Break free from your tool Inertia

by: Victor Muñoz S.

SRK Vancouver, Canada

Date June 26th, 2017

IMWA 2017 FINLAND Mine Water & Circular Economy

srk consulting

Outline – What is this talk about?

- From Spreadsheets to Satellite Information
- Hydrological sources
- The two-way challenge problem
- R language: A possible solution for hydrology
- My R Solution
- Conclusion

Information Paradigm

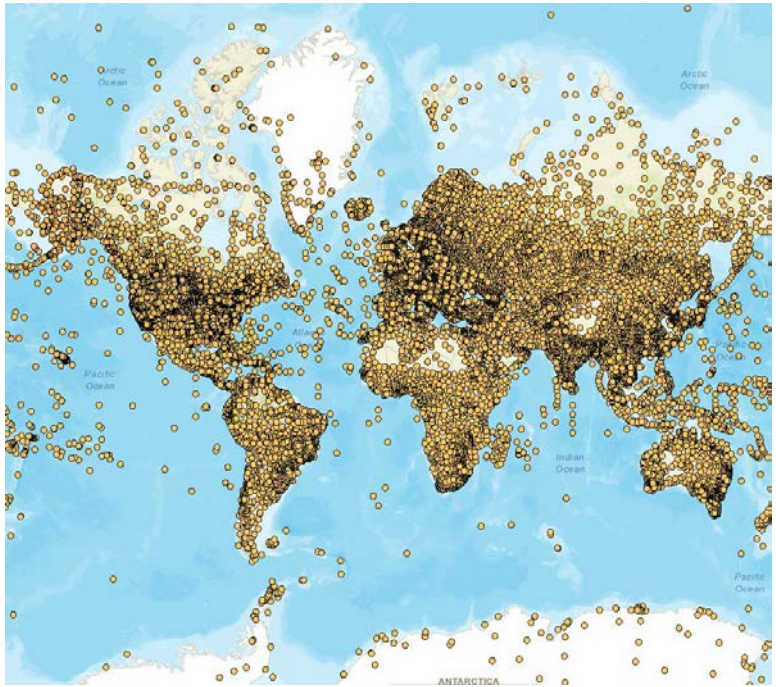
- *In 1980*
  Satellite technology was introduced, but information was scarce and not yet public.
  Hydrological analyses relied on simple spreadsheets such as Lotus 1-2-3 and early versions of Microsoft Excel.

- *In 1990*
  With internet, the amount of information started to increase.

- *Today*
  Meteorological information can be used to complement site data; and, public meteorological sources exponentially increased.

Meteorological Sources – Ground Base

- National Climatic Data center from NOAA
- Global Surface Summary of the day (GSOD): 9,000 Stations
- Global Historical Climatology Network (GHCN): 75,000 stations
- Records span up to 150 years.



srk consulting

Meteorology Source – Satellite Base

- Satellite-based rainfall estimates

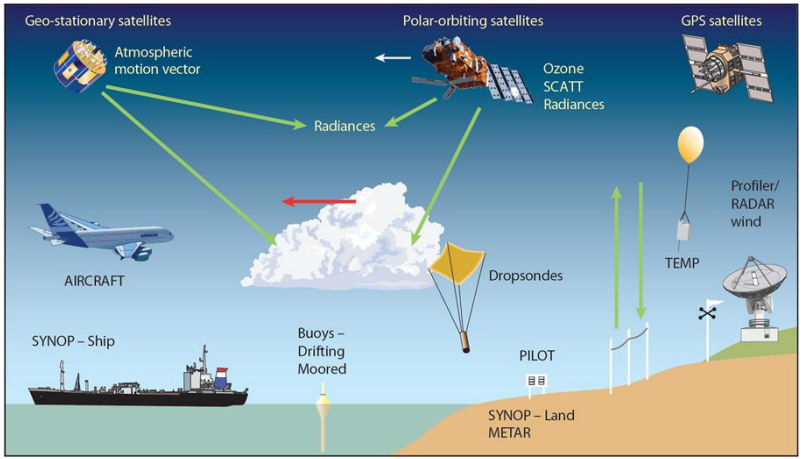
Dataset	Full name	Latitudinal coverage	Spatial resolution	Temporal coverage	Temporal resolutions	References
CMORPH	NOAA Climate Prediction Center (CPC) MORPHing technique	60° N–60° S	0.07°, 0.25°	Dec 2002–present	3-hourly, daily	Joyce et al. (2004); CPC-NCEP-NWS-NOAA-USDC (2011)
PERSIANN-CDR	PERSIANN Climate Data Record, Version 1 Revision 1	60° N–60° S	0.25°	Jan 1983–present	daily	Sorooshian et al. (2014); Ashouri et al. (2015)
PERSIANN-CCS-Adj	Precipitation Estimation from Remotely Sensed Information using Artificial Neural Networks	50° N–50° S	0.04°	Jan 2003–present	daily	Yang et al. (2016); Hong et al. (2004)
3B42v7	TRMM Multi-satellite Precipitation Analysis research product 3B42 Version 7	50° N–50° S	0.25°	Jan 1998–present	3-hourly, daily	Huffman et al. (2007, 2010)
CHIRPSv2	Climate Hazards group Infrared Precipitation with Stations Version 2.0	50° N–50° S	0.05°	Jan 1981–present	daily, pentadal, monthly	Funk et al. (2015)
MSWEPv1.1	Multi-Source Weighted-Ensemble Precipitation Version 1.1	90° N–90° S	0.25°	Jan 1979–Dec 2014	daily	Beck et al. (2017)
PGFv3	Princeton University Global Meteorological Forcing Version 3	17° S–57° S	0.25°	Jan 1979–Dec 2010	daily	Peng et al. (2016); Sheffield et al. (2006)

Source: Zambrano-Bigiarini et al (2017)

Meteorology Source – Hybrid models

- Reanalysis Tools: Data Assimilation combines land information with satellite information in one worldwide climatic model with daily/sub-daily information from 1979 to now.

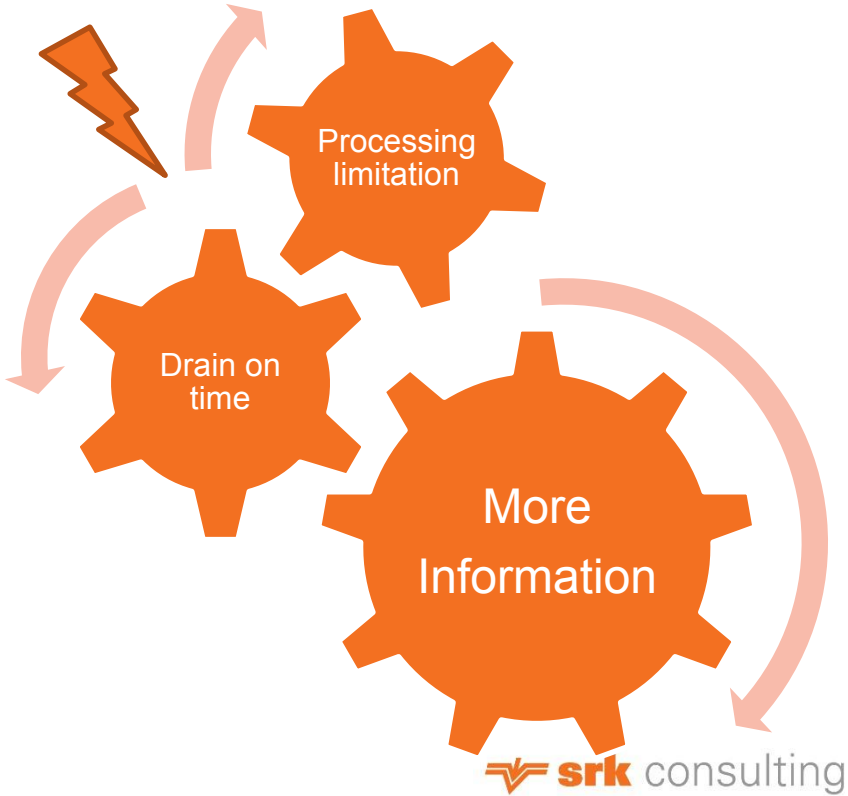
- Climate Change Info: These models and scenarios are presented in the assessment report (FAR, SAR, TAR, AR4, AR5). Each model at different spatial and temporal scales, present meteorological parameters up to year 2100.



srk consulting

The Two-Way Challenge

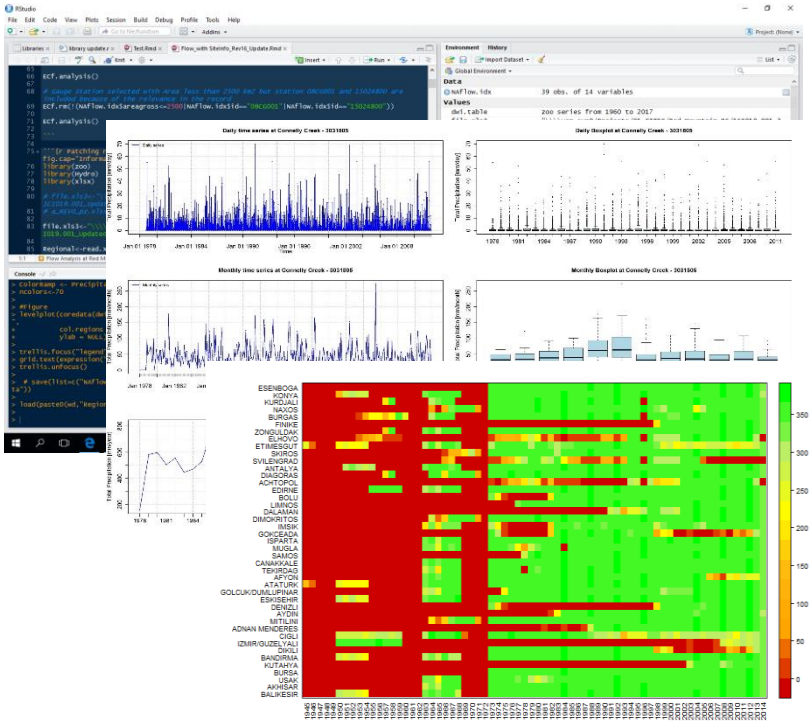
- Two challenges for consultants when using these sources:
- Drain on time: From capturing the information to transform the data to information.
- Processing limitations: The size of the information makes the use of spreadsheets a difficult to process.



srk consulting

R Language: A possible solution for hydrology

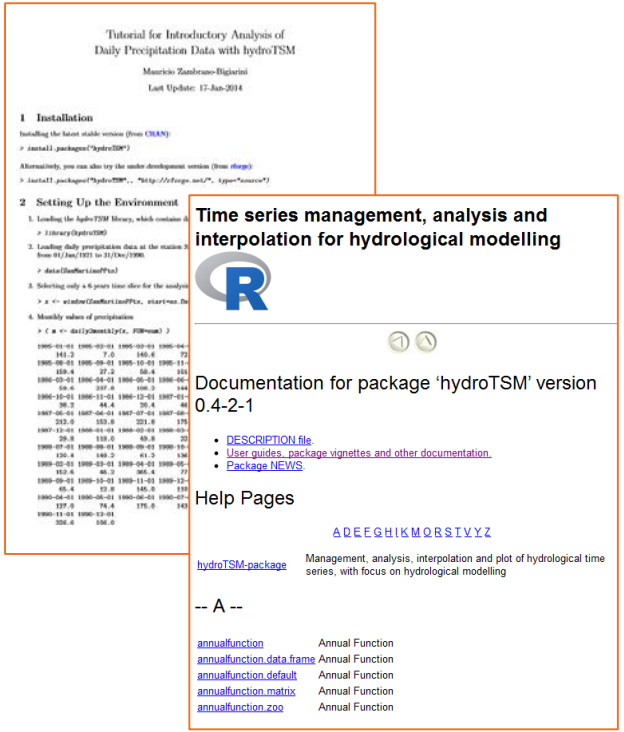
- But first… What is R?
- R is a free, open-source software environment, released in 1993.
- Became the standard problem-solving tool for researchers in industry, government, and academia. Specifically to handle large quantities of data.
- R uses a command line interface.
- The capacities of R can be extended with thousands of public libraries available in several areas of knowledge. (+10,000 April 2017)



srk consulting

R Language: A possible solution for hydrology

- **HydroTSM**: Hydrological data and time series analyses.
- **EcoHydRology** : Snowmelt models to Baseflow analyses
- **Evapotranspiration**: Evapotranspiration.
- **ncdf4**: Enables interacting with netCDF files.
- **nsRFA**: Frequency analyzes.
- **caret**: Predictive models includes: artificial neural networking, machine learning, parallel procesing, bootstrapping, and resampling.
- **Parallel**: Parallel computing.



Tutorial for Introductory Analysis of Daily Precipitation Data with hydroTSM

Mauricio Zambrano-Bigiarini

Last Update: 17-Jun-2014

1 Installation

2 Setting Up the Environment

Time series management, analysis and interpolation for hydrological modelling

Documentation for package 'hydroTSM' version 0.4-2-1

- DESCRIPTION file.
- User guides, package vignettes and other documentation.
- Package NEWS.

Help Pages

A D E F G H I K M O R S T V Y Z

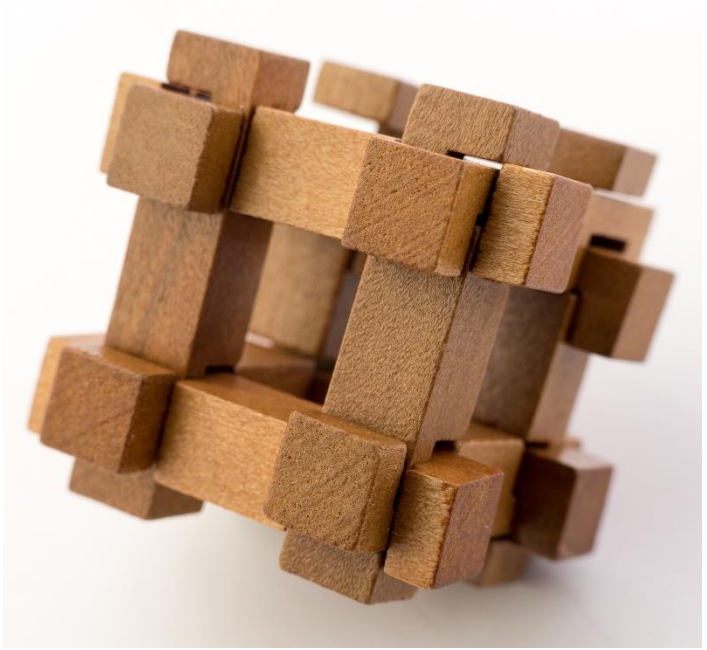
hydroTSM-package — Management, analysis, interpolation and plot of hydrological time series, with focus on hydrological modelling

-- A --

annualfunction — Annual Function
annualfunction.data.frame — Annual Function
annualfunction.default — Annual Function
annualfunction.matrix — Annual Function
annualfunction.zoo — Annual Function

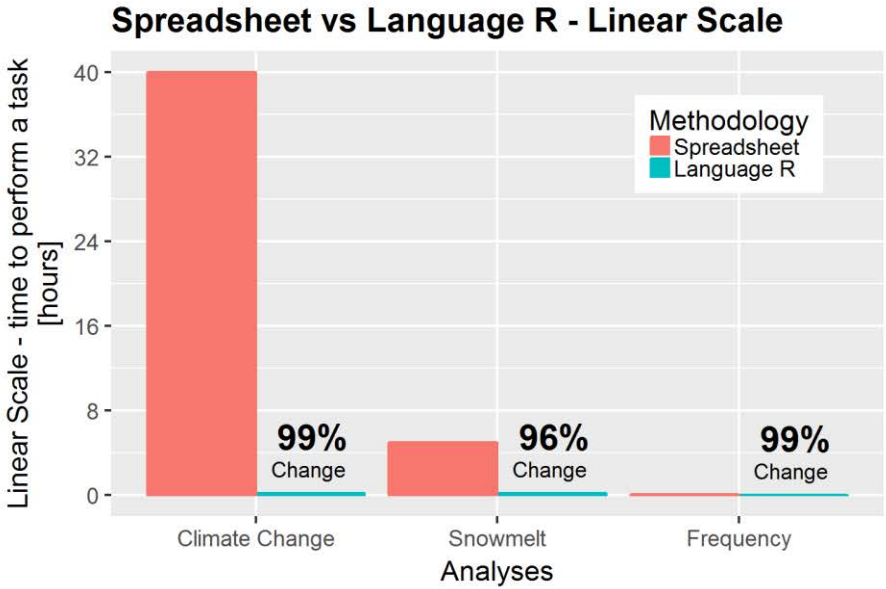
My R Solution: Hydro library

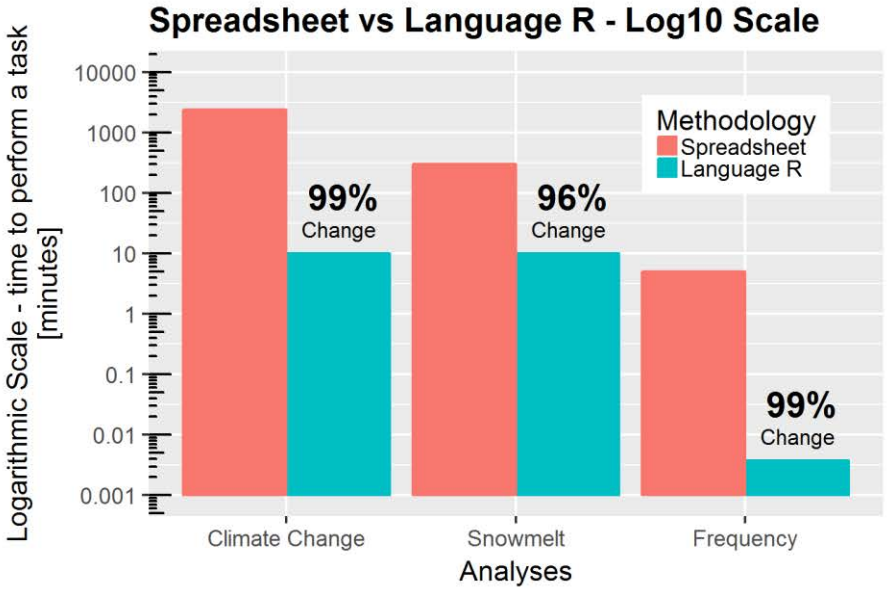
- Short script…to a personal library called Hydro.
- Now, +40 libraries. Based on my own necessities with custom-made script to improve hydrologic studies in any region of the world.



- Examples of the library are:
  - Climate Change Analysis => Next IMWA Presentation
  - Snowmelt model; and,
  - Frequency Analysis

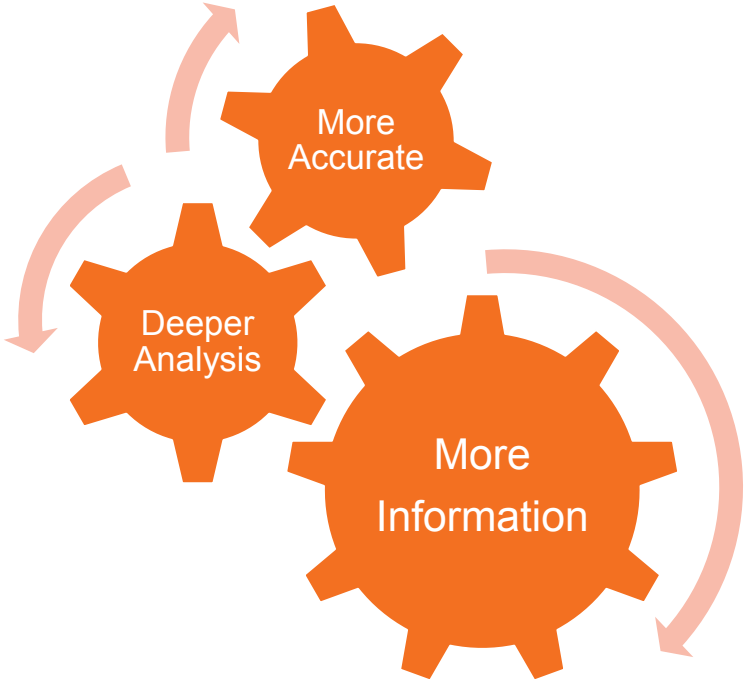
My R Solution: Hydro library





My R Solution: Hydro library

- An important reduction in analysis preparation time, which leads to broader and deeper analyses, such as correlation matrixes, cluster analysis, artificial neutral network or Bayesian statistics.



Conclusions

- The amount of hydrological information has increased dramatically.
- Time to go beyond traditional tools that kept us in our comfort zone.
- Script-based solutions like R bridge gap between consultancy and academia with simplicity and innovation.

Questions?