



OAC-1664061  
OAC-1664018  
OAC-1664119  
2017-2021

ACI-1148453  
ACI-1148090  
2012-2017

# Hydroshare: An online hydrologic information system for sharing data and models in support of hydrologic research

Access these slides in HydroShare by searching for "GeoEDF"

David Tarboton, Ray Idaszak, Jeffery S Horsburgh, Daniel P Ames, Jonathan L Goodall, Alva Couch, Pabitra Dash, Hong Yi, Christina Bandaragoda, Anthony Castronova, Bart Nijssen, Richard Hooper, Shaowen Wang, Maurier Ramirez, Jeffrey Sadler, Mohamed Morsy, Scott Black, Dandong Yin.

HydroShare is operated by CUAHSI with ongoing development through a collaborative project among Utah State University, Brigham Young University, CyberGIS Center University of Illinois, Tufts, University of Virginia, and RENCI University of North Carolina.



<http://www.hydroshare.org>





# HYDROSHARE

<http://www.hydroshare.org>

- Domain-specific data and model repository operated by the Consortium of Universities for the Advancement of Hydrologic Science, Inc. (CUAHSI)
- Gives users a way to share research products
- Has capabilities for collaboration
- Has links to computational resources
- Provides permanent digital objects with citable digital object identifiers for literature
- Gateway for web based modeling functionality
- Compatibility, dependency and capacity limitations
- Capability to reproduce workflows in a JupyterHub environment

A system to advance hydrologic science by enabling the community to more easily and freely share products resulting from their research, not just the scientific publication summarizing a study, but also the data and models used to create the scientific publication.

- Findable
- Accessible
- Interoperable
- Reusable

The screenshot shows the HydroShare website interface. At the top, there is a navigation bar with the HydroShare logo and links for HOME, MY RESOURCES, DISCOVER, COLLABORATE, APPS, HELP, and SIGN IN. Below the navigation bar, a banner states "HydroShare is CUAHSI's online collaboration environment for sharing data, models, and code." with a "Sign up now" button.

The main content area displays a "Discover" section with a background image of a snowy landscape. Below this, a data record for "TW Daniels Experimental Forest (TWDEF) Lidar" is shown. The record includes a "Sharing Status" of "Published", "Views" of 251, "Downloads" of 11, and "Comments" of "No comments (yet)". The record also lists the user "Michaela Teich" and a unique identifier "17bc8bc72dc60d6bd03c".

Metadata for the data is provided, including:
 

- Coordinate Systems/Geographic Projection: WGS 84 EPSG:4326
- Coordinate Units: Decimal degrees
- Place/Area Name: TW Daniels Experimental Forest
- Longitude: -111.5000°
- Latitude: 41.8600°
- Temporal: Start Date: 03/28/2008, End Date: 07/08/2009

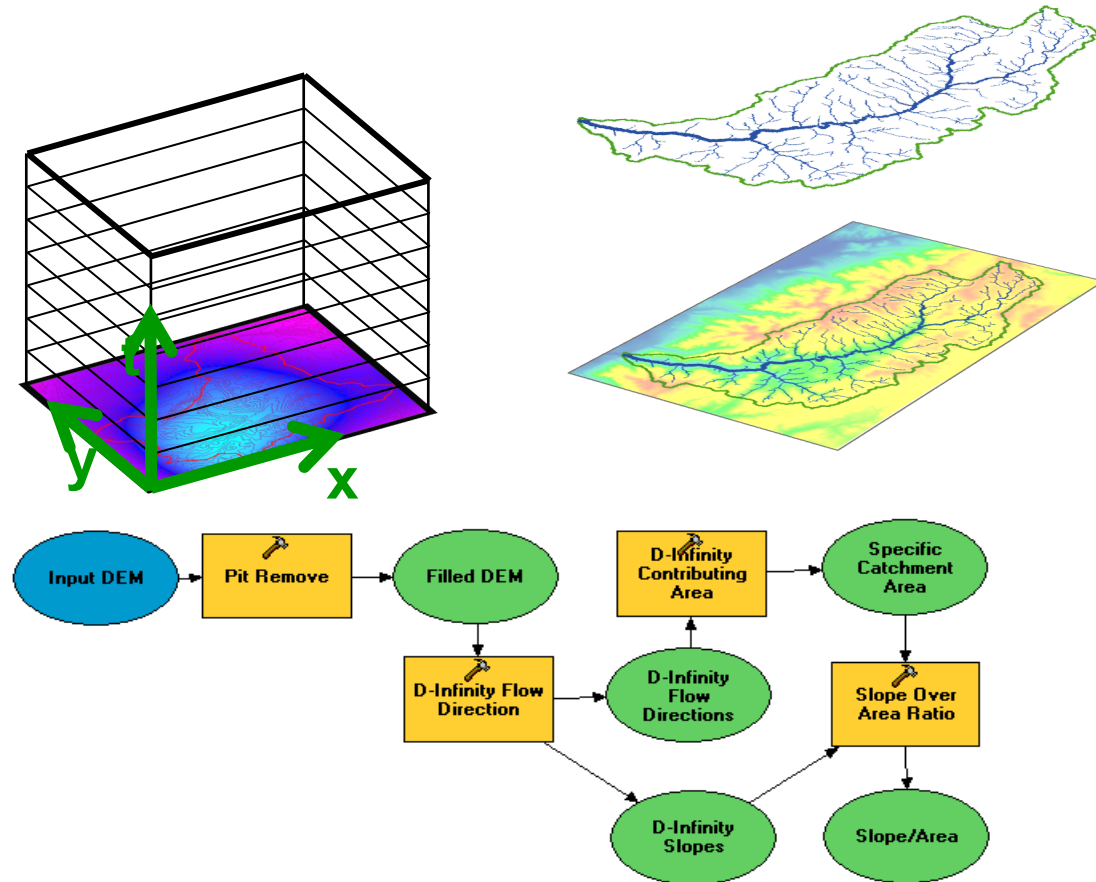
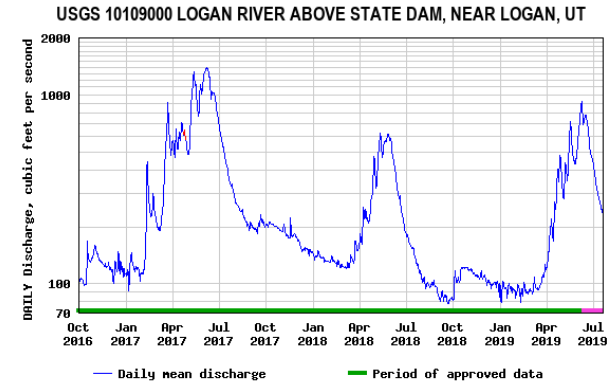
Subject Keywords are listed as: TW Daniels Experimental Forest, TWDEF, Lidar, DEM, and Snow Depth.





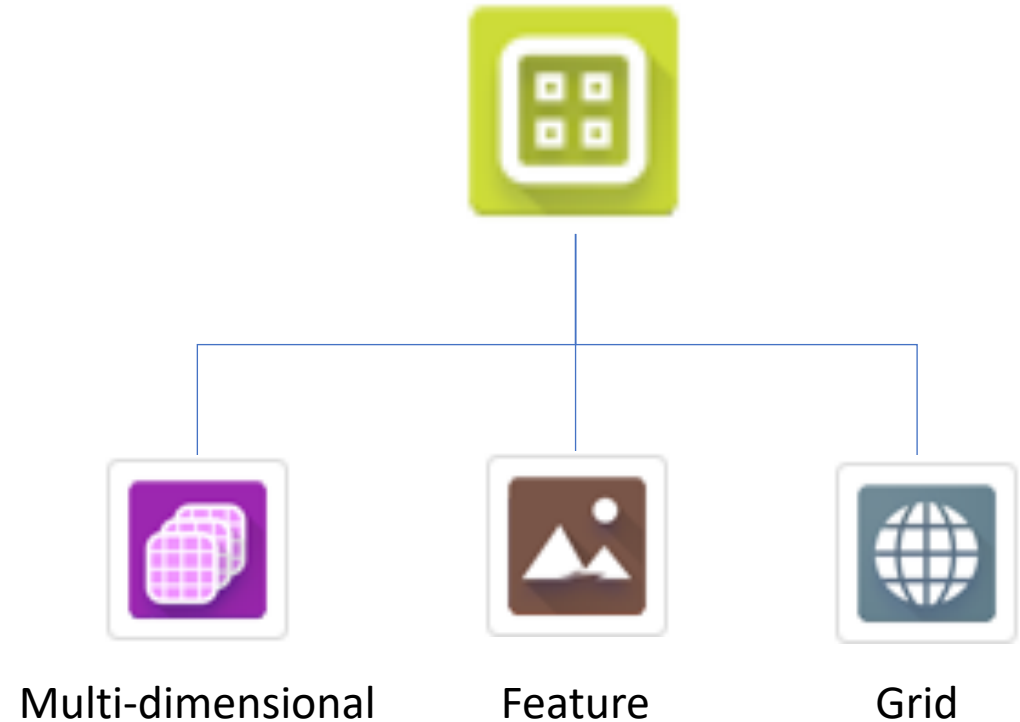
# Principles

- Data and models are first-class products of research and should be shared
- Data and models become **social objects**
- In HydroShare data and models are stored in and comprise “Resources”



# HydroShare OAI-ORE standard based Resource Data Model

- A **resource** can hold multiple content aggregations
  - Managed as one discoverable resource
  - One set of access controls (Owners, Editors etc.)
  - One unique identifier
  - One set of resource level metadata
- A **content aggregation**
  - Can hold one or multiple files that comprise a single logical object
  - Each being a different type of data
  - One set of aggregation level metadata



**Schema.org + Dublin Core machine readable metadata to make data in HydroShare FAIR**

# Resource Landing Page










Create



## Logan 10 m Terrain Analysis

Open with... ▾

<b>Authors:</b>	<a href="#">David Tarboton</a>	<b>Sharing Status:</b>	Public
<b>Owners:</b>	<a href="#">David Tarboton</a>	<b>Views:</b>	227
<b>Resource type:</b>	Composite Resource	<b>Downloads:</b>	43
<b>Storage:</b>	The size of this resource is 54.7 MB	<b>+1 Votes:</b>	Be the first one to <span>+1</span> this.
<b>Created:</b>	Feb 12, 2017 at 5:36 p.m.	<b>Comments:</b>	<a href="#">No comments (yet)</a>
<b>Last updated:</b>	Feb 16, 2019 at 5:37 p.m. <a href="#">David Tarboton</a>		
<b>Citation:</b>	<a href="#">See how to cite this resource</a>		
<b>Content types:</b>	<span>Geographic Feature Content</span> <span>Geographic Raster Content</span>		

Metadata header with view and download statistics

Content types

### Abstract

Results from Hydrologic terrain analysis performed on Logan River Basin Digital Elevation model using TauDEM

The input digital elevation model (DEM) is Logan.tif.

The sequence in the script script.py performs a TauDEM analysis that does the following

- Remove pits (by filling them)
- D8 Flow direction
- D8 Contributing area

# Conceptual HydroShare Architecture

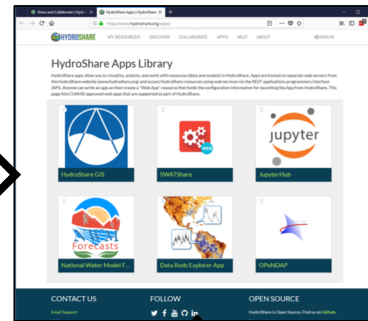
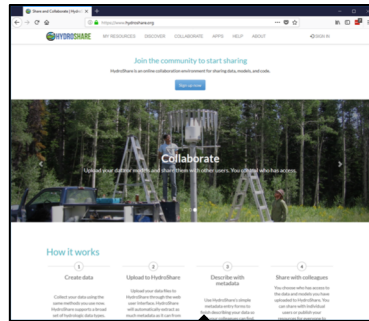
**Exploration and  
Content  
Management**

Django Website

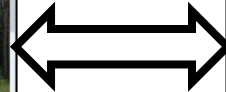


**Actions on and  
working with  
Resources**

Apps

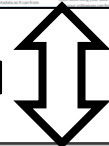


API

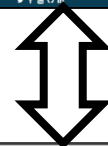


OAuth

API



API



**Storage**

**Resource Storage**

Integrated Rule Oriented Data System  
(iRODS)

Collaboration,  
Reproducibility,  
Credit, Transparency,  
Trust

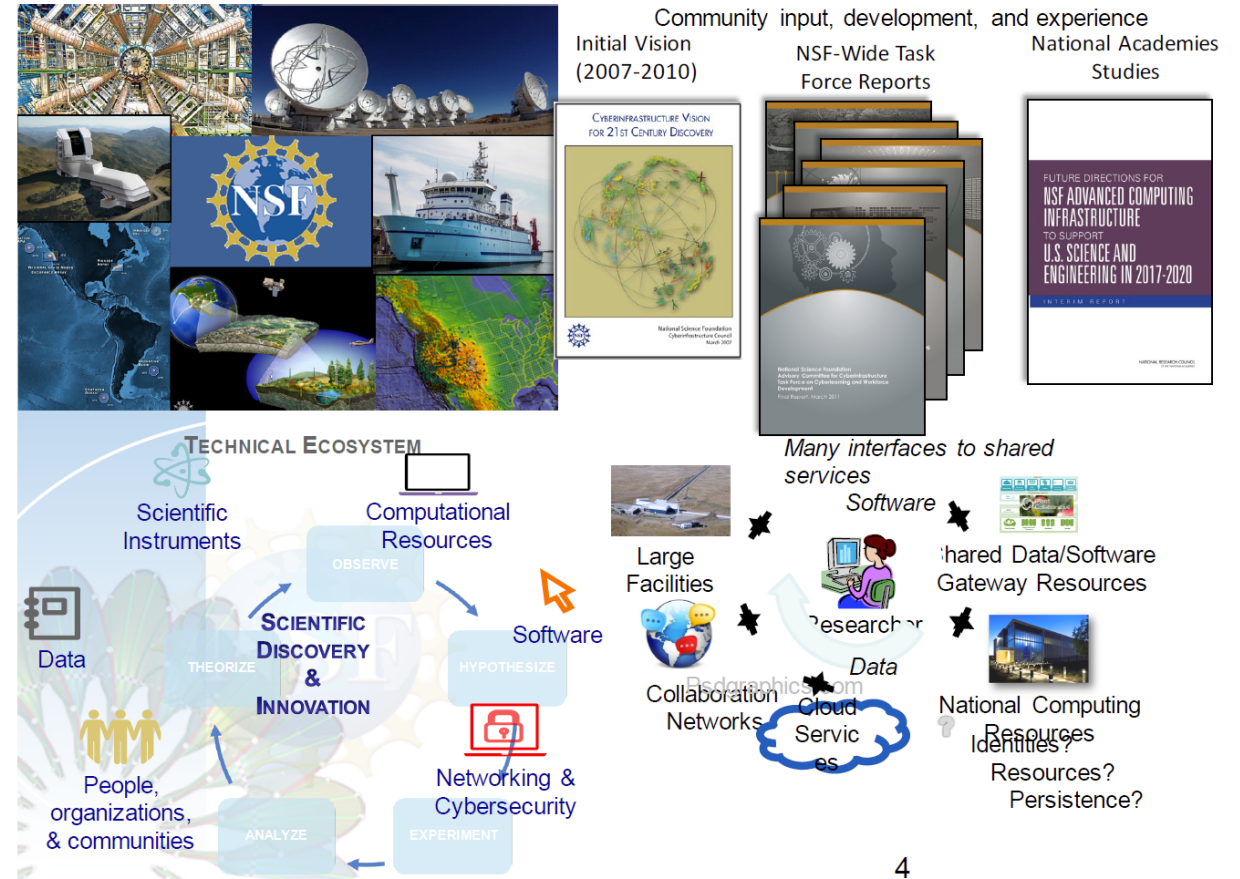
Server/Cloud Computation

- Platform independence
- Big (ish) data
- Reproducibility
- Reduce needs for software installation and configuration
- Scalable Analytics
- Extensibility
  - Anyone can set up a server/app platform (software service) to launch from (“Open with”) HydroShare and operate on content through API

Moving towards fully web based hydrologic innovation environment

# Interoperability and Software Ecosystems

- A foundation of the web
- No one system can do it all
- Applications programming interfaces (APIs)
- Unique Identifiers that enable linked data (web URI's)
- A cyberinfrastructure ecosystem of many interfaces to shared services
- Personal Cyberinfrastructure
  - Individually managed set of CI tools you assemble and learn to use to do your work



NSF vision for a cyberinfrastructure of many interfaces to shared services [Rajiv Ramnath, NSF Division of Advanced Cyberinfrastructure

<https://doi.org/10.6084/m9.figshare.4676173>]

# Connecting GeoEDF with HydroShare

- Modeling and Analysis Tools. “Open With”
- Resource storage interoperability. OAI-ORE + Bagit Resource Data Model

I think we should


- Develop capability to connect GeoEDF tools (e.g. connector tools) with HydroShare using Open With
- Explore convergence of the resource storage data model

Seamless interoperability for users through coordinated loosely coupled underlying  
CI architecture







# “Open With”


## Resource Level

HELP Create 

Open with... ▾

-  HydroShare GIS
-  CUAHSI JupyterHub
-  OPeNDAP








first one to  this.

Detailed description: This screenshot shows the 'Open with...' dropdown menu in a web application. The menu is open, displaying three options: 'HydroShare GIS', 'CUAHSI JupyterHub', and 'OPeNDAP'. The 'CUAHSI JupyterHub' option is highlighted with a red rectangular box. Above the menu, there are buttons for 'HELP' and 'Create', and a user profile picture. Below the menu, there is a small text snippet: 'first one to  this.'


## Content aggregation level






Content

← → ↕ [List View] [Grid View] ↑ Sort by ▾

       Learn more


📁 contents


 SWE\_time File Folder





-  Open
-  Download
-  Download zipped
-  Get file URL
-  OPeNDAP

Detailed description: This screenshot shows the 'Content' page of a web application. It features a navigation bar with 'Content' and a toolbar with various icons including back, forward, up, list view, grid view, sort by, window, refresh, link, clock, download, iR, and briefcase. Below the toolbar, there is a 'contents' folder icon. A file folder named 'SWE\_time' is selected, and a context menu is open over it. The menu items are 'Open', 'Download', 'Download zipped', 'Get file URL', and 'OPeNDAP'. The 'OPeNDAP' option is highlighted with a red rectangular box.

## File level

 logan File Folder Geographic Ra...

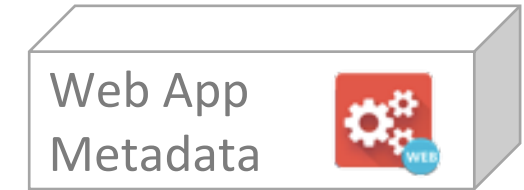
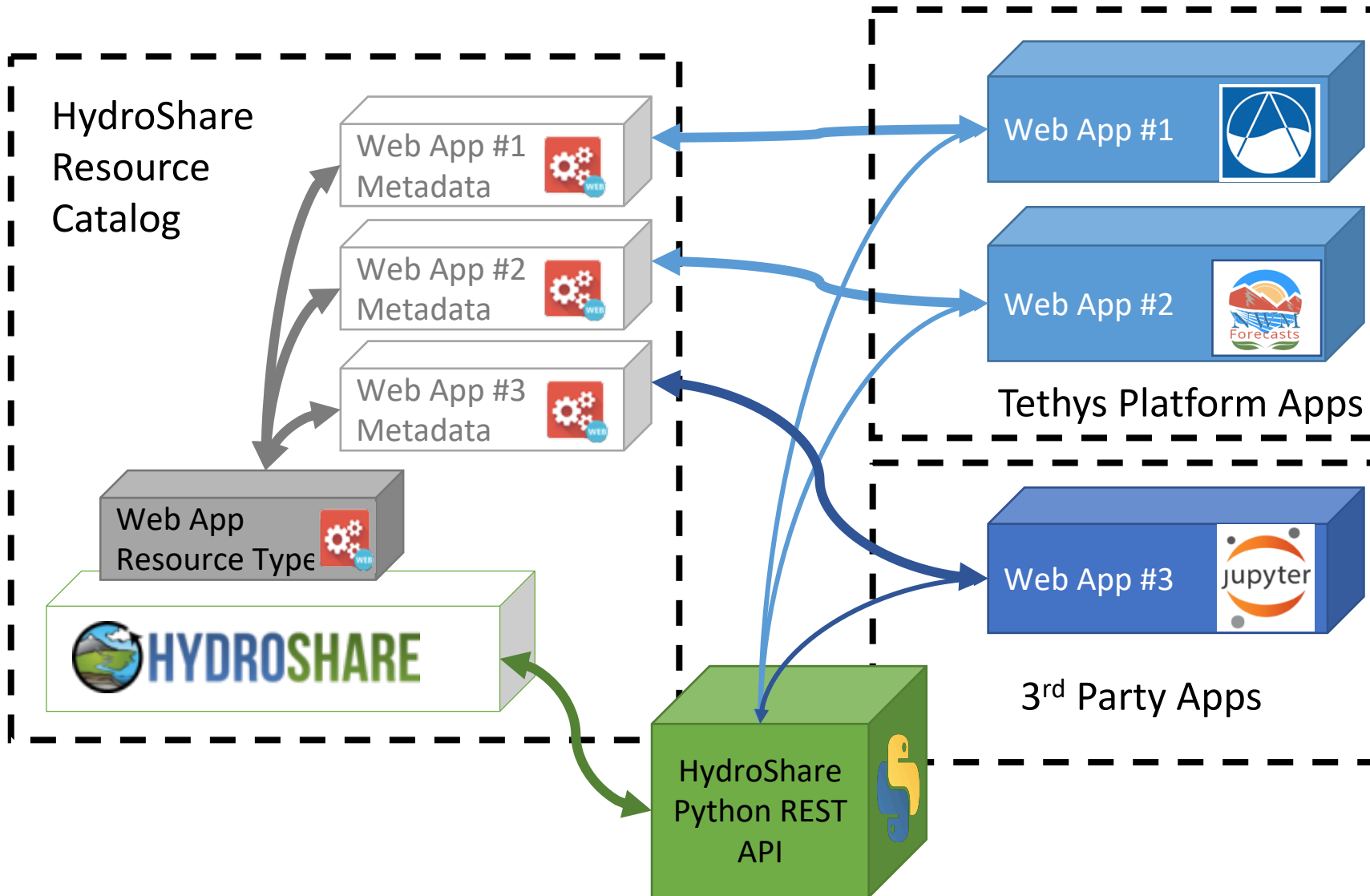
 taudem\_logan.ipynb ipynb File

-  Download
-  Download zipped
-  Get file URL
-  Jupyter Notebook View...

Detailed description: This screenshot shows the file level of a web application. It displays a file named 'taudem\_logan.ipynb' of type 'ipynb File'. A context menu is open over the file, showing options: 'Download', 'Download zipped', 'Get file URL', and 'Jupyter Notebook View...'. The 'Jupyter Notebook View...' option is highlighted with a red rectangular box. Above the file, there are navigation elements including a globe icon, the name 'logan', and the file type 'File Folder' and 'Geographic Ra...'. Below the file, there is a 'contents' folder icon.

# Web App Connector

Anybody can create a web app on any web server and configure a web app Connector for it to be launched from HydroShare



Predefined URL Launch Parameters:  
Resource ID:  $\${HS\_RES\_ID}$   
Resource Type:  $\${HS\_RES\_TYPE}$   
HydroShare username:  
 $\${HS\_USR\_NAME}$

Examples:  
[https://apps.hydroshare.org/apps/hydroshare-gis/?res\\_id=\\${HS\\_RES\\_ID}](https://apps.hydroshare.org/apps/hydroshare-gis/?res_id=${HS_RES_ID})  
[https://mygeohub.org/.../?res\\_id=\\${HS\\_RES\\_ID}&usr=\\${HS\\_USR\\_NAME}&src=hs](https://mygeohub.org/.../?res_id=${HS_RES_ID}&usr=${HS_USR_NAME}&src=hs)  
[http://hyrax.hydroshare.org/opendap/\\${HS\\_RES\\_ID}/data/contents/](http://hyrax.hydroshare.org/opendap/${HS_RES_ID}/data/contents/)

# JupyterHub

Terrain Processing - TauDem Example

Authors: Anthony Castronova  
Owners: Anthony Michael Castronova  
Resource type: Composite Resource  
Sharing Status: Public  
Views: 142  
Downloads: 17

Open with...  
HydroShare GIS  
CUAHSI JupyterHub  
OPeNDAP

1

CUAHSI  
universities allied for water research

Logout Control Panel

Loading resources before sending you to `tree/notebooks/data/4a7ba3bc84ca4c2c8c1de17b1200c0ac/4a7ba3bc84ca4c2c8c1de17b1200c0ac/data/contents/...`

2

Sync finished, redirecting...  
Click to see more details

NBFetch used to retrieve contents of resource into JupyterHub to be able to immediately open Notebook and act on resource content files

Implemented through collaboration with Martin Hunt, Science Gateways Community Institute Consultant

# JupyterHub

CUAHSI universities allied for water research

Logout Control Panel Welcome demo

Files Running Clusters

Select items to perform actions on them. Upload New ↕

0 / notebooks / data / 4a7ba3bc84ca4c2c8c1de17b1200c0ac / 4a7ba3bc84ca4c2c8c1de17b1200c0ac / data / contents File size

Name ↓ Last Modified

.. seconds ago

logan seconds ago

taudem\_logan.ipynb seconds ago 17.3 kB

3

CUAHSI universities allied for water research

taudem\_logan (unsaved changes) Python Logout Control Panel Welcome demo

File Edit View Insert Cell Kernel Widgets Help Not Trusted Python 2.7

Run

### 1. Script Setup and Preparation

Before we begin GIS processing, we must import several libraries into the notebook. The **hs\_utils** library provides functions for interacting with HydroShare, including resource querying, downloading and creation. The **taudem** library provides functions for simplifying the TauDEM GIS commands, workspace maintenance, as well as visualization. Finally, the `%matplotlib inline` command tells the notebook server to place plots and figures directly into the notebook.

**Note:** You may see some matplotlib warnings if this is the first time you are running this notebook. These warnings can be ignored.

```
In [ ]: # import required libraries for geoprocessing
import os
from utilities import hydroshare, taudem
%matplotlib inline
```

4

Analysis in JupyterHub

5

Save Results back to  
HydroShare



# Summary

HydroShare is a web based collaboration environment to enable more rapid advances in hydrologic understanding through collaborative data sharing, analysis and modeling

- Sharing and publication of data (DOI)
- Social discovery and added value
- Model sharing

Collaboration, Reproducibility,  
Credit, Transparency



- Model input data preparation
- Model execution
- Visualization and analysis (best of practice tools)

Server/Cloud Computation

- Platform independence
- Big data
- Reproducibility
- Interoperability
- Reduced needs for software installation and configuration

Open with... ▾



OAC-1664061  
OAC-1664018  
OAC-1664119  
2017-2021

ACI-1148453  
ACI-1148090  
2012-2017

# Thanks to the HydroShare team!

HydroShare is operated by CUAHSI with ongoing development through a collaborative project among Utah State University, RENCI University of North Carolina, CyberGIS Center University of Illinois, Tufts, University of Virginia, Brigham Young University, National Center for Atmospheric Research and the University of Washington.



To learn more

- Publications <https://help.hydroshare.org/about-hydroshare/publish/>
- Online Help <https://help.hydroshare.org/>



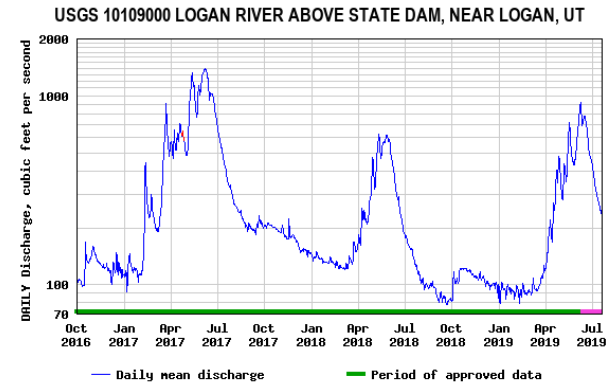
<http://www.hydroshare.org>



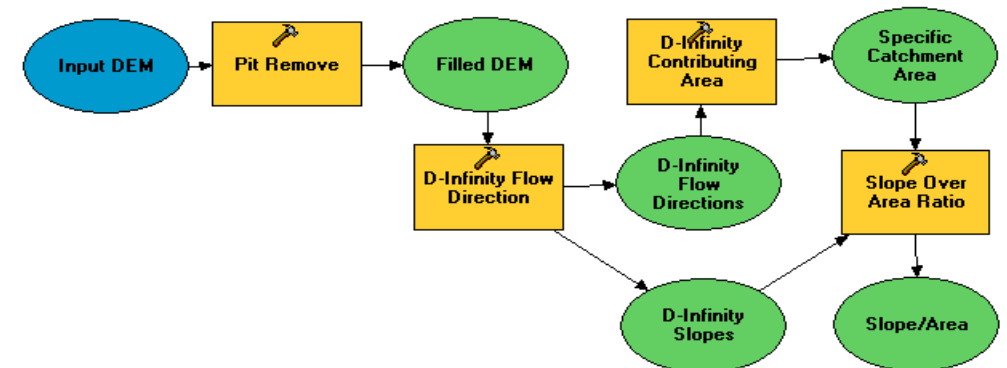
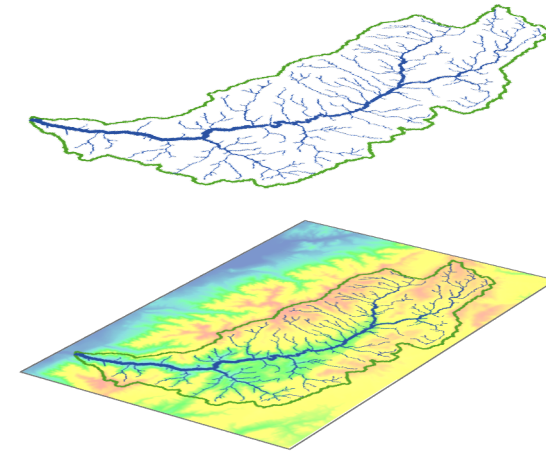
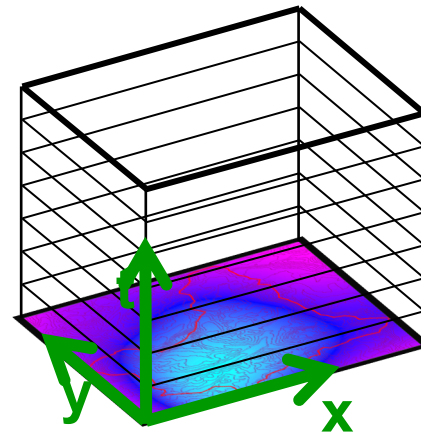
Extra Slides

# Value that HYDROSHARE provides

- Integration of information from multiple sources to enhance research
- Re-use of data beyond the purpose for which it was originally collected, extending the value of measurement, monitoring and research investments
- A platform for data management to support mandates for open data and access to the data that supports research findings
- Enhanced trust in research findings and management decisions through transparency and support for reproducibility
- Web based computational analysis and modeling functionality to overcome desktop compatibility, dependency and capacity limitations



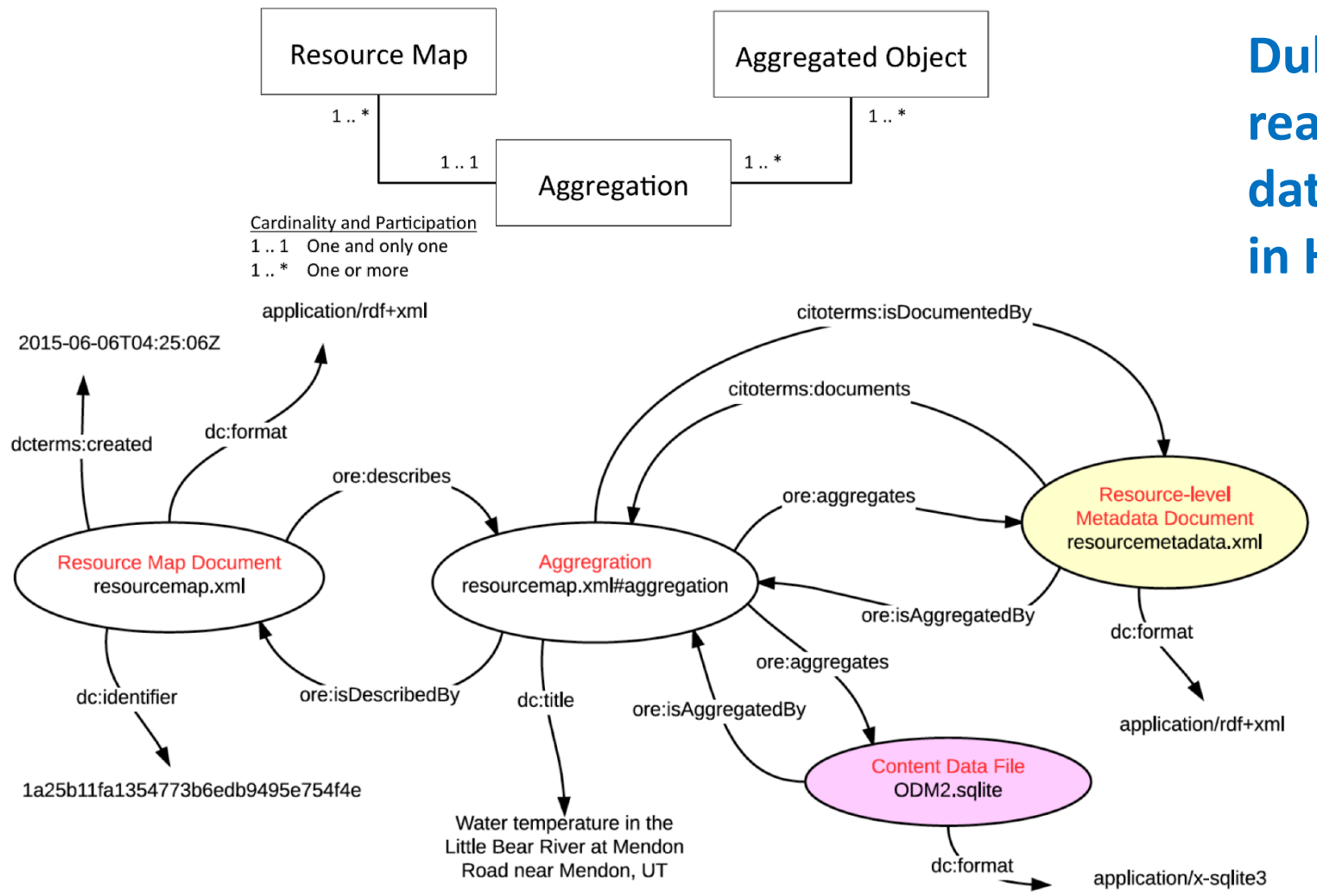
- Data and models are first-class products of research and should be shared
- Data and models become **social objects**





# HydroShare OAI-ORE standard based Resource Data Model

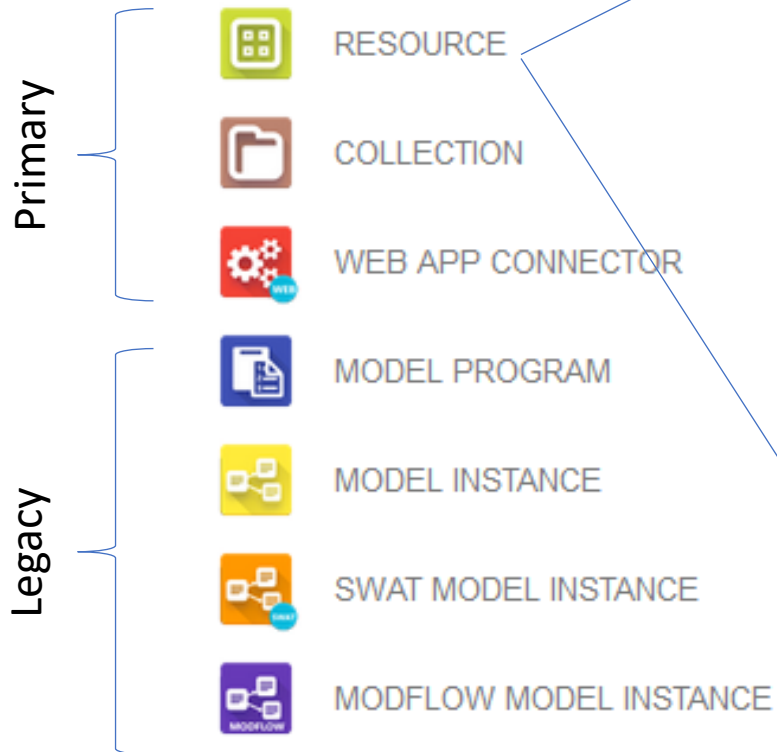
Dublin Core machine readable metadata and data model to make data in HydroShare FAIR



Horsburgh, J. S., M. M. Morsy, A. M. Castronova, J. L. Goodall, T. Gan, H. Yi, M. J. Stealey and D. G. Tarboton, (2016), "HydroShare: Sharing Diverse Environmental Data Types and Models as Social Objects with Application to the Hydrology Domain," JAWRA Journal of the American Water Resources Association, 52(4): 873-889, <http://dx.doi.org/10.1111/1752-1688.12363>.

# Resources and content aggregations

## Resources

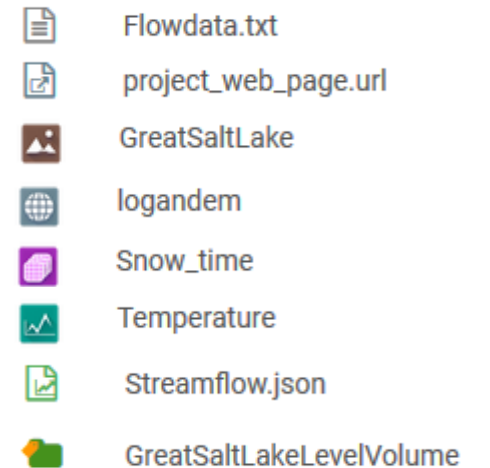


To be implemented as type aggregations within a composite resource

## Composite resource contents

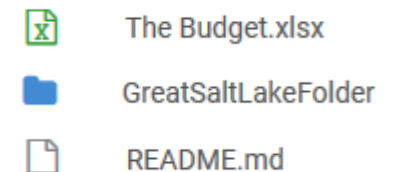
### Content type aggregations

- Single File (with external reference as URL as a special case)
- Geographic Feature
- Geographic Raster
- Multidimensional
- Time Series (ODM2 format)
- Referenced Time Series (JSON))
- File set (Folder with files)



### Files






- Single File
- Folder
- Readme (markdown or txt) that renders on landing page




# HydroShare App Development and Advancement

- Level 1: User creates app and web app connector. Private/shared with colleagues
- Level 2: Web app connector resource is public. Any user can access. Discoverable through discover. Needs to be deliberately added to open with, or associated with resource through appkey extended metadata. (e.g. GABBS multispec, Wikiwatershed)
- Level 3: The app meets documentation and maintenance requirements to be “CUAHSI Recommended”. Appears on Apps page. App developer supports and fixes bugs (e.g. SWATShare)
- Level 4: All of Tier 3 plus the app is hosted on CUAHSI server hardware - though the original developers own and maintain the code. App developer supports and fixes bugs (e.g. Data Rods Explorer)
- Level 5: All of Tier 3 plus the app is hosted on CUAHSI server hardware and the code is owned and maintained by CUAHSI. CUAHSI supports and fixes bugs. (e.g. CUAHSI JupyterHub, CUAHSI Time Series Viewer)

# README.MD rendering

	README.md	md File	2.8 KB
	README-ECMWF Flood Area Grids...	pdf File	34.7 KB
	glofas_areagrid_Harvey_Irma_part...	zip File	836.5 MB
	glofas_areagrid_Harvey_Irma_part...	zip File	921.0 MB
	glofas_areagrid_Harvey_Irma_part...	zip File	921.3 MB

 README.md

## ECMWF GloFAS - Harvey Flood Area Grids

These datasets were obtained from ECMWF/GloFAS on November 13, 2017, to include the flood forecast (area grid) for Hurricanes Harvey and Irma in the USA from August 15 - September 15, 2017. These are contained in netCDF files, one file per day.

Note that while folders and files may have the words "areagrid\_for\_Harvey" in the name, all the data here are for the southeast USA, encompassing both Harvey and Irma impact areas.

### Dataset variables

- **dis** = forecasted discharge (for all forecast step 1+30 as initial value and 30 daily average values, with ensemble members as 1+50 where the first is the so-called control member and the 50 perturbed members)



# Display of content aggregation metadata

Content



The screenshot shows a web-based content management system interface. At the top, there is a navigation bar with a search box labeled "Search current directory" and a "Sort by" dropdown menu. Below the navigation bar is a toolbar with various icons for navigation and actions, including a "Learn more" link. The main content area is divided into two panes. The left pane shows a directory tree with the path "contents / area grids (netCDF)". A list of folders is displayed, each with a purple icon, a name starting with "glofas\_areagrid\_for...", a type of "File Folder", and a "Multidimens..." label. The second folder in the list is highlighted in yellow. The right pane displays the metadata for the selected folder, which is titled "glofas\_areagrid\_for\_Harvey\_in\_USA\_2017081600Z". The metadata is organized into sections: "Title", "Spatial Coverage", "Extent", and "Spatial Reference". The "Spatial Coverage" section includes "Coordinate Reference System" (WGS 84 EPSG:4326) and "Coordinate Reference System Unit" (Decimal degrees). The "Extent" section lists four values: North (36.95), West (-106.949996948), South (25.05), and East (-75.0500030518). The "Spatial Reference" section is partially visible at the bottom.

contents / area grids (netCDF)

Icon	Name	Type	Label
	glofas_areagrid_for...	File Folder	Multidimens...
	glofas_areagrid_for...	File Folder	Multidimens...
	glofas_areagrid_for...	File Folder	Multidimens...
	glofas_areagrid_for...	File Folder	Multidimens...
	glofas_areagrid_for...	File Folder	Multidimens...
	glofas_areagrid_for...	File Folder	Multidimens...
	glofas_areagrid_for...	File Folder	Multidimens...
	glofas_areagrid_for...	File Folder	Multidimens...
	glofas_areagrid_for...	File Folder	Multidimens...
	glofas_areagrid_for...	File Folder	Multidimens...
	glofas_areagrid_for...	File Folder	Multidimens...

**Title**

glofas\_areagrid\_for\_Harvey\_in\_USA\_2017081600Z

**Spatial Coverage**

Coordinate Reference System  
WGS 84 EPSG:4326

Coordinate Reference System Unit  
Decimal degrees

**Extent**

North	36.95
West	-106.949996948
South	25.05
East	-75.0500030518

**Spatial Reference**

# Display of metadata elements

## References

---

### Related Resources

This resource cites: <http://www.globalfloods.eu/>

This resource belongs to the following collections:

---

Title	Owners	Sharing Status	My Permission
<a href="#">Harvey Flood Data Collections</a>	David Arctur · Harvey datamgr	Published	View
<a href="#">Irma Flood Data Collections</a>	David Arctur · datamgr Irma	Published	View

## Credits



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### Funding Agencies

This resource was created using funding from the following sources:

Agency Name	Award Title	Award Number
<a href="#">National Science Foundation (NSF)</a>	RAPID: Archiving and Enabling Community Access to Data from Recent US Hurricanes	1761673

# User Dashboard

[HOME](#) [MY RESOURCES](#) [DISCOVER](#) [COLLABORATE](#) [APPS](#) [HELP](#) [Create](#) 

## Getting Started

[Learn to use HydroShare](#) [Complete profile](#) [Browse data](#)

[Introduction to HydroShare](#) [Example resources](#) [Recent upgrades](#)


## Recently Visited

[Hide Getting Started](#)


Accessed	Title	First Author	Resource Type	Visibility
13 minutes ago	<a href="#">ECMWF GloFAS - Harvey+Irma Flood Area Grids</a>	European Centre for Medium-Range Weather Forecasting (ECMWF) GloFAS	Composite	Published
18 minutes ago	<a href="#">Logan 10 m Terrain Analysis</a>	<a href="#">David Tarboton</a>	Composite	Public
19 minutes ago	<a href="#">2013 Flooding: Hydrology and Impacts in Larimer County, Colorado</a>	<a href="#">Whitney Benson</a>	Composite	Public
21 minutes ago	<a href="#">Hurricane Harvey 2017 Story Map</a>	<a href="#">David Arctur</a>	Composite	Published
43 minutes ago	<a href="#">NOAA NHC - Irma Storm Track - Best Track + Advisories</a>	NOAA National Hurricane Center (NHC)	Composite	Published

< >

## Featured Apps

**CUAHSI JupyterHub**

Use this app to launch HydroShare data in an online Python environment that uses JupyterHub software stack.

**National Water Model Forecast Viewer**

Retrieve and preview National Water Model data.