/m^2 at forest and 40 g/m^2 at grassland. 1), 20)

-At forest evaporative fluxes are essentiallycontrolled by the amount of foliage. *i.e.*, leaf area index, while in grasslands soil moisture play more dominant role. This is because the LAI of the grass land is generally very small (< 1.0) and thus soil evaporation is more important.

- The amount of transpiration that constitute the total evapotranspiration has been determined by means of the Keeling plots as 60-70% at forest while 30-60% at grassland. 14)
- At grassland amount of biomass is highly influenced by grazing activity although the primary factor appears to be precipitation in spring.
- LAI is variable within the watershed both in time and space.

-The area averaged fluxes appear to be able to beestimated by the mixed layer variance method with the data obtained by an aircraft. 5)

- Satellite data together with linear energy balance model produced evaporation map of the watershed. 6), 18)
- Scintillometer produced fluxes averaged around 500 m horizontal scale.

3. Soil and plant ecology

- Difference of the amount of precipitation produced different level of Ca layer within the soil profiles, with deeper level in northern watershed with more precipitation. 15)
- In general surface soil has smaller permeability due to higher solid ratio and smaller amount of C within humus. 15)

-There is a clear difference in the soil profilesbetween natural area and abandoned cultivated area even after some 30 years. 7)

- Protected area of the size of 200 by 170 m yielded different surface features as well as resulting fluxes. After one year, LAI and above-ground biomass become somewhat larger than outside the fence, the amount of litter is clearly different, and the below-ground biomass doe not show significant difference. In the second year, the difference becomes more pronounced with the LAI inside about twice than that outside. As a result, evaporation and sensible heat flux became larger inside. This was not because of net radiation but because of decreased soil heat fluxes. 4)
- The net ecosystem production (NEP) is larger with C3 plants than C4 with clear increase after the rainfall. Diurnally, NEP decreases in the afternoon due to the decrease of the C3 plants NEP. 21)
- Soil respiration depends not only the soil temperature but also soil water content. 21)

4. Meteorology and climatology

- Regional climate model has shown that the aridity in the northern part of Tibet and surroundings is caused by the heating effect of the Tibet plateau which produces downward atmospheric movement in the north. 24), 25)
- The amount of precipitation and NDVI is correlated well in some areas and it appears that some parameters such as temperature and precipitation in the earlier seasons can be used to predict amount of grass of the later part of the same year. 3)
- There is a "break" in Mongolian rainy season. 12)

5. Future plan

- For the prediction of environmental change, development and modification of three models of a regional climate model, a distributed hydrologic model, and a carbon cycle model have been carried out, and its operation has been under discussion. 19), 22), 11)

VI List of presentations in this workshop from RAISE projects

The following list shows all the presentations contributed from RAISE project during this workshop. The last number indicates the presentation number in the program.

1) Tsujimura M., Budget analysis on groundwater and river water interaction in Kherlen River basin, eastern Mongolia, #5.
2) Tanaka T., Tsujimura M. and Abe Y., Groundwater recharge process in Kherlen River basin, eastern Mongolia, #6.
3) Iwasaki H., Impact of interannual variability of meteorological parameters on vegetation activity and predict possibility of vegetation activity over Mongolia, #12.
4) Kato H., Mariko S., Urano T. and Sugita M., Influence of grazing on surface fluxes and Net Ecosystem Production over the Mongolian Grassland, #14.
5) Kotani A. and Sugita M., Aircraft turbulence measurements to estimate surface heat fluxes from the mixed layer variance methods over semi-arid grassland in Mongolia, #15.
6) Matsuura Y. And Matsushima D., Estimation of Evapotranspiration in Northeastern Mongolia combining Satellite data and Ground data, #16.
7) Hoshino A., Tamura K., Asano M. and Higashi T., Comparison of several properties between the soils under the grassland and the abandoned field in the Kherlen River basin, Mongolia, #17.
8) Yamanaka T., Tsujimura M., Oyunbaatar D. and Davaa G., Isotopic variation of precipitation over eastern Mongolia, #18.
9) Kato H., Onda Y., Tanaka Y., Nishikawa T., Davaa G. and Oyunbaatar D., Overland flow generation and surface erosion in Mongolia, #19.
10) Kamimera H., Lu M., Doi H., Oyunbaatar D. and Davaa G., Spatial variation and long-term change of hydrological regime of Kherlen River basin, Mongolia, #20.
11) Sato T., Lee G., Lu M., Lee P., Chen Y., Kamimera H., Kimura F., Oikawa T. and Sugita M., Modeling approach to the atmosphere-hydrosphere-biosphere interactions in Mongolia, #23.
12) Iwasaki H. and Nii T., On "break" in Mongolian rainy season, #24.
13) Higuchi S., Shimada J., Tsujimura M., Abe Y. and Davaa G., Groundwater flow system in Kherlen River basin revealed by environmental tritium, #25.
14) Tsujimura M., Hydrological processes in Kherlen River Basin revealed by isotope tracer approaches, #26.
15) Asano M., Tamura K., Maejima Y., Matsuzaki H. and Higashi T., The characteristics of soils at the steppe of Kherlen River Basin, Mongolia, #27.
16) Saandar M. and Sugita M., Digital Atlas of Mongolian Natural Environments. (1) Vegetation, Soil, Ecosystems and Water, #28.
17) Adyasuren Ts., Byambakhuu I., Matsushima D., Ganbaatar T., Munbat T. and Sugita M., Some result for spectral reflectance of vegetation-soil associations in Kherlen River basin for under RAISE project, #29.
18) Matsushima D., Matsuura Y., Byambakhuu I. and Adyasuren Ts., An estimation of areal distribution of evapotranspiration over Khentii region using a combination of satellite data and a heat budget model, #32.
19) Doi H., Lu M. and Kamimera H., Development of a physically based model for soil water and heat transfer processes in semi-arid cold region, #33.
20) Li S-G., Asanuma J., Kotani A., Davaa G., Oyunbaartar D. and Sugita M., Water balance for a Mongolian steppe and its environmental constraints, #34.
21) Urano T., Oikawa T., Mariko S. and Kawada K., Seasonal dynamics of biomass and carbon dioxide fluxes in a Mongolian grassland, #35.
22) Lee P., Oikawa T., Mariko S., Lee G. and Chen Y., The estimation and verification of carbon / water cycle in a Mongo using Sim-CYCLE, #36.
23) Chen Y., Oikawa T., Mariko S., Lee G., and Lee P., Effect of grazing on net primary production in Mongolian grassland ecosystem, #37.
24) Sato T., Kimura F. and Hasegawa A., Cloud frequency in eastern Mongolia and its relation to the orography, #39.
25) Kimura F. and Sato T., Downscaling of precipitation over Mongolia using regional climate model, #40.
26) Adyasuren Ts, ECOASIA/FAO. Mongolian natural resource (land and water) database gateway, #43.

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