Water balance model mGROWA outputs as water scarcity indicators

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Water cycle

The Water Cycle

Ice and snow → Precipitation → Streamflow → Groundwater flow → Groundwater storage → Infiltration

Volcanic steam

Atmosphere

Sublimation → Desublimation

Fog and dew

Evaporation → Evapotranspiration

Surface runoff

Seepage

Spring

Freshwater

Groundwater storage

Oceans

Condensation

Plants

Animals

Vents and volcanos
Water balance model mGROWA

ARSO HYDRO
Slovenian Environment Agency
Water balance model mGROWA

Balancing the amount of water for every grid cell based on the water balance equation:

\[ p + q_{in} = et_a + q_t + (s_2 - s_1) \]

Calculation of the actual evapotranspiration based on the Penman-Monteith-equation, site-specific parameters and site-specific functions:

\[ et_a = et_0 \cdot k_{LN} \cdot f(\beta, \gamma) \cdot f(s) \]

**BOWAB**
- for sites with vegetation
- impervious surface
- expandable

function \( f(s) \) is defined differently for different sites
Water balance model mGROWA

Climatic data basis & site conditions:
- Temperature
- Precipitation
- Grass reference evapotranspiration
- Land use
- Topography
- Soil profiles and soil hydraulic parameters
- Percentage Imperviousness
- Depth to the water table
- Hydrogeological units and hydraulic permeability
- Artificial drainage systems
- Waterlogging tendency

Simulation of snowpack, evapotranspiration and runoff generation:
- Snowfall
- Actual evapotranspiration
- Snowpack
- Soil moisture distribution in the root zone
- Capillary rise from groundwater
- Total runoff

Rule-based computation of variables and indices:
- Drought statistics:
  - Number of days with high soil moisture deficit
- Crop-specific irrigation need

Separation of runoff components and groundwater recharge:
- Direct runoff components:
  - Interflow
  - Drainage runoff
  - Runoff from urban areas
  - Surface runoff
  - Snowmelt
- Groundwater recharge
mGROWA model results connected to drought, water scarcity:
- runoff quantities
- groundwater recharge
- ...
- snow accumulation
- ...
- soil water deficit
mGROWA → groundwater recharge

mean monthly gw recharge 1981-2010
Cumulative GW recharge
Snow Water - mGROWA

Snowpack water equivalent 2011-09-01
Snow Water feeds rivers in spring
High water stress also in the Alps

Soil water deficit in the root zone 2012-08-16
mGROWA → drought indicators

- soil water deficit
- soil water content
- groundwater recharge
- connection to CLIMATE SCENARIOS
Water scarcity and drought

- definition
- tools “exist“
- indicators
- application of measures
thanks...