

RAISE Project to Study the Atmosphere-hydrosphere-biosphere Interactions in Northeastern Asia

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1. 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 an 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 decades. 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 (Fig.1).

The main focus of this research project, RAISE (the Rangelands Atmosphere-Hydrosphere-Biosphere Interaction Study Experiment in Northeastern Asia) is 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

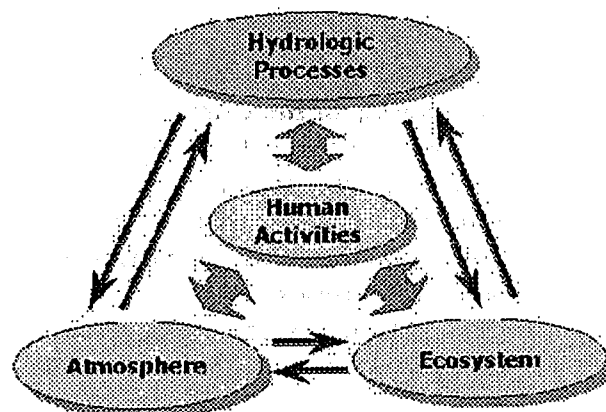


Fig. 1 Interaction of atmosphere, hydrosphere, and biosphere.

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. These studies will be carried out as a joint project between Institute of Meteorology and Hydrology and Japanese scientists' teams. It is expected that Environmental Education and Research Institute ECO Asia will also join the project.

2. Study Area

Kherlen river basin in northeastern part of Mongolia, and its surrounding regions have been selected as the study area. The basin has the area of 122,500 km² (total area in Mongolia), 71,500 km² (upriver part of Choybalsan) or 39,400 km² (upriver part of Undorhaan). Kherlen River has its headwater source at Henty mountain in the northeast of Ulaanbaatar and runs eastward through

moderately hilly plane. Annual runoff is from 100 to 200 mm at western headwater part consisting of mountainous forest, and decreases down to approximately 25 mm at the central and downstream parts mainly consisting of grassland. In this experimental basin, we will carry out intensive field observations on two different vegetation areas: mountainous forest and grassland.

3. Study Targets.

3.1 Understanding of the Current Status

The project will carry out studies to address the following specific targets in order to understand the current status of and interactions among the hydrosphere, atmosphere, and biosphere.

- (1) Land surface-atmosphere energy/water exchanges and estimation of areal evapotranspiration
- (2) Relationship between grassland ecosystem and human activity
- (3) Water/mass cycle processes using isotopes
- (4) Meso-scale atmosphere model and Monsoon circulation and water vapor transport process over the East Asia semi-arid region
- (5) Runoff analysis by distributed hydrological model

3.2 Prediction of the Future Status

For the prediction of the possible environment changes in the future, the following simulations will be carried out with models constructed and optimized for this region (Fig.2).

- (1) Atmospheric environment
- (2) Hydrological cycle
- (3) Rangeland biomass

4. Observations

In order to obtain needed data for the project, the following special observations are being planned.

4.1 Intensive Observations in 2003

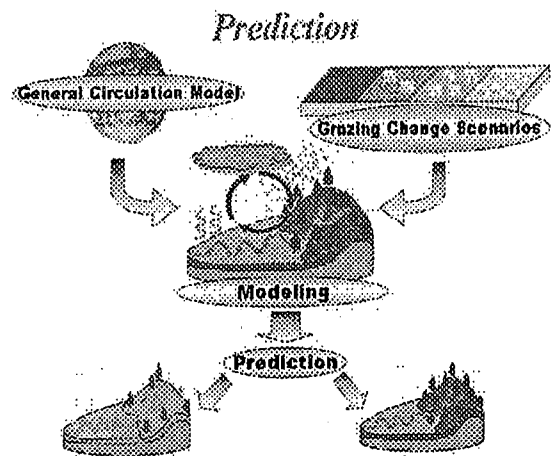


Fig.2 Prediction mode

An intensive observations will be carried out from spring through winter of 2003. Table 1 summarizes the itemized list of measurements sorted by the site. (See also Figs.3-8). In addition, aircraft measurements will be carried out for the purpose of surface remote sensing, sampling of water vapor in the atmosphere, turbulence measurements of air and water vapor with AN-2 aircraft of MIAT. Also, the doppler radar data being operated by IMH will be continuously recorded for the analysis as part of and in collaboration with CEOP (Coordinated Enhanced Observation Period) activity.

4.2 Continuous Observations

After the year 2003, some observations will be continued to capture the longer-term variations.

5. Concluding Remarks

Currently, with the help of IMH, preparations for the special observations to be made in 2003 are in progress. The fences needed to protect stations have been constructed already. A test flight of MIAT AN-2 was carried out. With current plan, stations will be constructed in March of 2003, and will start operation. The intensive observations will start soon afterward.

Table 1 List of Special Measurements to be Made by RAISE Project.

Location/Name	Type	Measured items
Forest	Flux station	Fluxes, general meteorology and hydrology
		Water and water vapor sampling
		Biological parameters
Mungenmorit	GPS station	GPS
Baganuur	AWS	General meteorology and hydrology, fluxes by a bulk method
Baganuur (Hillslope)	Hillslope	Discharge, soil erosion of protected and unprotected area
Khereen Bayan-Ulaan	Flux	Fluxes, general meteorology and hydrology of protected and unprotected area
		Water and water vapor sampling
		Biological parameters of protected and unprotected area
		GPS
		Sintilometer measurements
Khereen Bayan-Ulaan (Hillslope)	Hillslope	Discharge, soil erosion of protected and unprotected area
Undorhaan	AWS	General meteorology and hydrology, fluxes by a bulk method
Darhan	AWS	General meteorology and hydrology, fluxes by a bulk method
Jagalthaan	AWS	General meteorology and hydrology, fluxes by a bulk method
Bayanchandmani	GPS station	GPS

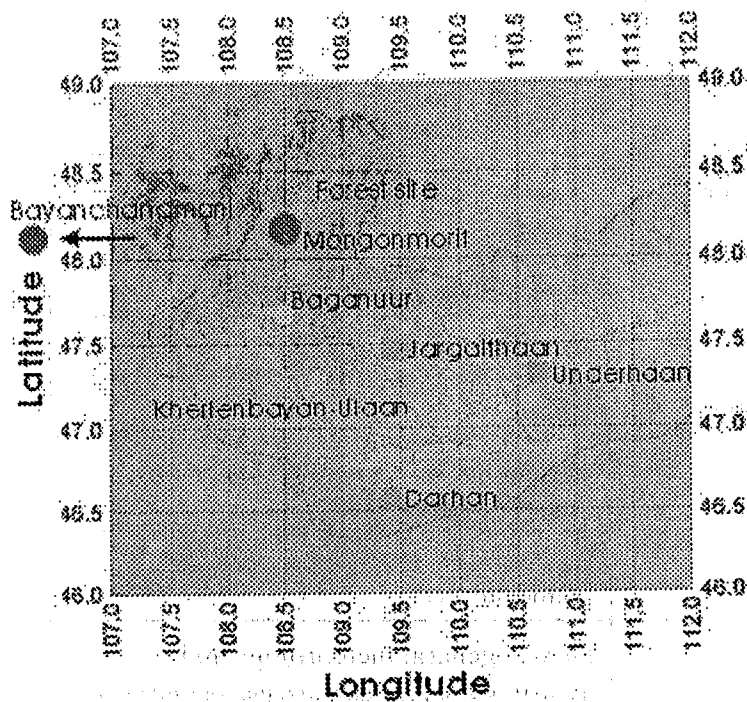


Fig. 3 A map showing observation sites for RAISE in upper Kherlen river basin and its vicinity. Larger circles represent GPS stations, smaller circles hillslope sites, triangles the flux stations, and squares AWS stations.

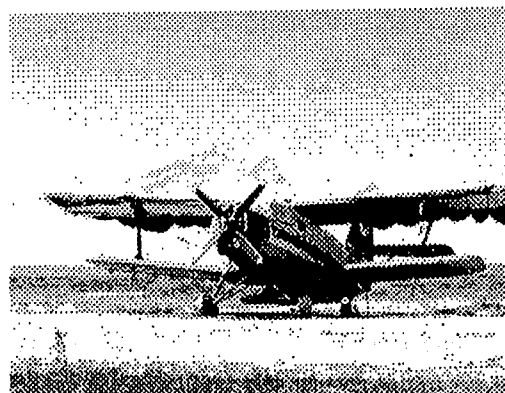


Fig. 4 AN-2 aircraft to be used for RAISE project

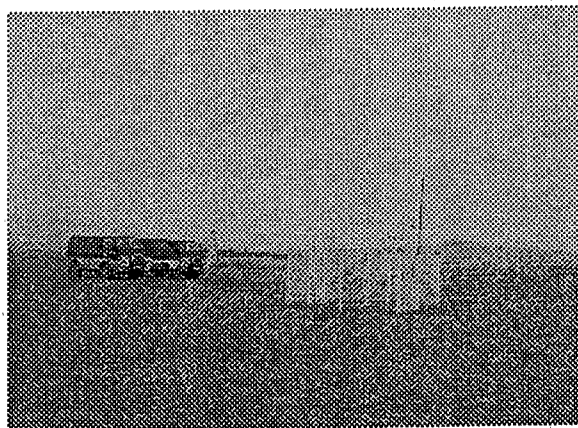


Fig.5 Flux station to be constructed at Khereen Bayan-Ulan (photo by Dr Li)

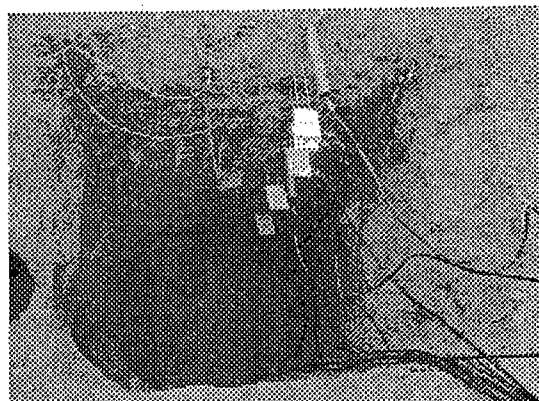


Fig. 6 Soil moisture and temperature sensors being buried at Forest site (photo by Dr Li)

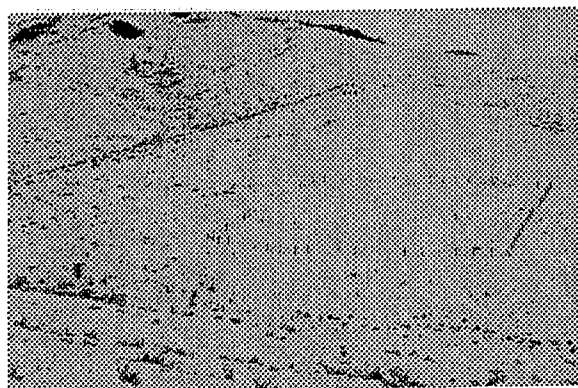


Fig.7 Protected area on the hillslope at Bagamuur (photo by Prof. Tamura)

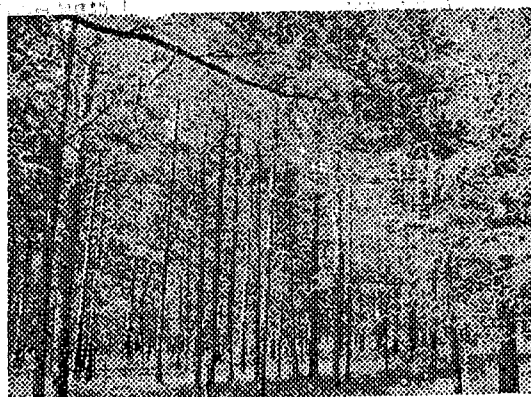


Fig. 8 View of the Forest site (photo by Dr Li)