Modeling sustainability of water resources in Tuul River watershed in Mongolia

Javzansuren Norvanchig

Timothy Randhir

IIT Madras, Chennai

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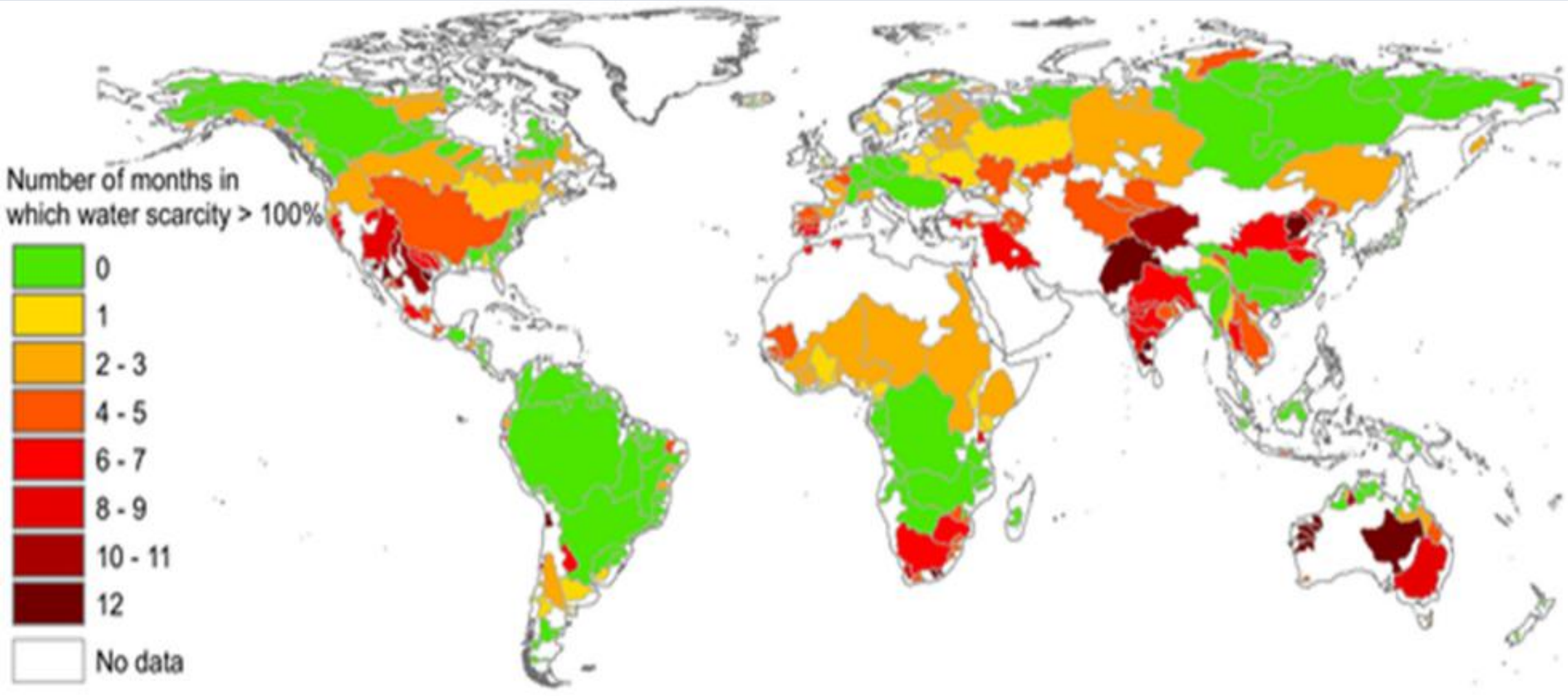
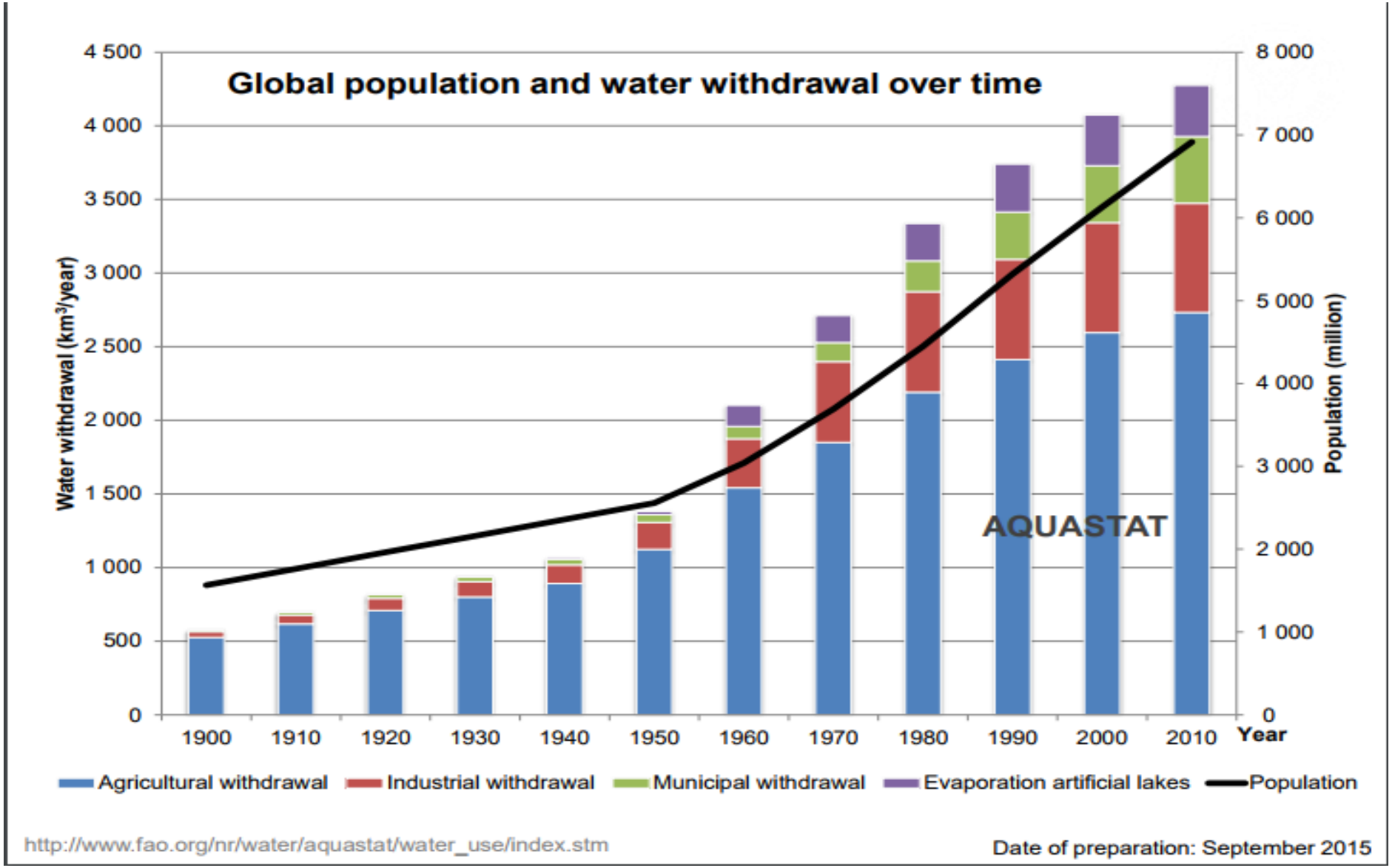
Agenda

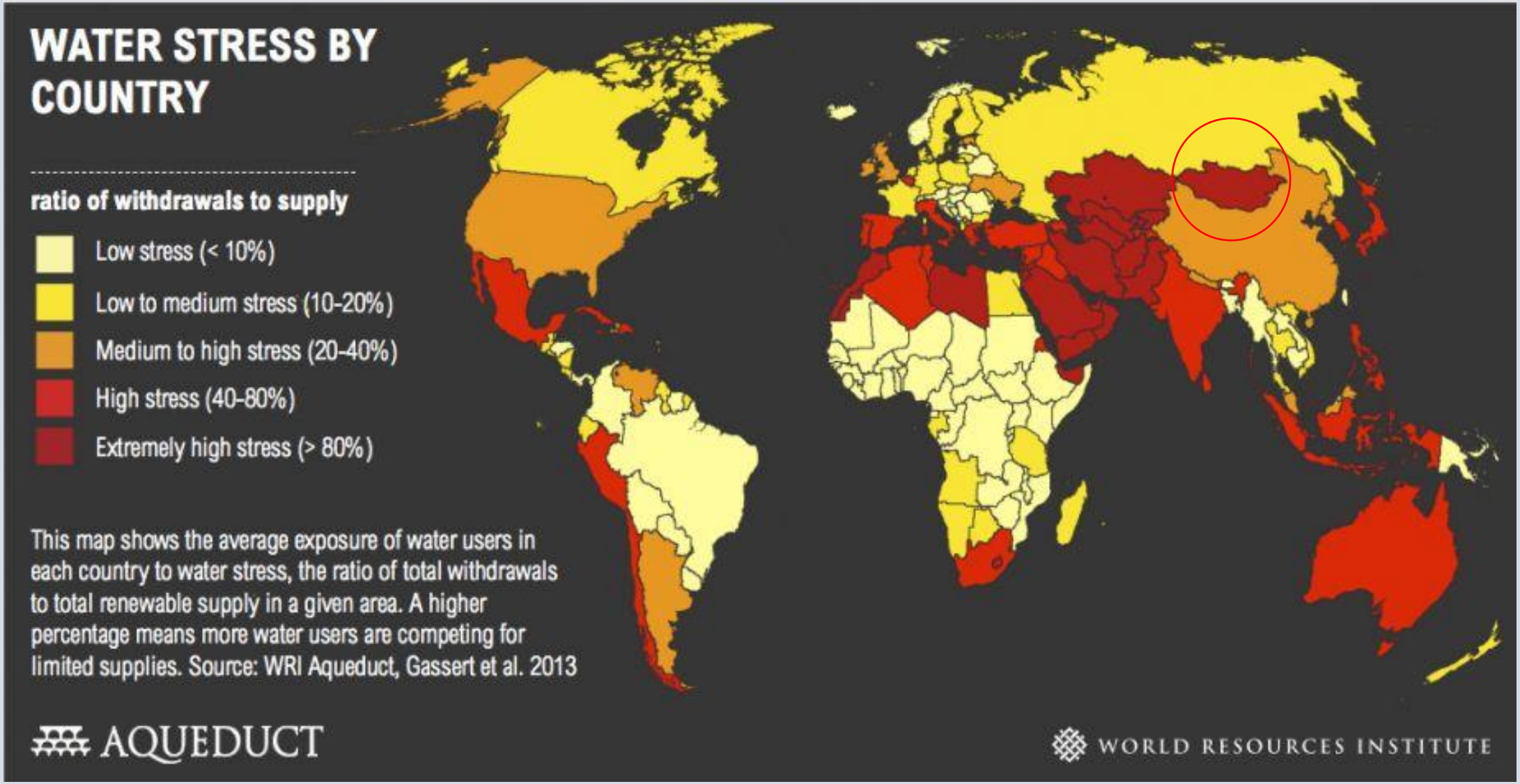
- Background
- Problems
- Objectives
- Methods
- Preliminary results
- Expected outcome



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.

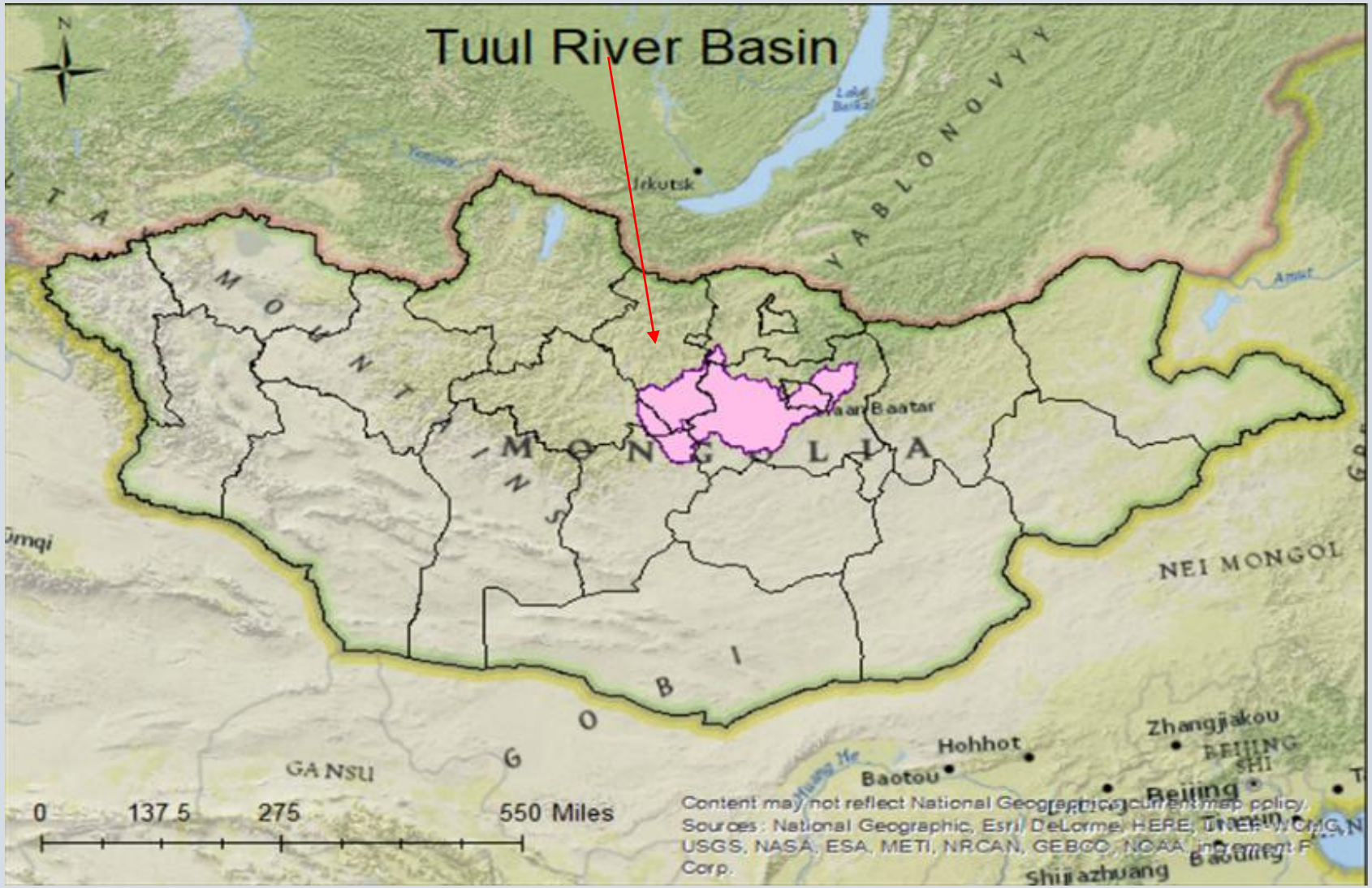
Hoekstra AY, Mekonnen MM, Chapagain AK, Mathews RE, Richter BD (2012) Global Monthly Water Scarcity: Blue Water Footprints versus Blue Water Availability. PLOS ONE 7(2): e32688. https://doi.org/10.1371/journal.pone.0032688


Global population and water withdrawal over time
Water withdrawal (km³/year)
Population (million)
Year
AQUASTAT
4 500
4 000
3 500
3 000
2 500
2 000
1 500
1 000
500
0
8 000
7 000
6 000
5 000
4 000
3 000
2 000
1 000
0
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
2010
Agricultural withdrawal
Industrial withdrawal
Municipal withdrawal
Evaporation artificial lakes
Population
http://www.fao.org/nr/water/aquastat/water_use/index.stm
Date of preparation: September 2015


WATER STRESS BY COUNTRY
ratio of withdrawals to supply
Low stress (< 10%)
Low to medium stress (10-20%)
Medium to high stress (20-40%)
High stress (40-80%)
Extremely high stress (> 80%)
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
AQUEDUCT
WORLD RESOURCES INSTITUTE

Tuul River Basin

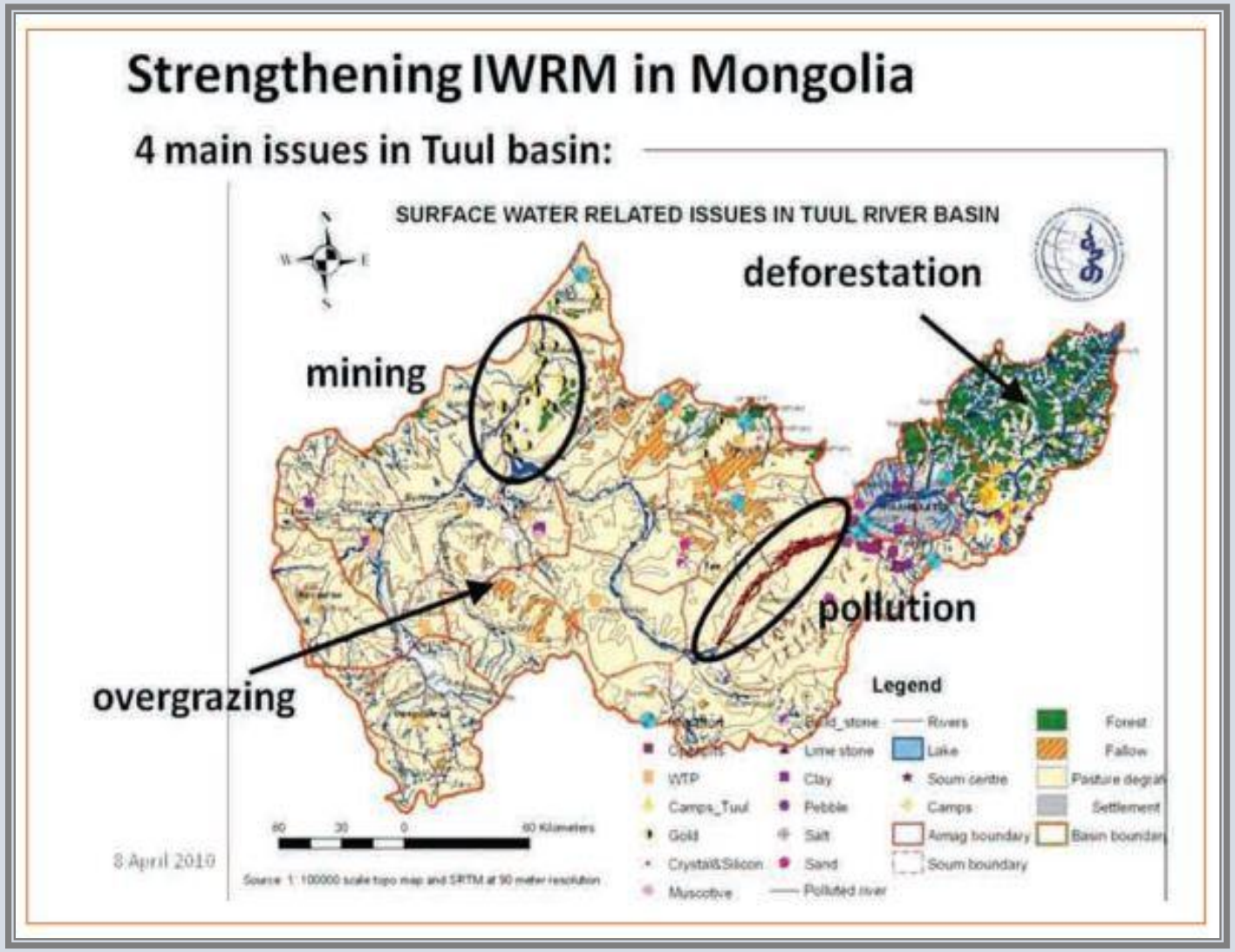
- 704 km long, with a catchment area of 49,994.3 km^2 *
- 46% of the total Mongolian population and 68.4% of entities and organizations**



Source :*(Dolgorsuren, G et al. 2012).
**(National Statistical Office 2017)

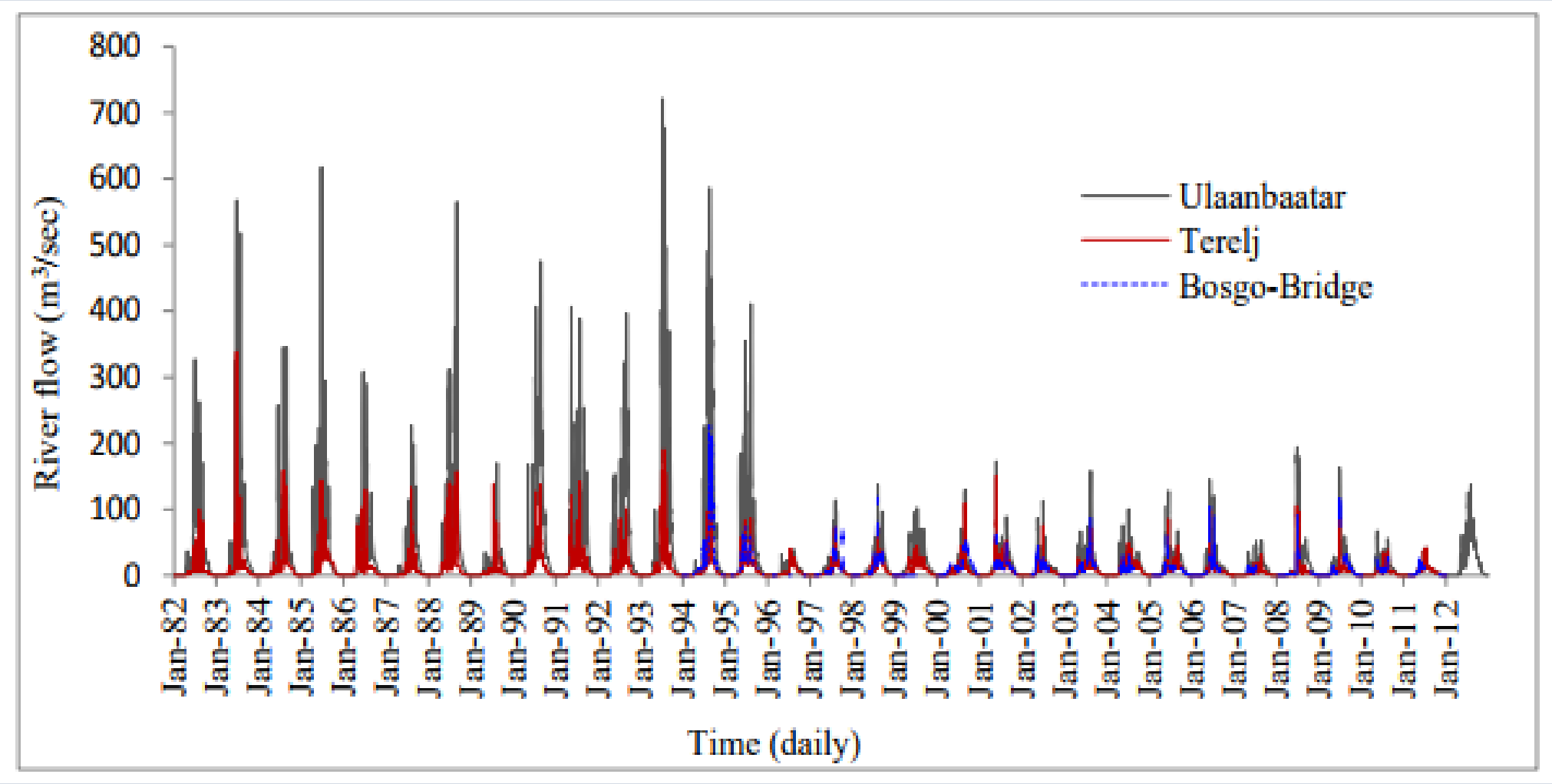
Main issues in Tuul River Basin

- Groundwater exploitation
- Mining
- Deforestation
- Overgrazing
- Pollution



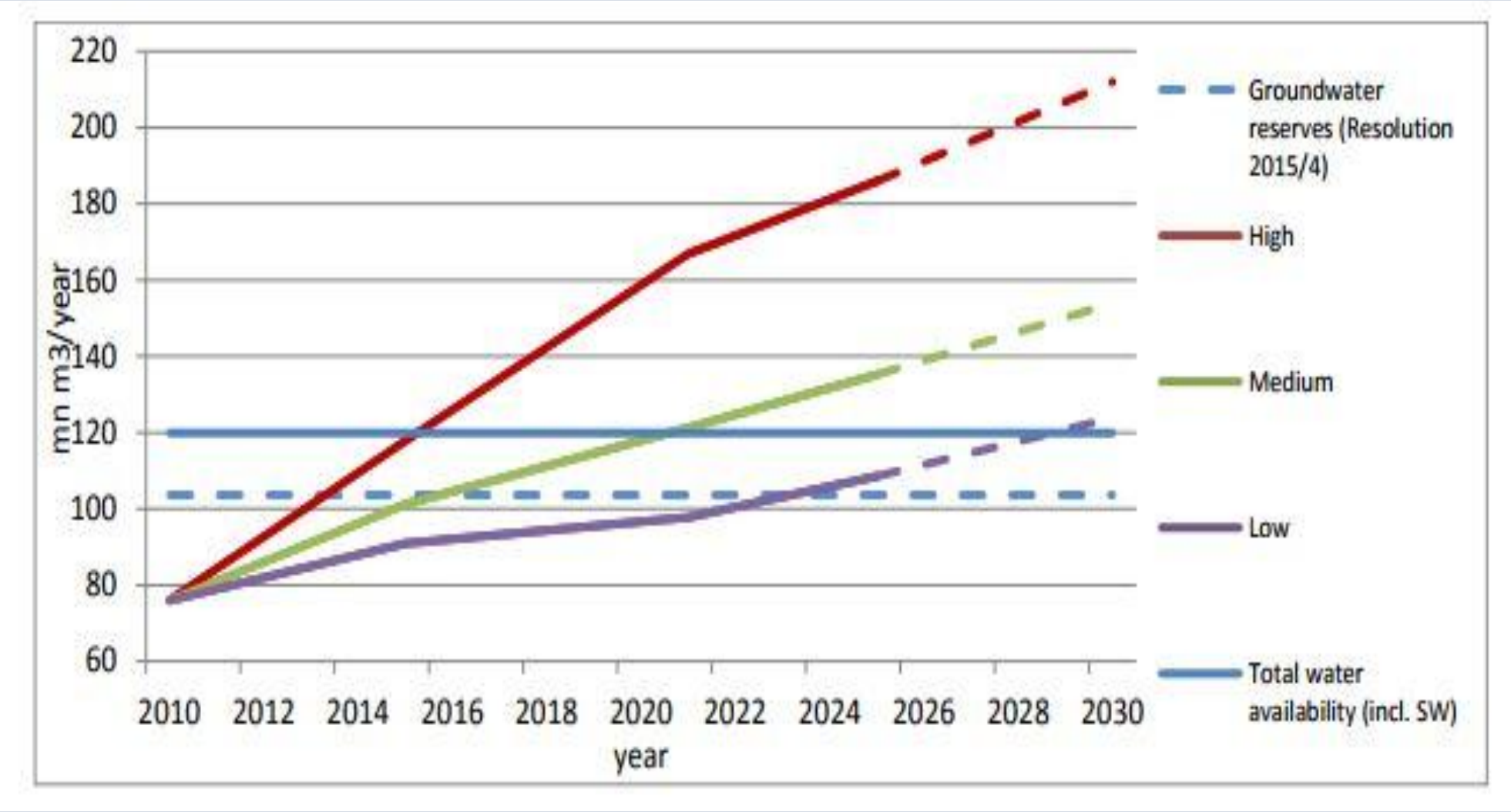
*(Dolgorsuren, G et al. 2012).

Tuul River January streamflow measurements at 3 stations (1982-2012)



Data source : NAMHEM, Mongolia

Water Supply and Demand prediction for Ulaanbaatar city



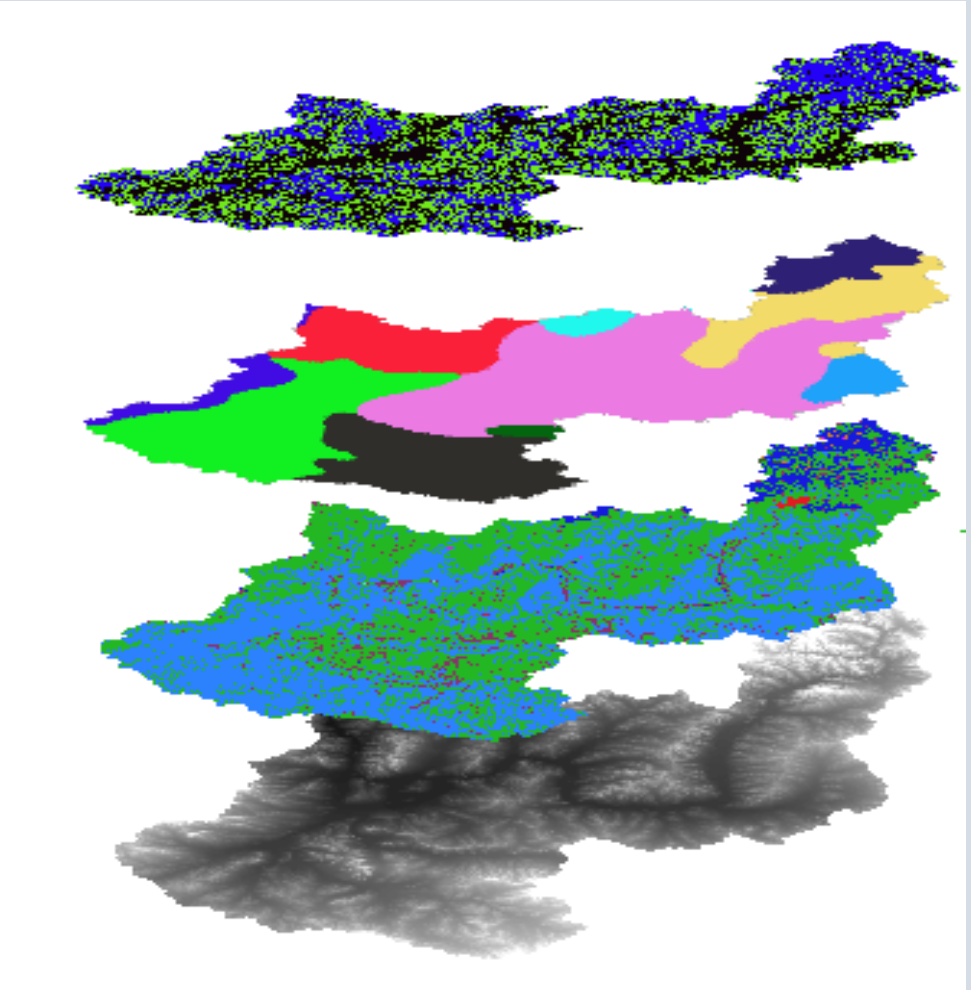
Source: 2030 Water Resource Group

Objective of the study

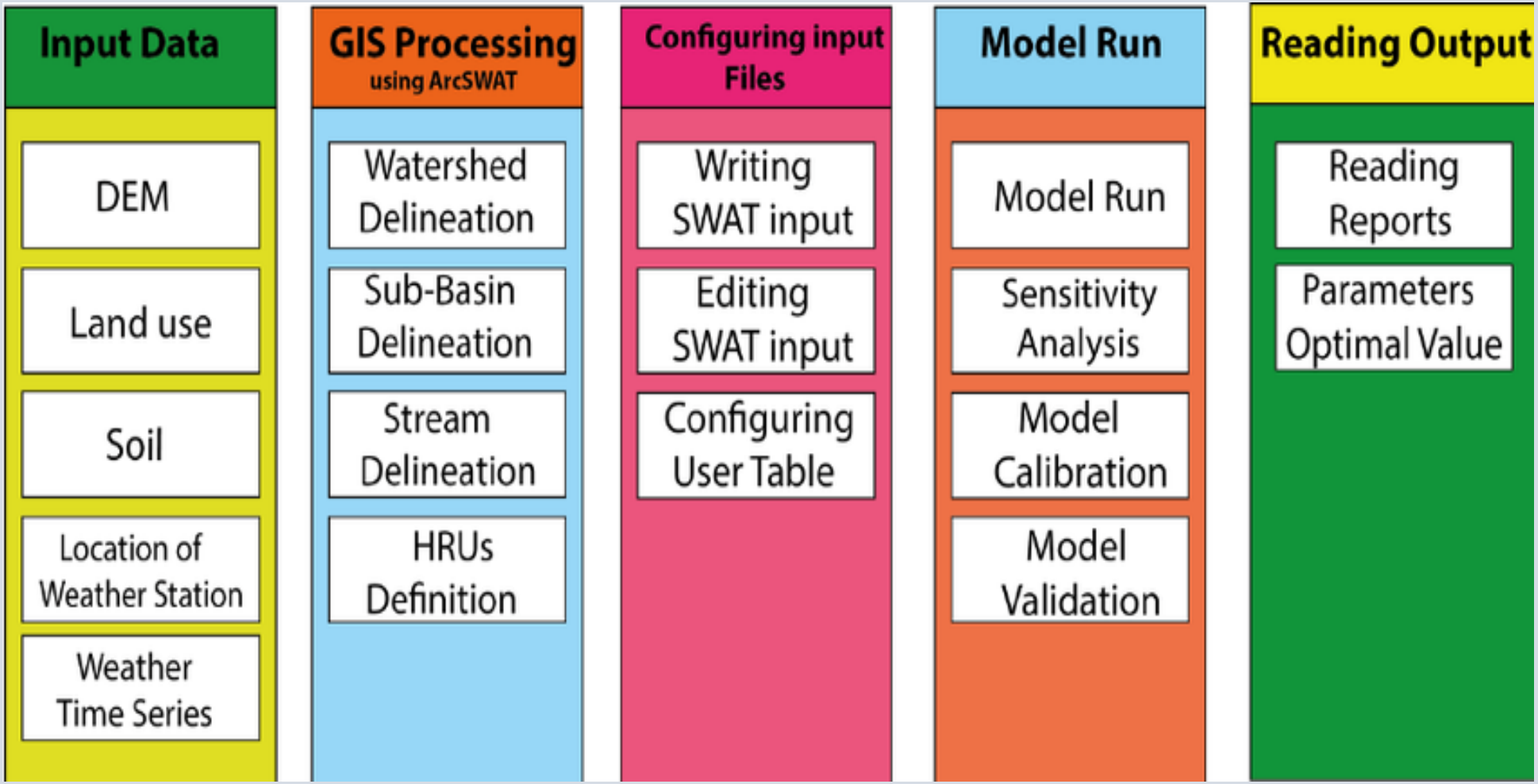
The main objective of this study is to evaluate ecohydrological processes at subbasin scale for sustainable water management using physically based Soil and Water Assessment Tool(SWAT) for the Tuul River Basin in Mongolia.

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.

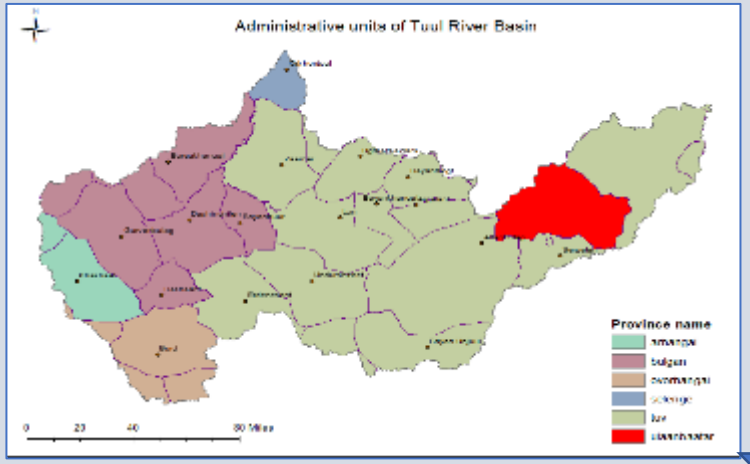


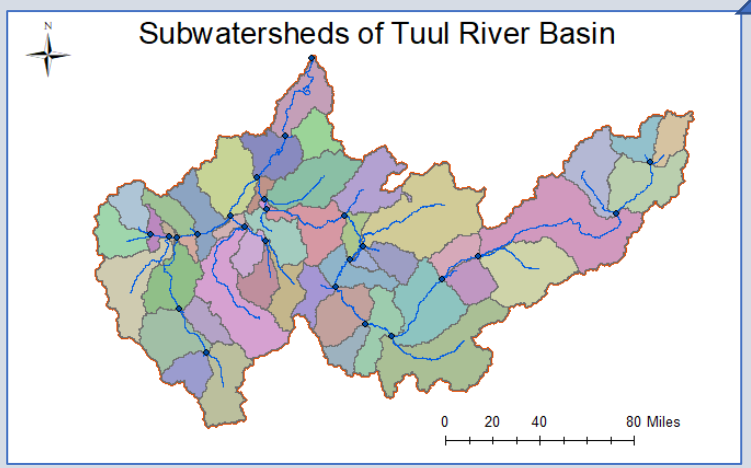
*(Arnold et al. 1998)



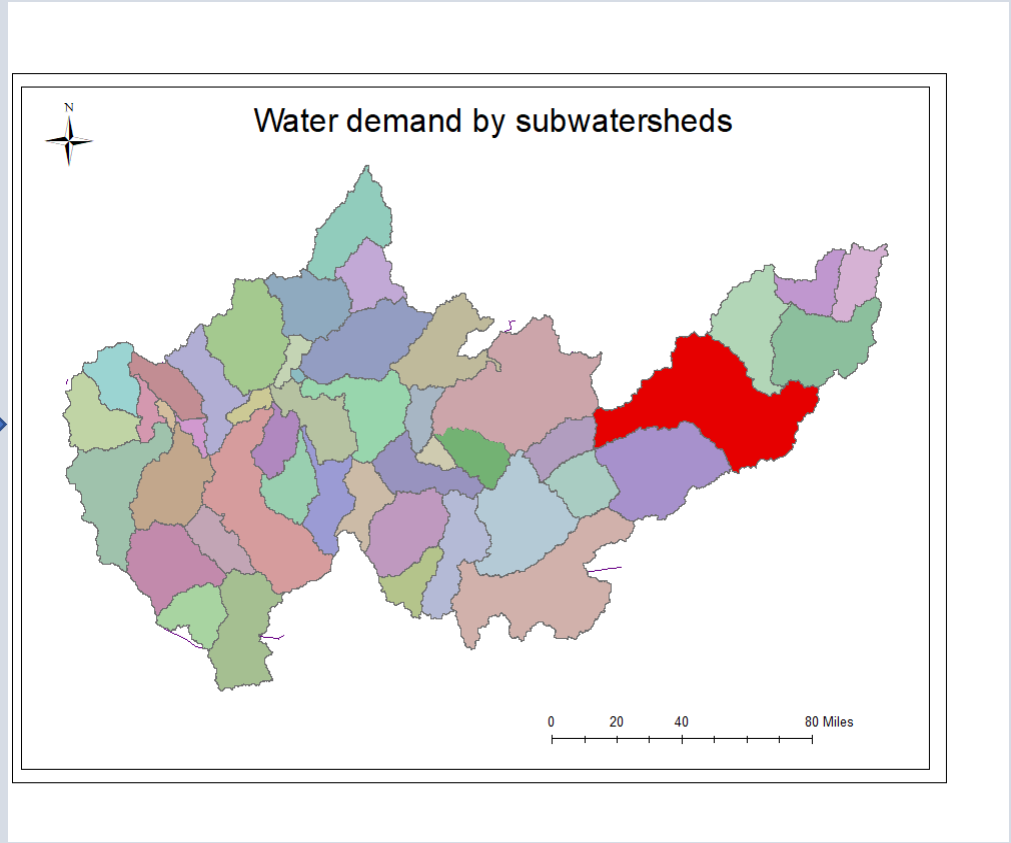
Diwakar et al. (2014)

Water Demand Estimation



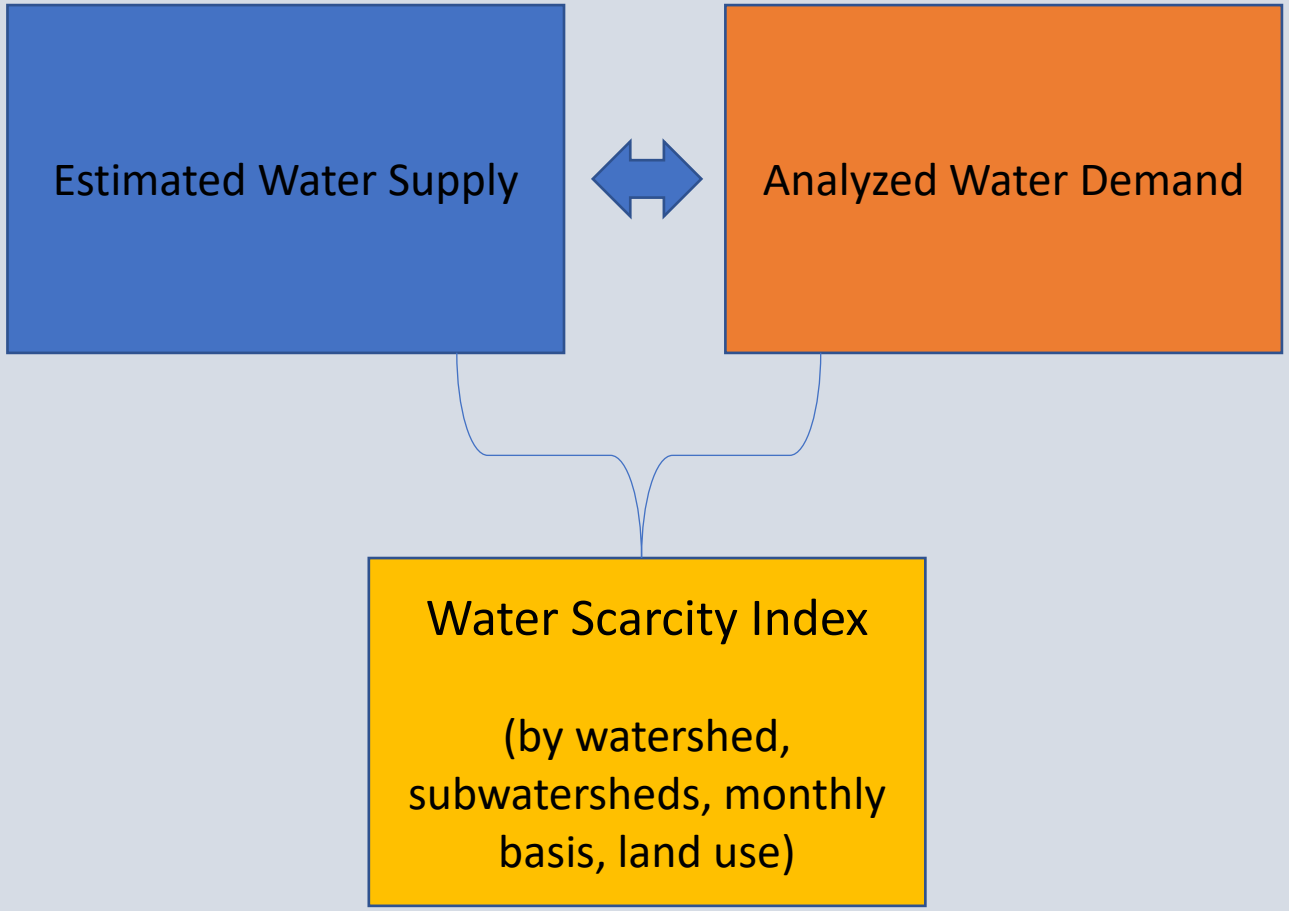


Area weighted overlay in GIS



Water demand = Number of users * per capita use

Water Supply and Demand Dynamics



$$WTA_i = \frac{\Sigma_i WU_{ij}}{WA_i}$$

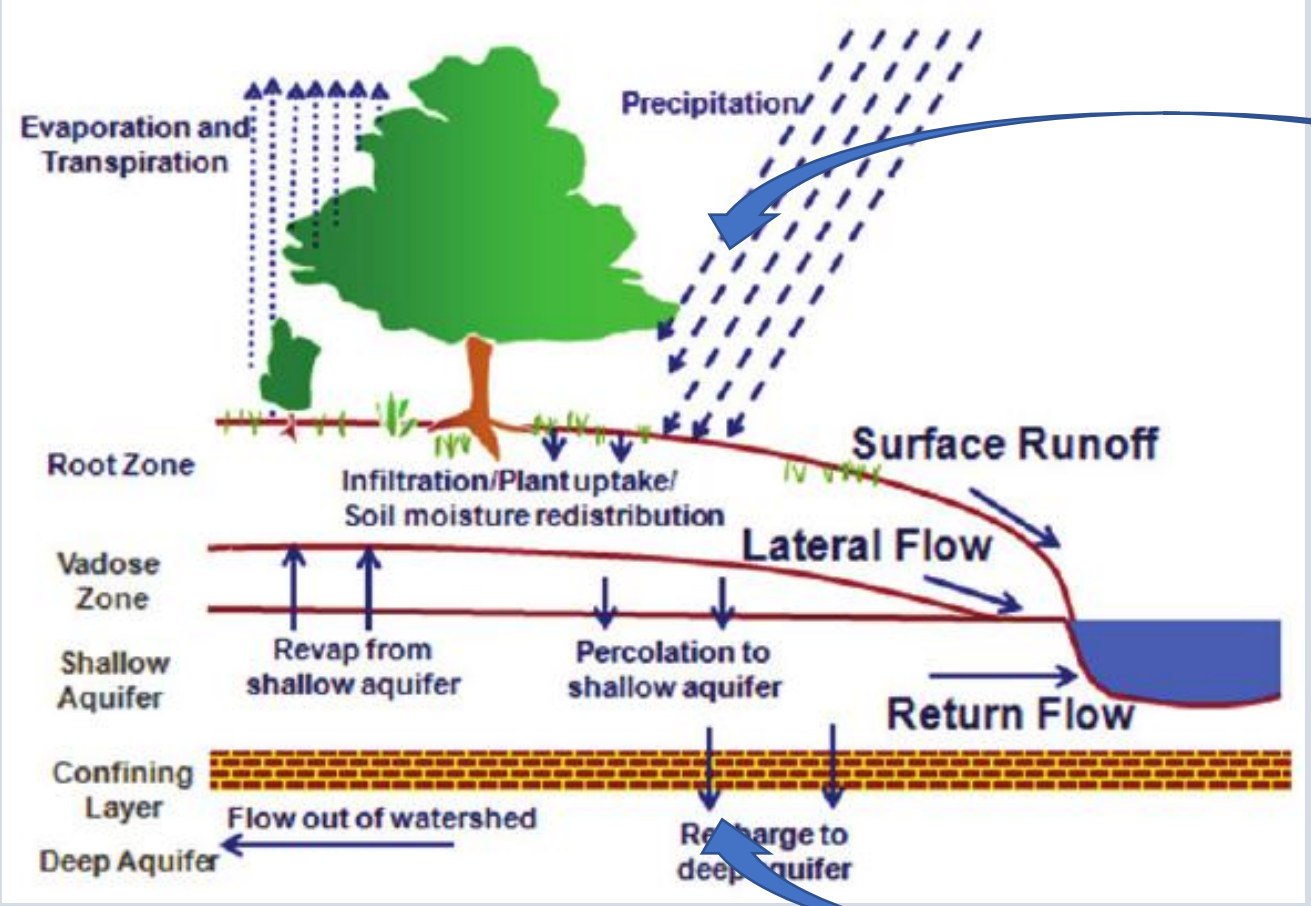
water to availability ratio (WTA)

$$WSI = \frac{1}{1 + e^{-6.4WTA8\left(\frac{1}{0.01}-1\right)}}$$

Water Scarcity Index WSI

(Pfister et al.2009)

Strategies to support water sustainability



BEST MANAGEMENT PRACTICES

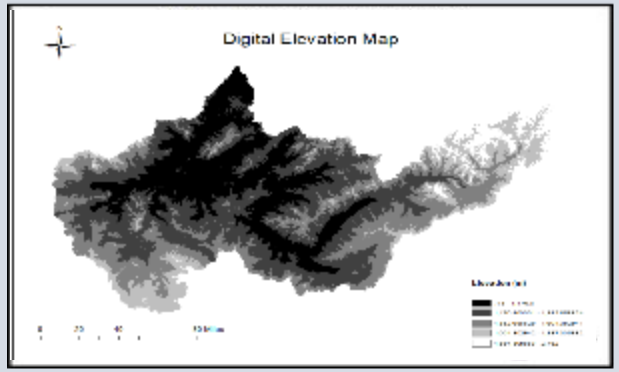
Water Supply Augmentation Options

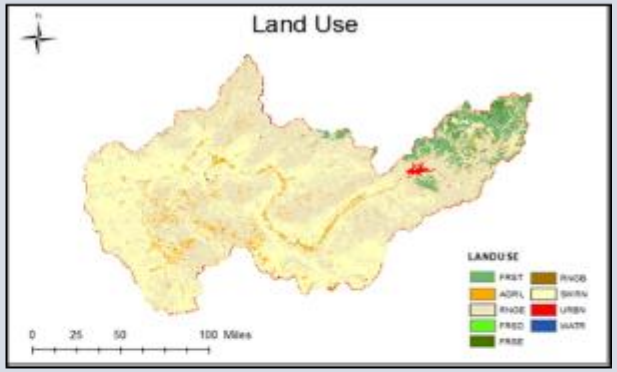
Water demand management Options

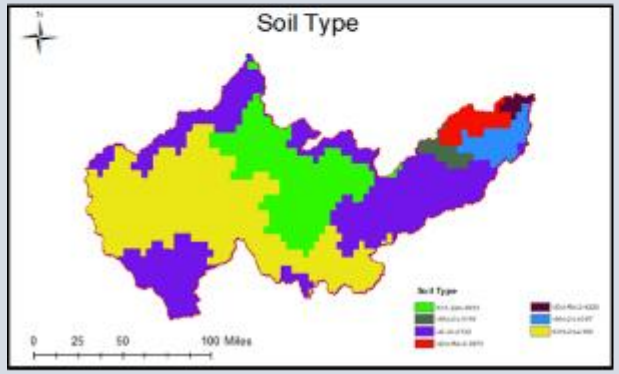
Simulation of ecohydrological processes

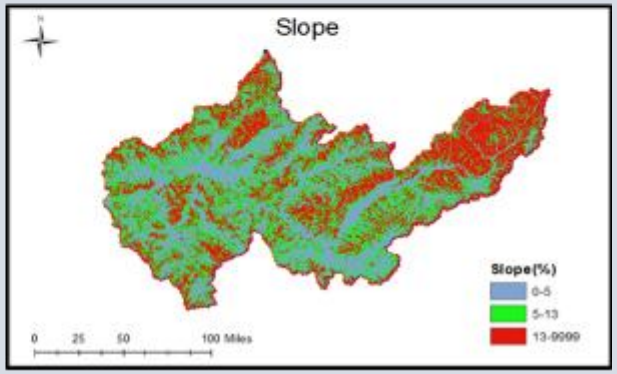
Input Data

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

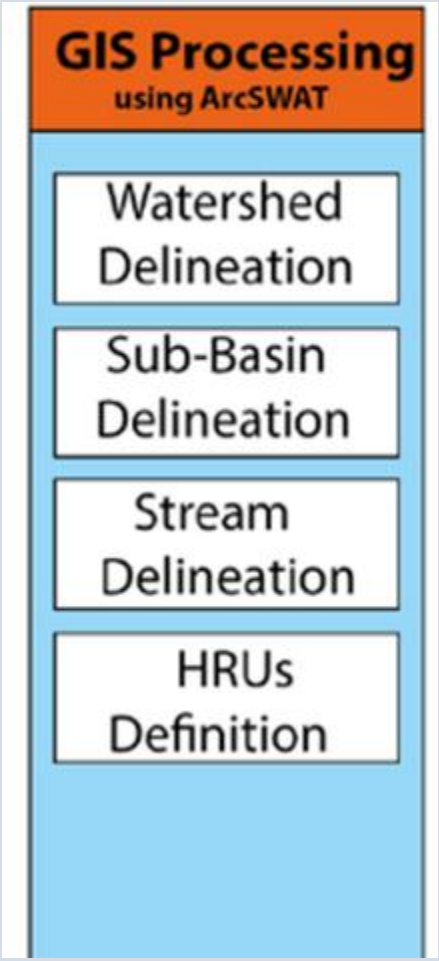


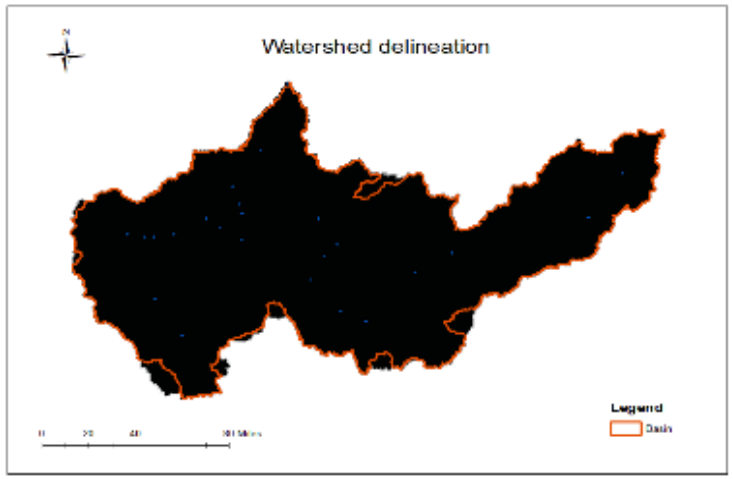


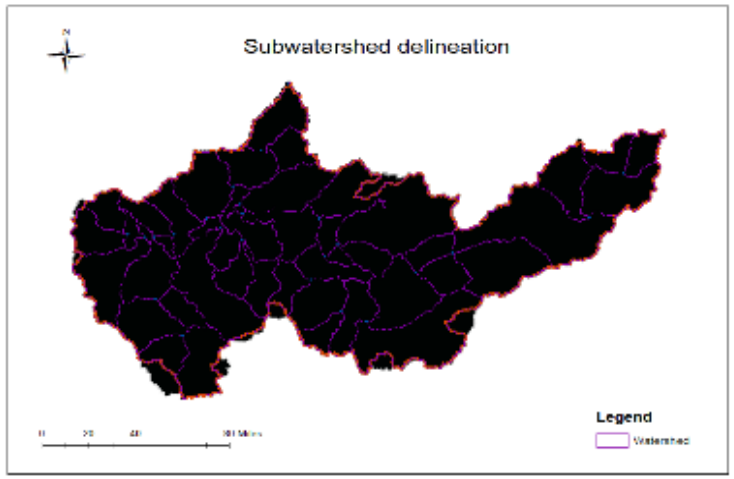


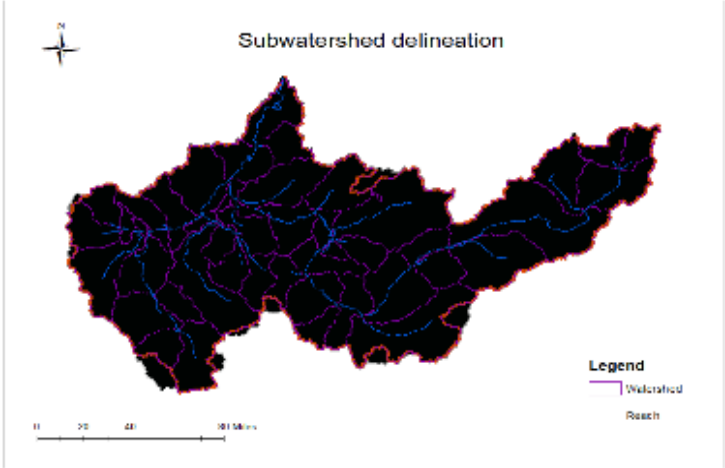


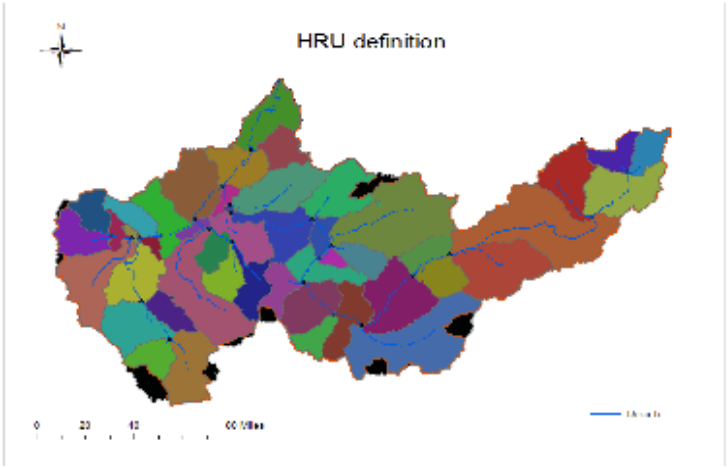
Simulation of ecohydrological processes



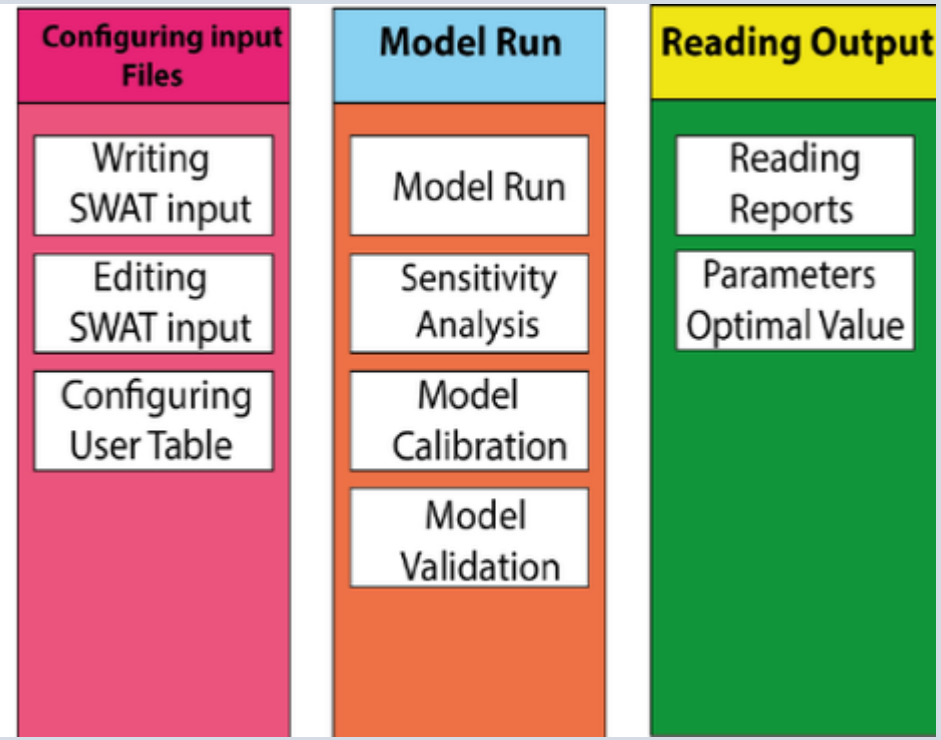


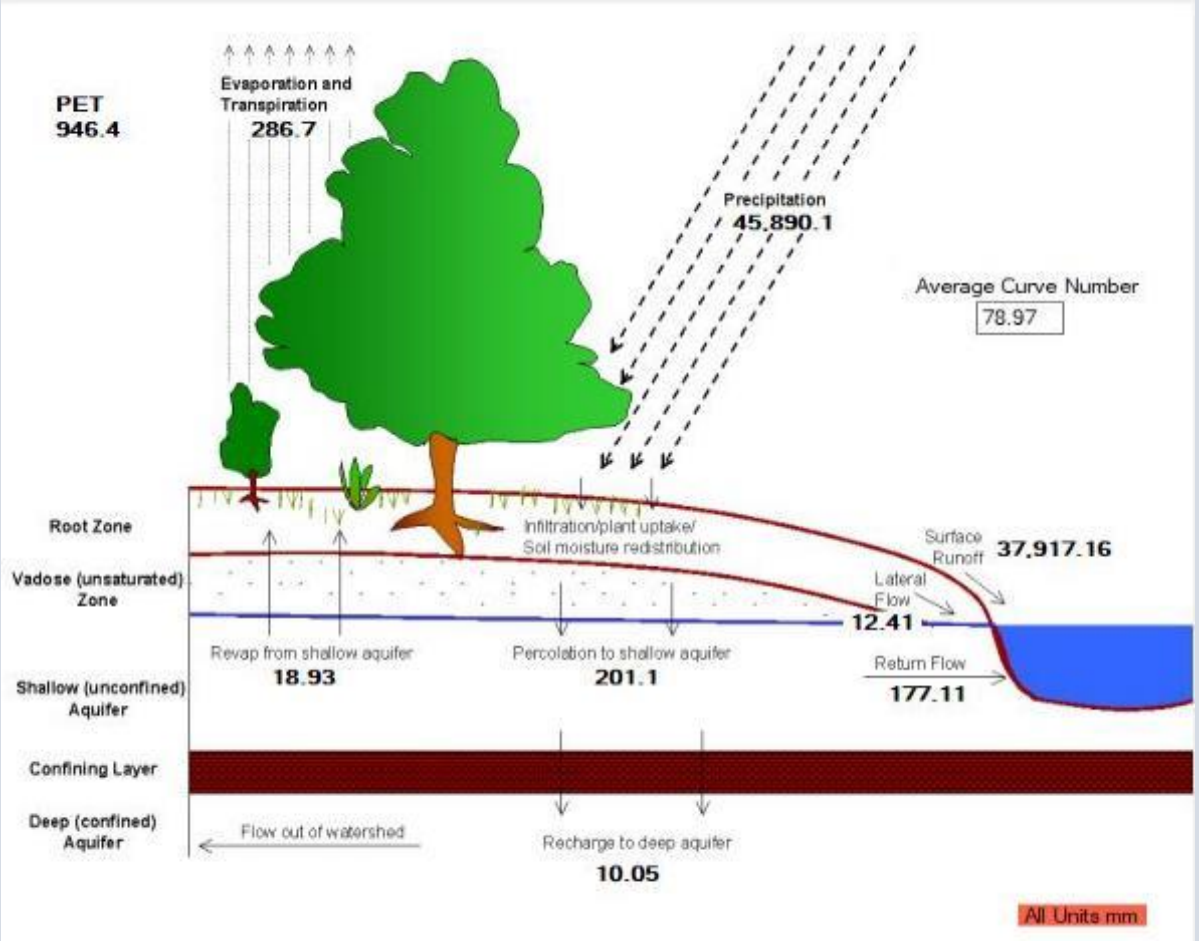




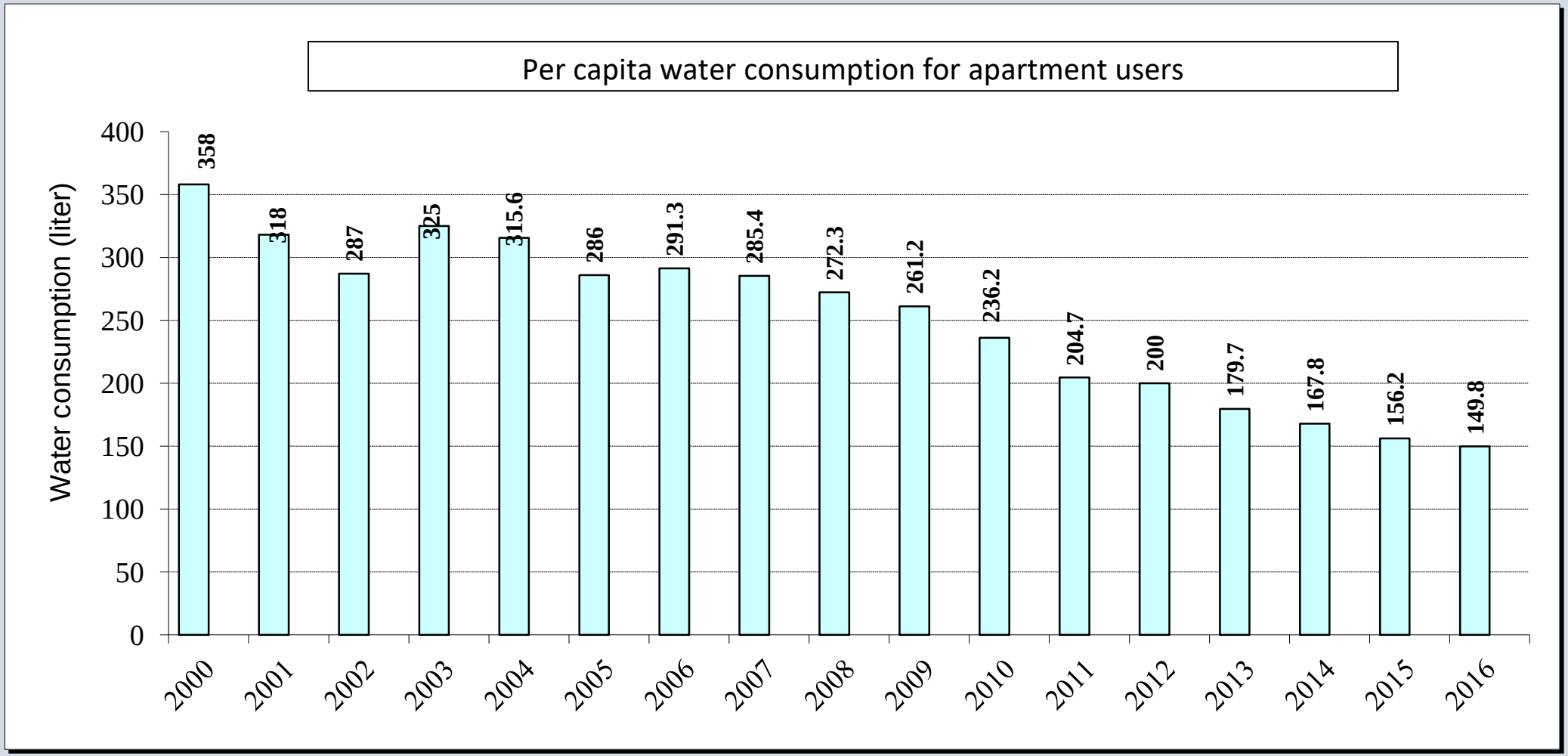


Simulation of ecohydrological processes



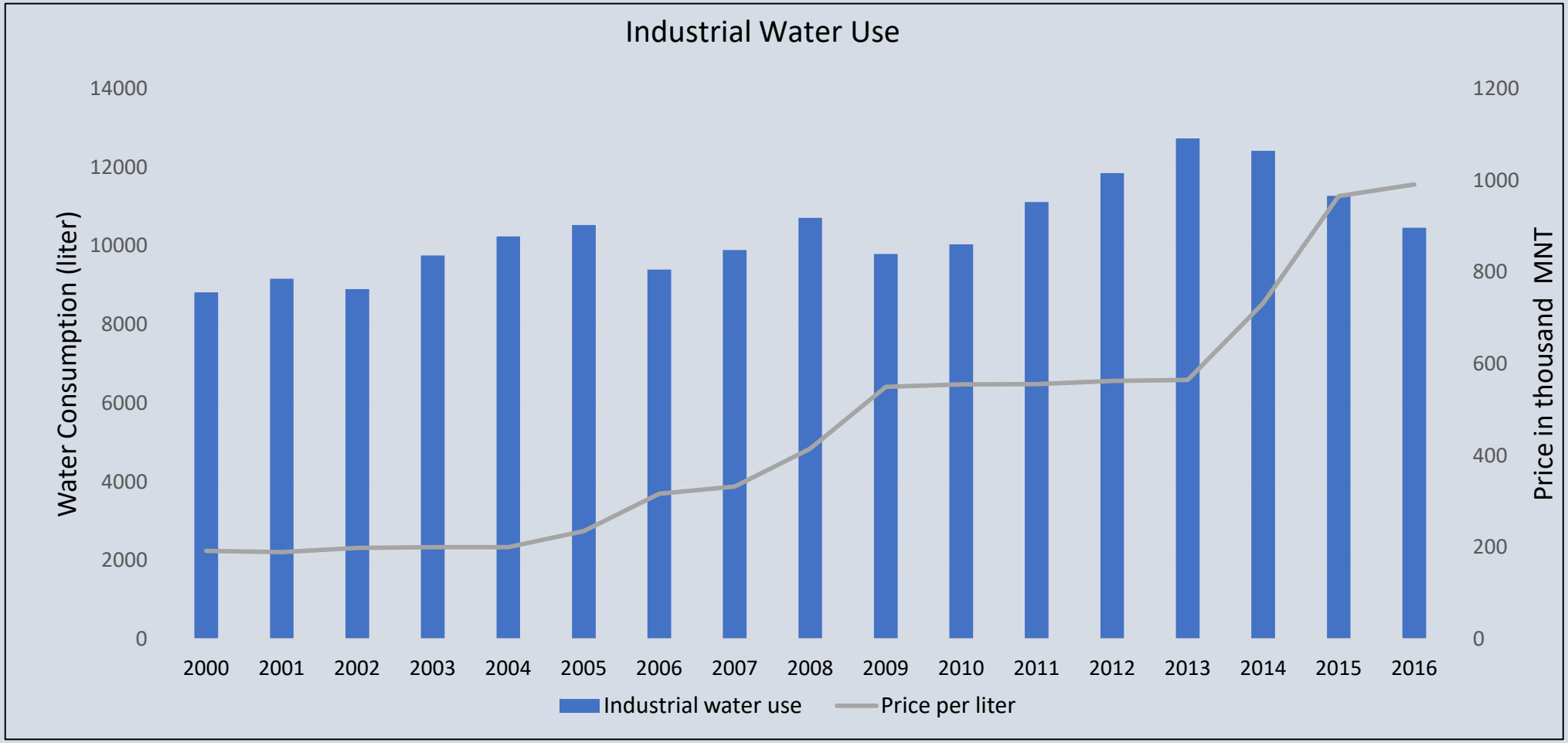


Water Demand Estimation



Data source: USUG

Water Demand Estimation



Data source: USUG

Water management strategies

BEST MANAGEMENT PRACTICES		
	Water Supply Augmentation Options	• New source • Reuse of treated waste water for non potable purposes • Leak detection and reduction in unaccounted water • Grey water usage in commercial and apartment buildings
	Water demand management Options	• Installation of high efficiency toilets, showerheads • Pricing strategy

- 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

Acknowledgements

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