Spatial allocation of low resolution runoff model outputs to a high resolution stream network

Workflow in ‘hydrostreamer’ R package

1. compute_weights( river, HSgrid, [aol], [basin], [drain.dir], [segment.weight] )
   - i.e. compute river segment weights by Basin: using area of catchment within a grid cell to weight by a. river segment b. Voronoi polygon c. delineated from drainage direction d. user input
   - HSgrid object: - routed river network - weighted basin features - HSgrid

2. compute_segment_runoff( HSgrid or HSrgrid) 
   - i.e. allocate weighted cell runoff to each river segment
   - River network with segment specific runoff timeseries (HSrunoff)

3. accumulate_runoff( HSrflow )
   - i.e. apply river routing
   - River network with flow timeseries (HSflow)

4. hydrostreamer’ in GitHub: https://github.com/mkkallio/hydrostreamer

Purpose

- To improve global water scarcity assessments.
- Runoff allocated to river segments within output grid cells (i.e. downscaling runoff into explicit high-res river network).
- Done as simply and with the least input requirements as possible.

How?

- An Open Source R [1] package ‘hydrostreamer’
  1. Create polygon grid from input raster
  2. Weight river segments or basins within each grid cell
  3. Assign grid cell value to river segments according to weights.
  4. Apply river routing
  - Minimum input data: runoff timeseries, river network

3S Basin Test Case

- 79 500 km² tributaries of the Mekong - Sekong, Sesan and Srepok.
- Monsoon climate with distinct dry and wet season.
- Total runoff output from 12 models at 30 minute resolution obtained from Inter-Sectoral Model Intercomparison Project (ISIMIP) [2]
- Tested also one model at 6 minute and another one with 3m resolution.
- Simples possible river routing: add everything downstream at each timestep (month)

Results

- VISIT performs best at most stations
- Different weighting methods differ in results only at the smallest streams, at higher stream orders the small differences upstream are efficiently averaged out
- When stream density-to-raster resolution gets too low, segment-based weighting is not valid as not all cells contain river segments.

Conclusion and future ‘hydrostreamer’

- Results meaningful on monthly scale, but issues in the edges of area of interest.
- Confirmed Kartimipout et al [3] that Voronoi is viable alternative to DEM delineated catchment areas.
- Recommended weighting by physical properties of segments: either basin (Voronoi, or DEM delineated), or segment length.
- Investigate providing an interface in ‘hydrostreamer’ to existing river routing applications (e.g. RAPID [4] or mizuRoute [5]).
- Add functions in ‘hydrostreamer’ to create optimal station-specific model ensembles of several input models.

References