Modeling sustainability of water resources in Tuul River watershed in Mongolia

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Agenda

Background
Problems
Objectives
Methods
Preliminary results
Expected outcome
Number of months during the year in which the blue water footprint exceeds blue water availability for the world's major river basins, based on the period of 1996–2005.

This map shows the average exposure of water users in each country to water stress, the ratio of total withdrawals to total renewable supply in a given area. A higher percentage means more water users are competing for limited supplies. Source: WRI Aqueduct, Gassert et al. 2013
Tuul River Basin

- 704 km long, with a catchment area of 49,994.3 km² *
- 46% of the total Mongolian population and 68.4% of entities and organizations**

**(National Statistical Office 2017)
Main issues in Tuul River Basin

- Groundwater exploitation
- Mining
- Deforestation
- Overgrazing
- Pollution

*(Dolgorsuren, G et al. 2012).*
Tuul River January streamflow measurements at 3 stations (1982-2012)

Data source: NAMHEM, Mongolia
Water Supply and Demand prediction for Ulaanbaatar city

Source: 2030 Water Resource Group
Objective of the study

The main objective of this study is to evaluate ecohydrological processes at subbasin scale for sustainable water management using physically based Soil and Water Assessment Tool (SWAT) for the Tuul River Basin in Mongolia.
Simulation of ecohydrological processes

- SWAT* (Soil and Water Assessment Tool)
- a semi-distributed, eco-hydrological model developed to assess the effect of management and climate on water supplies, sediments, and agricultural, chemical yields.

*(Arnold et al. 1998)
# Background

- Problems
- Objective

# Methods

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Diwakar et al. (2014)
Water Demand Estimation

Water demand = Number of users * per capita use

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Area weighted overlay in GIS

Subwatersheds of Tuul River Basin

Water demand by subwatersheds
Water Supply and Demand Dynamics

- Estimated Water Supply
- Analyzed Water Demand
- Water Scarcity Index
  (by watershed, subwatersheds, monthly basis, land use)

Water Scarcity Index WSI

\[
WTA_i = \frac{\sum_i W U_{ij}}{WA_i}
\]

water to availability ratio (WTA)

\[
WSI = \frac{1}{1 + e^{-6.4WTAB\left(\frac{1}{0.01} - 1\right)}}
\]

Water Scarcity Index WSI

(Pfister et al.2009)
Strategies to support water sustainability
Simulation of ecohydrological processes

**Input Data**

- DEM
- Land use
- Soil
- Location of Weather Station
- Weather Time Series

**Example Maps**

- Digital Elevation Map
- Land Use
- Soil Type
- Slope
Simulation of ecohydrological processes

GIS Processing using ArcSWAT

Watershed Delineation

Sub-Basin Delineation

Stream Delineation

HRUs Definition

Watershed delineation

Subwatershed delineation

Subwatershed delineation

HRU definition
Simulation of ecohydrological processes
Water Demand Estimation

Per capita water consumption for apartment users

Data source: USUG
Water Demand Estimation

Industrial Water Use

Data source: USUG
Water management strategies

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<td>• New source</td>
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<td>• Reuse of treated waste water for non potable purposes</td>
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<td>• Leak detection and reduction in unaccounted water</td>
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<td>• Grey water usage in commercial and apartment buildings</td>
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<th>Water demand management Options</th>
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<td>• Installation of high efficiency toilets, showerheads</td>
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<td>• Pricing strategy</td>
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Background | Problems | Objective | Methods | Preliminary results | Expected outcome |
• Ecohydrological processes such as urbanization and groundwater withdrawals are influencing water supplies;

• Water demand of the Tuul River basin is increasing and have tendency to further increase;

• There are temporal and spatial variations of water supply and demand in the basin; and

• There is an urgent need to propose strategies for water sustainability at watershed and city scales.

• The model could act as the baseline to simulate effects of different environmental policy as well as management scheme at the subwatershed and whole water basin systems

• It can provide informational basis to decision makers to prioritize and forecast the potential impacts of the management policies
Thank you

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