

RWater –A HUBZero Tool for K-12 Hydrology Education

Adnan Rajib

PhD Student

Venkatesh Merwade

Associate Professor

Lyles School of Civil Engineering, Purdue University



Motivation

How can we enhance students' ability to analyze the 'cause-and-effect' relations in hydrologic processes?

Relating classroom concepts with real observations

Interpreting real-time events from real locations

- Data extraction
Not emphasizing on data post-processing
- Visualization
Not concentrating on how to create a plot
- Interpretation
Focus on the science part

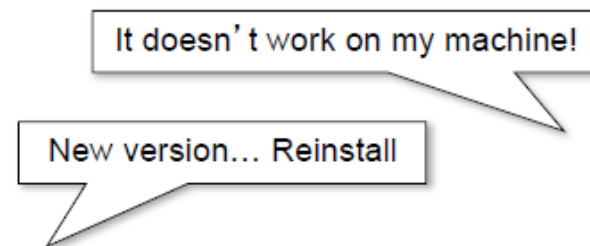


User-friendly tool-kit

Platform independent
Scalable



32-bit
64-bit



RWater:

Design for Classroom Teaching

- It pulls streamflow data directly from the USGS website
 - ▣ Only required information: time period and location ID
 - ▣ Does not require any data post-processing
- Following the data-driven modules, students can write/modify R scripts to create visualizations
- Those visualizations allow users to understand the **cause and effect relationships** in hydrology
 - ▣ Making it interesting and practical
- Total 7 learning modules
 - ▣ Contain both hypothetical and real-time examples
 - ▣ Each module has a short quiz to evaluate students' learning

Introducing RWater

powered by mygeohub

Adnan Rajib

Water Hub
Platform for water education, research, data access, partnership and collaboration

HOME TOOLS RESOURCES EXPLORE ABOUT WATER HUB

<https://mygeohub.org/tools/rwater>

RWater tool
RWater - A cyber enabled analysis and visualization tool for hydrologic data.



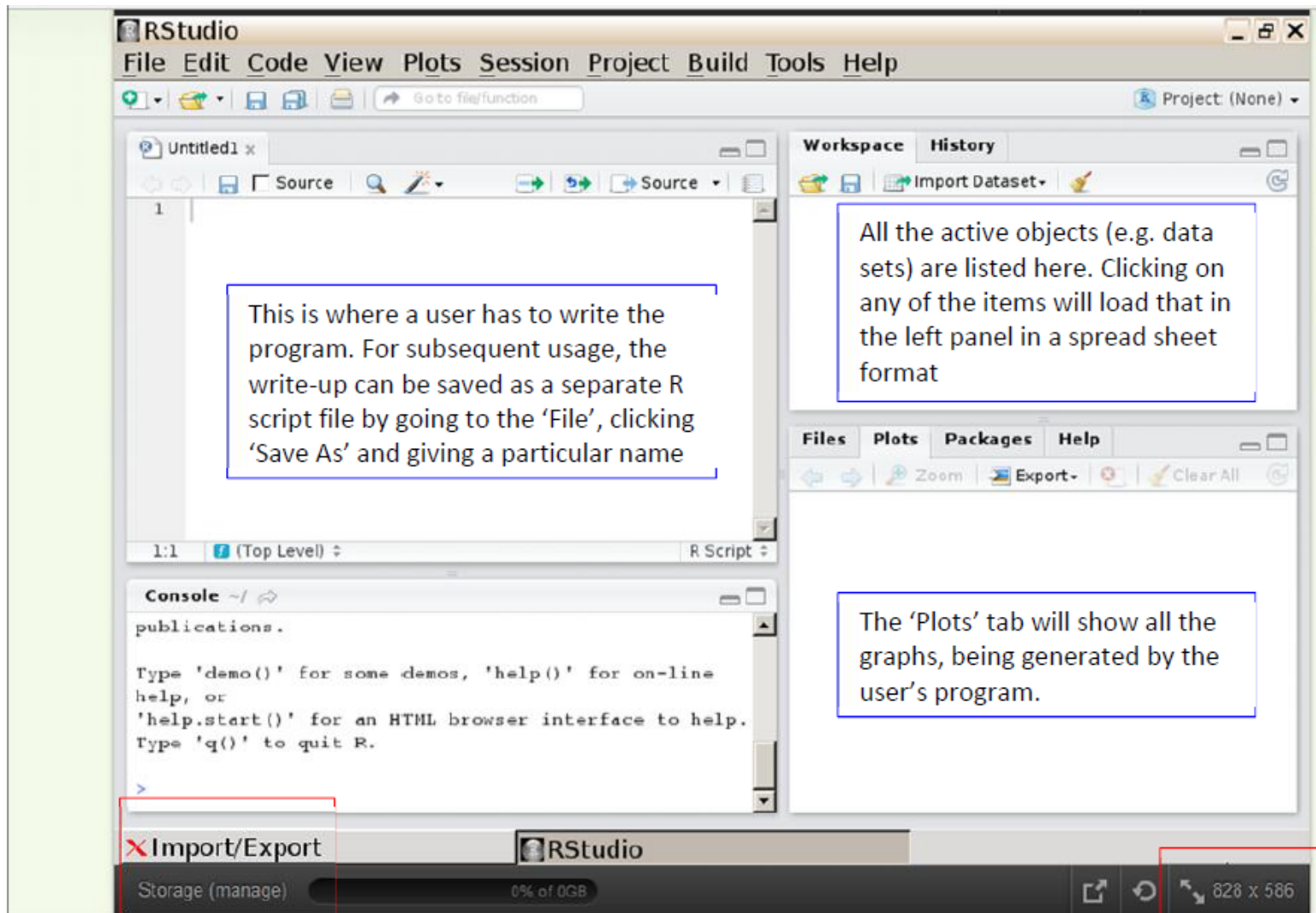
The screenshot shows the RWater tool interface. On the left, there is a code editor with R code for a flood frequency analysis. The code includes comments and functions for calculating peak flow, fitting a Gumbel distribution, and plotting the results. On the right, there is a workspace area with a data table and a plot titled 'Flood Frequency Analysis, Blackberry Creek (1971-1990)'. The plot shows Annual Peak Flow (cfs) on the y-axis (0 to 1000) versus Return Period, T (year) on the x-axis (1 to 100). The plot displays data points, a fitted Gumbel distribution curve, and a reference line.

Runs in a self contained environment on Purdue's cyber-infrastructure (WaterHUB)

- Does not require any installation any software
- Does not store anything on user's computer
- All you need is a Java compatible browser

RWater Interface

<https://mygeohub.org/tools/rwater>



This is where a user has to write the program. For subsequent usage, the write-up can be saved as a separate R script file by going to the 'File', clicking 'Save As' and giving a particular name

All the active objects (e.g. data sets) are listed here. Clicking on any of the items will load that in the left panel in a spread sheet format

The 'Plots' tab will show all the graphs, being generated by the user's program.

Import/Export

Allows users to upload any file to the RWater directory or download any file from therein.



828 x 586

A user can re-size the RWater interface to fit into the computer screen by clicking on this icon and dragging the cursor, preferably in diagonal direction

Sample Rwater Project

https://mygeohub.org/tools/rwater/session?sess=3224

RWater Terminate Keep for later

RStudio

File Edit Code View Plots Session Project Build Tools Help

Project: (None)

```
Module7.example.R*  
33 # Set up x axis tick positions and labels  
34 Ttick = c(1.001, 1.01, 1.1, 1.5, 2, 3, 4, 5, 6, 7, 8,  
35 xtlab = c(1.001, 1.01, 1.1, 1.5, 2, NA, NA, 5, NA, NA,  
36 y = -log(-log(1 - 1/T))  
37 ytick = -log(-log(1 - 1/Ttick))  
38 xmin = min(min(y), min(ytick))  
39 xmax = max(ytick)  
40  
41 # Fit a line by method of moments, along with  
42 KTick = -(sqrt(6)/pi)*(0.5772 + log(log(Ttick)))  
43 QTtick = mean(Q) + KTick*sd(Q)  
44 nQ = length(Q)  
45 se = (sd(Q)*sqrt((1+1.14*KTick + 1.1*KTick^2)/nQ))  
46 LB = QTtick - qt(0.975, nQ - 1)*se  
47 UB = QTtick + qt(0.975, nQ - 1)*se  
48
```

72:1 (Top Level) R Script

Console

```
> # Add fitted line and confidence limits  
> lines(ytick, QTtick, col = "black", lty=1, lwd=2)  
> lines(ytick, LB, col = "blue", lty = 1, lwd=1.5)
```

Workspace History

Data

bb71_90 20 obs. of 4 variables

Files Plots Packages Help

Zoom Export Clear All

Flood Frequency Analysis, Blackberry Creek (1971-1990)

Annual Peak Flow (cfs)

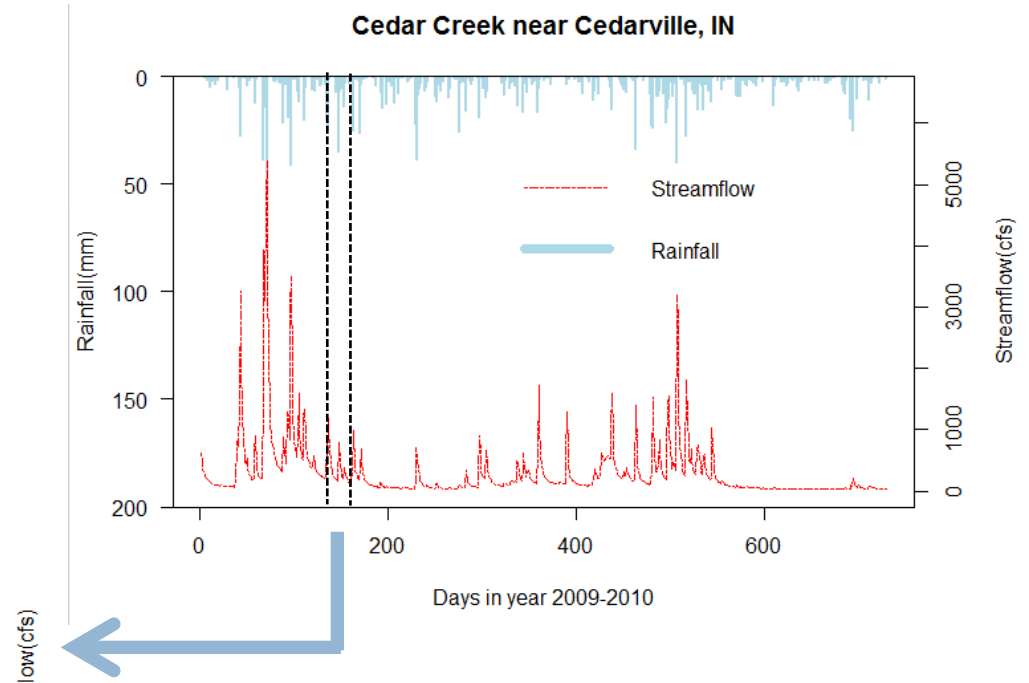
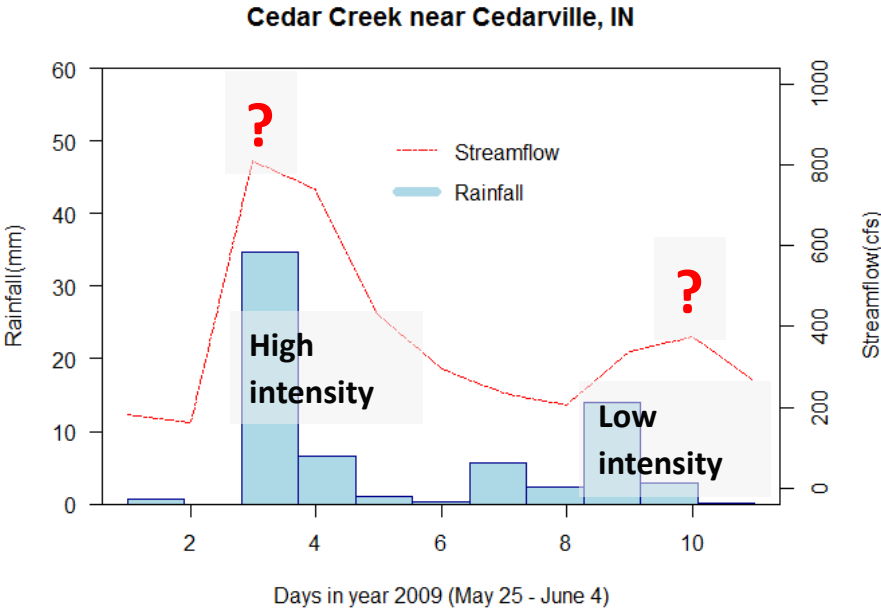
Return Period, T (year)

Storage (manage) 0% of 4.9GB 1097 x 585

Science from RWater

Understanding Rainfall-Streamflow Relationship

Example for Cedar Creek, IN



RWater Example
Real-time data for Cedar Creek, IN

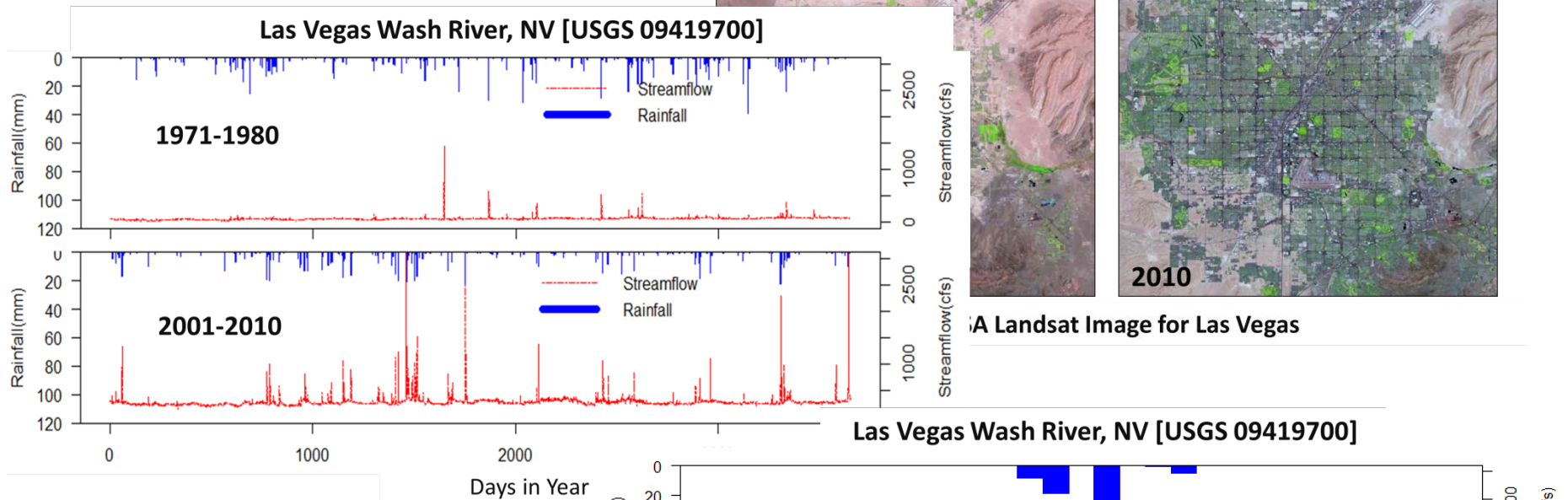
Science from RWater

Streamflow Response with Landuse Change

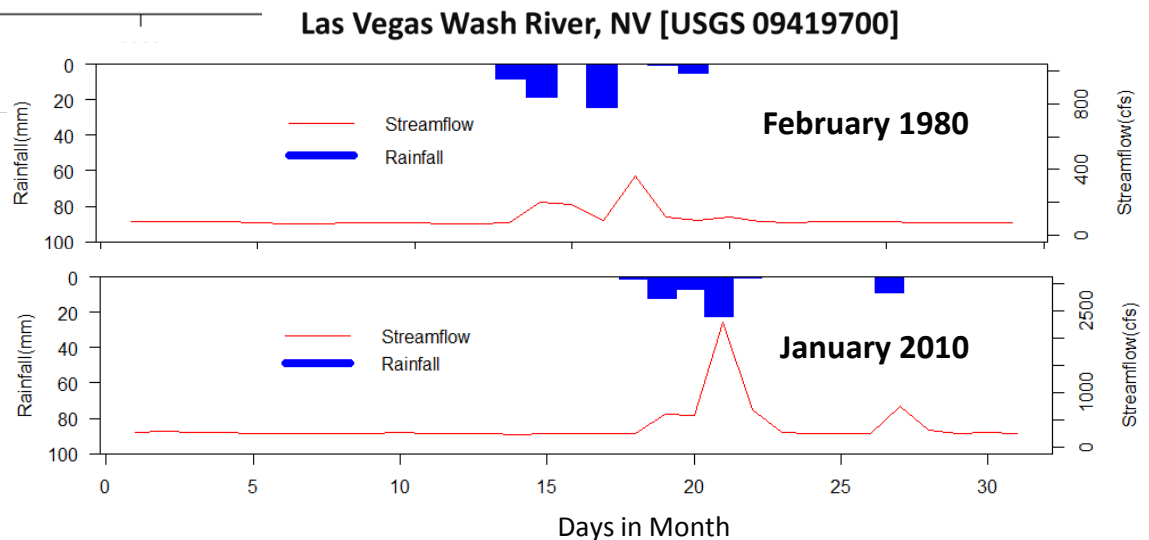
Example for Las Vegas, NV

<https://earthengine.google.org/#intro/LasVegas>

More frequent extreme event in recent times!



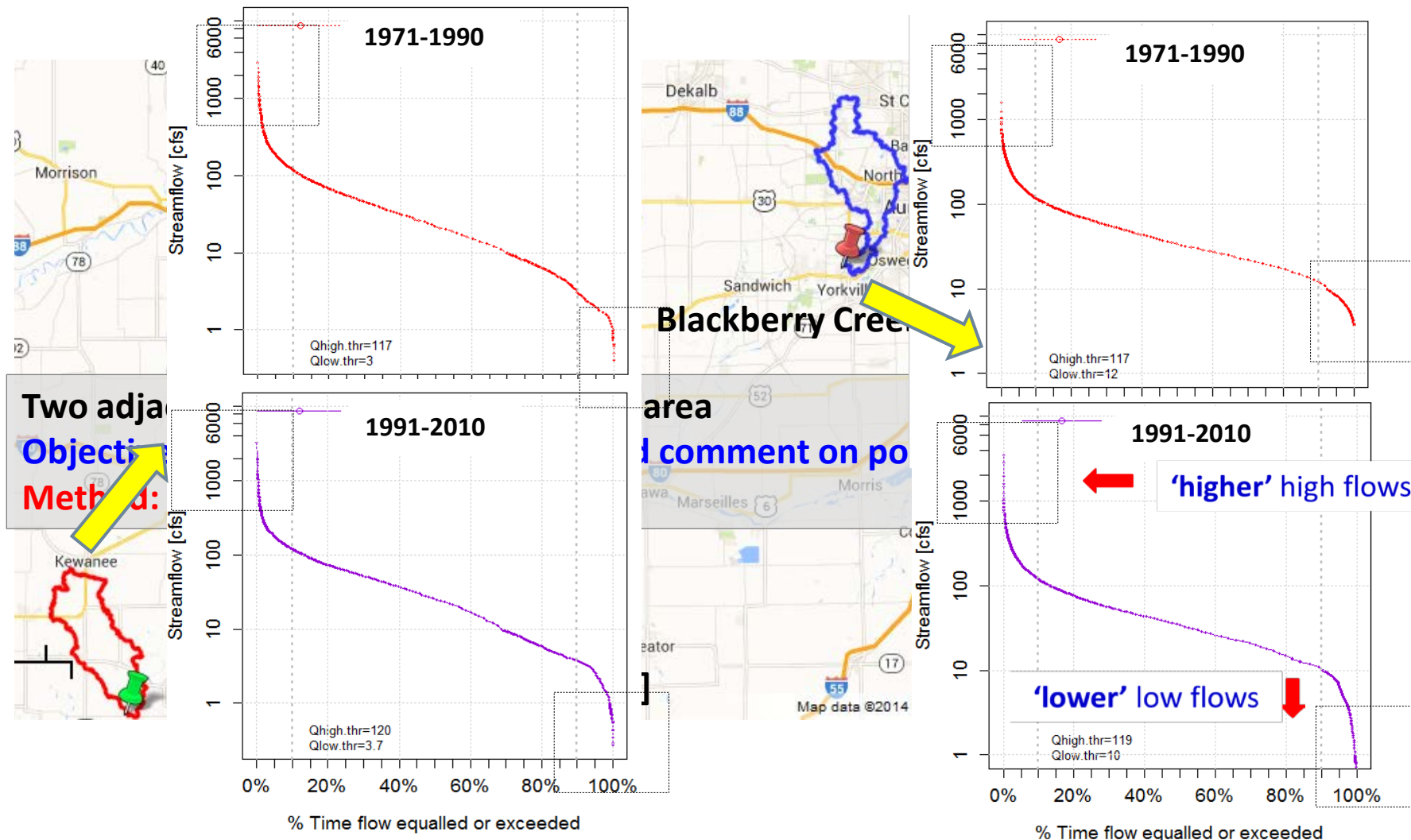
Higher Peak Discharge and shorter Lag Time!



Science from RWater

Trending Urbanization by Flow Duration Curve

Example for Chicago area



Student-Teacher Evaluation

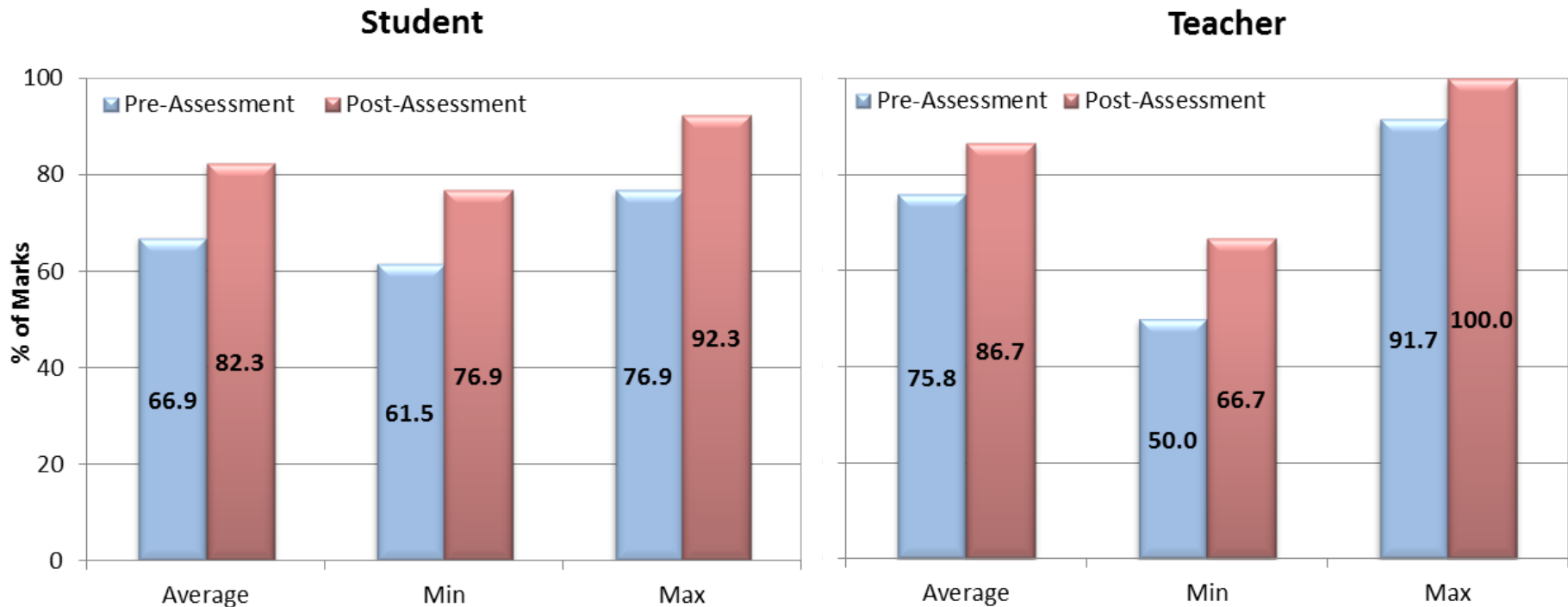
- **Summer Residential Program,**
College of Education, Purdue University
29 June – 12 July, 2014
Total 7 High School Students (9-12 Grade)
- **RWater Teacher's Workshop,**
Lyles School of Civil Engineering, Purdue University
17 – 18 July, 2014
Total 20 Middle and High School Teachers



Student-Teacher Evaluation

Survey Results

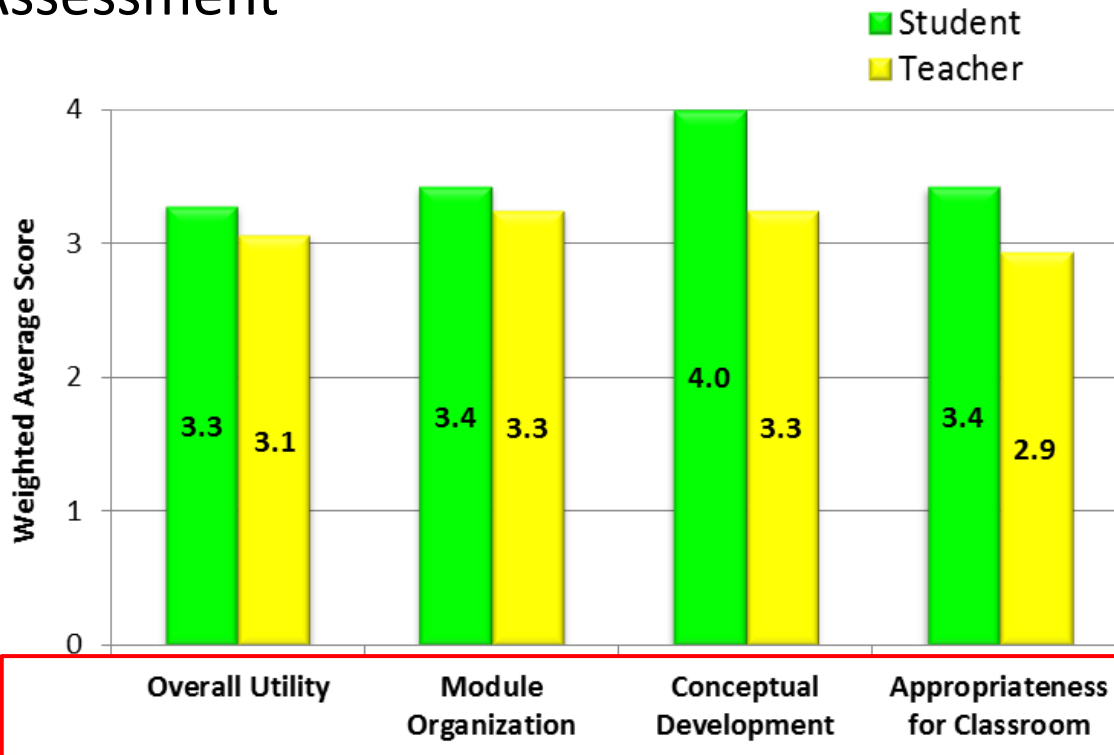
- Testing the improvement in users' hydrologic understanding
- Pre/Post Assessment



Student-Teacher Evaluation

Survey Results

- User opinion on RWater's Utility
- Post Assessment



Evaluation
Criteria



Response	Strongly Agree	Agree	Disagree	Strongly Disagree	Undecided
Score	4	3	2	1	0

Future Work

- Addition of a conceptual rainfall-runoff model with opportunities of high performance calibration
 - Making RWater a comprehensive modeling and analysis tool
- Testing RWater for upper undergraduate/graduate class
 - Making RWater applicable from K-12 to the graduate level
- Creating a database with RWater class projects from participating schools/universities all over United States.
 - This will record hydrologic assessments over the real locations across the country, being done by the students.

Tool link: <https://mygeohub.org/tools/rwater>

Modules: <https://web.ics.purdue.edu/~vmerwade/rwater>

Thank You!

Questions ?

Contacts:

Adnan Rajib: adnanrajib@purdue.edu

Venkatesh Merwade: vmerwade@purdue.edu