2016 INNOVATION COMPETITION SUBMISSION

Tools for Hydrology

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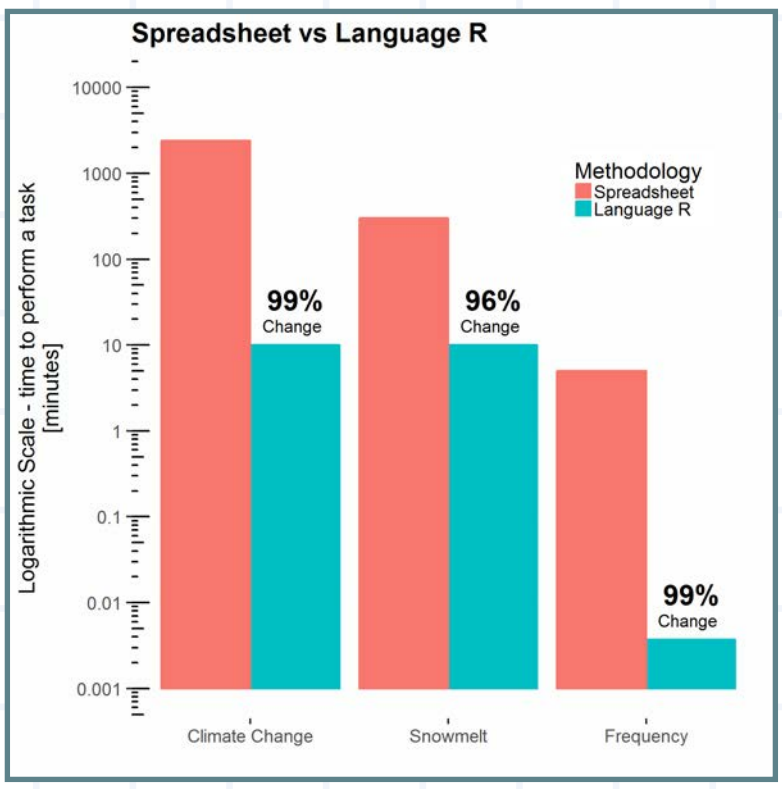
R Tools for Hydrology (RTH) was created by Victor Muñoz and represents an important competitive advantage in hydrological science from data collection to analysis. RTH graphs and analyzes data well beyond the capacity of spreadsheets and in far less time.

Benefits of RTH. Hydrological analyses are typically conducted using spreadsheets to evaluate less than a dozen stations over several days. RTH, however, allows data from hundreds of stations to be analyzed within hours or even minutes. Thus, RTH significantly improves understanding of regional and local hydrology compared to spreadsheet analysis.

For example, RTH allows us to significantly reduce analysis time such as:

- climate change from 1 week to less than 10 minutes
- snowmelt from 5 hours to 10 minutes
- frequency analysis from 5 minutes to less than 1 second

The bar graph shows these benefits.



What Makes RTH Unique? In minutes, RTH allows us to see, access, and receive through short commands records from meteorological institutions such as:

- Environment Canada
- USGS
- Conagua (Mexico)
- NOAA

RTH can handle analysis that a spreadsheet cannot such as:

- correlation matrices
- cluster analysis
- k-means
- trend analyzes
- non-parametric regressions

It can also handle snowmelt models, climate change models, patching processes, frequency analysis, peak and low flow conditions, probable maximum precipitation, regression analyzes with parametric and IDF estimations, and meteorological annual, monthly, daily, and sub-daily parameters.

Improving RTH. RTH uses more than 30 different script libraries to perform hydrological analyses. Because these libraries are continuously being updated and increasing in number, RTH has the potential to grow as far as curiosity (and budget) allows. In practical terms, this means RTH is always under construction.

R Software Language was created in 1993 and uses a command line interface. R is mostly used for statistics and data mining. As of January 2016, there are more than 7800 data libraries at the Comprehensive R Archive Network (CRAN).

Reanalysis models comprise worldwide meteorological data from 6 to 24 hour intervals from 1979 to present. The models are compiled from public ground to satellite data. The time series are considered representative of a region. I prepared RTH to capture and analyze information from MERRA (NASA) or ERA-Interim (ECMWF) reanalysis models. Within RTH, I use the models to complement and/or patch actual meteorological data or when no regional data is available in an area.

For **climate change analysis**, I prepared an R script library that allows estimation of climate change parameters worldwide. This library compiles data from Environment Canada. The results are combined with meteorological reanalysis data to produce just one numerical result for climate change. This one value allows for practical engineering solutions.

For **snowmelt analysis**, a typical R script energy snowmelt model requires numerous inputs such as temperature, precipitation, wind speed, slope, and aspect. However, using RTH, I can produce a daily snowmelt model for anywhere on the planet using just two inputs: longitude and latitude. This new snowmelt model compares different sites and snowcourses that have important similarities that can be used form making snowmelt and related predictions.