# WATER

## (Water Availability Tool for Environmental Resources)

## USGS Kentucky Water Science Center
## Kentucky Division Of Water

U.S. Department of the Interior
U.S. Geological Survey

# Overview

- Purpose
- Value
- Configuration
- Demonstration
- Potential Applications
- Conclusions

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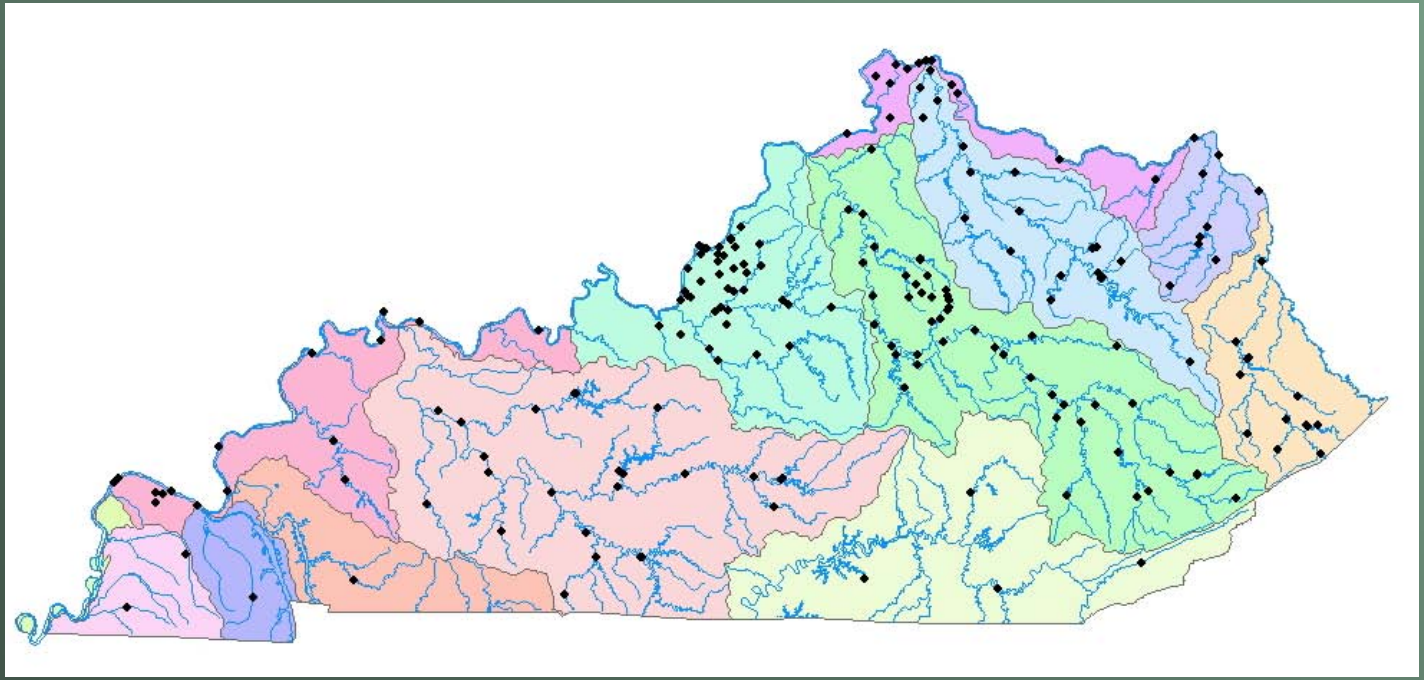
# The purpose of WATER

- **Quantifiable and consistent method for estimating streamflow in ungaged basins within the Commonwealth of Kentucky.**



# The purpose of WATER

- **Decision Support Application**
  - **A modern computer application that compiles individual decision steps into an overall software structure.**
  - **Includes spatial data, quantitative/qualitative models, and knowledge from experts.**
  - **Component based architecture**

***To Provide Information to Help Researchers and Managers Make More Informed Decisions.***

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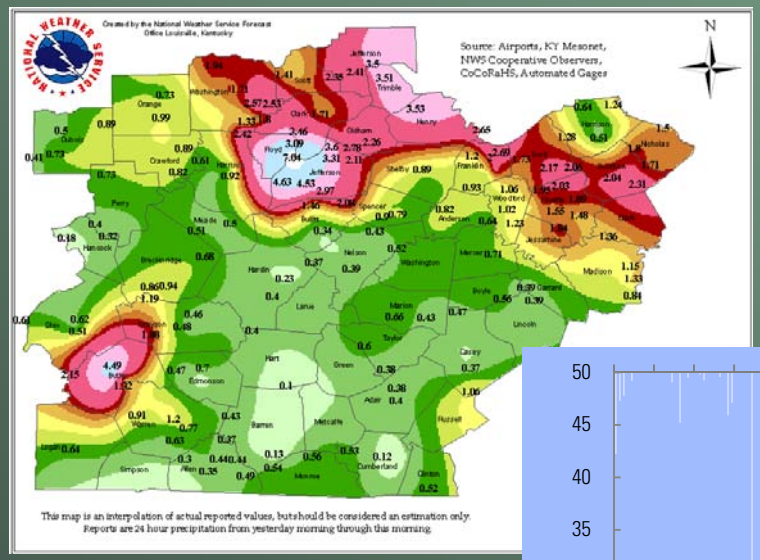
# The value of WATER

## Precipitation Record or Forecast

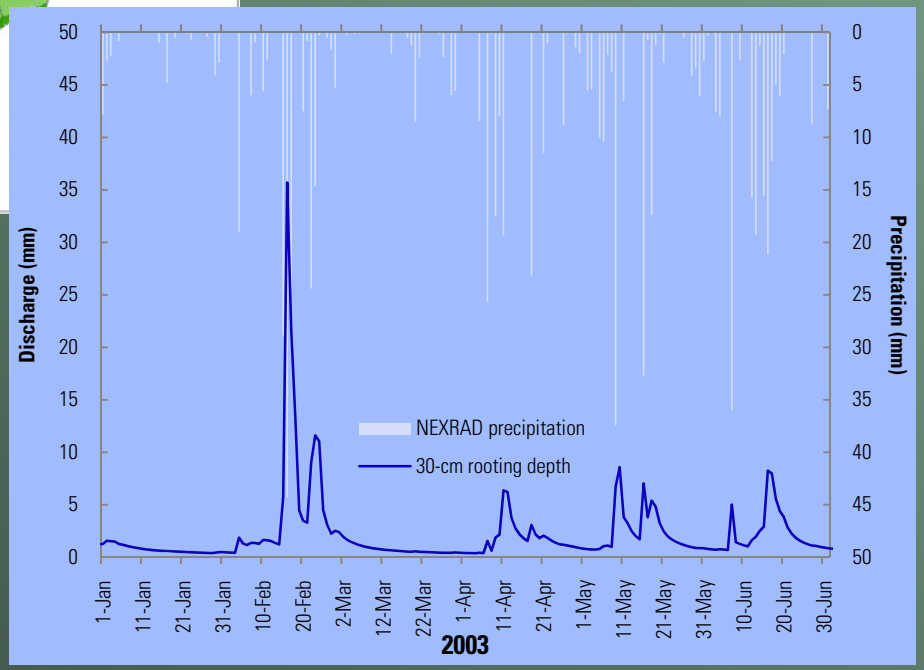



Nutrient Loads

Long-term Flow Record

Eco Flows

Hydrograph




Water Budget

Water Allocation Decisions

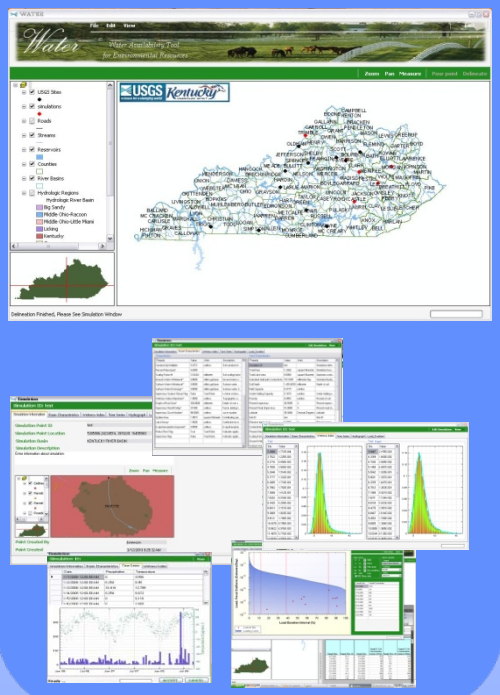
Flood Forecast

Disaster Preparedness

# The Configuration of the WATER Application

WATER

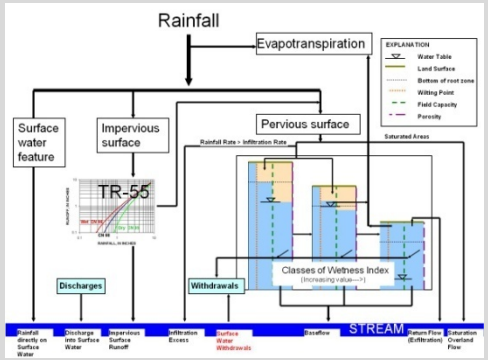
## Interactive



## Decision

State-Wide Data Layers

## MyMODEL

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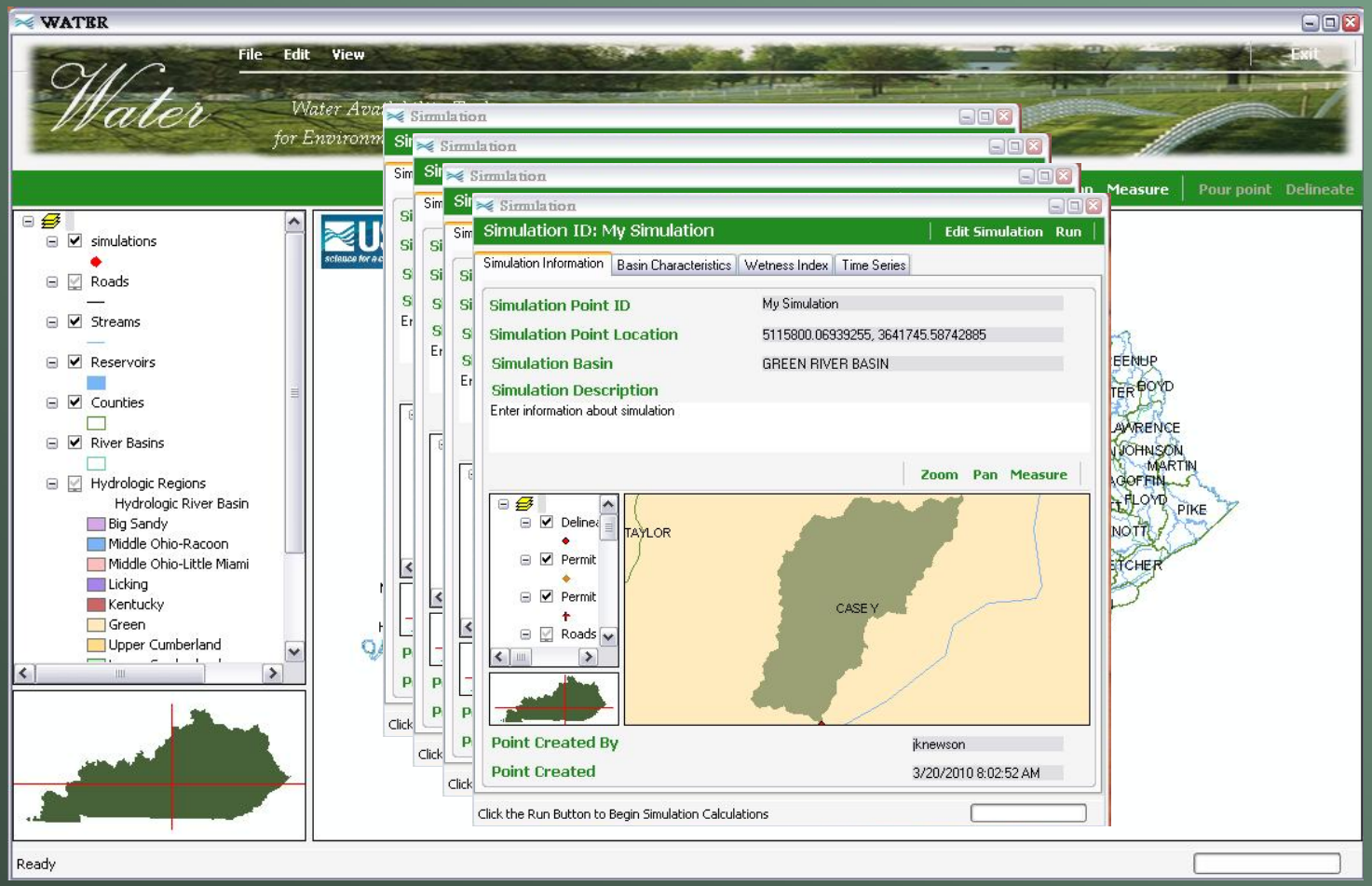
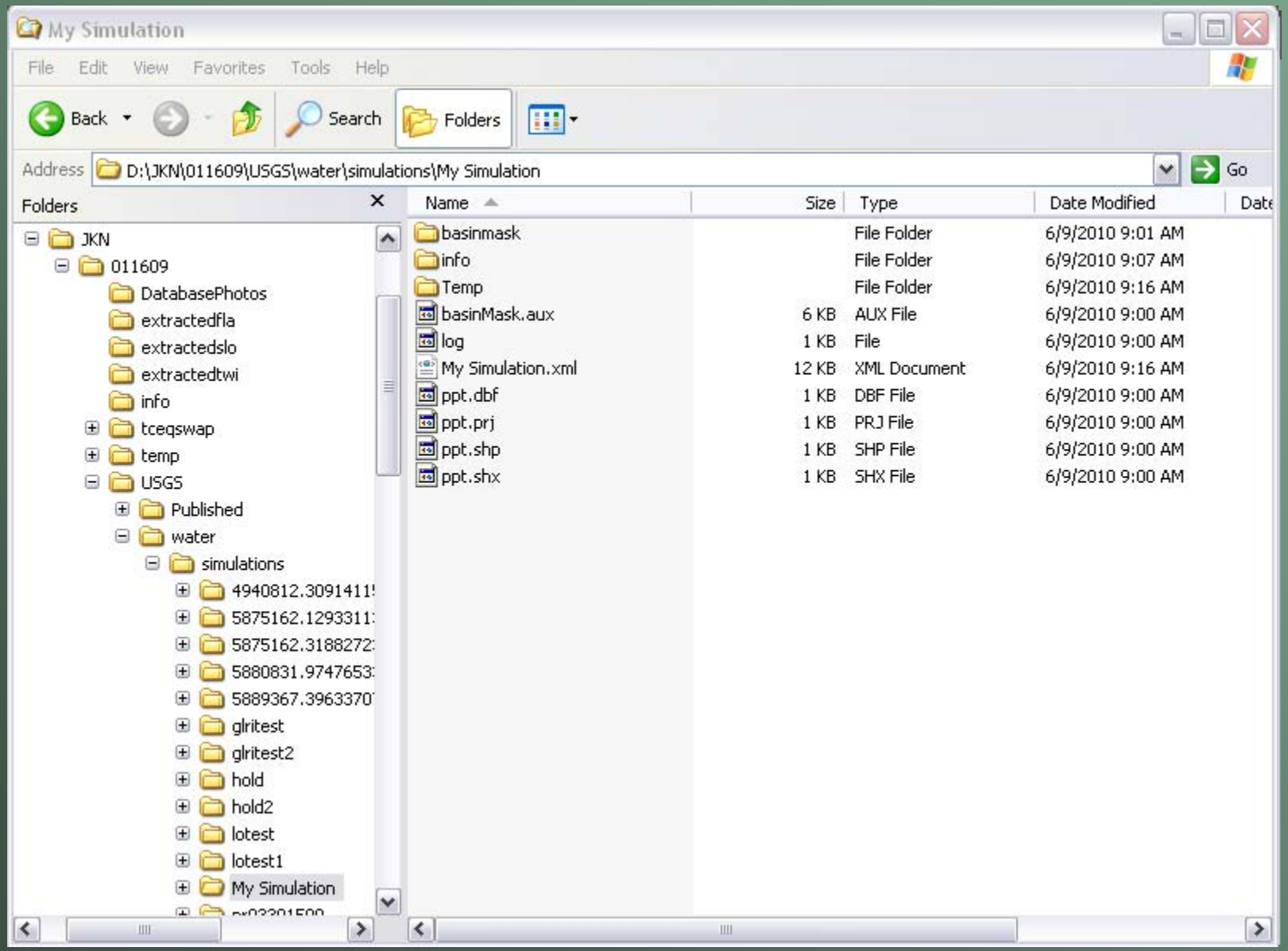
# User Interface

- Hide Complexities and Technical Details
- Provide Feedback
- Allow User to Select Simulation Area



# Database


My Simulation
File Edit View Favorites Tools Help
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Search
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glritest2
hold
hold2
lotest
lotest1
My Simulation
Name Size Type Date Modified
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info File Folder 6/9/2010 9:07 AM
Temp File Folder 6/9/2010 9:16 AM
basinMask.aux 6 KB AUX File 6/9/2010 9:00 AM
log 1 KB File 6/9/2010 9:00 AM
My Simulation.xml 12 KB XML Document 6/9/2010 9:16 AM
ppt.dbf 1 KB DBF File 6/9/2010 9:00 AM
ppt.prj 1 KB PRJ File 6/9/2010 9:00 AM
ppt.shp 1 KB SHP File 6/9/2010 9:00 AM
ppt.shx 1 KB SHX File 6/9/2010 9:00 AM

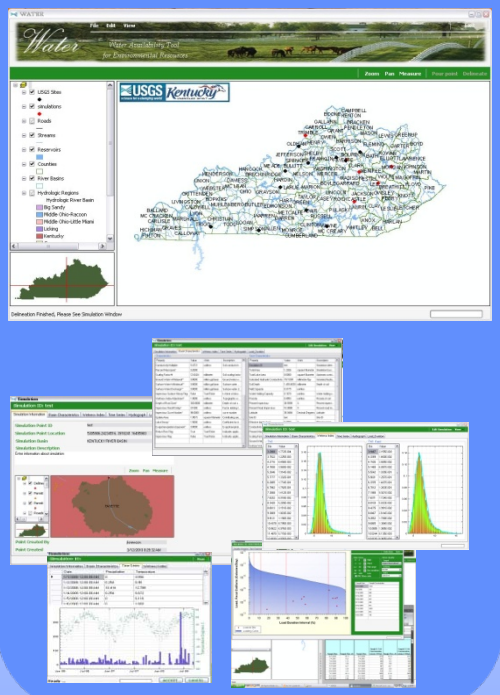
# DEMO

- Install WATER Application
- Set Simulation point
- Delineate Basin

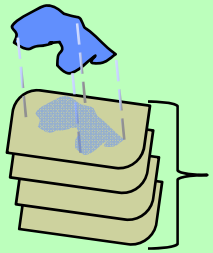
# The Configuration of the WATER Application

WATER

## Interactive

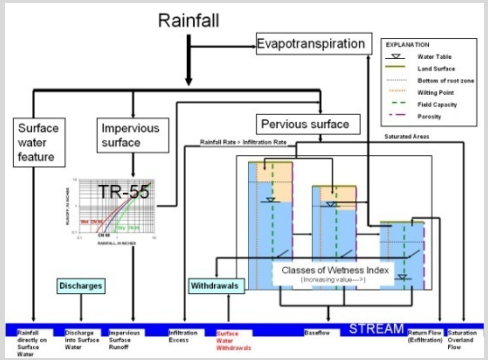


## Decision



Data Layers

## MyMODEL

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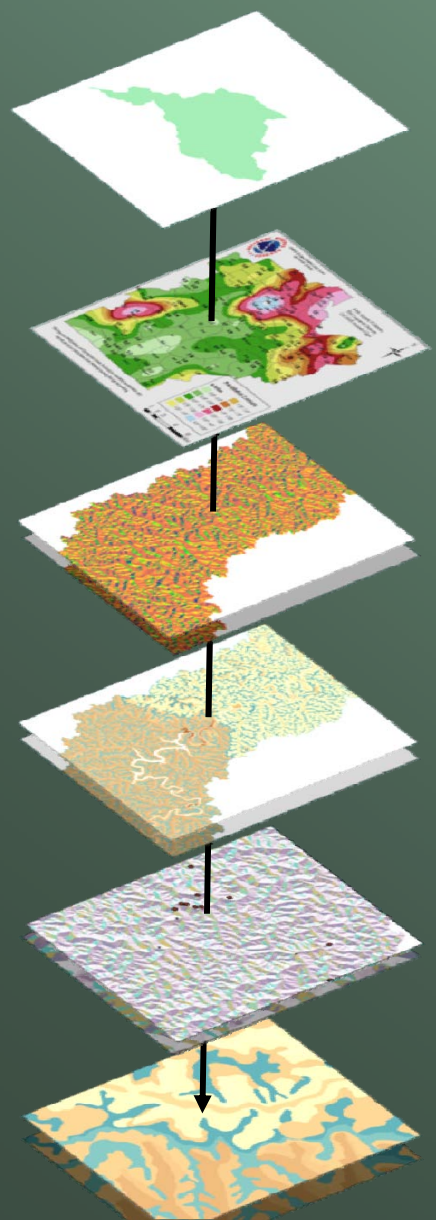
# Decision Support



**Working Basin**

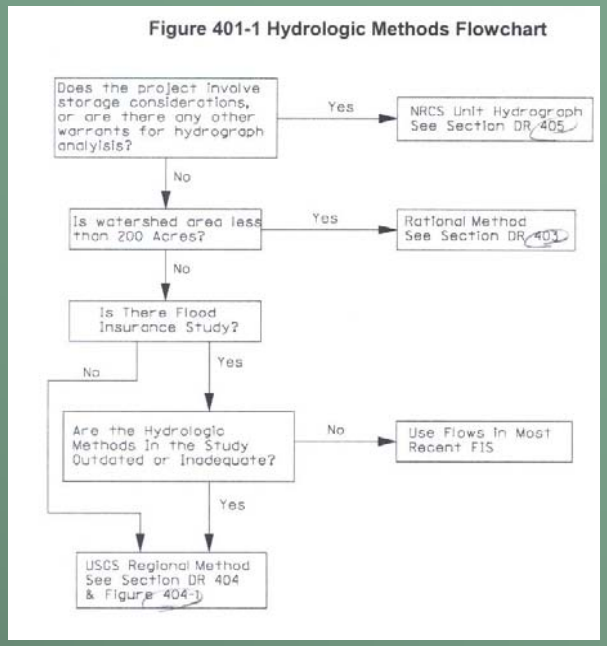
**Gridded Precipitation Record or Precipitation File**

**Digital Elevation Model**

**Spatial Soil Characteristics**

**Hydrologic / Flood Studies**

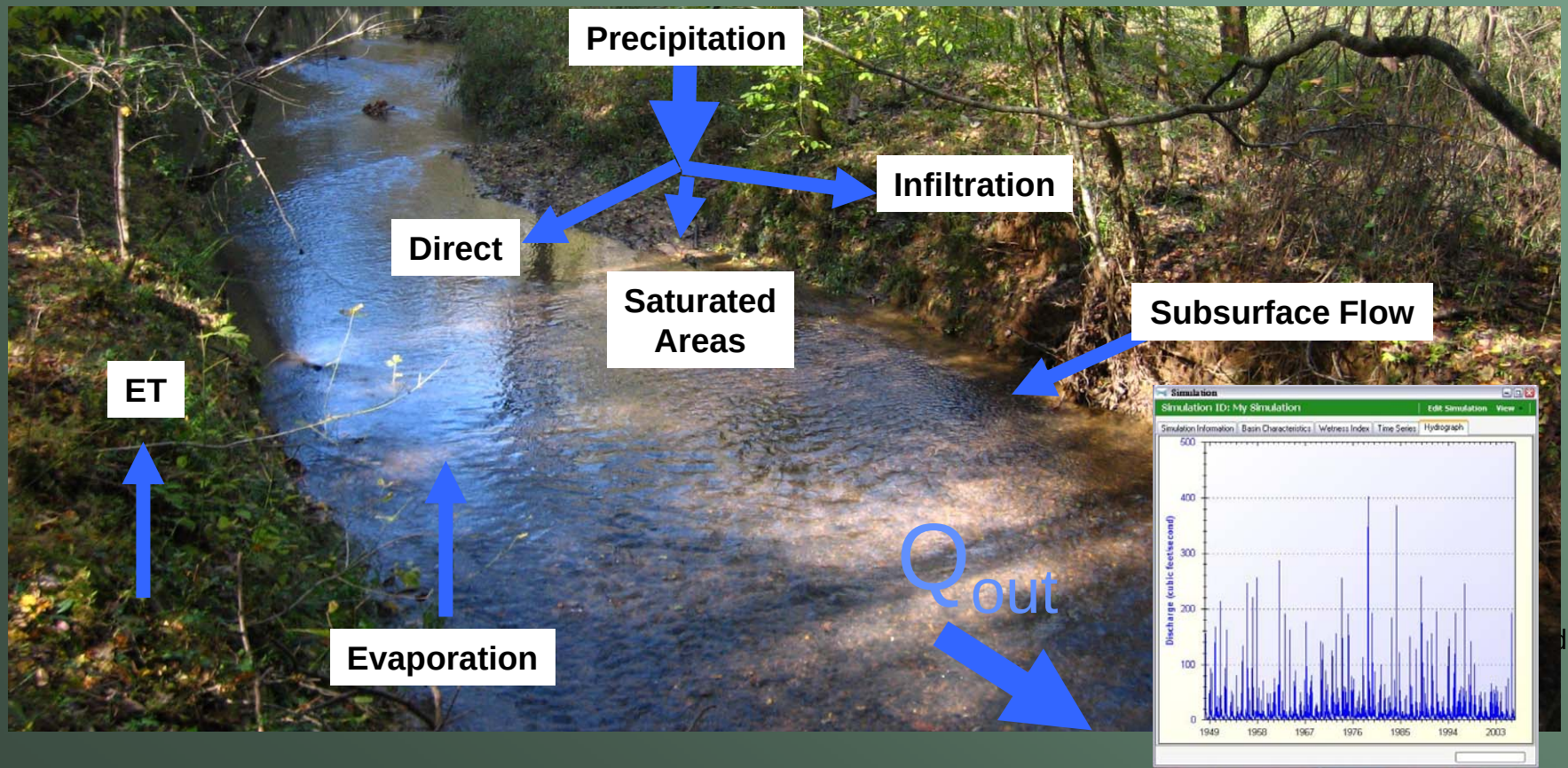
**NLCD Land Coverage**




***Model***

# Hydrologic Model

- TOPography-based hydrological MODEL
- Developed by Beven and Kirkby, 1979
- "Physically-based watershed model that simulates the variable-source-area concept of streamflow generation." (Wolock, 1993)



# Data Sources

# TOPMODEL Inputs

**NOAA/NWS Temperature and Precipitation Cooperative-Station and NEXRAD Data**

*Climate Generator (model) and(or) gridded NEXRAD data*

**DEM → Stream Network**

**KY Dam Safety Commission**

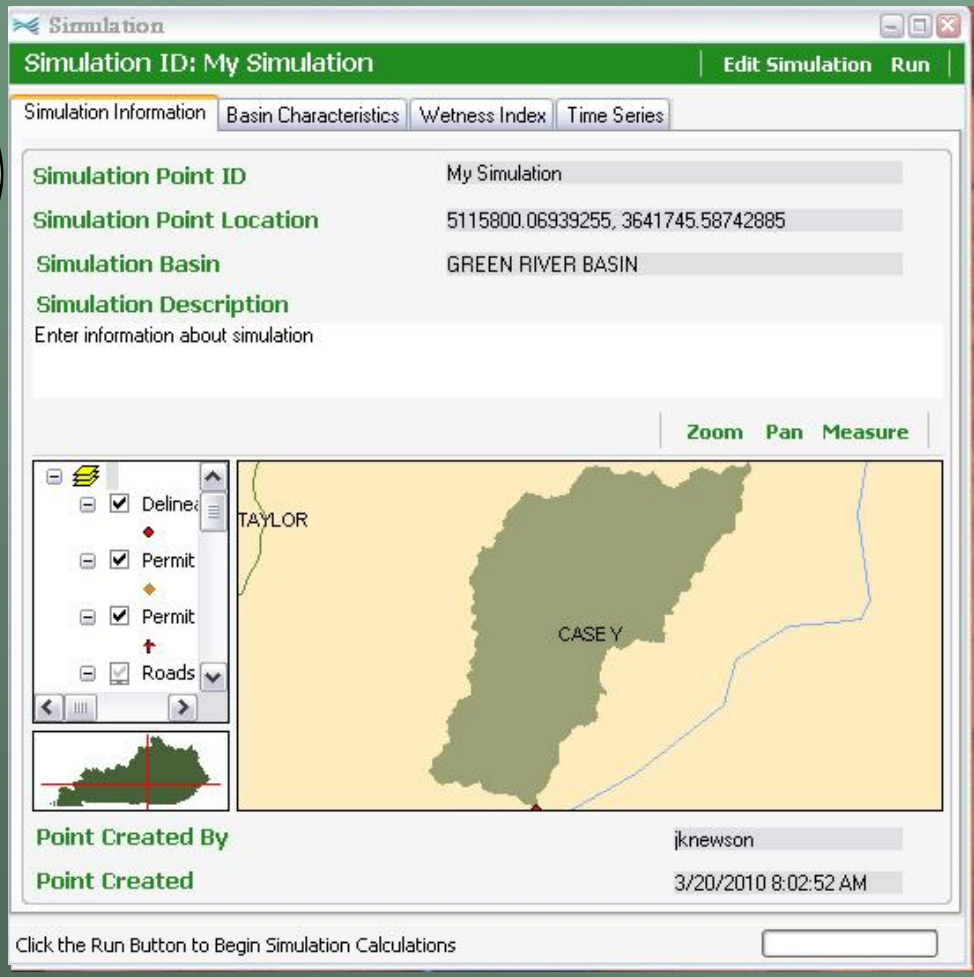
**Soil Survey Geographic Data**

**TR-55 Impervious Erosion Curve**

**National Land Cover Data 2001**

**KY Pollutant Discharge Elimination System**

**KY Division of Water**



# Soil Characteristics

| SSURGO Variables | Calculated "m" |
|---|---|
| ▪ Hydraulic conductivity (moderately high or higher)<br>▪ Available Water Capacity<br>▪ Field Capacity<br>▪ Porosity<br>▪ Depth (based on conductivity)<br><br>And…..<br><br>▪ Scaling Parameter "m" computed from processed SSURGO data<br>▪ *m* = readily drained soil porosity/rate of decrease with depth | **Conductivity Multiplier**<br>$\frac{K_{sat}\text{ - High}_{surface}}{K_{sat}\text{ - Low}_{depth}}$<br>**Scaling Parameter**<br>$f = \frac{\ln(conductivity\ multiplier)}{soil\ depth}$<br>$m = \frac{porosity - field\ capacity}{f}$ |

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Temperature and
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and NEXRAD Data

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Elimination System

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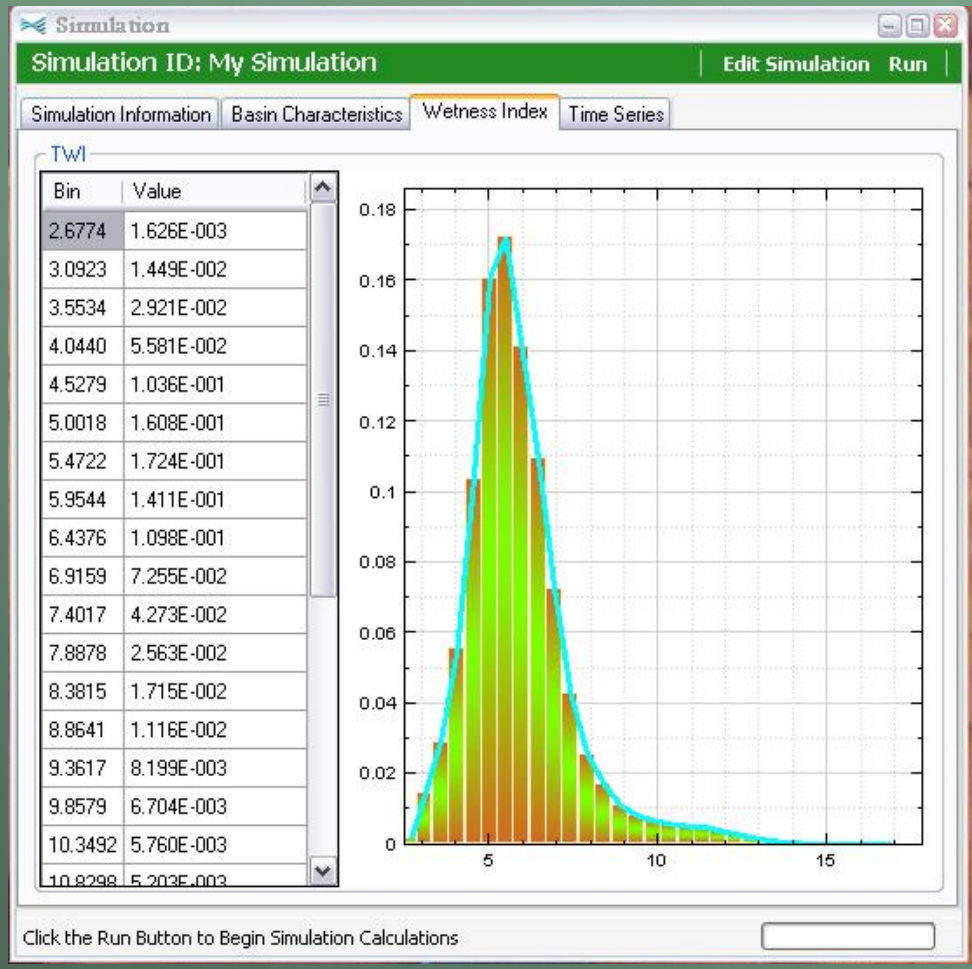
# TOPMODEL Inputs

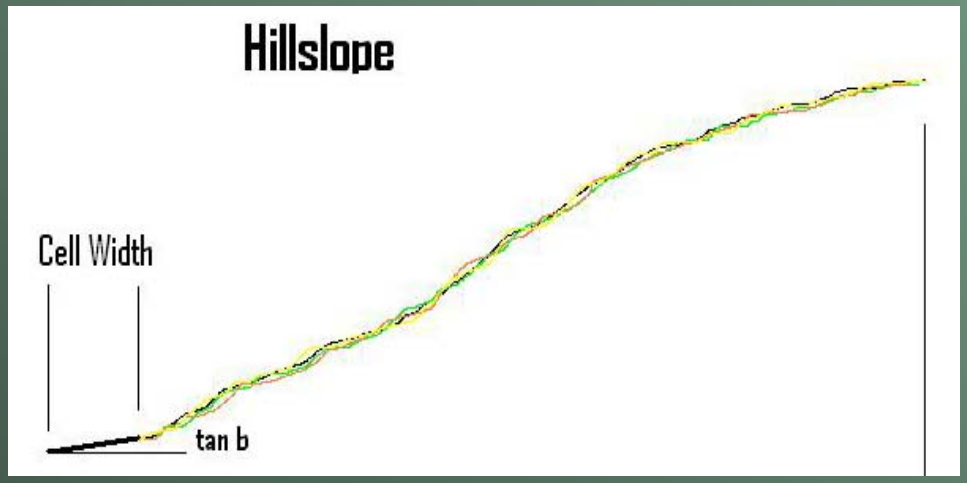



| Bin | Value |
|---|---|
| 2.6774 | 1.626E-003 |
| 3.0923 | 1.449E-002 |
| 3.5534 | 2.921E-002 |
| 4.0440 | 5.581E-002 |
| 4.5279 | 1.036E-001 |
| 5.0018 | 1.608E-001 |
| 5.4722 | 1.724E-001 |
| 5.9544 | 1.411E-001 |
| 6.4376 | 1.098E-001 |
| 6.9159 | 7.255E-002 |
| 7.4017 | 4.273E-002 |
| 7.8878 | 2.563E-002 |
| 8.3815 | 1.715E-002 |
| 8.8641 | 1.116E-002 |
| 9.3617 | 8.199E-003 |
| 9.8579 | 6.704E-003 |
| 10.3492 | 5.760E-003 |
| 10.8298 | 5.203E-003 |

# Topographic Wetness Index
# Semi-Distributed Approach

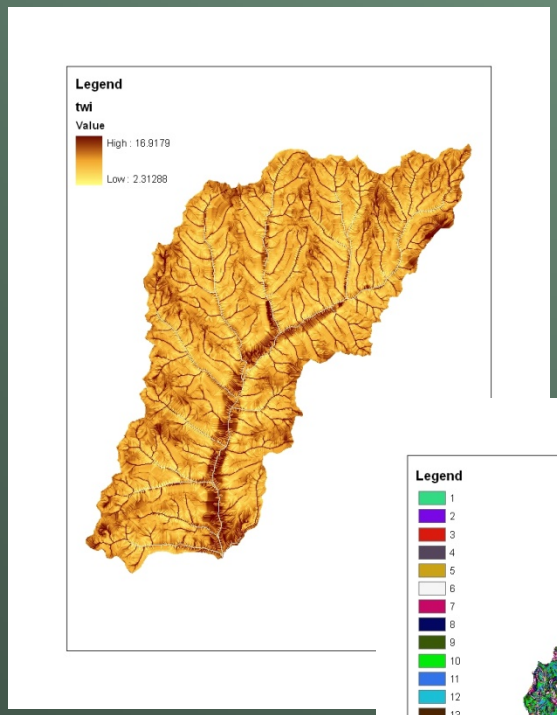
How does water accumulate in the basin?

$$TWI = \ln\left(\frac{upslope\ contributing\ area}{\tan\ slope}\right)$$

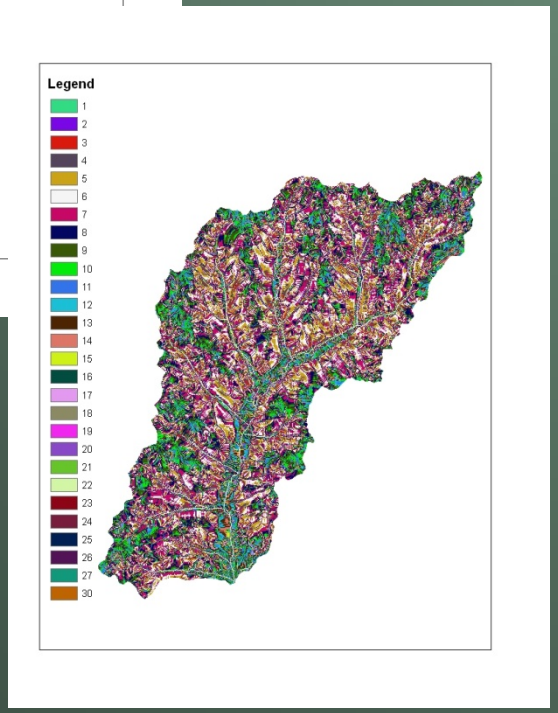



High values of TWI → High potential for saturation
Low values of TWI → Low potential for saturation

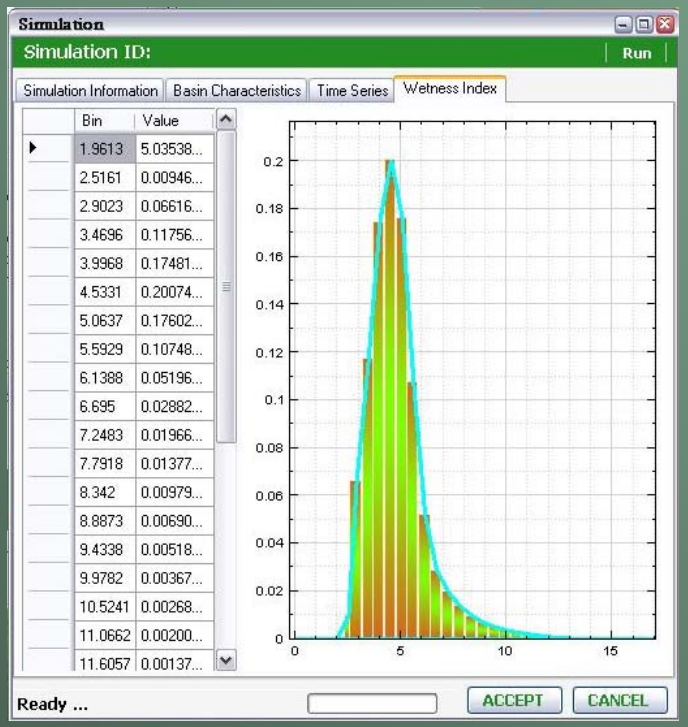
# Topographic Wetness Index
# Semi-Distributed Approach




- **Equal Interval**
  - **Each bin has the potential of having input cells that have the same range from the extremes**




Grid cells with the same TWI are hydrologically similar



# Basic TOPMODEL equation:

$$S_x = \bar{S} + m\left(T\overline{WI} - TWI_x\right)$$

*S* – saturation deficit
*TWI* – topographic wetness index
*m* –controls range of variability in saturation deficit

as *m* ↑, variability in *S* ↑ and water table gradient ↑

due to <u>increased</u> effect of topography -

this attenuates peak flow and steadies base flow

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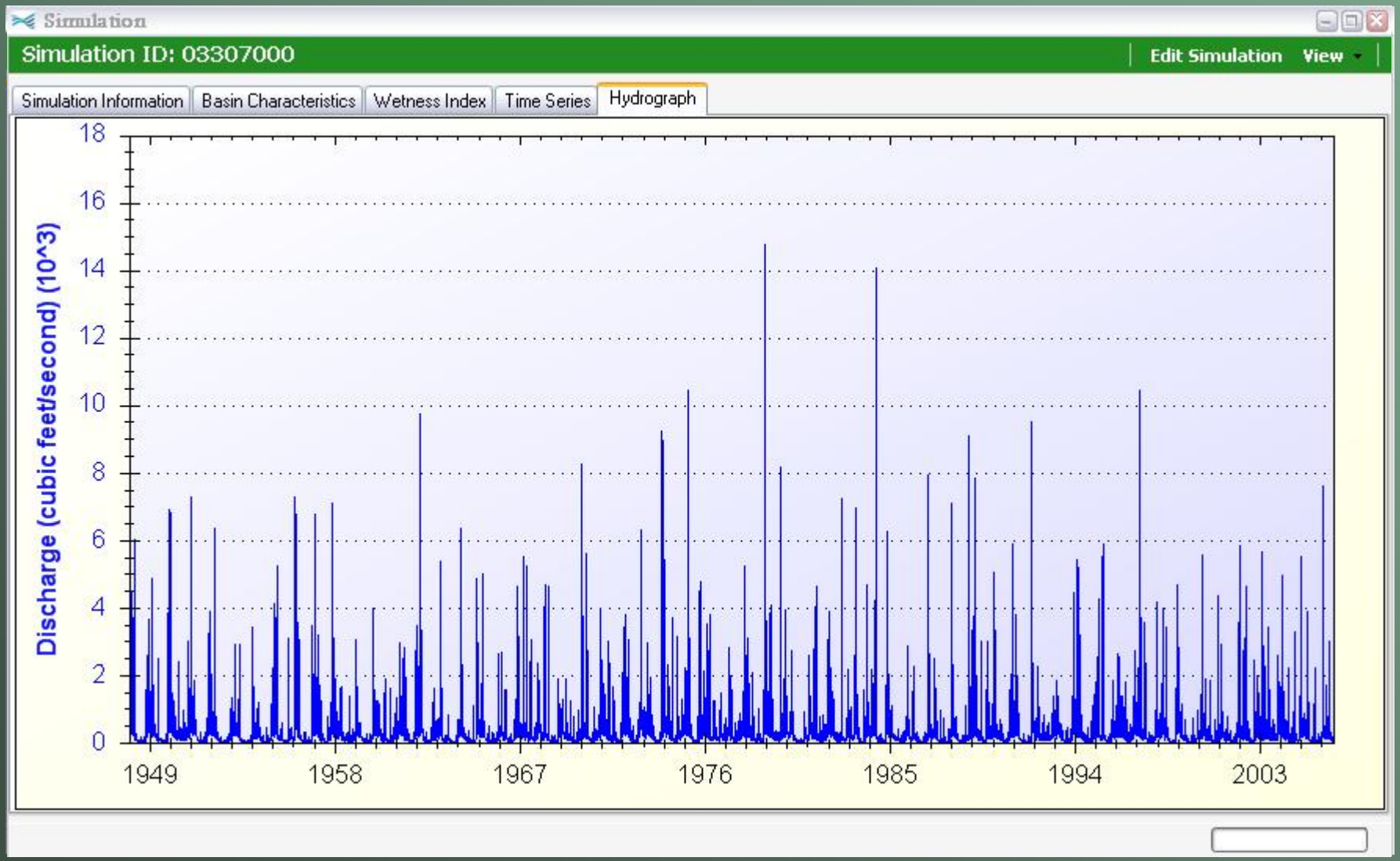
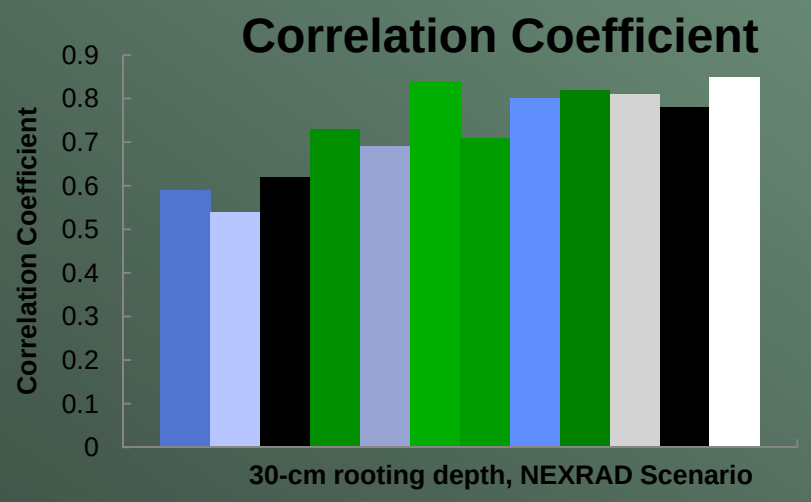
# Identifying Internally Drained Regions

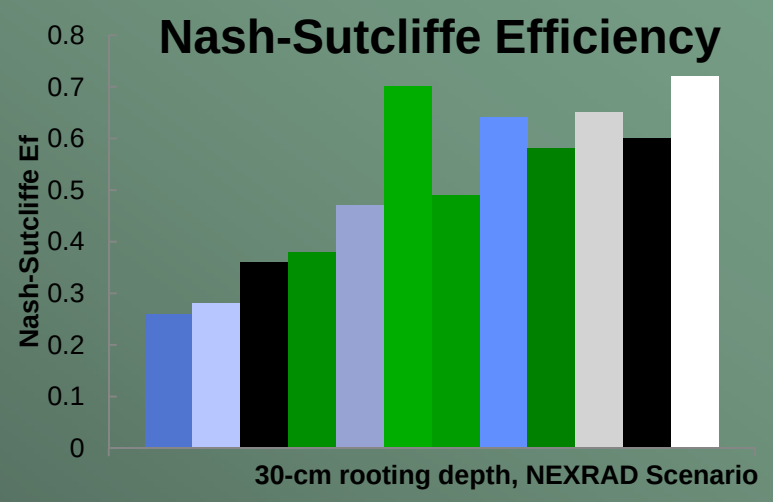


# DEMO

- Load Data from layers
- Run Model

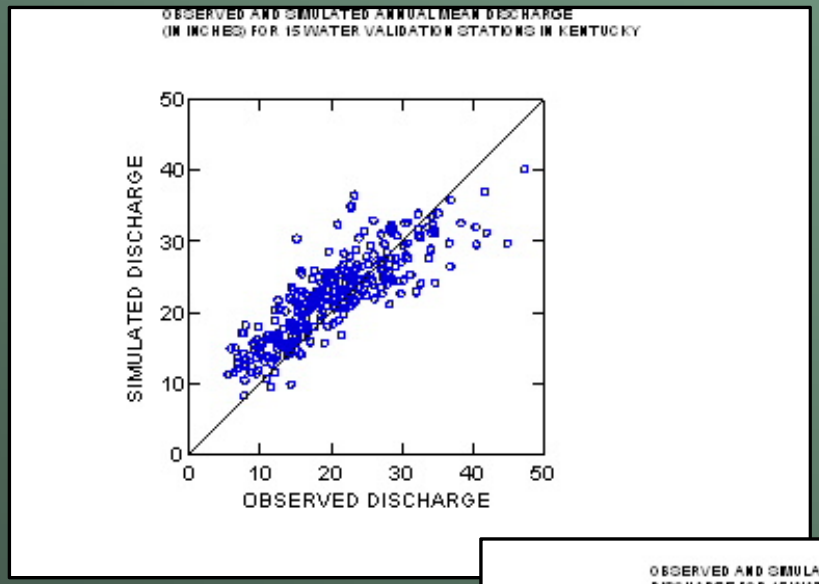
# TOPMODEL Statistical Validation - How well does it work over all flows?

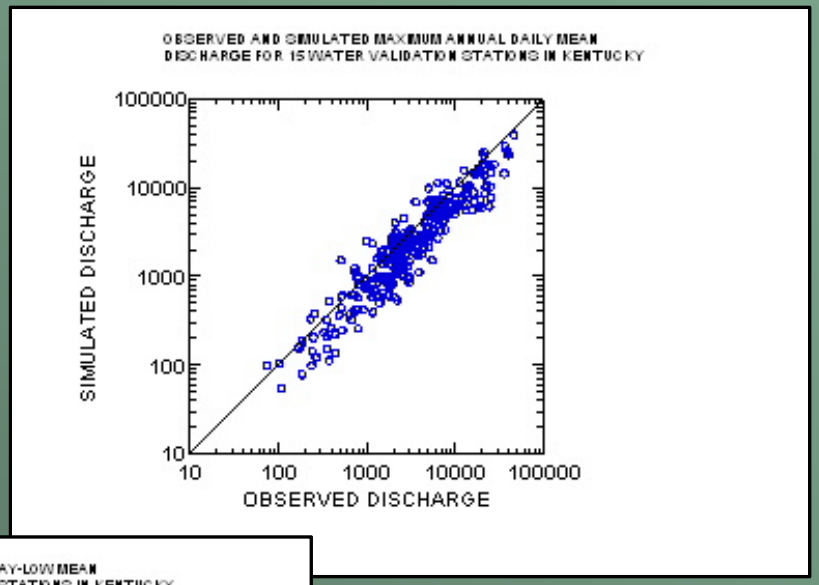


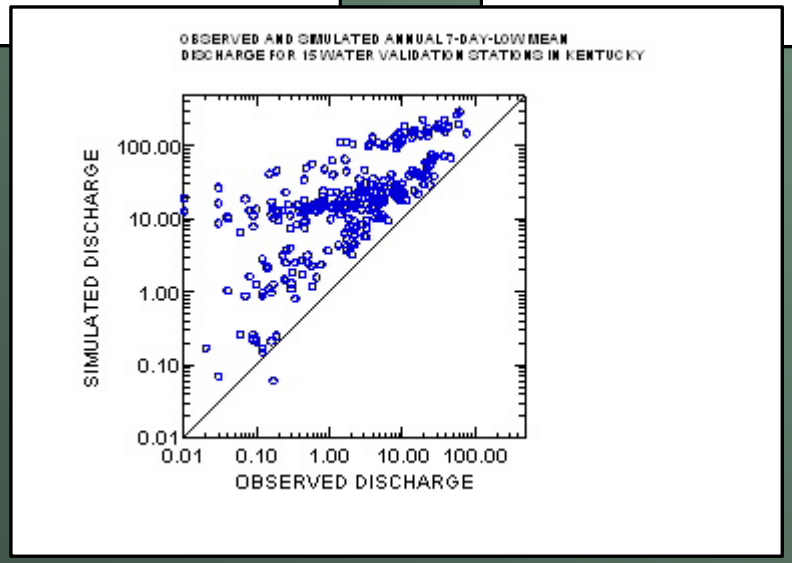



# TOPMODEL Statistical Validation

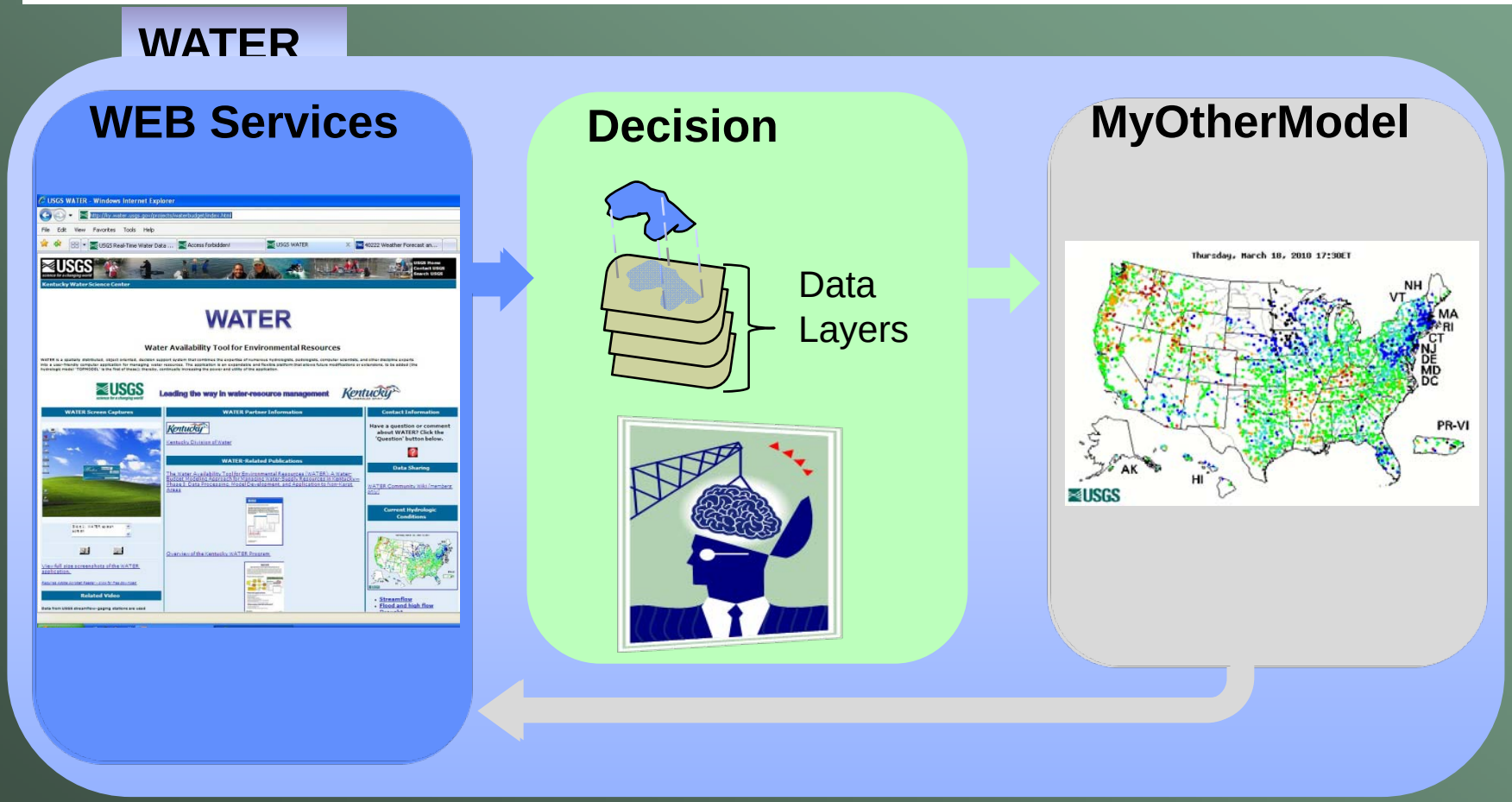
## How well does it work by flow regime?



# Component Based Architecture

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# Potential Applications

- Estimating water availability for permitting land use planning
- Flow statistics
- Drought mitigation
- Flood forecasting
- Water quality
- Source water assessments
- Defining ecoflows for aquatic habitats
- etc …

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# Conclusion

- **WATER is component based → provides a flexible platform to add functionality.**
- **WATER incorporates knowledge from experts, spatial data and quantitative/qualitative models.**
- **WATER is an application that compiles decision steps in order to provide information to help researchers and manager make more informed decisions.**

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# Cooperative Partners

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WATER Application Website:
http://ky.water.usgs.gov/projects/waterbudget/index.html