Integrated Water Resources Management in Central Asia: Model Region Mongolia (MoMo)

Regional Hydrology and Meteorology

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Introduction

Within the project ‚Integrated Water Resources Management (IWRM) in Central Asia – Model Region Mongolia (MoMo - Phase 2)‘ the components of the water balance and their governing factors are studied in a sub catchment of the Kharaa river basin, NE Mongolia. Mongolia is facing a large number of **water management problems** like increasing water withdrawals, the deterioration of water quality due to intensified agricultural, mining and industrial activities as well as obsolete water supply infrastructure and wastewater treatment facilities, to mention a few examples (Menzel et al., 2011). This study is of major interest for the protection of the **scarce water resources** since the study site is situated in the transition belt between the **sub-humid taiga** and the **semi-arid steppe** zones. The mountainous and mostly forested taiga zone is an important headwater for the adjacent populated steppe regions. For a better understanding of the freshwater generating and withdrawing processes we study primary **meteorological** and **hydrological** parameters like precipitation, evapotranspiration and runoff.

Aims

- To conduct intensive field investigations and to establish a **monitoring program** to study relevant hydrological, hydrometeorological and ecological processes in the sensitive Kharaa headwater regions
- To extent the data basis for detailed studies of the regional hydrology based on refined **hydrological simulation** tools (MoMo - Phase1) and to improve our ability to assess potential impacts of climate change in this region
- To jointly establish regional **water- and land-use scenarios** as a base for an assessment of future water shortages, including climate change
- To deliver scientific support for the establishment of a **natural reserve area for the Kharaa river** in the context of IWRM
- To train and supervise students and young scientists from Mongolia in hydrometeorological methods

Study Site and Methods

The study site is located in the **Sugnugur basin**, one of the most important headwaters of the Kharaa river catchment (14,500 km²) north of the Mongolian capital Ulan Bator (Fig. 1 and 2). It is characterized by a semi-arid climate, with 70 % of the annual precipitation of ~ 400 mm falling during the summer months (Menzel et al., 2011). Temperature in this extreme continental climate rises above 30°C in summer and can reach a minimum of below -40°C during winter. Due to intense radiation and limited plant available water, vegetation differs greatly, depending on exposition. South exposed hill slopes are steppe-like vegetated, whereas north exposed hill slopes are characterized by dense taiga forests consisting mainly of *Pinus Sibirica*, *Larix Sibirica* and *Betula Platyphylla*. However, frequent forest fires occur which are presumed to strongly impact runoff formation processes in this mountainous region.

Fig. 1. Headwater of the Kharaa river in the Khentii mountains.

Since 2011 the **main hydrometeorological station** has been in operation at the entrance of the Sugnugur valley (Fig. 3). It includes the collection of a wide range of parameters in high temporal resolution, such as air temperature, relative humidity, wind speed and direction and precipitation as well as snow height in winter.

Short-wave and long-wave radiation are measured in both upward and downward direction. Soil temperature and soil moisture (TDR) have been recorded on three plots. Soil heat flux has been determined using a heat flux plate (HFP).

In the upper part of the catchment three **soil moisture transects** were installed in the south exposed, forested north exposed and burned north exposed hill slopes accompanied by infiltration and precipitation measurements. Soil moisture sensors (FDR) were used in triple replicates at each transect point to account for soil heterogeneity. Two temporary **meteorologic stations** and **river gauges** were installed in two vallyes of the Sugnugur headwaters to account for assumed spatial differences in weather conditions and hydrological characteristics.

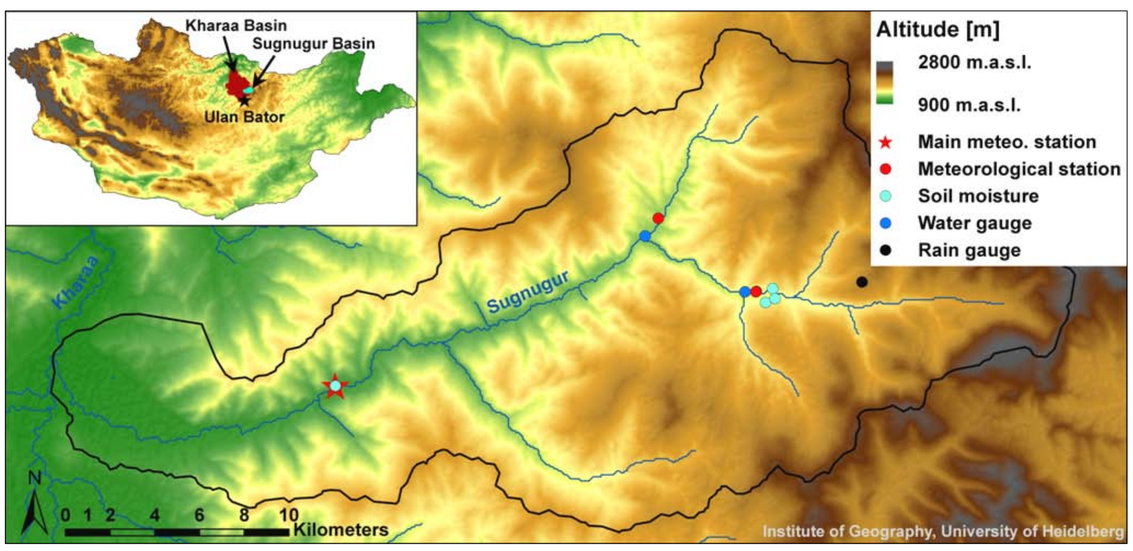

Fig. 2. Topographic Map of the Sugnugur basin. Depicted are the locations of the observation points of the monitoring program.

Fig. 3. Main hydrometeorological station in the Sugnugur valley.

Fig. 4. Installation of the rain gauge at the highest elevation (2026 m).

Three additional rain gauges have been installed at different elevations (1193 m, 1483 m and 2026 m) to measure an altitude dependent **gradient in annual precipitation** in order to improve hydrological modeling (Fig. 4).

Characteristic **vegetation parameters** (e.g. height, leaf area index) and weather observations are recorded. In addition, **soil specific parameters** like porosity and a water retention curve are analyzed.

Actual **evapotranspiration** has been determined using the physically-based, ecohydrological model **TRAIN**. Validation of model output is based on the calculation of evapotranspiration by means of the **Bowen Ratio Energy Balance Method** directly in the field, using the gradients of air temperature and vapour pressure between two heights (0.5 m and 2.0 m).

Further, runoff simulations have been conducted using **HBV-D** (calibration and validation with field data) including **climate scenarios**.

Literature

Menzel, L., Hofmann, J., Ibisch, R., 2011. Studies of water and mass fluxes to provide a basis for an Integrated Water Resources Management (IWRM) in the catchment of the River Kharaa in Mongolia. *Hydrologie und Wasserbewirtschaftung* **55 (2)**, 88-103.

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