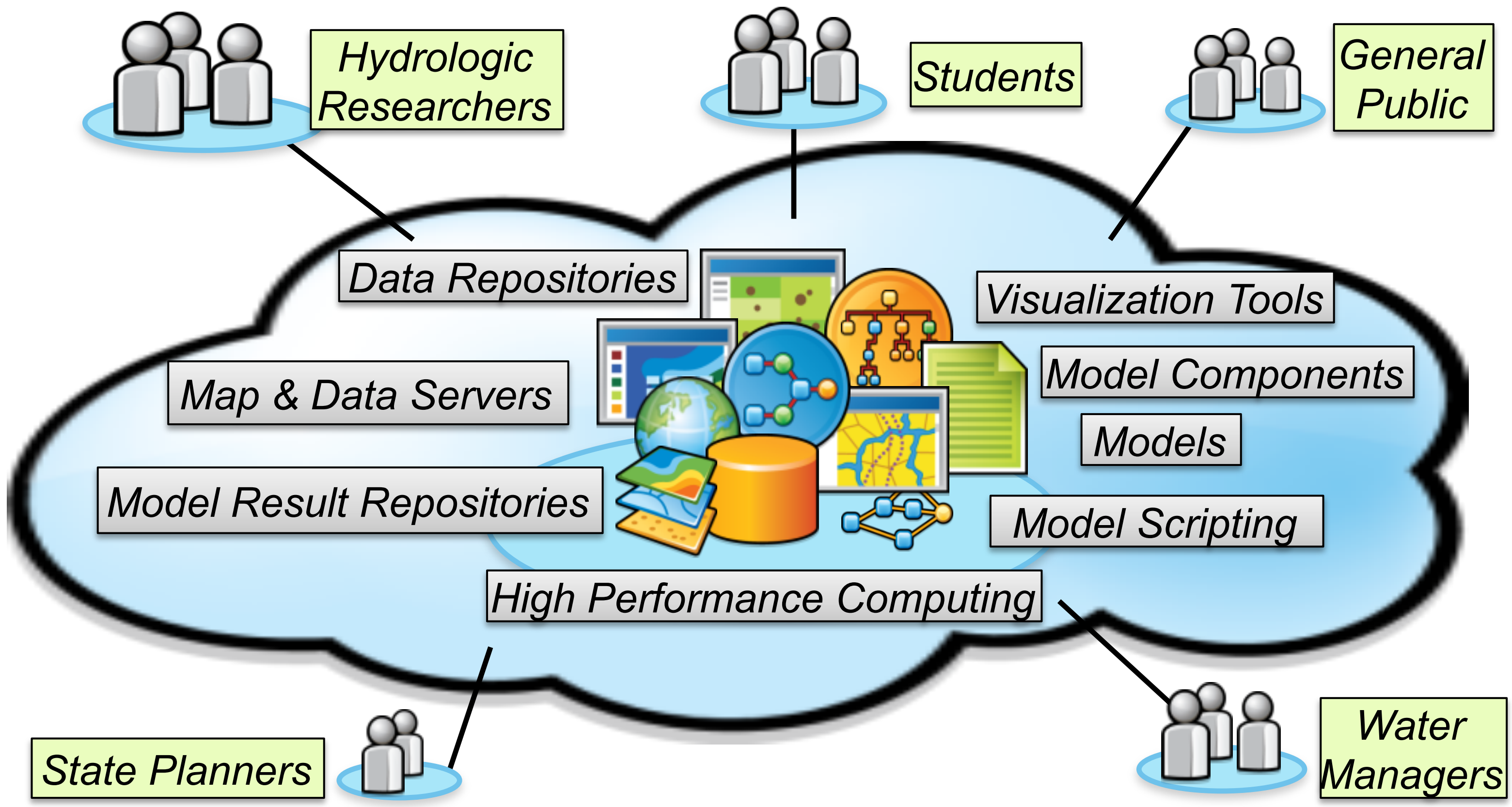
CI-WATER Component 2

Enhance Access to Data- and Computationally-Intensive Modeling

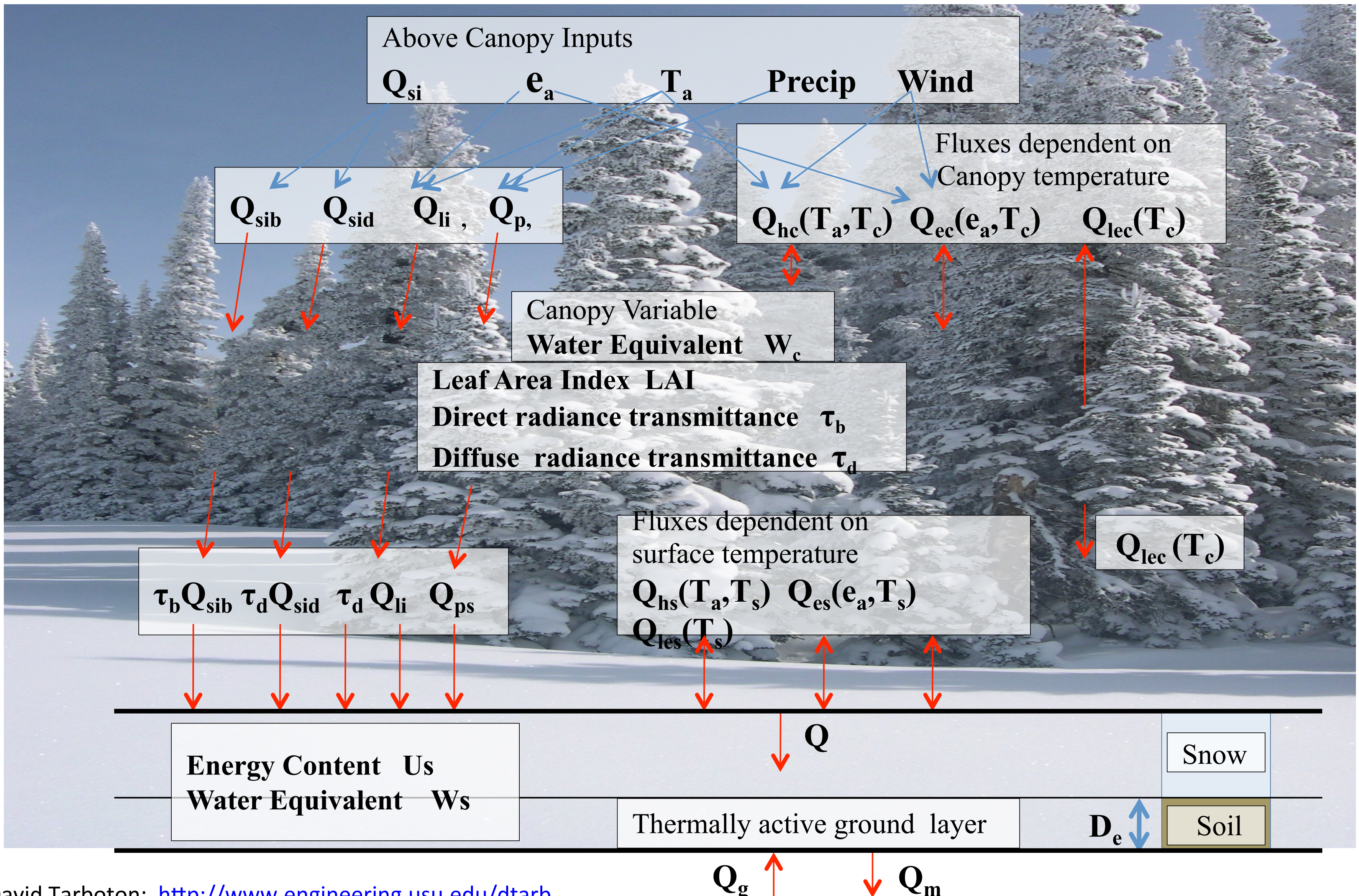


David Tarboton (USU)
Jeff Horsburgh (USU)
David Rosenberg (USU)
Jim Nelson (BYU)
Norm Jones (BYU)
Steve Burian (UU)
Steve Gray (UWYO)
Scott Miller (UWYO)
Kristi Hansen (UWYO)
Courtenay Strong (UU)

Modeling Use Cases to discover general aspects of data and functional requirements

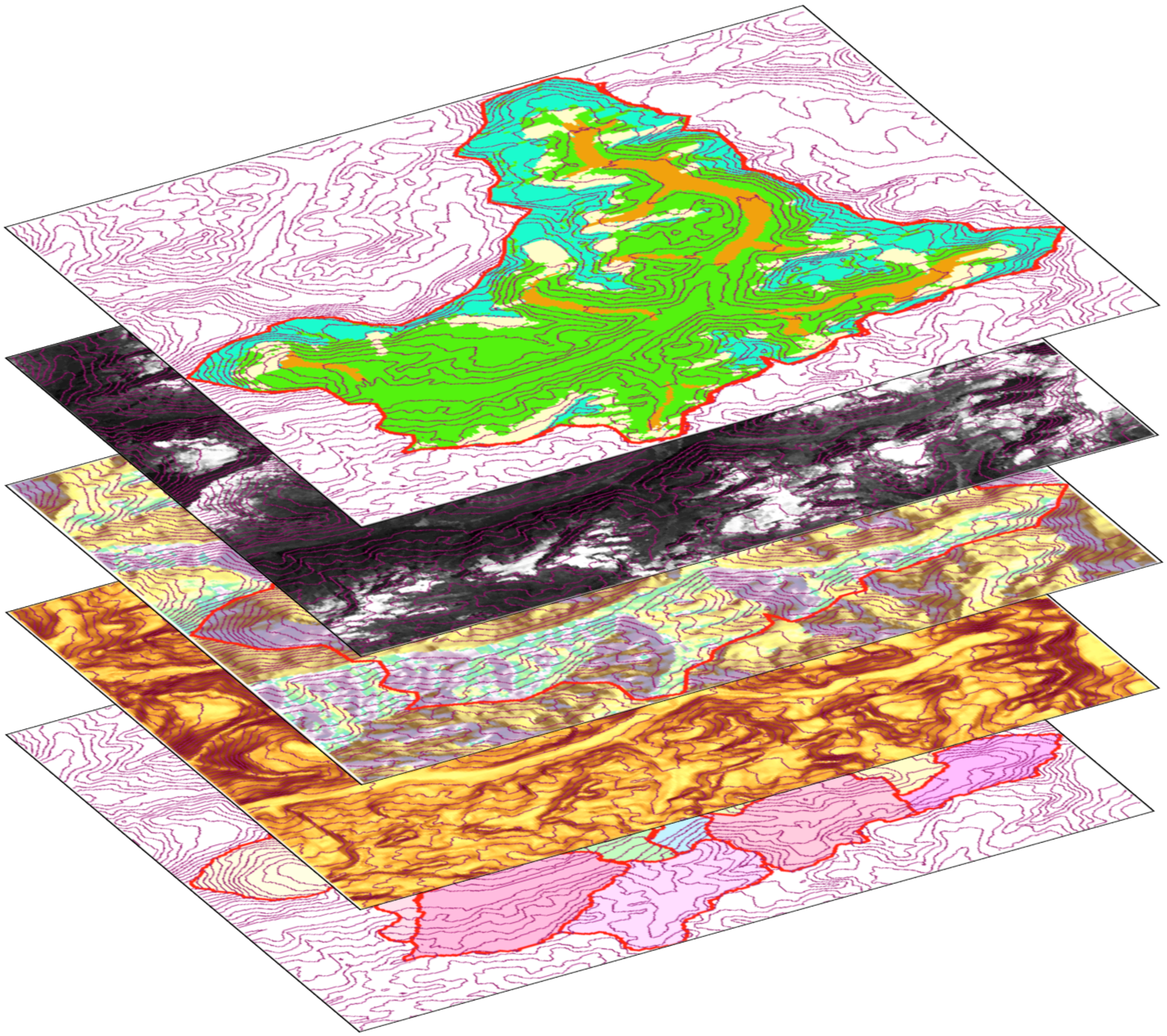
- UEB Snow Model
- SWAT
- WRIA 1 Water Resources
- Utah DWR Modflow (BYU)
- Urban Water Management (UU)

Processes in the Utah Energy Balance Snowmelt Model at a point



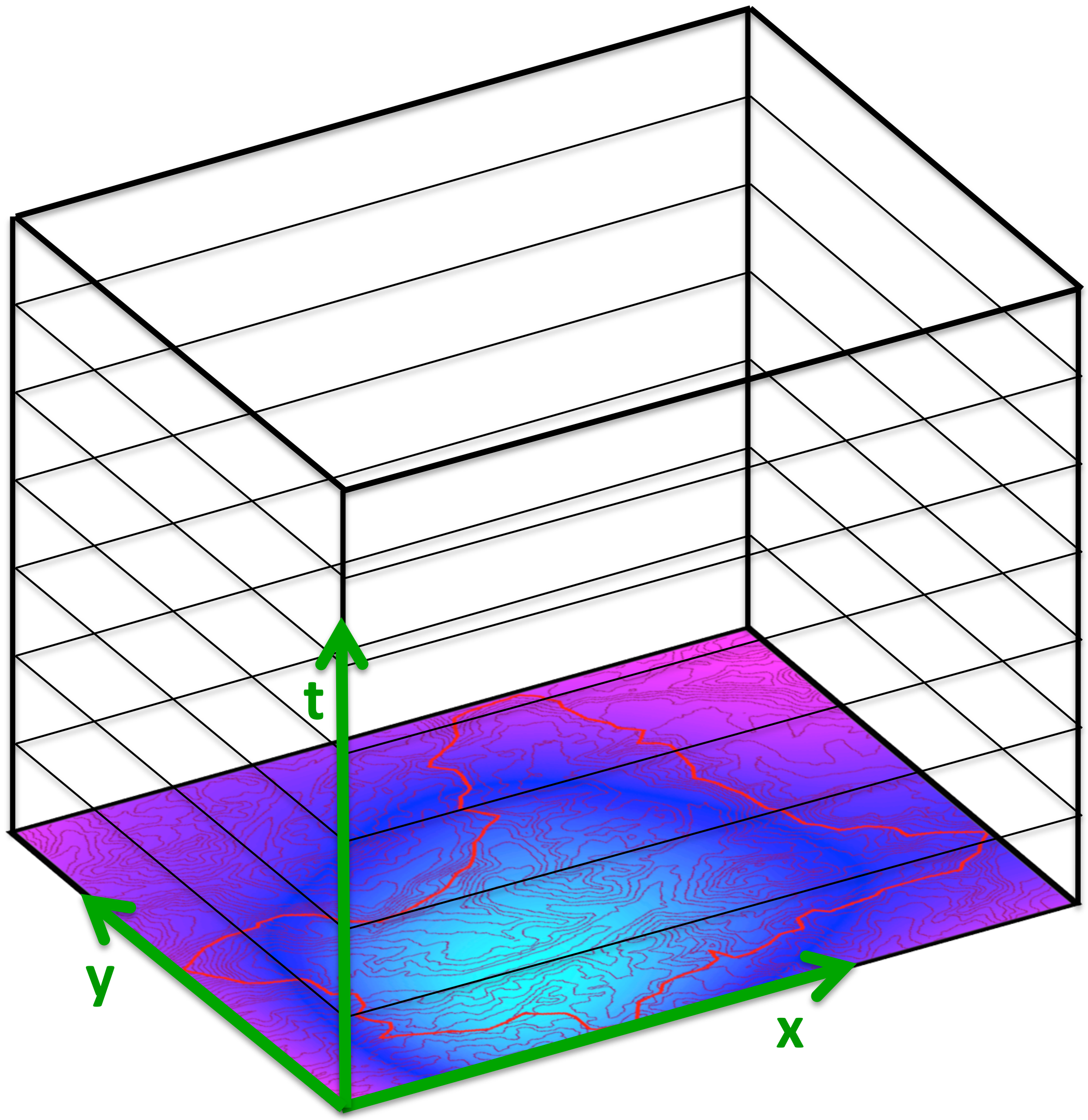
David Tarboton: http://www.engineering.usu.edu/dtarb

Spatially Variable Input Layers



- Elevation
- Vegetation
- Albedo
- Aspect
- Slope
- Subwatersheds
- Others ...

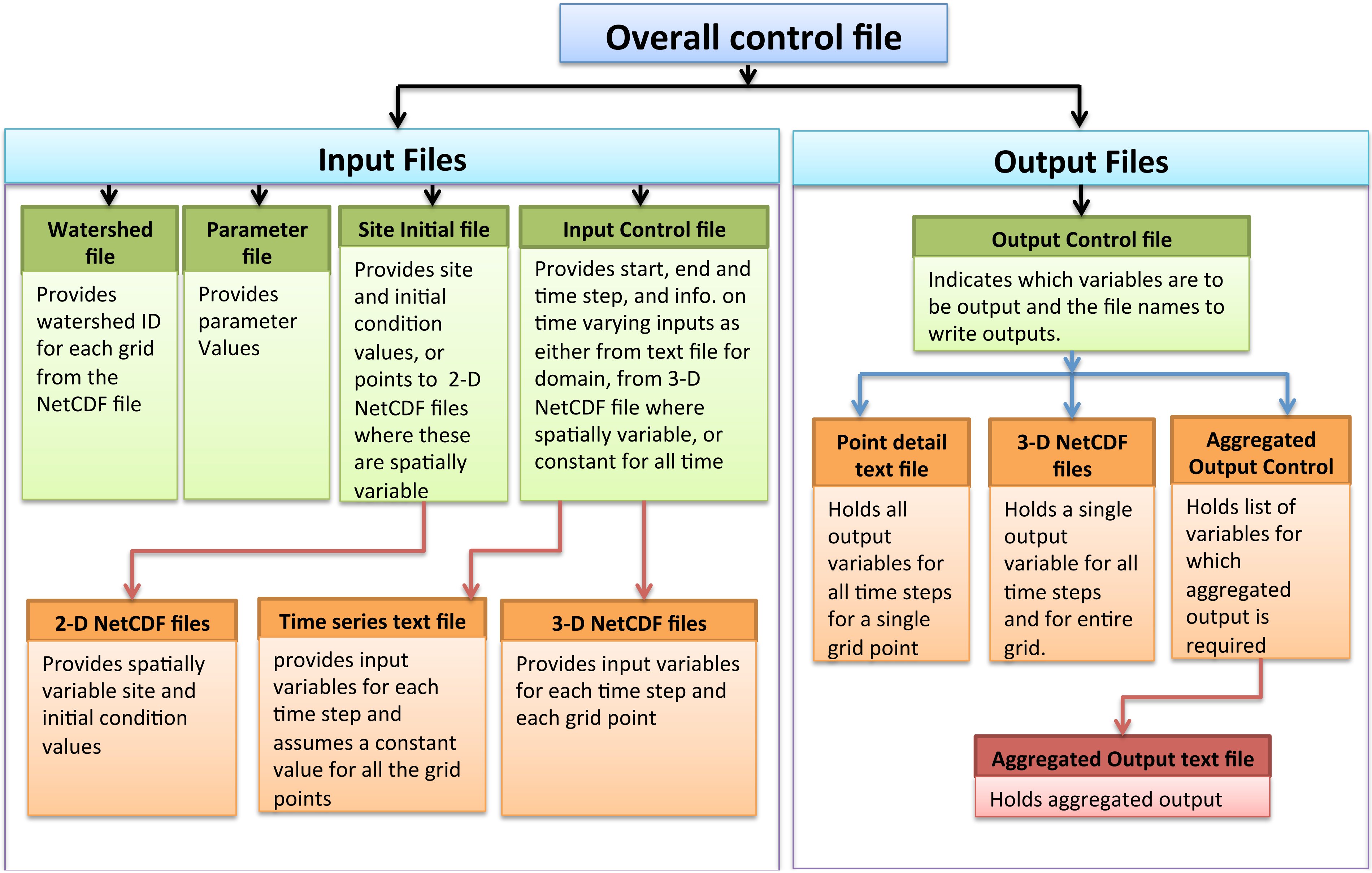
Space time inputs



- Precipitation
- Air temperature
- Solar Radiation
- etc.

- As 3D NetCDF files

File-Based Input-Output System



Extending HIS Functionality to support this use case

Formats

- Point Observations (Time Series in ODM/WaterML)
- Feature data set (Shapefile of points, lines or polygons and attribute tables)
- Raster data set (GeoTIFF file)
- Multidimensional space/time data set (NetCDF file)

Functionality

- Generalize catalog to include these formats (OGC CSW, other finer grained systems)
- Adopt or develop appropriate web services or data delivery mechanisms (THREDDS, OpenDAP, ArcGIS Server, ...)

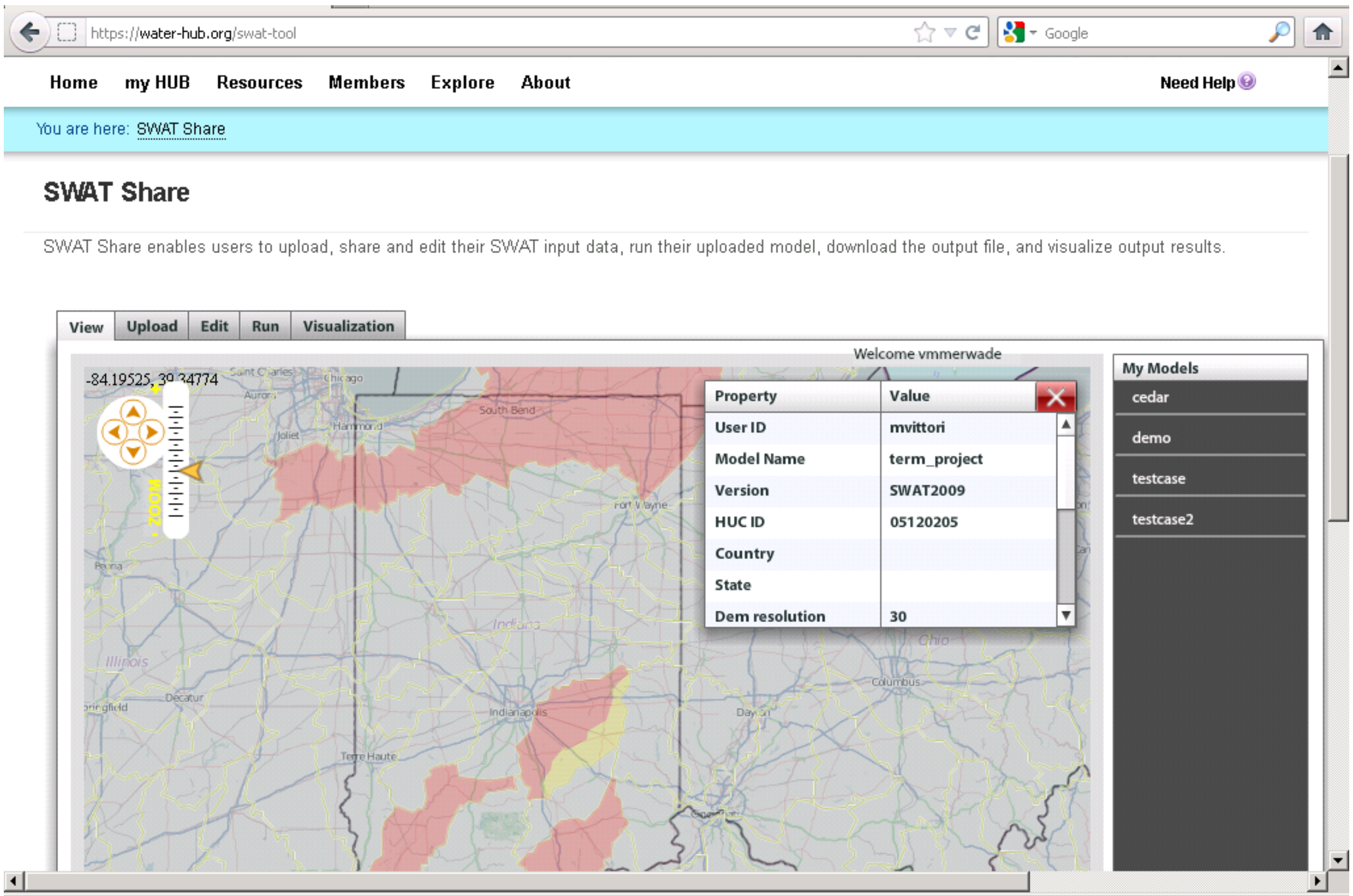
Many details to be worked out

SWAT in the Little Bear River

- mountainous,
- semi-arid,
- snowmelt-dominated,
- highly managed

Water-hub.org

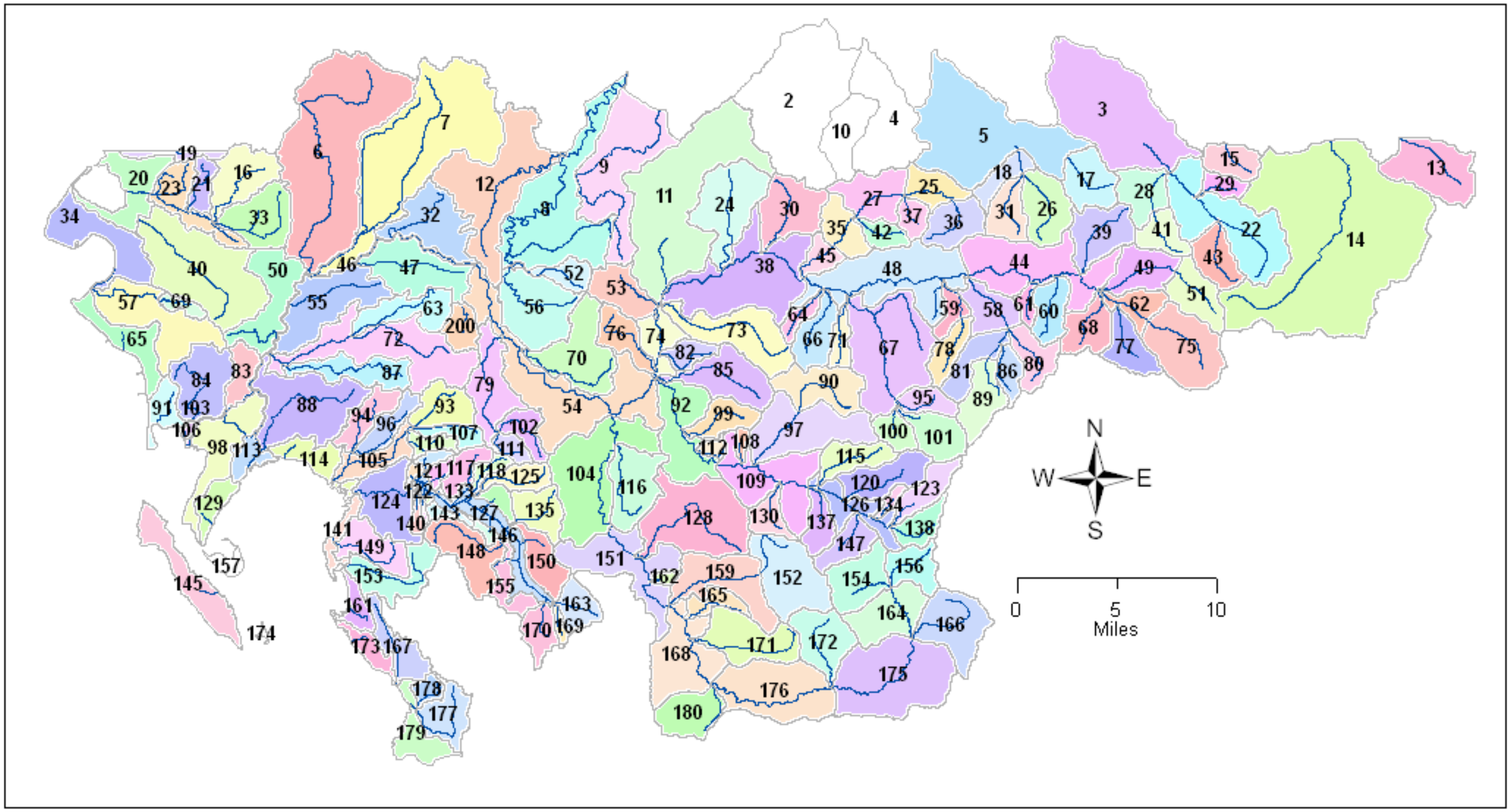
- A HUBZero based tool for publishing, sharing, and accessing Soil Water Assessment Tool (SWAT)



www.water-hub.org/swat-tool

From Venkatesh Merwade

WRIA 1 distributed catchment-scale water resources planning model

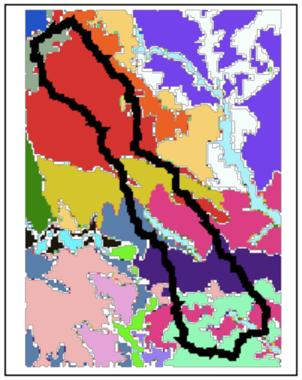


Tarboton, D. G., (2007), "Surface Water Quantity Model Development and Calibration, WRIA 1 Watershed Management Project Phase III, Task 4.1 report," Utah Water Research Laboratory, Utah State University, http://wria1project.whatcomcounty.org/uploads/USU/2008/Task4.1-SWQNcalibration.pdf.

Tarboton, D. G., (2007), "Validation of Surface Water Quantity Model through Analyses of Scenarios, WRIA 1 Watershed Management Project Phase III, Task 4.2 report," Utah Water Research Laboratory, Utah State University, http://wria1project.whatcomcounty.org/uploads/USU/2008/Task4.2-SWQNvalidation.pdf.

STATSGO Soil derived parameters

Zone Code
Polygon
Layer



Soil Grid Layers
Joined to
Polygon Layer

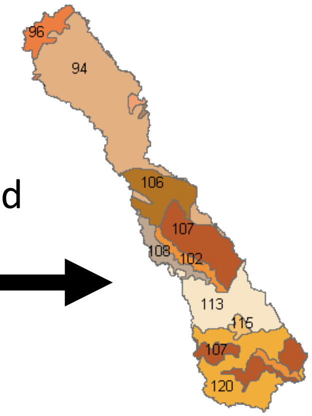
Soil texture for each of the 11 standard soil depth grid layers from PSU gridding of NRCS STATSGO data.

silt loam
silt loam
silt loam
silt loam
silty clay loam
silty clay loam
silty clay
silty clay
silty clay
bedrock

$\triangle\theta_1, \triangle\theta_2, \& \psi_\phi$

$\Delta\theta_1$
0.117
0.117
0.117
0.117
0.120
0.120
0.084
0.084
0.084
0.012

Depth
weighted
average



f & K

K
0.0260
0.0260
0.0260
0.0260
0.0060
0.0060
0.0037
0.0037
0.0037
0.0000

Exponential decrease with depth

$$K = K_o e^{-f z}$$

Soil parameter look up by zone code

ZONE CODE	f	K_{sat}	ψ_f (m)	$\triangle\theta_1$	$\triangle\theta_2$
4	4.43	222.09	0.68	0.12	0.17
10	2.05	228.11	0.76	0.11	0.18
11	46.23	681.10	0.39	0.13	0.14
14	1.06	284.00	0.72	0.11	0.17
17	1.06	1207.37	0.23	0.18	0.13
21	1.06	350.10	0.45	0.14	0.16
26	5.33	211.84	0.70	0.11	0.17
30	2.04	233.59	0.75	0.11	0.18
34	1.06	3.60	0.01	1.00	0.00
47	2.10	240.09	0.72	0.12	0.18
88	29.82	702.70	0.19	0.15	0.12
91	18.20	154.94	0.44	0.11	0.14
94	10.39	201.74	0.46	0.13	0.15
96	1.06	242.40	0.42	0.13	0.15
99	1.06	259.20	0.79	0.12	0.19
102	38.85	158.26	0.43	0.08	0.12

…

Table of Soil Hydraulic Properties – Clapp Hornberger 1978

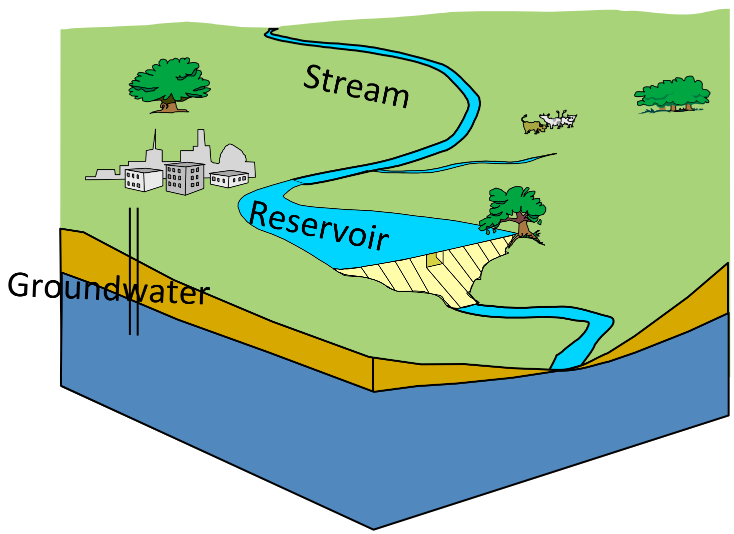
TEXTURE CLASS	TEXTURE NAME	k_{sat} (m/hr)	porosity n	ψ_f (m)	b	θ_{fc}	θ_{wilt}	$\triangle\theta_1$	$\triangle\theta_2$
1	sand	0.6336	0.395	0.1	4.1	0.173	0.068	0.222	0.105
2	loamy sand	0.5616	0.410	0.1	4.4	0.179	0.075	0.231	0.104
3	sandy loam	0.1249	0.435	0.2	4.9	0.248	0.115	0.187	0.134
4	silt loam	0.0259	0.485	0.8	5.3	0.368	0.180	0.117	0.188
5	silt	0.0259	0.485	0.8	5.3	0.368	0.180	0.117	0.188
6	loam	0.0250	0.451	0.5	5.4	0.313	0.155	0.138	0.158
7	sandy clay loam	0.0227	0.420	0.3	7.1	0.299	0.175	0.121	0.123
8	silty clay loam	0.0061	0.477	0.4	7.8	0.357	0.219	0.120	0.138
9	clay loam	0.0088	0.476	0.6	8.5	0.391	0.250	0.085	0.140
10	sandy clay	0.0078	0.426	0.2	10.4	0.316	0.220	0.110	0.096
11	silty clay	0.0037	0.492	0.5	10.4	0.408	0.284	0.084	0.125
12	clay	0.0046	0.482	0.4	11.4	0.400	0.287	0.082	0.113
13	Organic materia	0.6336	0.395	0.1	4.1	0.173	0.068	0.222	0.105
14	Water	0.0004	1.000	0.0	1.0	0.003	0.000	0.997	0.003
15	Bedrock	0.0004	0.100	0.5	15.0	0.088	0.068	0.012	0.020
16	Other	0.0004	0.400	0.3	7.0	0.276	0.160	0.124	0.115

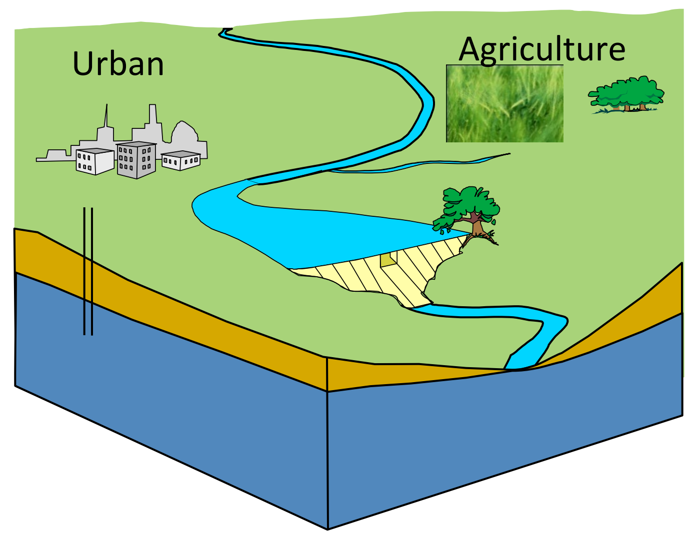
Water Management

Sources
- Reservoir
- Groundwater
- Stream

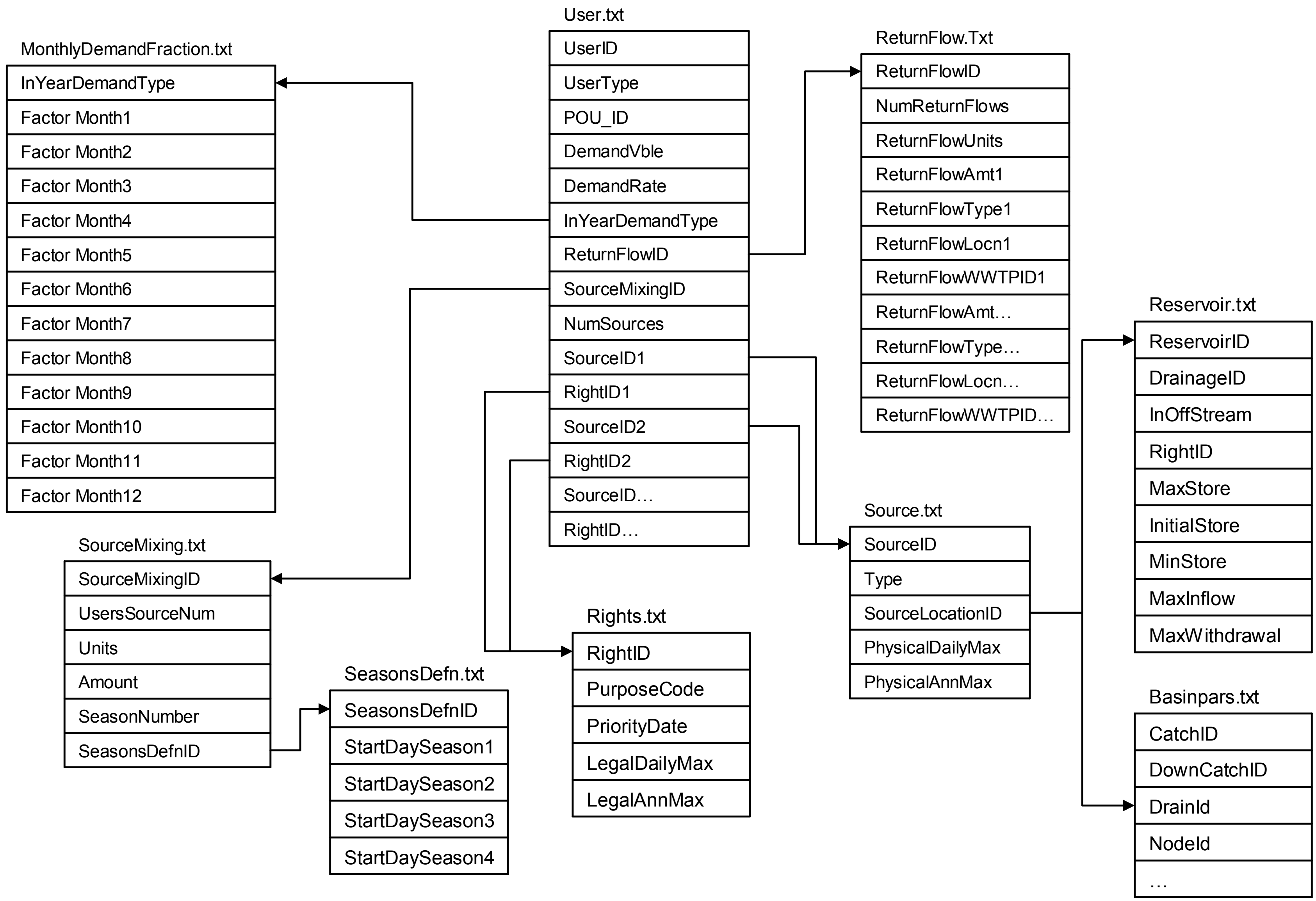
- Withdrawal limited by availability and right priority

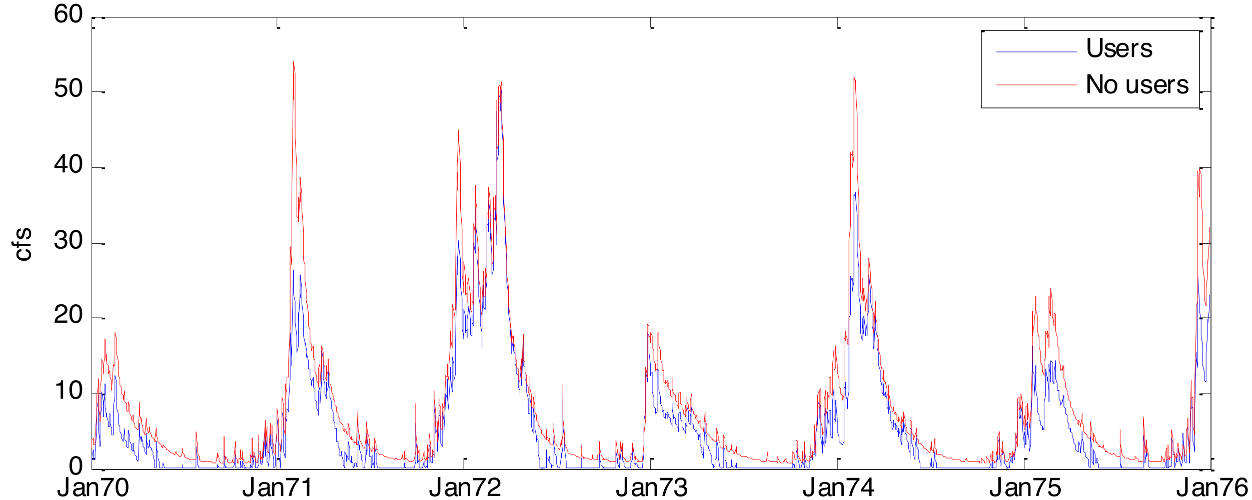
Uses
- Irrigation
  - Soil moisture demand driven
- Non Irrigation
  - Per capita driven
- Diversions



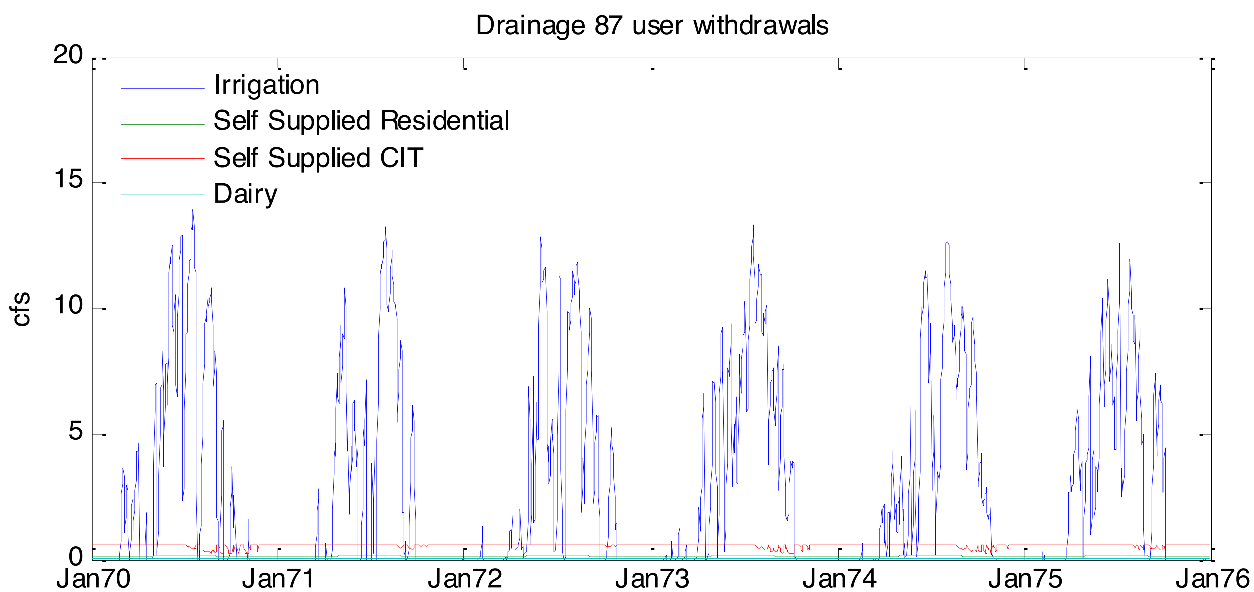


Water Management Schema



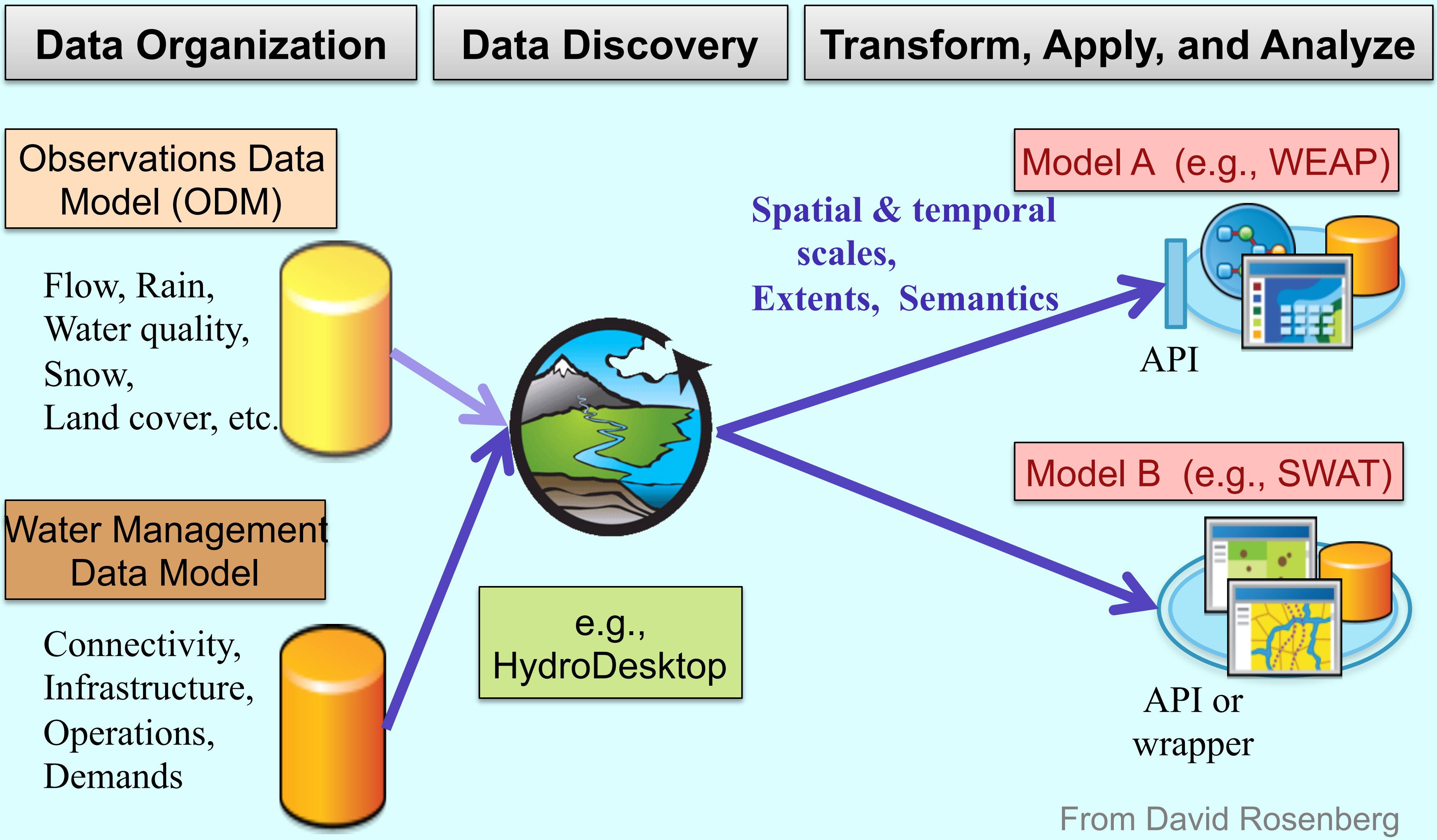


Streamflow at ProjnodeID=164, Drainage 87, Deer Creek.



Existing conditions simulation of user withdrawals from Deer Creek Drainage (Drainage 87)

Delivering data to water resources models



From David Rosenberg

A road map to deliver data

1. Identify data needs of models
2. Synthesize data commonalities and differences
3. Build data model for water management features
4. Integrate water management data model with existing data discovery services
5. Transform discovered observational and water management data to formats models can use

From David Rosenberg

Information Model for Model Data

State Variables	Information required to completely characterize the state of the system at any point in time
Static Inputs	Required terrestrial variables, site information and geography/connectivity
Dynamic Inputs	driving variables e.g. precipitation and temperature
Parameters	unchanging properties of the system or physical constants
Initial Conditions	Starting of the state variables
Dynamic Outputs	Time and space varying outputs

Types of Variables

Code	Vary in time	Vary in Space	Examples
SCTC			Physical constants, model parameters
SCTV	Y		Top of atmosphere solar radiation. Any quantity whose variability scale is much larger than domain.
SVTC		Y	Slope, aspect, soil type, specific catchment area.
SVTV	Y	Y	Air temperature, Precipitation, Vegetation

Our work ahead

- Water management data components
  - Data model design, prototyping and implementation
- Urban data components
  - Data model design, prototyping and implementation
- Deploy data services for additional data formats
  - [Point observations], Feature, Raster, Space Time
- Develop HUBzero capability and interfaces
- Develop post processing and visualization tools
- Develop community collaboration capabilities