Application of SWAT to Quantify Internal Renewable Water Resources in Iran

Monireh Faramarzi
monireh.faramarzi@eawag.ch

Eawag: Swiss Federal Institute of Aquatic Science and Technology

Picture: Doosti dam, central Khorasan province
Content

- General background
- Objectives
- Methodology
  - model area
  - model input
  - model setup
- Results
The proposed research project aims to assess the feasibility of applying the ‘virtual water strategy’ to alleviate water stress in Iran.

### Background

- Regional crop structure adjustment
- Inter-provincial food trade
- Socio-economic factors

Improving regional/provincial and national water productivity and Water use efficiency
Start with SWAT:

- Quantification of regional water resources
- Quantification of provincial water resources
Area: 1,648,000 km² (165 million hectare)
Altitudes: -80 m to 5670 m
Average annual precipitation: 252 mm
Precipitation range: 20-2000 mm
Temperature: -44 to 56 degree C.
Karkheh Dam
Max. Volume: 8437.0 MCM
Operation: 2000

Karaj Dam
Max volume: 206.35 MCM
Operation: 1961

Latyan Dam
Max volume: 99 MCM
Operation: 1967

Aras Dam
Max. Volume: 1960 MCM
Operation: 1971

Zayandeh Rud Dam
Max volume: 1656.85 MCM
Operation: 1970

Karkheh Dam
Max. Volume: 8437.0 MCM
Operation: 2000

Karaj Dam
Max volume: 206.35 MCM
Operation: 1961

Latyan Dam
Max volume: 99 MCM
Operation: 1967

Aras Dam
Max. Volume: 1960 MCM
Operation: 1971

Zayandeh Rud Dam
Max volume: 1656.85 MCM
Operation: 1970

Karkheh Dam
Max. Volume: 8437.0 MCM
Operation: 2000

Karaj Dam
Max volume: 206.35 MCM
Operation: 1961

Latyan Dam
Max volume: 99 MCM
Operation: 1967

Aras Dam
Max. Volume: 1960 MCM
Operation: 1971

Zayandeh Rud Dam
Max volume: 1656.85 MCM
Operation: 1970

Karkheh Dam
Max. Volume: 8437.0 MCM
Operation: 2000

Karaj Dam
Max volume: 206.35 MCM
Operation: 1961

Latyan Dam
Max volume: 99 MCM
Operation: 1967

Aras Dam
Max. Volume: 1960 MCM
Operation: 1971

Zayandeh Rud Dam
Max volume: 1656.85 MCM
Operation: 1970
Model input
(Global data)

Landuse (Extracted from global USGS landuse/land cover)

DEM (Extracted from global USGS DEM map)

Soil (Extracted from global FAO soil map, 1995)
Model input
(Local data)

Synoptic stations (providing daily precipitation, max. and min. temperature)

Hydrometric stations (providing river daily discharge data)

Lake-inland water & River map

Large reservoirs map
Model setup

1. **Arc-GIS** (Olivera et al., 2006) interface was used to parameterize whole the area

2. Based on DEM and stream network whole the area was divided into 506 sub-basins (threshold drainage area was set to $600 \text{ km}^2$)

3. Dominant soil and land use was selected to provide soil and land use data in the model

4. 20 large reservoirs/dams were contributed to the model

5. Considered simulation period for calibration was 16 years from 1987-2003 considering 3 years warm up period
Definition of three approaches used in calibration processes using SUFI-2:

1. Global approach

- Global parameterization
- Change of each parameter was applied globally
- \[ g_{opt} = \frac{1}{81} \sum_{i=1}^{81} \phi_i ; \text{ 22 global parameters} \]

2. Scaling approach

- Global parameterization
- Change of each parameter was applied based on landuse and soil
- \[ g_{opt} = \frac{1}{81} \sum_{i=1}^{81} \phi_i ; \text{ 268 scaled parameters} \]

3. Regional approach

- Global parameterization

(Krause et al., 2005):
\[
\begin{align*}
\phi &= \begin{cases} 
2 & \text{for } 0 < b \leq 1 \\
1 & \text{for } b > 1 
\end{cases} \\
\end{align*}
\]
Average weighted coefficient of determination for the eight hydrologic regions and the whole country.
Weighted coefficient of determination ($\phi$) at 81 stations across the Country

**Paye-Pol watershed area: 42630 km²**

- $\phi$: 0.65
- P-factor: 0.99
- R-factor: 1.82

**Pole-Kaleh watershed area: 5677 km²**

- $\phi$: 0.60
- P-factor: 0.70
- R-factor: 0.93

**Pole-Choom watershed area: 11180 km²**

- $\phi$: 0.32
- P-factor: 0.33
- R-factor: 3.13
95 PPU of regional renewable water resources (First round of calibration)

![Graph showing renewable water resources by hydrologic regions.](image-url)
Final results from the final parameter set (Regional approach):
1. Internal renewable blue water resources and actual evapotranspiration at provinces
3. Average (1990-2002) monthly internal renewable blue water (IRWR), Actual evapotranspiration (ET) and Soil water for Khozestan province.
2. Blue water resources at sub-province level
(was constructed based on final parameter set resulted from “Regional approach”)