Fact Sheet for the DRYP Modeling System

Summary

The DRYland Partitioning water balance model (DRYP) is a process-based, distributed hydrological model developed to capture key hydrological processes across different climatic conditions including drylands, where most other models fail[1,2]. DRYP characterizes all relevant hydrological processes at and below the land surface, including groundwater flow. DRYP is a modular, versatile, and parsimonious Python-based model with limited data requirements, which can be used to anticipate and plan for climatic and anthropogenic changes in basins and regions on different temporal horizons (months to decades).

Processes Represented

- Climate simulation module enables use of any climate forcing data on any timescale (e.g., seasonal forecasts, decadal projections, historical simulations), which can be represented as realistic rainstorms (with area, intensity, duration, velocity, etc.)
- Runoff generation by infiltration-excess overland flow and saturation overland flow
- Two-way groundwater/surface water interactions support characterization of groundwater contributions to stream baseflow and streamflow contributions to (focused) aquifer recharge
- Groundwater flow below major lakes and between aquifers with different properties
- Emergence/dessication of ephemeral water bodies (temporary ponds)
- Dynamic vegetation responses to hydrology for spatially varying plant distributions with different rooting depths and seasonal cycles of phenology
- Anthropogenic water use through point-based groundwater pumping, flow diversion, and/or irrigation over broader spatial areas

Inputs

- Climate forcing data as spatiotemporal fields of rainfall and evaporative demand
- Parameters representing topography, soils, vegetation cover, aquifer properties

Key Outputs

- Groundwater recharge (separately for diffuse and focused recharge)
- Groundwater storage
- Streamflow
- Actual evapotranspiration (separately for riparian zones and uplands)
- Soil moisture
- Runoff
- Vegetation water stress

Existing Implementations of DRYP

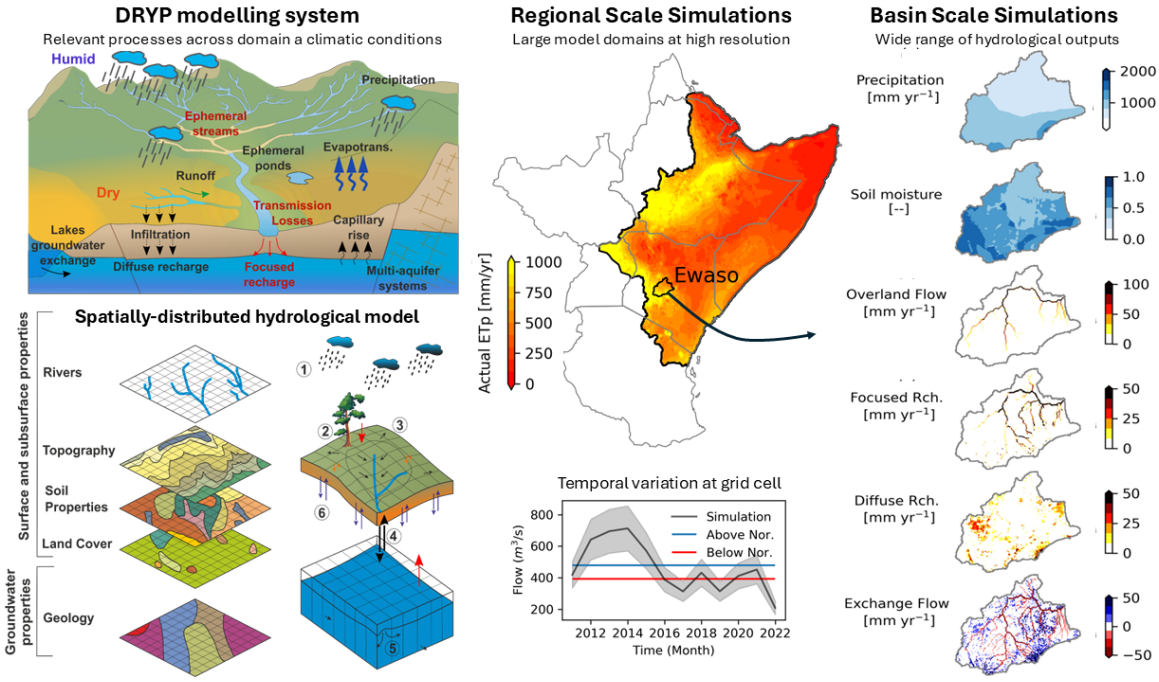
- Horn of Africa Drylands (HAD) - ~2,000,000 km^2 domain historical run (2001-2023) with monthly outputs at 1-km resolution, developed under DOWN2EARTH project
- Climate into Useful Water And Land Information in Drylands (CUWALID) seasonal forecasting system for the HAD, operating at ICPAC (WMO Regional Climate Center)
- Basin-scale water balance analyses of climate forcing (HAD[3], Walnut Gulch, AZ[1])

DRYP Capabilities

- 1-km spatial and 1-hr temporal resolution (adaptable based on user needs)
- Climate simulation module enables exploration of any climate change scenarios
- Flexible post-processing supports many different output types (change maps, time series, water balance diagrams, etc.)
- Open-source software development, documentation, sample datasets, and training exercises support users
- Model can run on PC desktop (for small jobs) or HPC Linux systems.

Future Prospects

- 1-km resolution model for entire African Continent (currently under development as part of HYDROAWARE project, funded by MSCA Global Fellowship)



1 Quichimbo, E. A., Singer, M. B., Michaelides, K., Hobley, D. E. J., Rosolem, R. & Cuthbert, M. O. DRYP 1.0: a parsimonious hydrological model of DRYland Partitioning of the water balance. *Geosci. Model Dev.* **14**, 6893–6917 (2021). https://doi.org:10.5194/gmd-14-6893-2021

2 Quichimbo, E. A., Singer, M. B., Michaelides, K. & Cuthbert, M. O. DRYP 2.0: A hydrological model for local and regional scale across aridity gradients. *EGUsphere* **2025**, 1–34 (2025). https://doi.org:10.5194/egusphere-2025-5316

3 Quichimbo, E. A., Singer, M. B., Michaelides, K., Rosolem, R., MacLeod, D. A., Asfaw, D. T. & Cuthbert, M. O. Assessing the sensitivity of modelled water partitioning to global precipitation datasets in a data-scarce dryland region. *Hydrological Processes* **37**, e15047 (2023). https://doi.org:https://doi.org/10.1002/hyp.15047