Developing a River Basin Repository for the Next Generation Water Resources Modeling Framework

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Next Generation Water Resources Modeling Framework (NextGen)

NOAA's Office of Water Prediction (OWP) leads development of the Next Generation Water Resources Modeling Framework (NextGen). NextGen provides increased flexibility for dealing with the hydrologic heterogeneity that exists across CONUS by allowing different hydrologic models to be used for different basins. But how do we choose the best model to use for each basin in NextGen? How do we know when basins are ***hydrologically similar***?

River Basin Data Collections

- **CAMELS (Catchment Attributes and Meteorology for Large-sample Studies).** 671 CONUS basins with minimal human impact that span a wide range of hydroclimatic conditions. 52 basins also in MOPEX.
- **MOPEX (Model Parameter Estimation Experiment).** 431 well-monitored, lower-impact basins with focus on parameter estimation for hydrologic models.
- **NOAA RFC (River Forecast Center) Basins.** US is divided into 13 RFCs that collaborate with USGS to monitor 9109 basin DCPs via GOES. See **Figure 4**.
- **USDA ARS (Agricultural Research Service) Experimental Watershed Network.** 771 basins, many with long discharge records. In STEWARDS.
- **USGS FPS (Federal Priority Streamgages).** 4756 monitoring stations; "backbone" of the larger USGS stream gaging network.
- **USGS GAGES-II (Geospatial Attributes of Gages for Evaluating Streamflow v2).** 2057 "reference" (least-disturbed) sites and 7265 "non-reference" basins (9322 total). Most have discharge data for 20+ years. Has all but 7 MOPEX basins. A subset of 1947 "selected basins" has many additional attributes & includes all CAMELS basins and 743 HCDN basins.
- **USGS NWIS Basins w/ Discharge Data.** 27890 stations, about 9665 active.
- **Also**: CZO, HCDN, LTER, & NEON basin collections.

Figure 1. **USGS Gage ID**: 09219200, **Name**: Blacks Fork above Smiths Fork, Near Lyman, WY, **NWS Loc. ID** = BSKW4, **RFC**: CBRFC, **HSA**: SLC, **GOES ID**: 17B80684, **Lon**: -110.20596, **Lat**: 41.39415, **Area**: 324.4 sq mi, **HUC**: 14040107, **Elev**: 6433 ft, **State**: WY, **Stn. type**: Stream, **Horiz. Datum**: NAD83, **Not in**: CAMELS, GAGES-II, or MOPEX, etc.
Basin metadata is needed to set up model runs in NextGen.

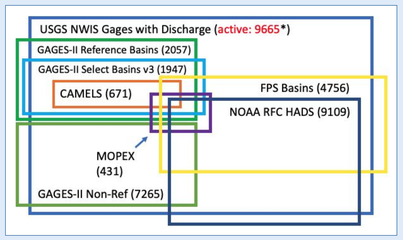

Figure 2. A Venn diagram showing many of the basin data collections.

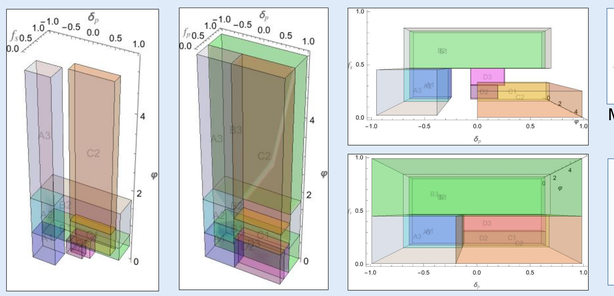

Figure 3. Cuboid regions in parameter space that define the SWB system classes. (a) Original, with unclassified regions. (b) Extended version that classifies any basin.
δ_p = precip seasonality, φ = aridity index, f_s = snow fraction.

Mathematica

python powered

QGIS

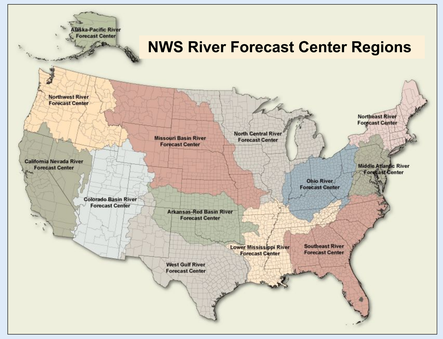

Figure 4. Map of the 13 NOAA River Forecast Center (RFC) Regions of the US.

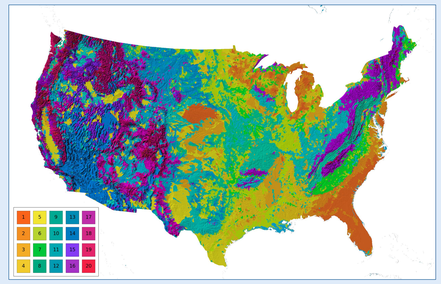

Figure 5. CONUS, divided into 20 classes, or Hydrologic Landscape Regions.

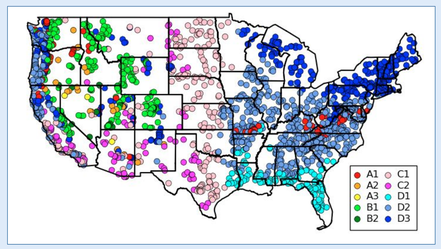

Figure 6. Each dot represents a GAGES-II basin (centroid), classified into one of the 10 SWB classes. Within the A, B, & C classes, a higher number indicates *higher aridity*.
The SWB classes are:

A1, **A2**, **A3**: Precipitation out of phase w/ ET
B1, **B2**: Snow-dominated
C1, **C2**: Precipitation in phase with ET
D1, **D2**, **D3**: Mild seasonality and humid
(*D1 has no snow; snowiness of D3 > D2*)

Basin Classification Systems

Several basin classification systems were used to divide basins into hydrologically similar groups. Many basins from each group are needed to carefully test NextGen.

Hydrologic Landscape Regions (HLR):

Winter (2001) & Wolock et al. (2004) divided the US into 43,931 watersheds and used cluster analysis to group them into 20 classes (with codes 1 to 20) based on similarities in land-surface form, geology (soil & bedrock types), and climate characteristics. See **Figure 5**.

Seasonal Water Balance Method (SWB):

Berghuijs et al. (2014), using MOPEX data, introduced a more process-based system to classify basins based on 3 hydroclimatic indices for: (1) aridity (ratio of annual potential ET to precipitation), (2) seasonality & timing of precipitation, and (3) fraction of precipitation falling as snow. We extended the SWB system. See **Figs. 3 and 6**.

Hydrograph-based Classifications:

Basins can also be classified based on the shapes of their observed or modeled hydrographs into groups such as: flashy, slow, snow-dominated, and regulated.

NextGen River Basin Repository

We developed a **River Basin Repository** that collates information from many different river basin data collections. Basin metadata was then used to classify basins using multiple methods. These classifications &. metadata can be used to (1) select a representative set of basins for model testing, (2) obtain model input data, and (3) map basins to the "best" NextGen model.

- ✔ The basin data sets were often difficult to obtain, incomplete, or poorly documented, & each provided different attributes in different formats.
- ✔ A collection of Python utilities (over 11,000 lines of code) were written to extract, clean, & collate information from all the basin data collections. See: github.com/peckhams/topoflow36/utils/ngen
- ✔ The new repository consists of many individual TSV files, a "master" TSV file, references, and URLs. See: github.com/peckhams/nextgen_basin_repo

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REFERENCES:

- Berghuijs, W.R., M. Sivapalan, R.A. Woods, and H.H.G. Savenije (2014) Patterns of similarity of seasonal water balances: A window into streamflow variability over a range of time scales, Water Resources Research, 50(7), 5638-5661. (SWB method.)
- Over, T.M., Farmer, W.H., and Russell, A.M. (2018) Refinement of a regression-based method for prediction of flow-duration curves of daily streamflow in the conterminous United States: U.S. Geological Survey Scientific Investigations Report 2018–5072, 34 p. (Key paper on GAGES-II.)
- Wolock, D.M., T.C. Winter, G. McMahon (2004) Delineation and evaluation of hydrologic-landscape regions in the United States using geographic information system tools and multivariate statistical analyses, Environmental Management, 34(1), S71-S88. (HLR method.)

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