Utah-Wyoming EPSCoR Track 2 Grant

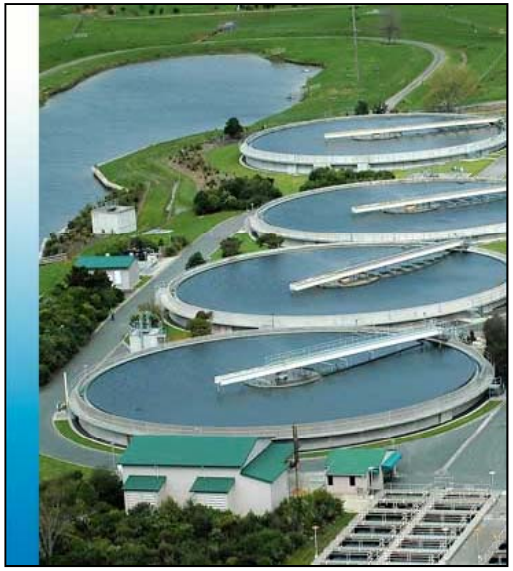
CI-WATER: Cyberinfrastructure to Advance High Performance Water Resource Modeling

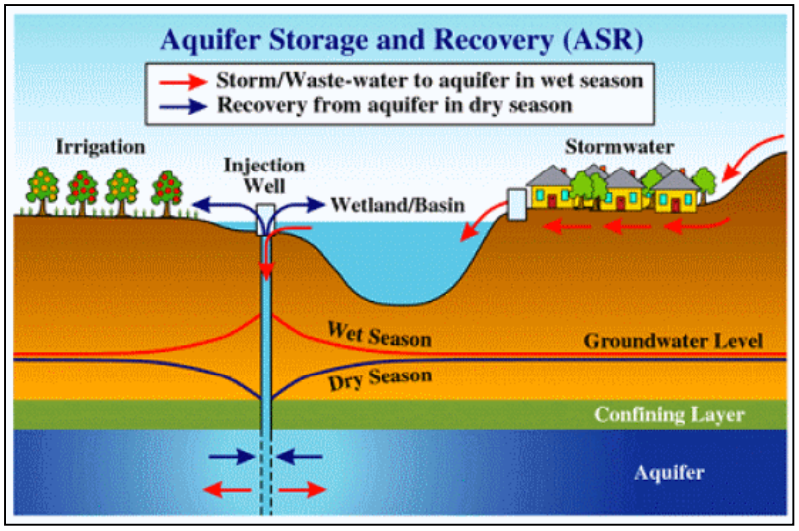
Water Demand

- Water is often a non-renewable resource
- Water demand in the Western US is surpassing available supplies

Water Resource Management

- Increasingly sophisticated
- Requires innovative solutions
  - ➔ Conservation and re-use
  - ➔ Aquifer storage and recovery
  - ➔ Water rights/diversions





Team Members

BYU
BRIGHAM YOUNG UNIVERSITY

Norm Jones, Jim Nelson, Gus Williams

UtahStateUniversity
COLLEGE OF ENGINEERING

David Tarboton, Jeff Horsburgh, David Rosenberg

THE UNIVERSITY OF UTAH

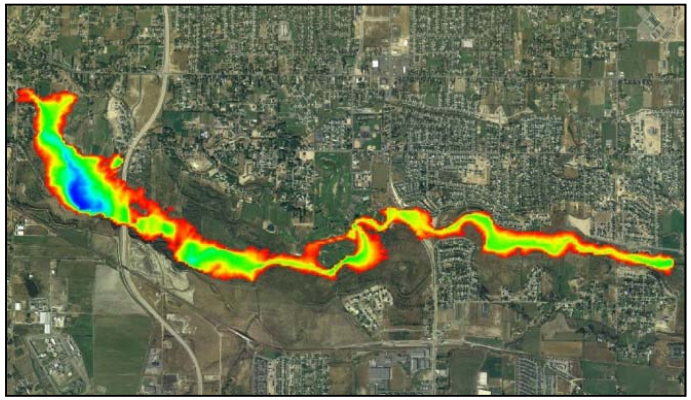
Steven Corbato, Laura Hunter, Steve Burian, Christine Pomeroy , Courtenay Strong

UNIVERSITY OF WYOMING
New Thinking

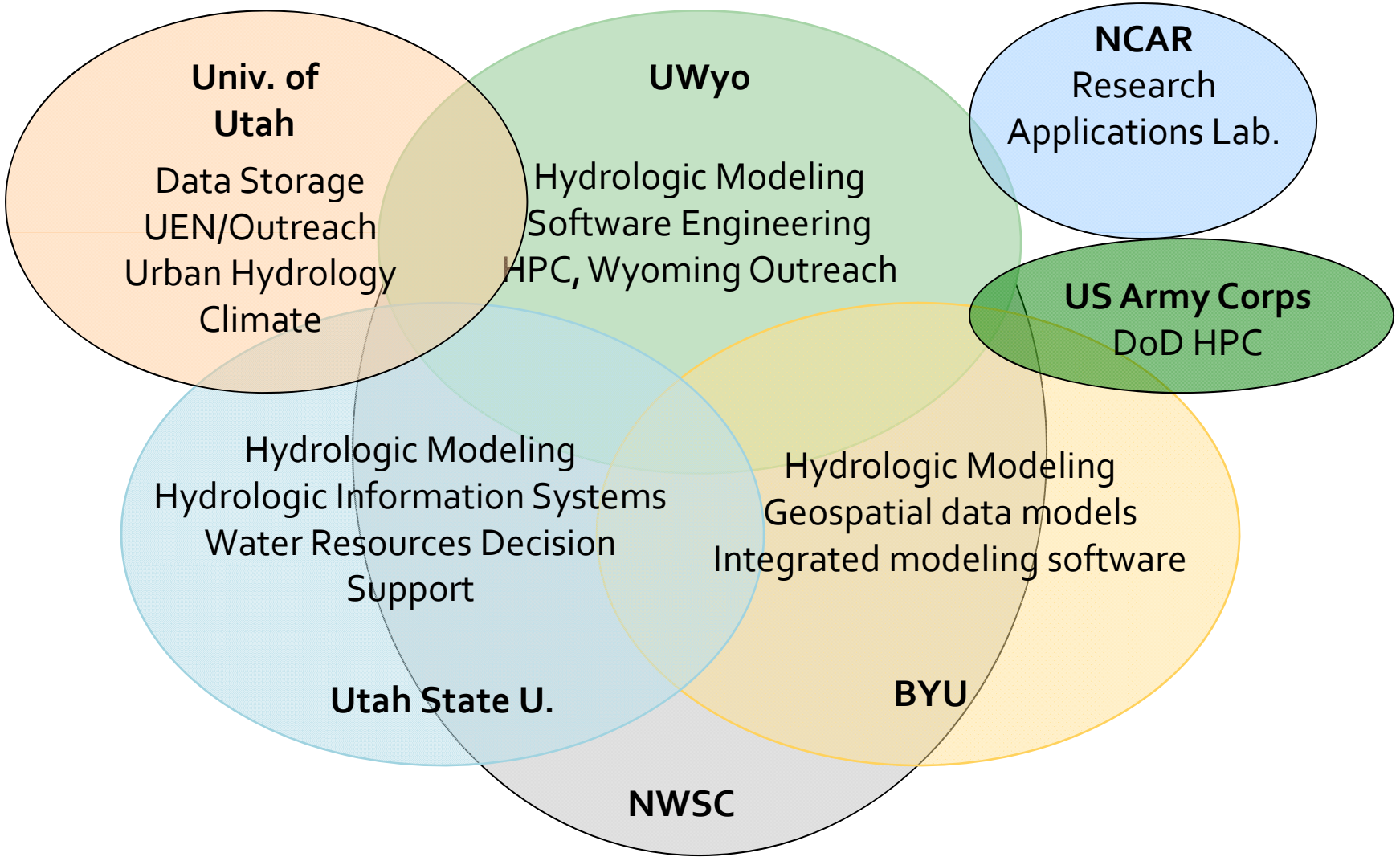
Fred Ogden, Craig Douglas, Kristi Hansen, Scott Miller, Ye Zhang, Gi-Hyeon Park, Ginger Paige, Robert Aylward

Project Objectives

1. Enhance cyberinfrastructure facilities
2. Enhance access to data- and computationally-intensive modeling
3. Advance high-resolution multi-physics watershed modeling
4. Promote STEM learning and water science engagement



Team


Univ. of Utah
Data Storage
UEN/Outreach
Urban Hydrology
Climate
UWyo
Hydrologic Modeling
Software Engineering
HPC, Wyoming Outreach
NCAR
Research Applications Lab.
US Army Corps
DoD HPC
Hydrologic Modeling
Hydrologic Information Systems
Water Resources Decision Support
Utah State U.
Hydrologic Modeling
Geospatial data models
Integrated modeling software
BYU
NWSC

Objective #1

Enhance cyberinfrastructure facilities

Cyberinfrastructure

- Access to NWSC supercomputer
- New mid-level supercomputer at UWYO
- Disk farm at UU

The NCAR-Wyoming Supercomputing Center (NWSC) provides dedicated *petascale* capabilities for geosciences.

NWSC Partners:

University of Wyoming

Wyoming Business Council

NSF

State of Wyoming · Great Seal

NCAR National Center for Atmospheric Research

Cheyenne LEADS
The Cheyenne-Laramie County Corporation for Economic Development

Cheyenne Light Fuel & Power

UCAR University Corporation for Atmospheric Research

Architects, Contractors and Consultants:

H+L Architecture | Saunders Construction, Inc. | California Data Center Design Group | Rumsey Engineers | RMH Group
Martin & Martin Consulting Engineers | Rider Levett Bucknall | Reliable Resources | E Cube, Inc.

Wyoming's 20% Share of NWSC's 72,300 cores represents a huge increase in EPSCoR HPC capabilities…

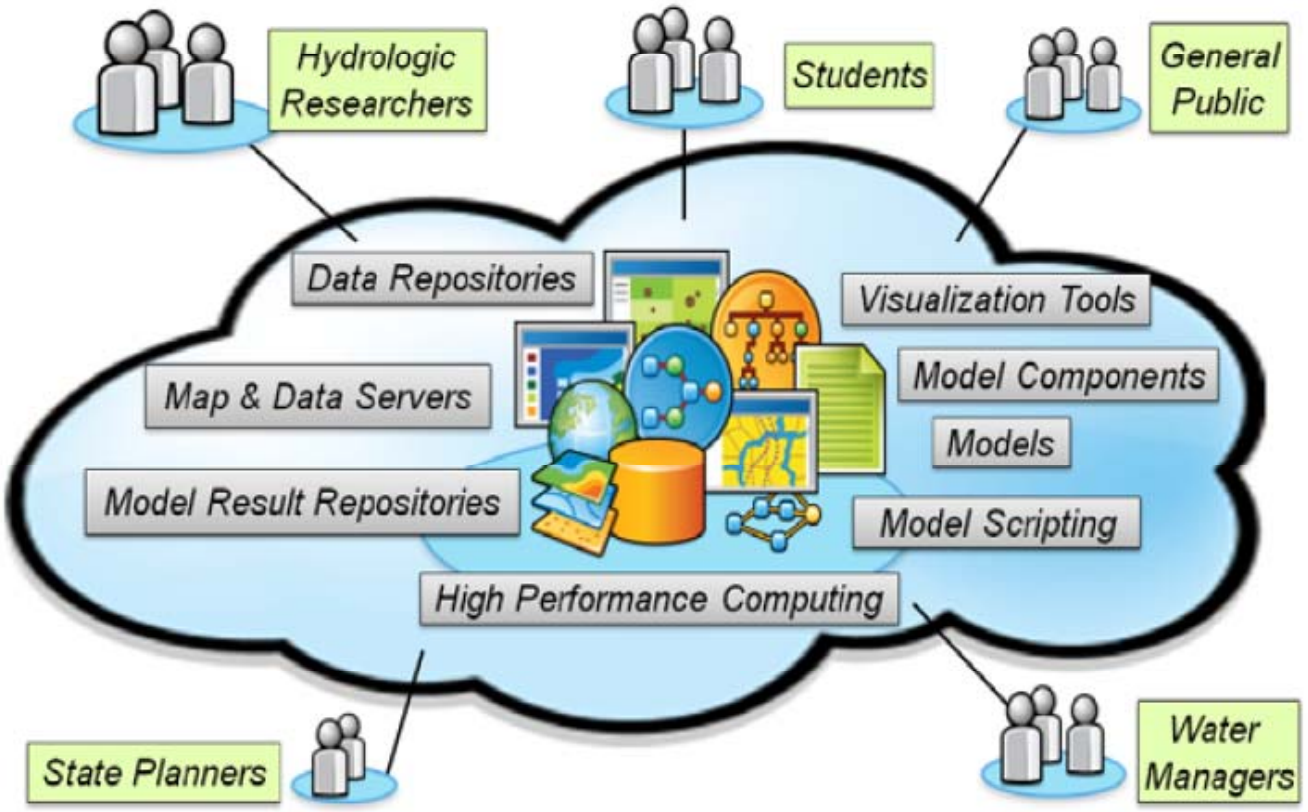
- On the latest (6/11) Top500 list of fastest supercomputers, Wyoming's share on NWSC-1 alone is estimated to be…
  - The 28th fastest computer in the world
  - The 14th largest supercomputer in the US
  - The largest system in an EPSCoR state outside of Department of Energy facilities
  - The largest resource controlled by a university in the US

Reference: http://www.top500.org

Objective #2

Enhance access to data- and computationally-intensive modeling

Enhance Access



Goal is to provide and use these tools to enhance the capacity for water resource planning and management in the Utah-Wyoming region

Data Modeling and Services - USU

Consortium of Universities for the Advancement of Hydrologic Science, Inc.

- 110 US University members
- 6 affiliate members
- 12 International affiliate members

(as of March 2009)

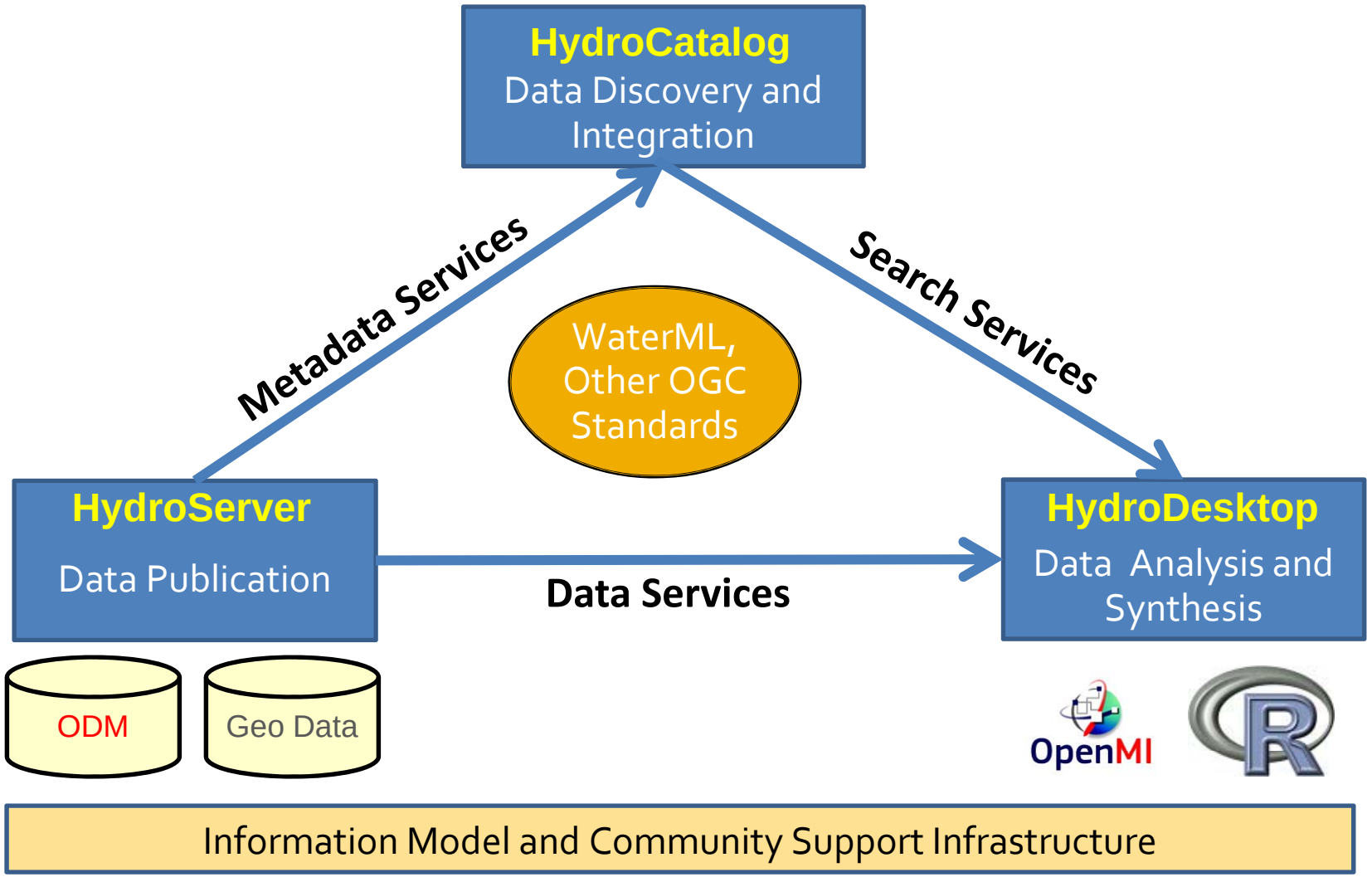
An organization representing more than one hundred United States universities, receives support from the National Science Foundation to develop infrastructure and services for the advancement of hydrologic science and education in the U.S.

CUAHSI
universities allied for water research

http://www.cuahsi.org/

Support
EAR 0753521

CUAHSI Hydrologic Information System (HIS) Services-Oriented Architecture

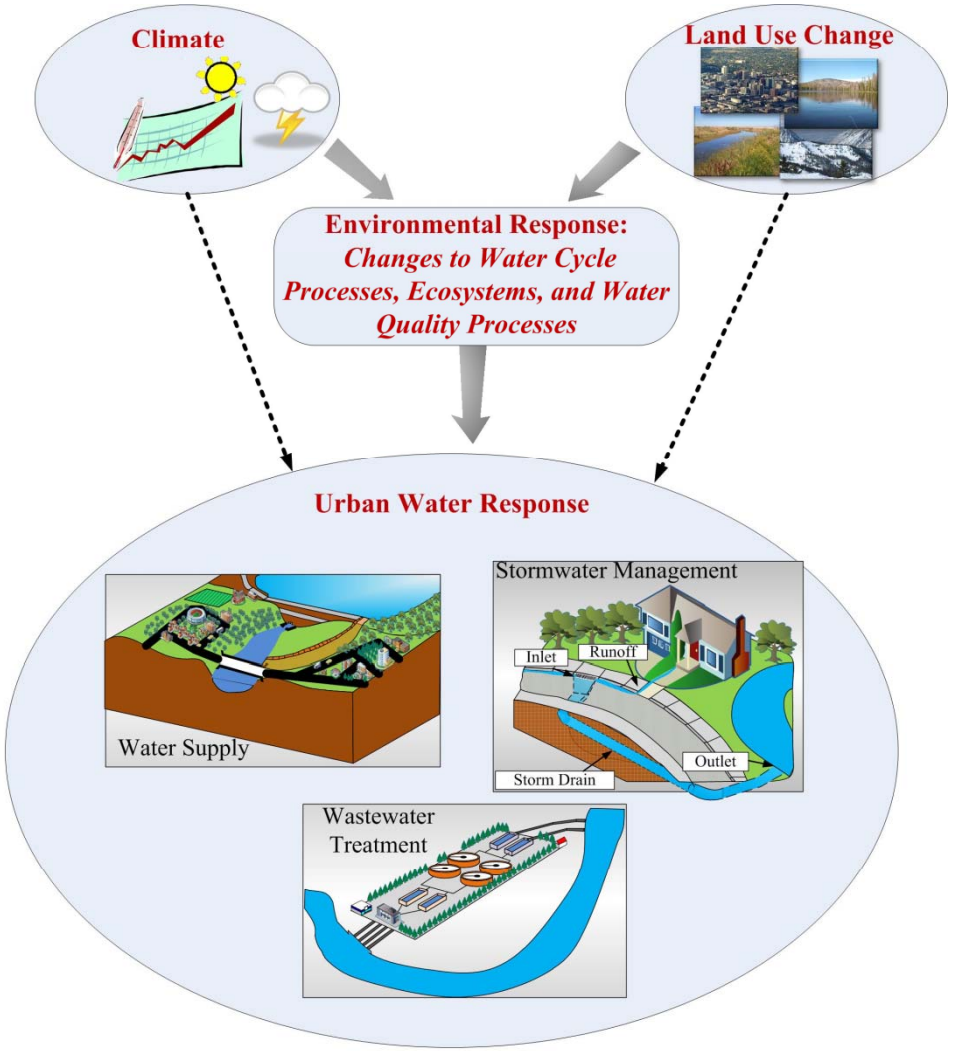


Climate and Urban Modeling - UU

1. Climate variability including extremes

2. Climate-urban-water cyberinfrastructure

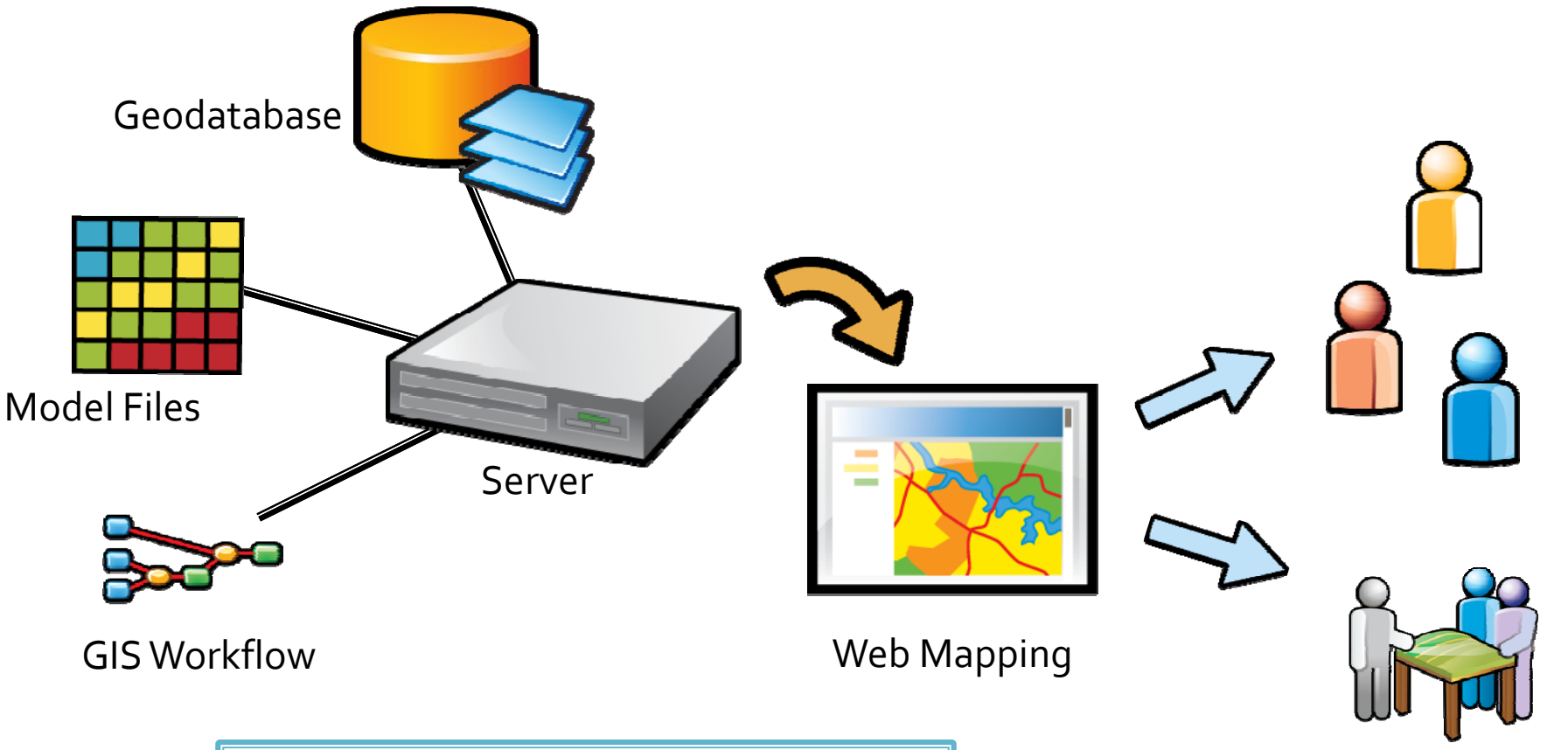
3. Design, operation, and risk of urban water infrastructure



UU Research Plans

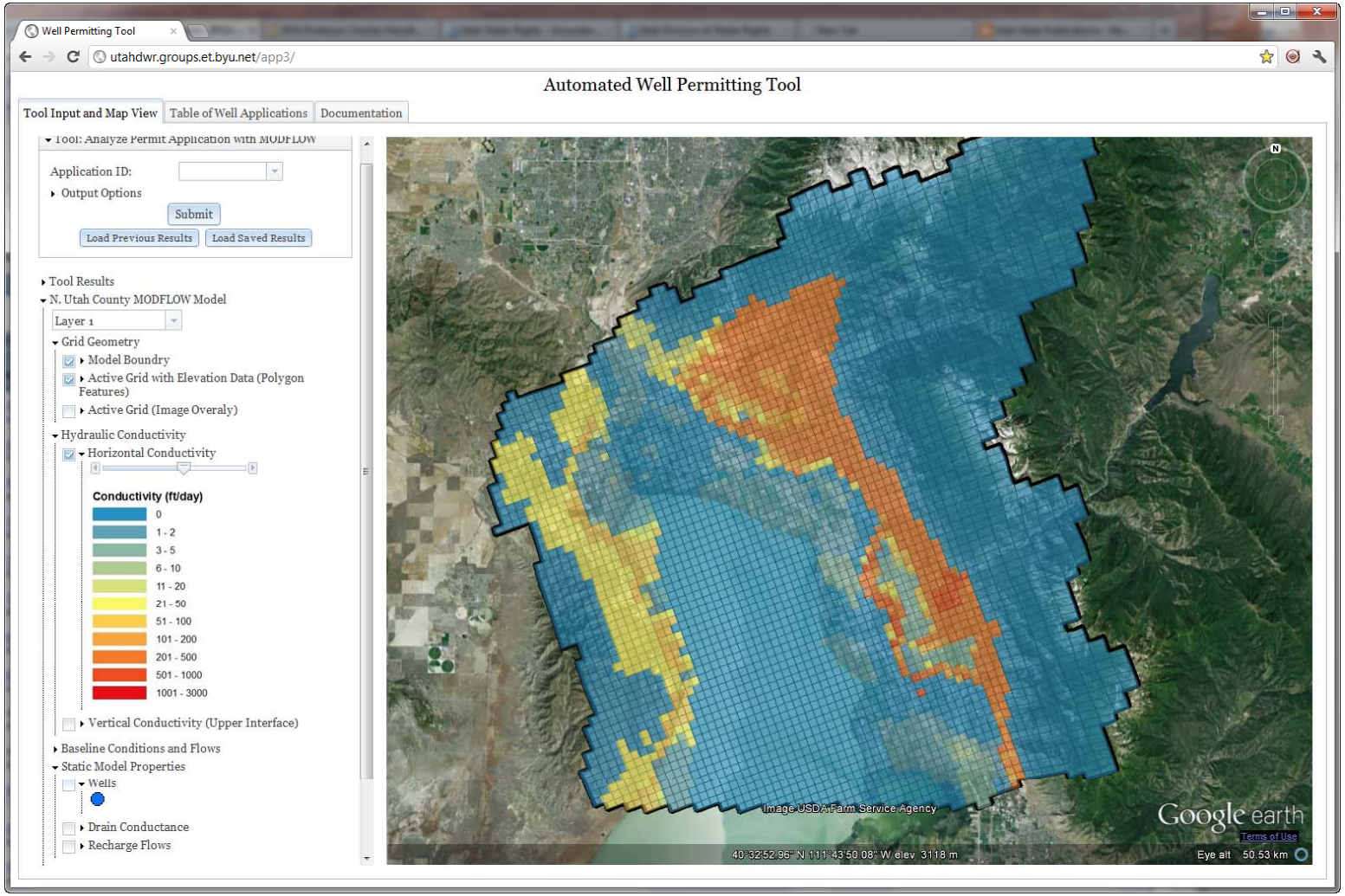
- Develop software to quickly generate future meteorological (precip., temp., etc.) scenarios
- Link climate simulation results to urban water systems models
- Analyze urban water system response to climate variability and the associated adaption costs

Modeling and Visualization Tools - BYU

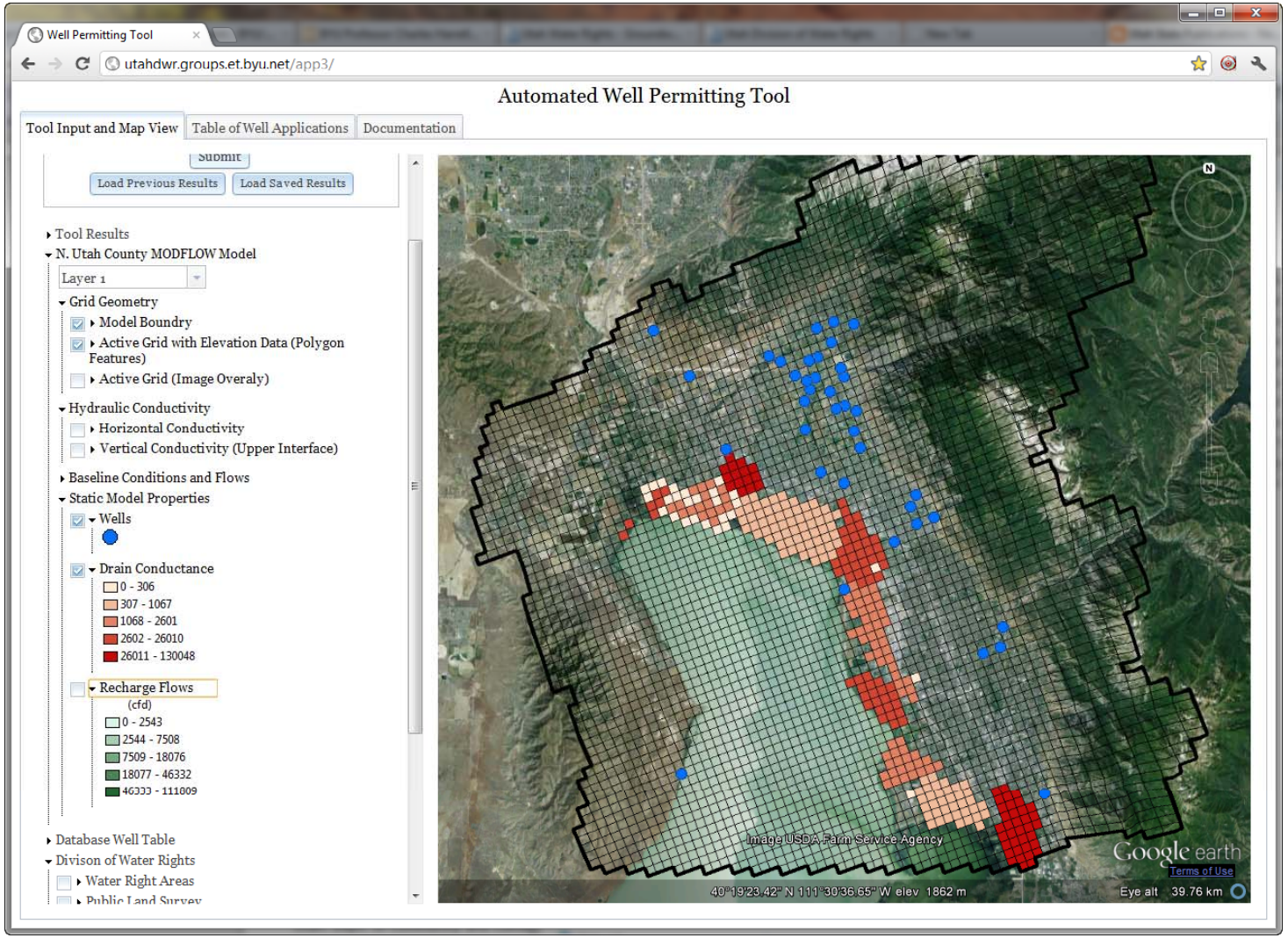


Cloud-Based Modeling and Visualization

UDWR Web-Based Simulation Tool



Static Model Data



Map Layers from UDWR Server

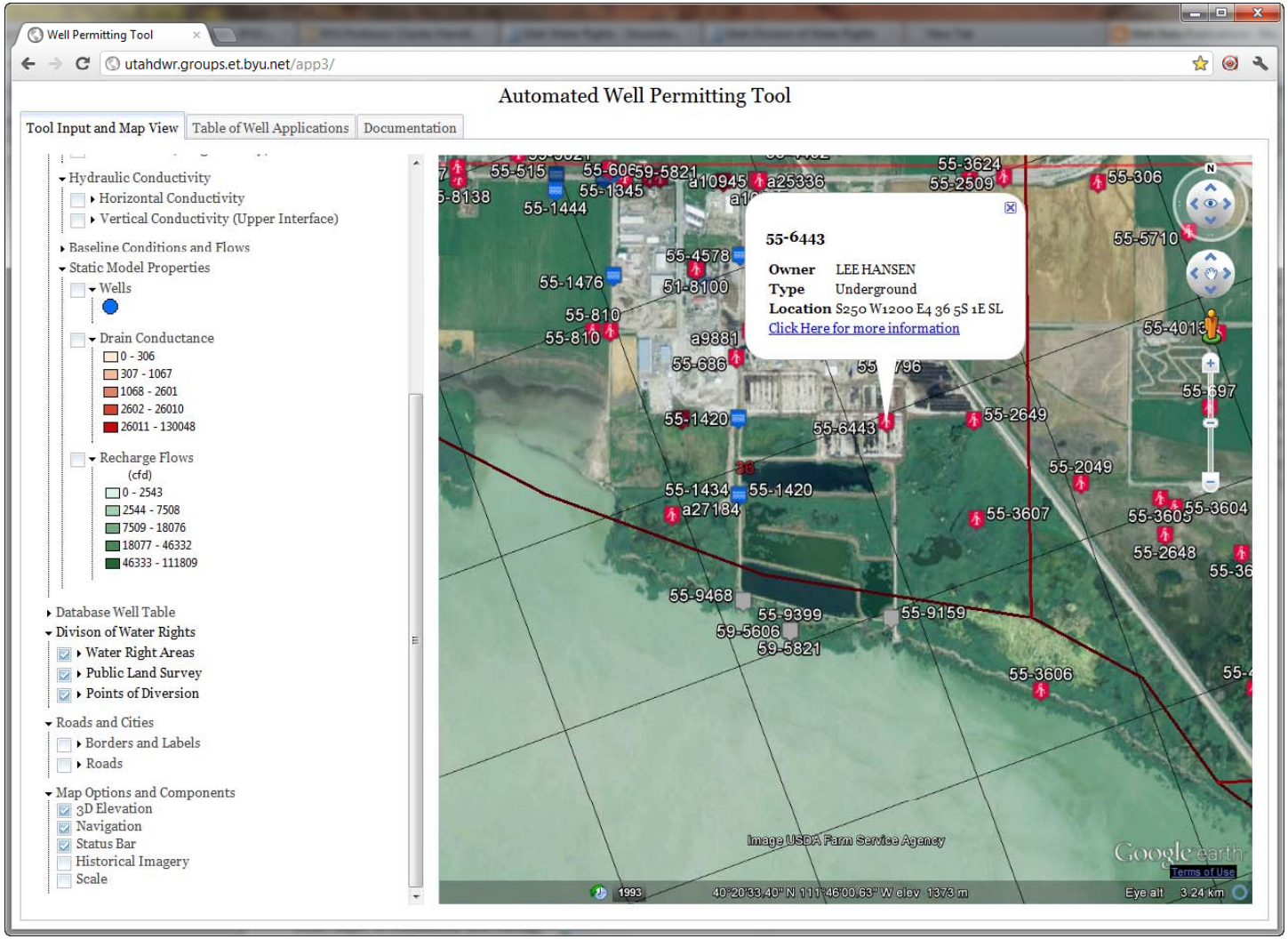
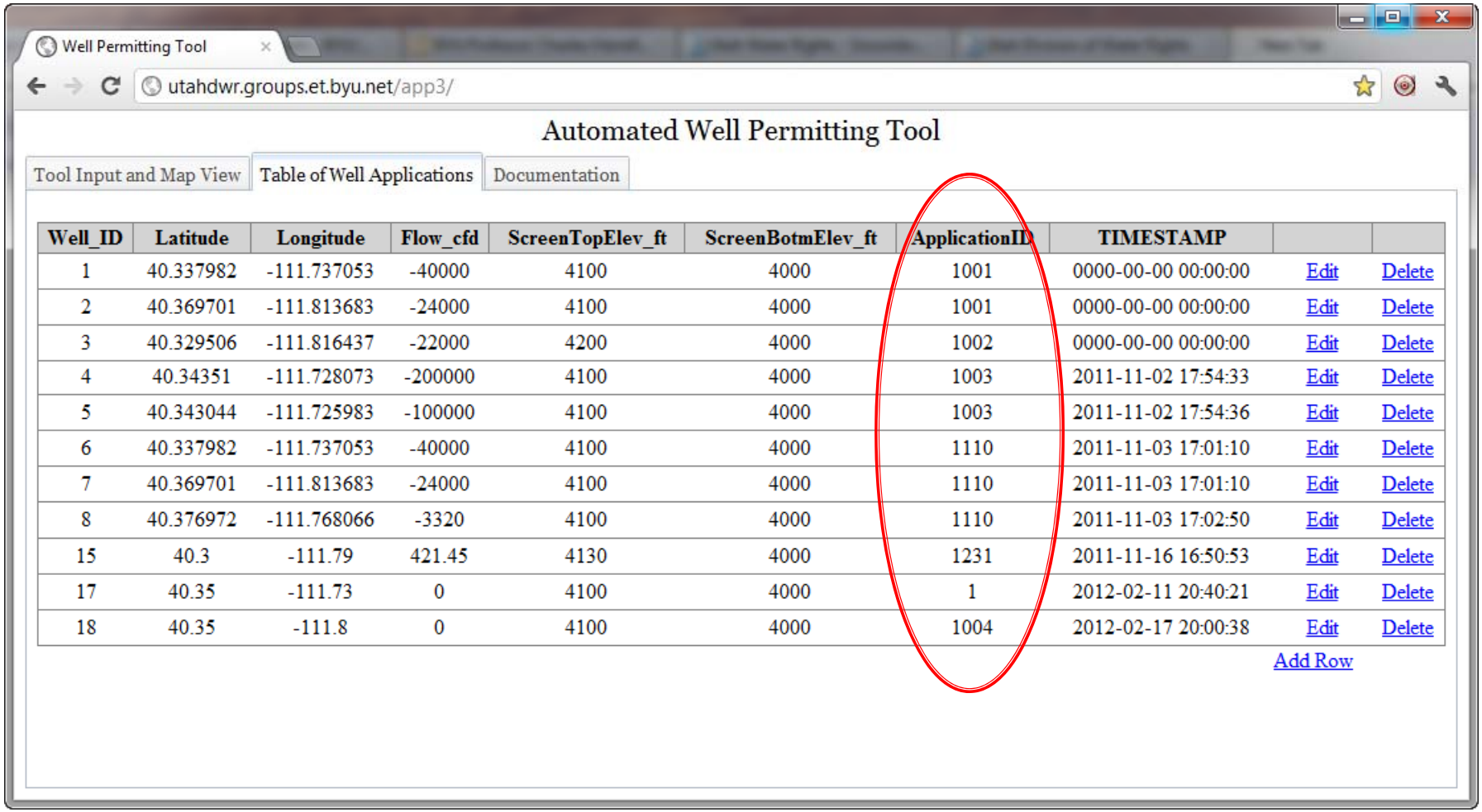


Table of Well Applications



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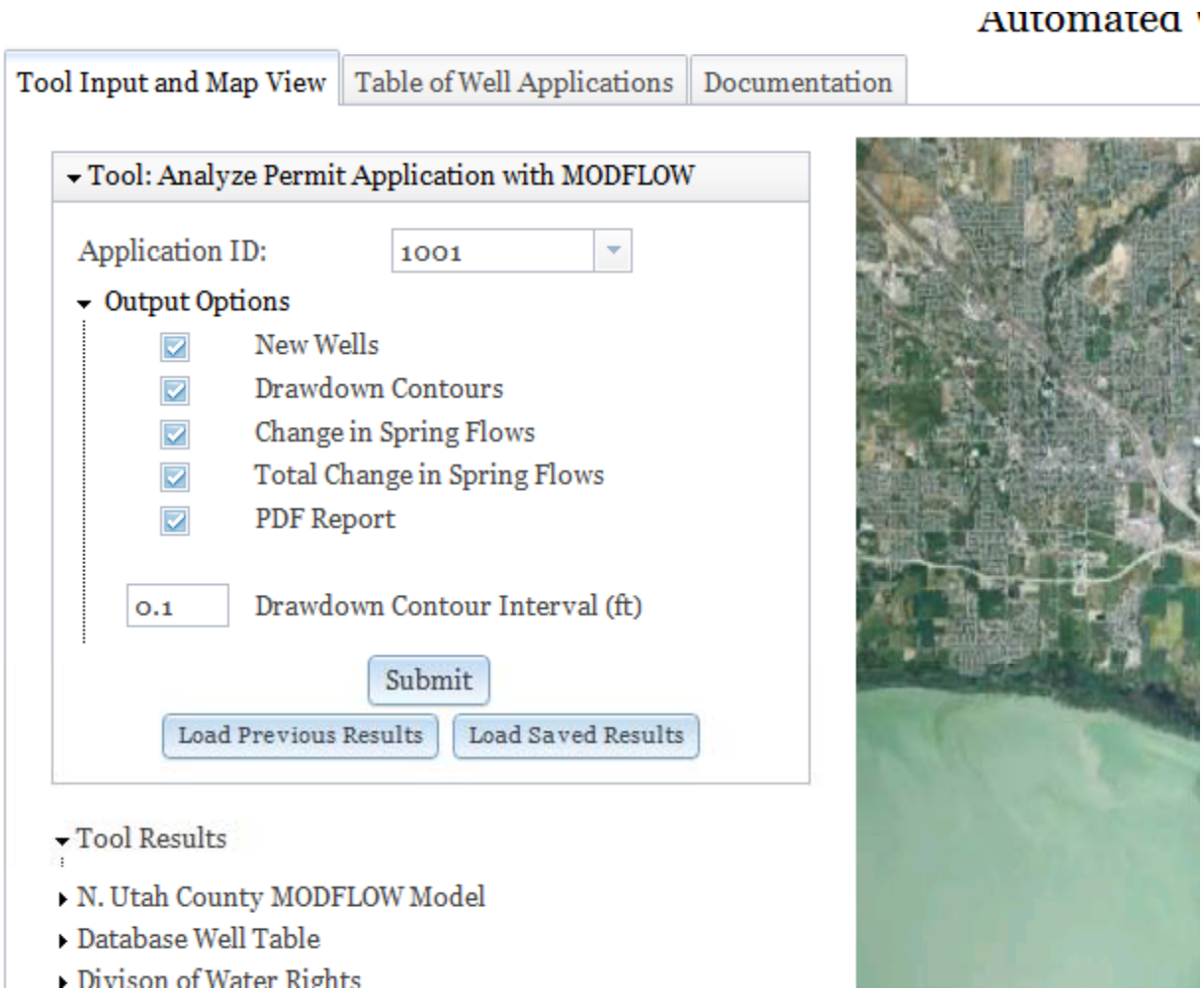
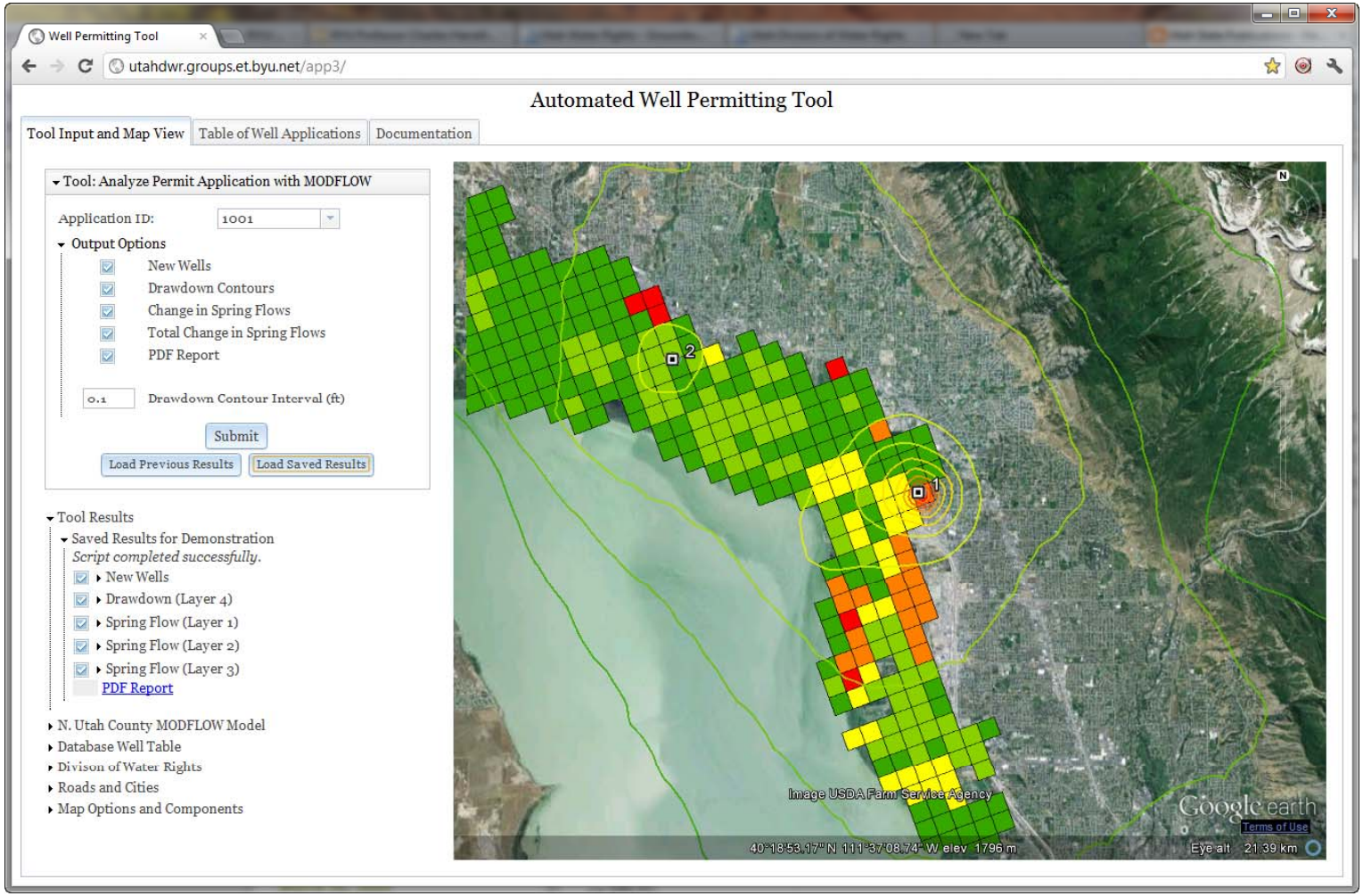
2	40.369701	-111.813683	-24000	4100	4000	1001	0000-00-00 00:00:00	Edit	Delete
3	40.329506	-111.816437	-22000	4200	4000	1002	0000-00-00 00:00:00	Edit	Delete
4	40.34351	-111.728073	-200000	4100	4000	1003	2011-11-02 17:54:33	Edit	Delete
5	40.343044	-111.725983	-100000	4100	4000	1003	2011-11-02 17:54:36	Edit	Delete
6	40.337982	-111.737053	-40000	4100	4000	1110	2011-11-03 17:01:10	Edit	Delete
7	40.369701	-111.813683	-24000	4100	4000	1110	2011-11-03 17:01:10	Edit	Delete
8	40.376972	-111.768066	-3320	4100	4000	1110	2011-11-03 17:02:50	Edit	Delete
15	40.3	-111.79	421.45	4130	4000	1231	2011-11-16 16:50:53	Edit	Delete
17	40.35	-111.73	0	4100	4000	1	2012-02-11 20:40:21	Edit	Delete
18	40.35	-111.8	0	4100	4000	1004	2012-02-17 20:00:38	Edit	Delete

Add Row

Submitting a Model Run



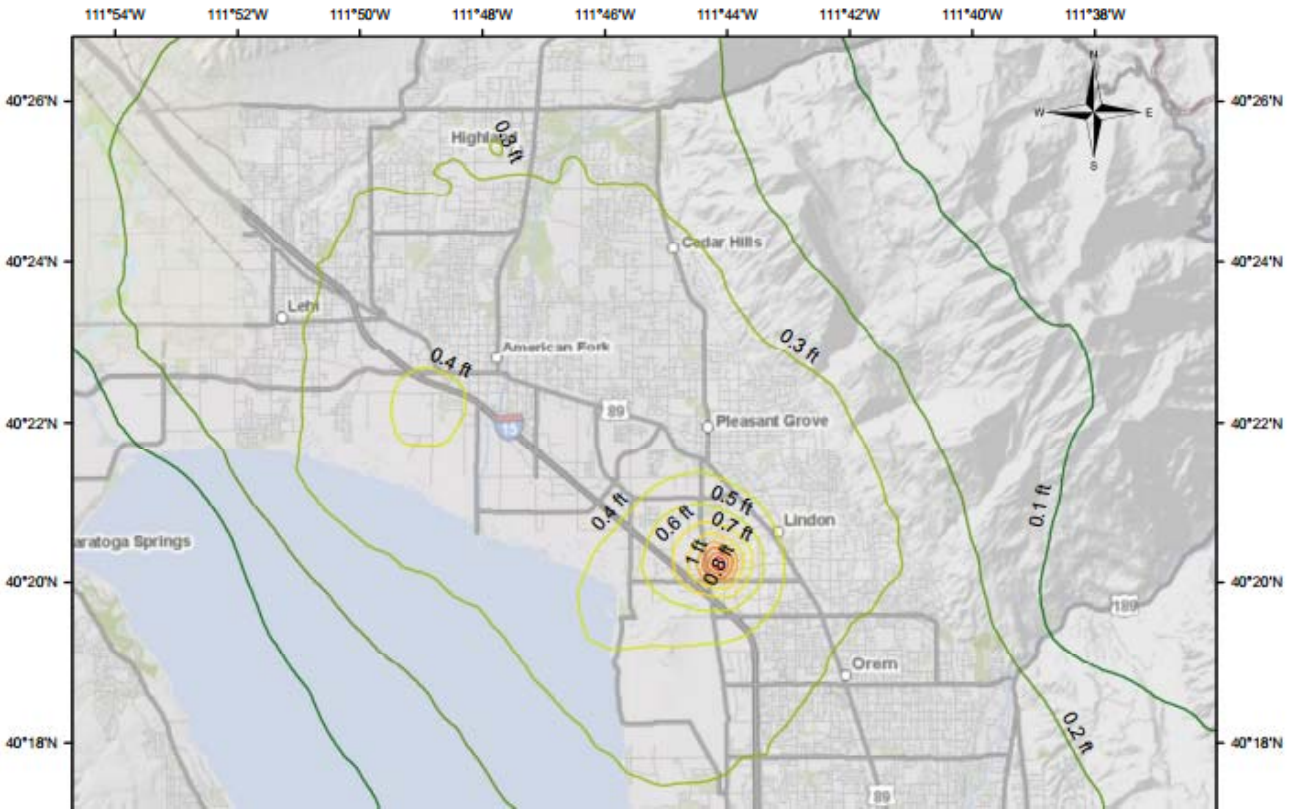
Model Results



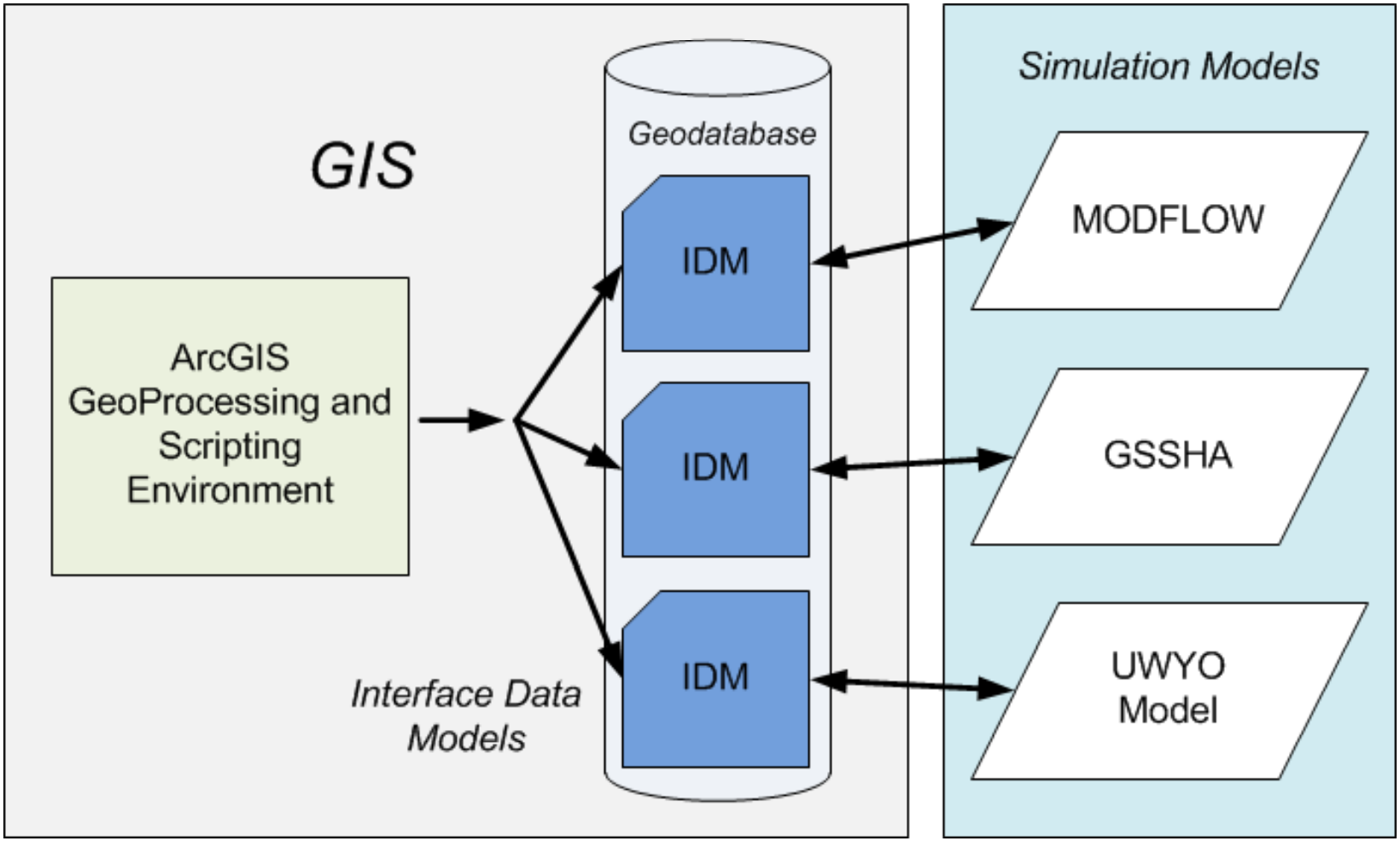
PDF Output

SIMULATED AQUIFER DRAWDOWN: LAYER 4

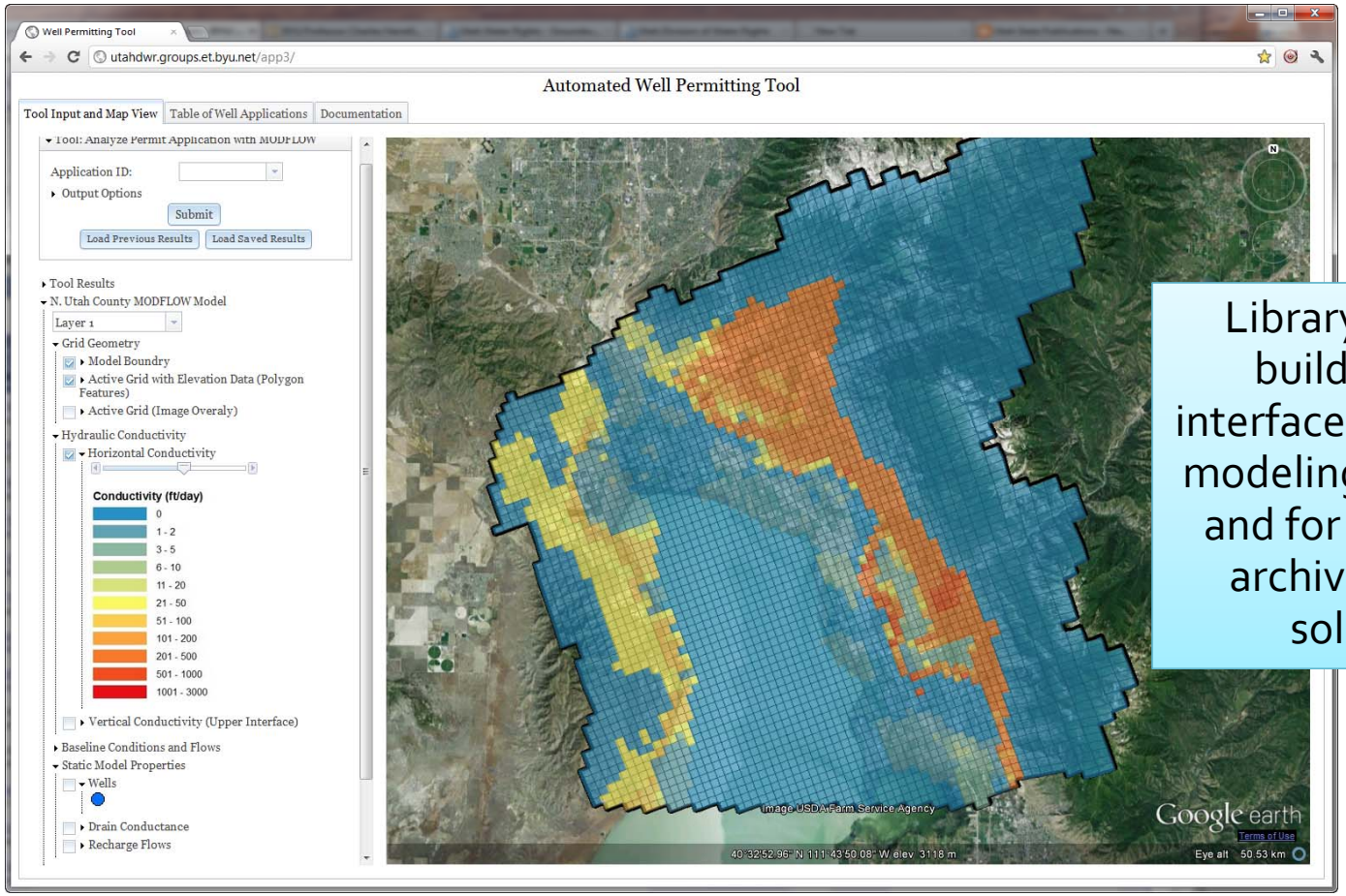
North Utah County MODFLOW Model Simulation Results



Model Scripting Tools



Web-Mapping API

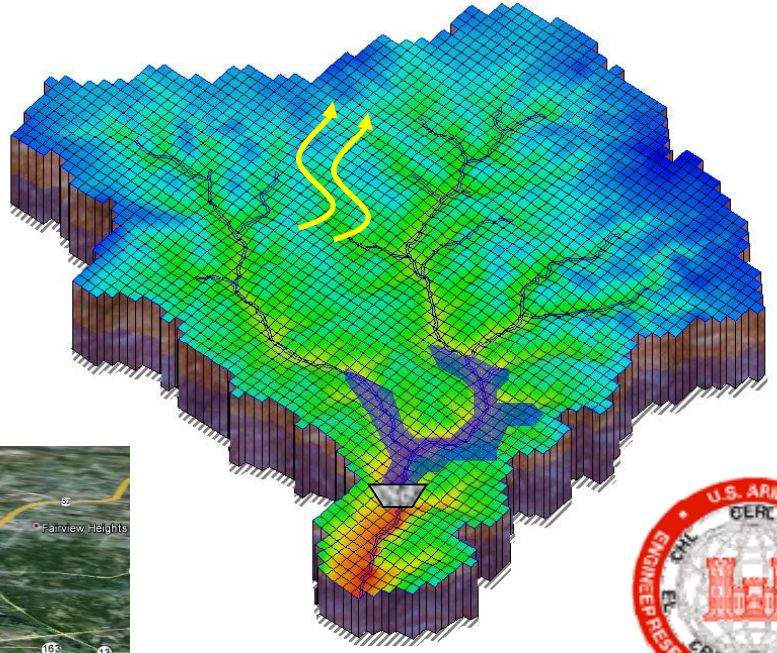


Library (API) for building web interfaces to scripted modeling workflows and for visualizing archived model solutions

GSSHA Toolkit

- Snowmelt
- Flooding
- Urban flooding
- Stormwater runoff
- Levee breach

Gridded Surface/Subsurface Hydrologic Analysis (GSSHA) model



UNIVERSITY OF WYOMING
New Thinking

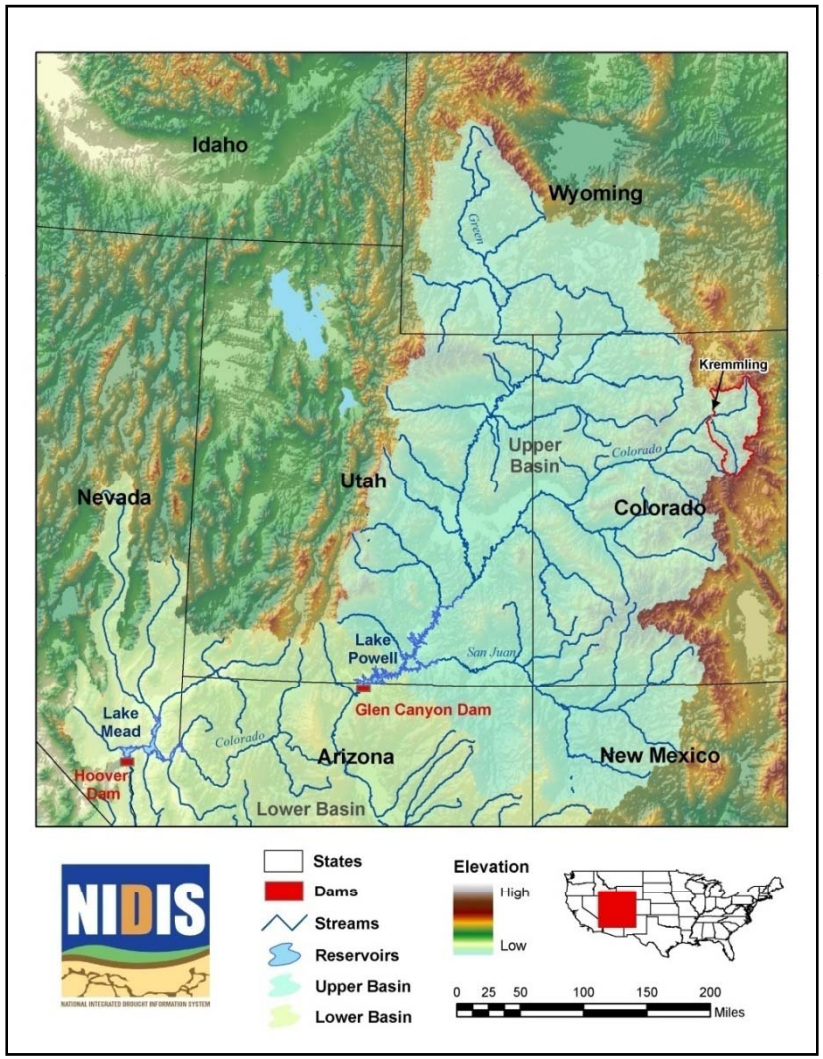
Objective #3

Advance high-resolution multi-physics watershed modeling

CI-WATER Component 3 Objective

- Develop a high-resolution, large-scale hydrologic model to answer three questions:
  - What are the potential impacts of climate change on the long-term yield of water from the upper Colorado River basin?
  - How will future land-use changes due to development and natural causes such as fire, pine bark beetle affect water supplies?
  - What are the effects of trans-basin diversions and increases in water consumptive use on the water storage in Lake Powell in 50 years?

Upper Colorado River Basin



Basin Area: 288,000 km^2

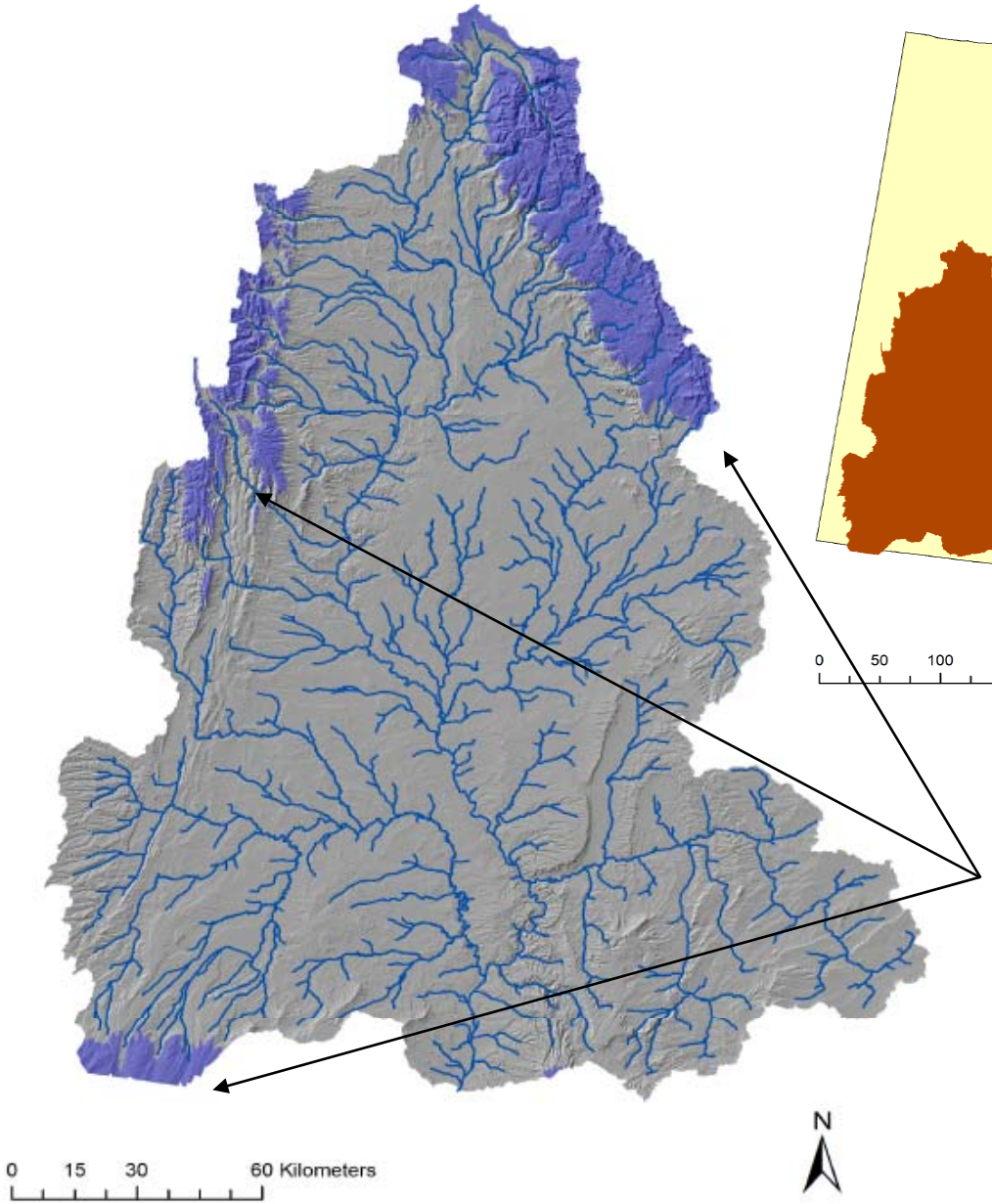
Streams: 467,000 km

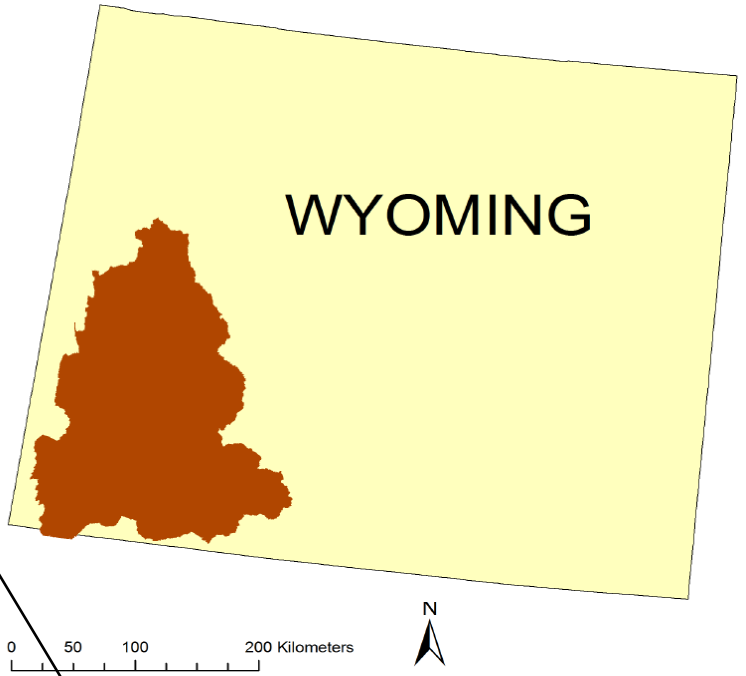
Population: 400,000 (est)

Area above 2700 m: 14.5% (9,000 ft)

Area above 3050 m: 3.2% (10,000 ft)

Test Area: Green River Basin in Wyoming





Darker blue areas are those above 2700 m elevation (9000 ft) where most snow melt occurs.

Leveraging – Model Development

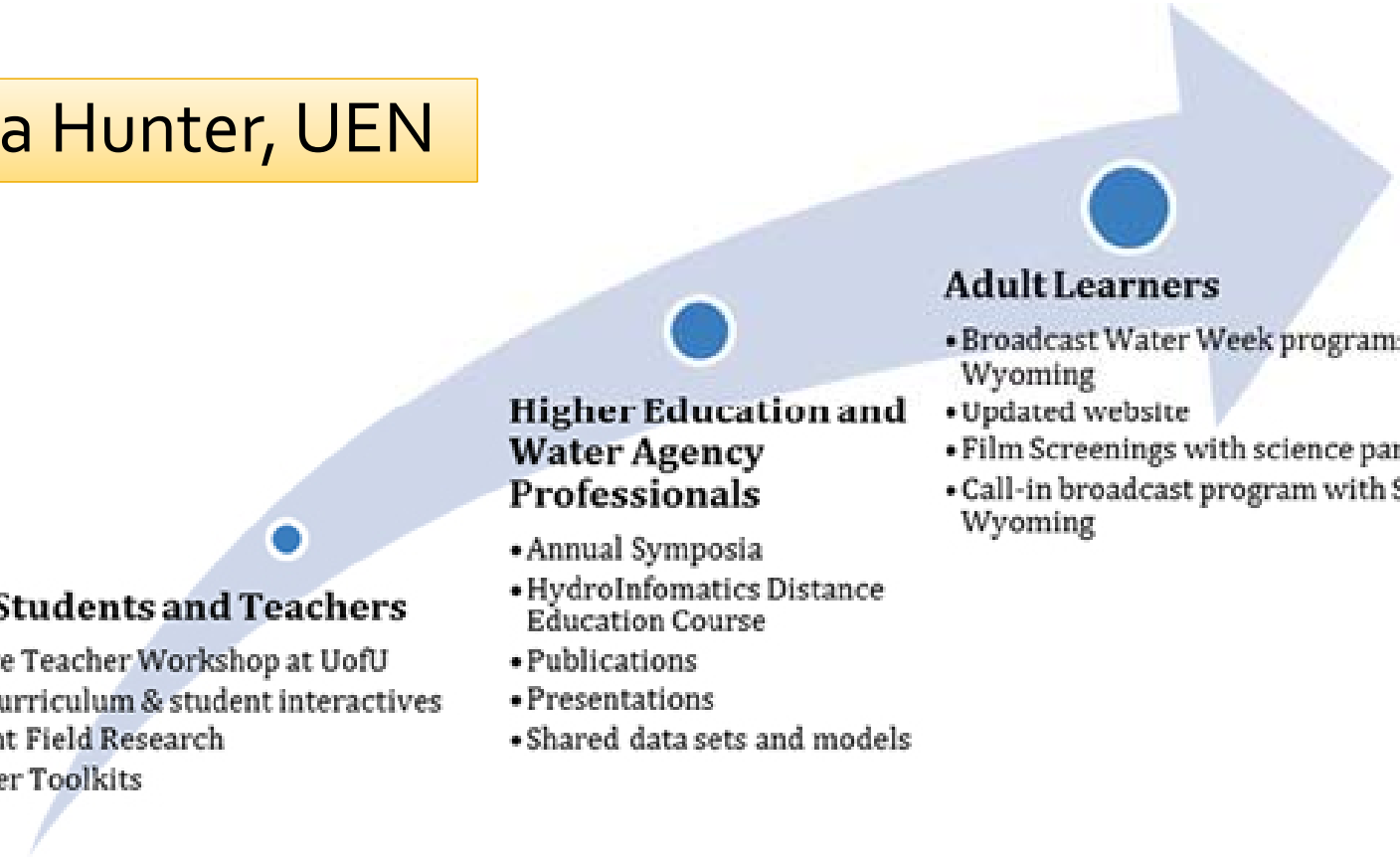
- USACE-ERDC providing:
  - Finite element computational kernel derived from ADH model
  - Computational model builder (CMB)
  - ezVIZ HPC vizualization tools
  - ezHPC user interface toolkit

Objective #4

Promote STEM learning and water science engagement

Outreach Program

Laura Hunter, UEN



K-12 Students and Teachers

- Science Teacher Workshop at UofU
- New curriculum & student interactives
- Student Field Research
- Teacher Toolkits

Higher Education and Water Agency Professionals

- Annual Symposia
- HydroInfomatics Distance Education Course
- Publications
- Presentations
- Shared data sets and models

Adult Learners

- Broadcast Water Week programs in Utah and Wyoming
- Updated website
- Film Screenings with science panel discussions
- Call-in broadcast program with Science panel in Wyoming

www.ci-water.org

CI-WATER

A Utah-Wyoming Cyberinfrastructure Water Modeling Collaboration

CI-WATER
An EPSCoR Project

Community: Learn More

CI-WATER will enhance STEM learning and water science engagement:

- Foster STEM learning through coordinated K-12 activities between Wyoming and Utah.
- Foster collaborative research and strategic partnerships among institutions, junior faculty, students and industry professionals.
- Engage the general public and increase cyber-literacy and regional water understanding.

Long-term Impacts and Outcomes:

- New collaborative online course in Hydroinformatics
- Greater public awareness of water issues and water science
- Programming challenges, code camps, and summer of code opportunities for students
- Production and national distribution of new curricula and resources including CI-WATER toolkits
- Increased networking and collaboration among water researchers, students, water industry professionals and the general public.

STEM Learning and Water Science Engagement

- Laura Hunter (UU)
- Beth Cable (UWYO)
- Rudy Calvert (WY PBS)
- David Rosenberg (USU)
- Norm Jones (BYU)
- Madlyn Runburg (UMNH)
- Louisa Stark (UU)

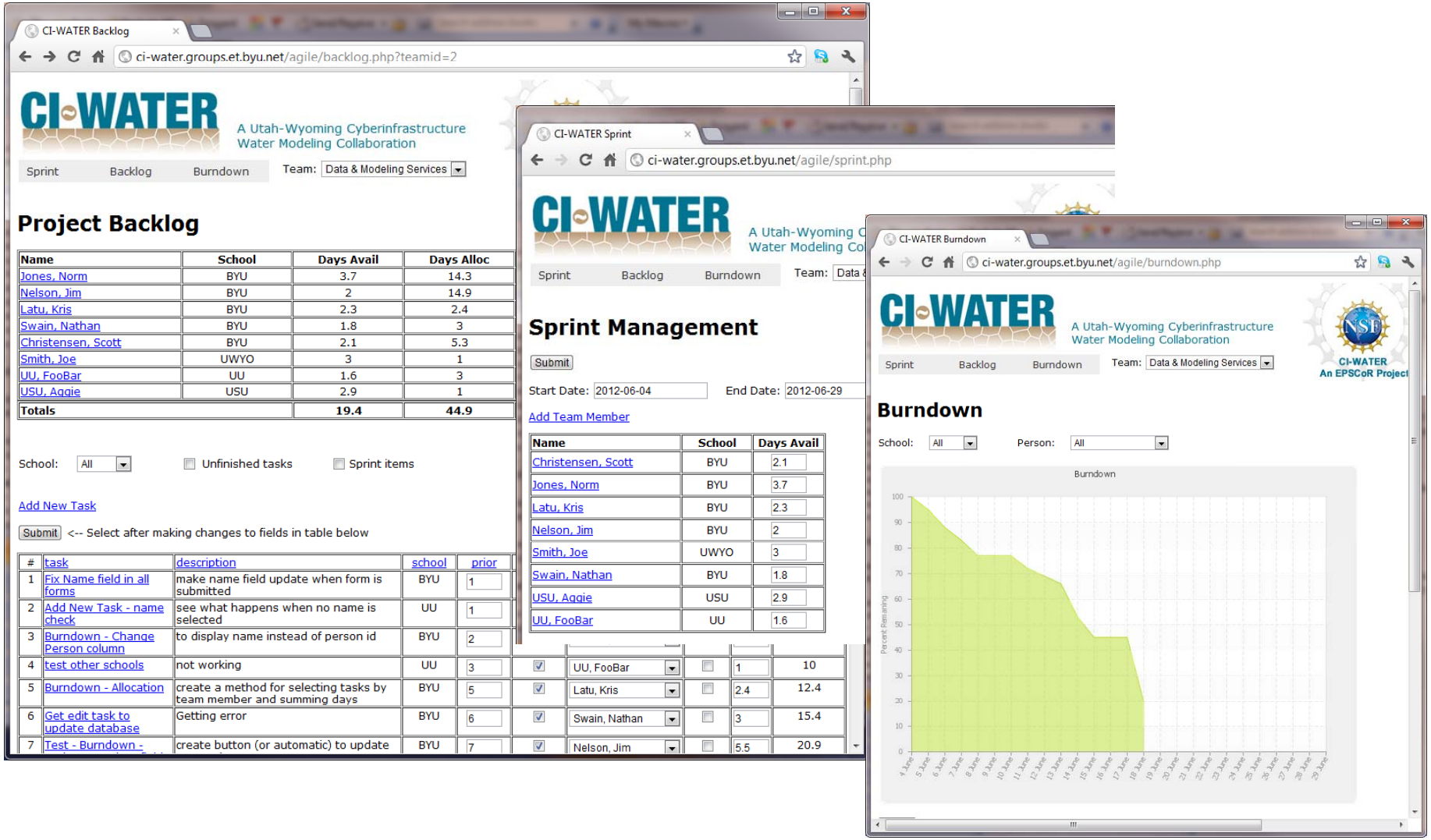
Project Status

- Student Recruitment
- Planning
- Outreach
- First Annual Meeting in September

BYU

- Continued planning and recruiting
- 1 Post-Doc starting next week
- 2 PhD students engaged in early work and planning
- Further application of DWR well permitting
- Development of GSSHA geodatabase model
- Rolling out Agile database management for all parties to use.

Agile Program Management



UofU

- 1 Post Doc to start in August
- 1 PhD student recruited to start in August
- Working with SLC Public Utilities to apply their climate – water resources modeling tools.
- Developing plans

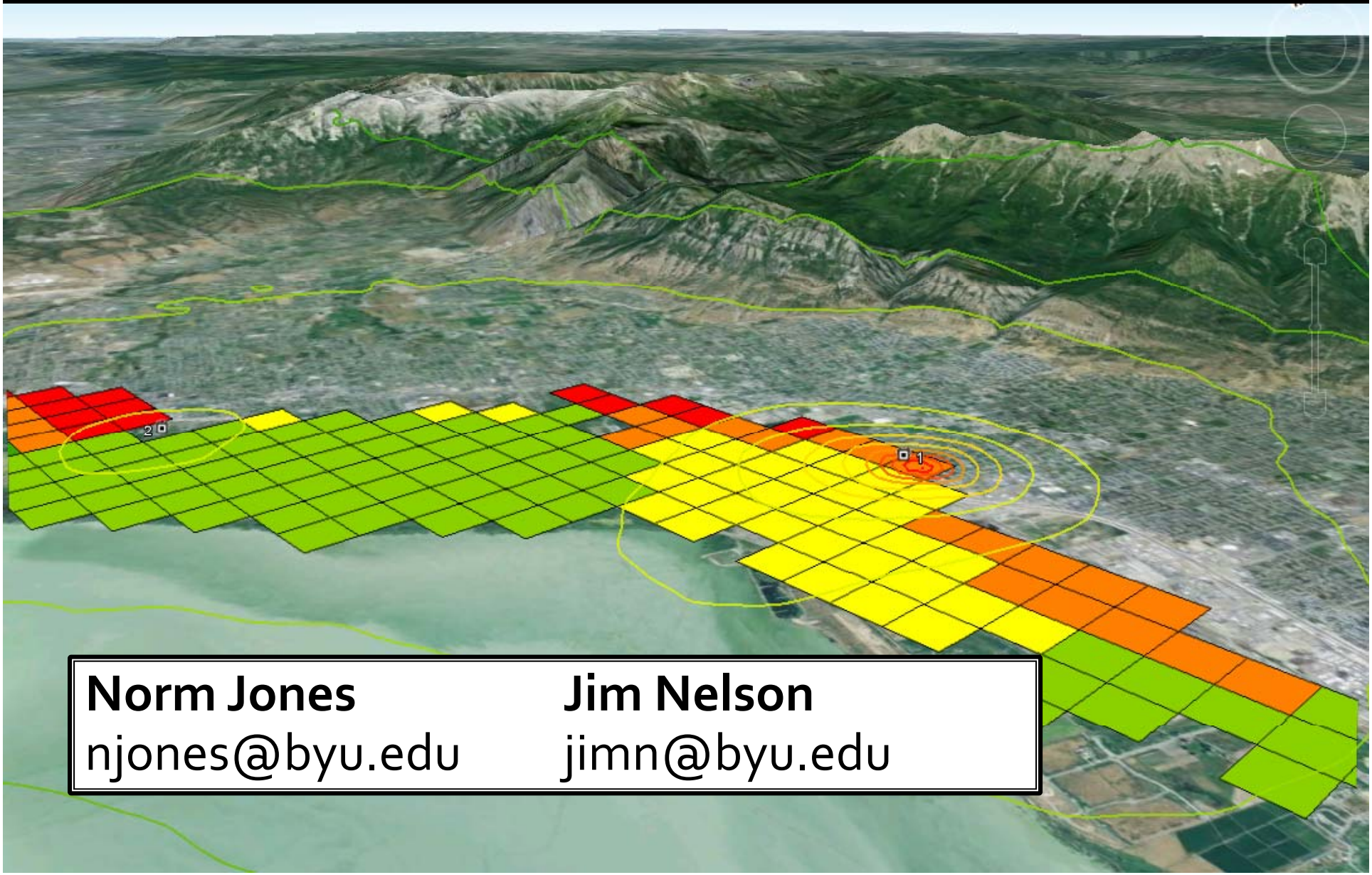
USU

- Two PhD's recruited (1 in July, the other in transition from an MS)
- Programmer/Analyst hired to start mid July
- HubZero evaluation for hosting tools
- General access from modeling data to HIS being evaluated
- Modeling workshop Aug. 9-10 to explore other aspects of data management and model integration.

Wyoming

- Writing specifications for the UW cluster acquisition, developing a competitive bidding process, meeting with vendors, and soliciting bids.
- Writing job descriptions / hiring
- Hired two positions
- Meeting with Army Corps to develop collaborations
- Planning with UW team
- Discussion, planning for suitable map projection

Thank you



Norm Jones
njones@byu.edu

Jim Nelson
jimn@byu.edu