RWater: A Cyber-enabled Data-Driven Tool for Enhancing Hydrology Education

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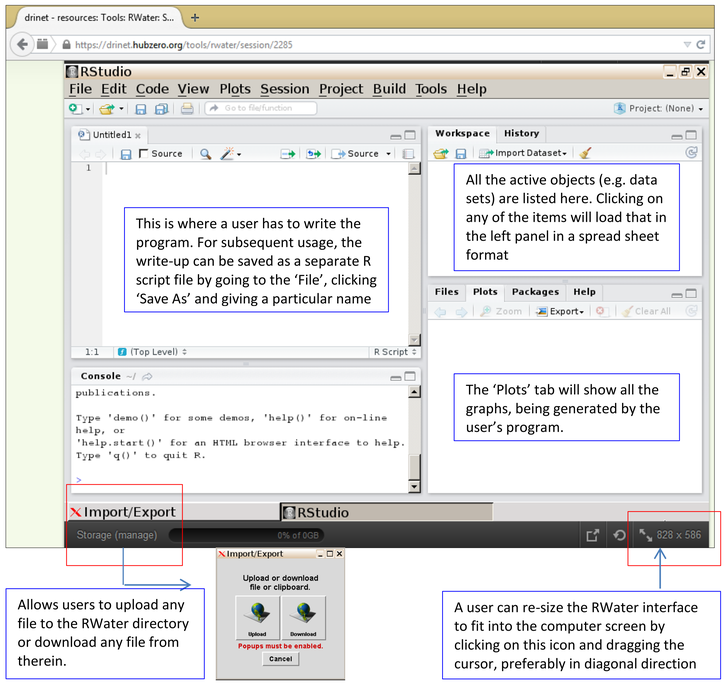
1. Abstract

Enhancing students' analytical ability of interpreting complex hydrologic processes from limited classroom environment has been a subject of long-standing research. From this perspective, a novel internet-based educational tool, called RWater, is developed using Purdue University's HUBzero technology. Following real-time hydrologic data-driven modules, students can write small scripts in R to create visualizations identifying the effect of rainfall distribution and watershed characteristics on runoff generation, and investigate the impacts of landuse and climatic change on streamflow response in actual locations. The overall experience from this tool can potentially improve students' analytical ability of interpreting the 'cause-and-effect' relationships in hydrologic processes even from a limited classroom environment.

2. RWater Interface

- Accessible from any internet browser
- Does not require installation of any software
- Does not store any data in the user's computer directory



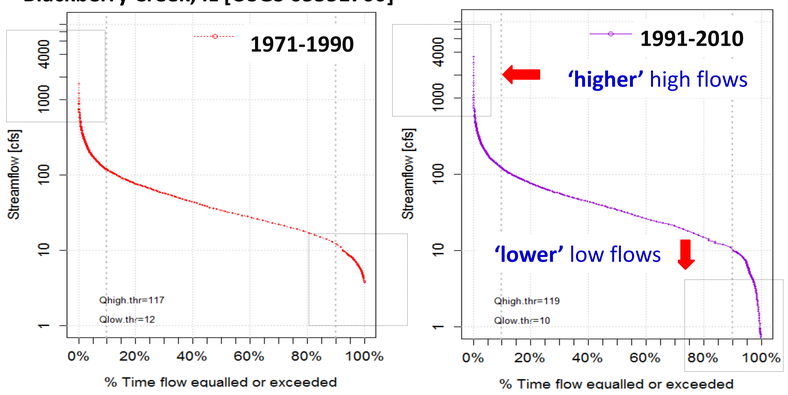
3. List of Modules

1. Understanding the hydrologic cycle
2. Effect of rainfall intensity on streamflow response
3. Rainfall-streamflow relationship based on real-time gage station data
4. Effect of watershed characteristics on runoff generation
5. How does urbanization effects streamflow over time
6. Assessment of urbanization effect on streamflow using Flow Duration Curve
7. Flood Frequency Analysis to assess return period of extreme events

4. Science from RWater

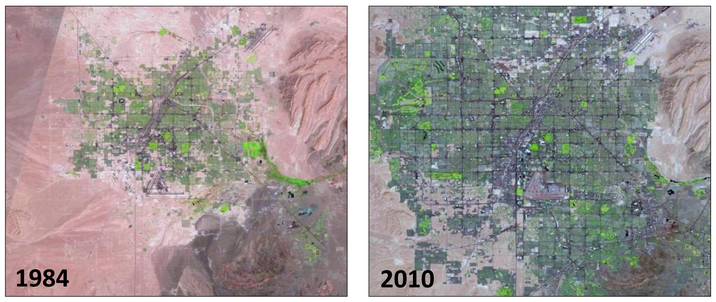
Trending Urbanization by Flow Duration Curve

Blackberry Creek, IL [USGS 05551700]



Streamflow Response with Landuse Change

Example for Las Vegas, NV



NASA Landsat Image for Las Vegas

- RWater can directly download USGS streamflow data
- Only information needed: gage ID and the duration of data (start/end date)
- Changes required only in the **highlighted** portion of the script (as shown)

'Generic' body of an RWater script [Flow Duration Curve]

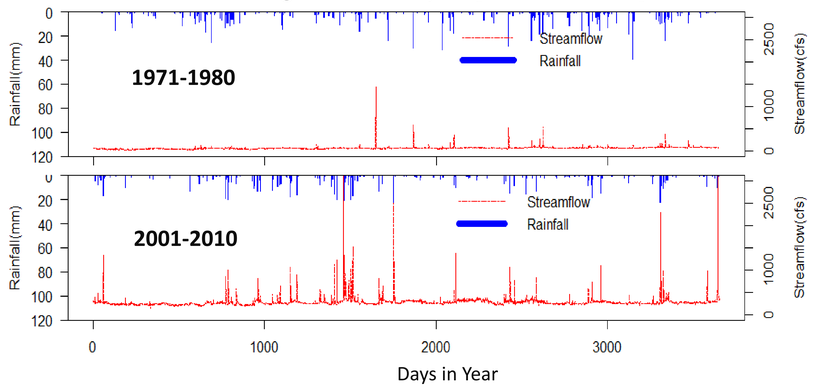
```
### Downloading streamflow data directly from USGS
### Two separate time period

blackberry1<-importDVs("xxxx", code="00060", stat="00003",
                       sdate="xxxx", edate="xxxx")
blackberry2<-importDVs("xxxx", code="00060", stat="00003",
                       sdate="xxxx", edate="xxxx")

### Plotting the Flow Duration Curve

fdc(xxxx,
    lQ.thr=0.9, hQ.thr=0.1,
    plot=TRUE, log="y",
    main= "Blackberry Creek FDC (1971-1990)",
    xlab="% Time flow equalled or exceeded",
    ylab="Streamflow [cfs]",
    ylim=c(xxxx,xxxx),
    yat=c(xxxx,xxxx,xxxx,xxxx,xxxx,xxxx),
    col="red", pch=21, lwd=500,
    lty=3, cex=0.4,
    cex.axis=1.2, cex.lab=1.2, leg.txt="xxxx",
    leg.cex=1, leg.pos="topright",
    verbose=TRUE,
```

Las Vegas Wash River, NV [USGS 09419700]



5. Student-Teacher Evaluation on RWater

Purdue University, July 2014

- Summer Residential Program,
  College of Education, Purdue University
  29 June – 12 July, 2014
  Total 7 High School Students (9-12 Grade)
- RWater Teacher's Workshop,
  Lyles School of Civil Engineering, Purdue University
  17 – 18 July, 2014
  Total 20 Middle and High School Teachers
- A two-stage (pre and post usage) evaluation survey has been conducted in both these programs.
- The survey results demonstrate RWater's potential to improve students' understanding on various cause-and-effect relationships in natural water cycle.

6. Future Work

- Developing an integrated website with all the modules and generic scripts
- Creating a database with RWater class projects from participating schools all over United States. This will record hydrologic assessments over the real locations across the country, being done by the students at K-12 level.

Reference: Rajib and Merwade (2013), "RWater," https://drinet.hubzero.org/resources/rwater