Brokering as a Framework for Hydrological Model Repeatability

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4. NCAR, 5. ESRI, 6. NSIDC, 7. Cornell University

Outline

- Policies for Funded/Published Data
- Introduction to NSF EarthCube
- Introduction to Brokering and NSF's BCube
- Issues with Hydro Modeling Data
- What is Brokering and BCube
- How might Brokering help us validate published studies

(2008) later applied modifications to the *CN* method to better represent saturation-excess run-off from VSAs. For example, Dahlke *et al.* (2009) found that coupling the 'VSA interpretation' of the *CN* method with a simple water balance model predicted run-off generation consistent with field observations from Town Brook watershed in Upstate New York. Subsequent VSA modifications of the *CN* method have been successfully integrated into existing water quality models (Generalized Watershed Loading Function, Schneiderman *et al.*, 2007 and Soil and Water Assessment Tool (SWAT), Easton *et al.*, 2008).

The SWAT is a watershed model of particular interest to conservation and nutrient management planning as it offers flexibility in the range of input data that can be used and employs process-based P cycling (Veith *et al.*, 2008; Arnold *et al.*, 2010; Nietsch *et al.*, 2011). Easton *et al.* (2008) re-conceptualized SWAT to represent VSA hydrology (SWAT-VSA) and demonstrated improved predictions of run-off source areas and P loss in a glaciated watershed with shallow permeable soils above a relatively continuous restrictive layer on a steep to moderately sloped landscape. The promising results from that and other recent SWAT-VSA projects (Pradhanang *et al.*, 2013; Woodbury *et al.*, 2013) justify an expansion of its testing to more complex agricultural landscapes with more variably drained soils and a less consistent restrictive layer, all of which complicate the hydrologic and chemical processes.

This study comprehensively evaluates SWAT-VSA against a standard version of SWAT in WE38, a small

MATERIALS AND METHODS

We applied both SWAT and SWAT-VSA in the WE38 watershed and compared model predictions with measurements of stream flow and dissolved P in the stream and distributed measures of soil moisture and run-off frequency obtained from eight hillslope soil trenches located in areas with and without fragipan restricting layers (Figure 1). The initializations of both versions of SWAT reflect an intense focus on two sub-watersheds of WE38, FD36 and Mattern, which have undergone extensive hydrological investigation. Characterizations of these two sub-watersheds from previous studies (Gburek *et al.*, 2002, 2006; Needelman *et al.*, 2004; Veith *et al.*, 2008; Buda *et al.*, 2009a, 2013) were used to parameterize the model and corroborate model predictions. Multi-year field management schedules were built into the models for each individual agricultural field within the two sub-watersheds. Note that we did not calibrate either model to improve P predictions but rather relied on a detailed field management database and expert scientific knowledge of the watersheds to parameterize the models. This enabled an unbiased determination of the effect of incorporating VSA into SWAT on P predictions.

Watershed description

WE38 is a first-order upland agricultural watershed in the Ridge and Valley physiographic region of south central Pennsylvania and has undergone intensive study

NEW DATA POLICIES, NSF/AGU/Journals

"Earth and space science data should be widely accessible in multiple formats and long-term preservation of data is an integral responsibility of scientists and sponsoring institutions."

- all data necessary to understand, evaluate, replicate, and build upon the research must be made available and accessible whenever possible.
- data include, but are not limited to: data used to generate, or be displayed in, figures, graphs, plots, videos, animations, or tables in a paper.
- AGU reserves the right to refuse publication when authors are unwilling to make the underlying data available or otherwise refuse to comply with this Data Policy.

As Hydrological Model Paper Reviewers

Before:

Is this study repeatable?

Now Adding:

Can I locate and access all the data needed to repeat this study?

As reviewers, we need to reject the papers when we can not access the data!

Our initial reviews are now easier?

EarthCube and Open Data Sharing

A community of communities

EarthCube

Accelerating Scientific Discovery

Credits: from top to bottom: NOAA Okeanos Explorer Program (CC BY-SA 2.0), NASA/Kathryn Hansen (CC BY 2.0), and Canyonlands National Park/Neal Herbert (CC BY-NC-SA 2.0).

NSF EarthCube Goals

Accelerate Advancement of Science
Meet grand challenges
Leverage shared cyberinfrastructure technology

"The problems of data use are half technical and half social."

–Someone at almost every professional science meeting

Hydrological Modeling Data

Survey of Hydrological Modelers for the IDRC-Canada "Advancing The Application Of Climate and Hydrological Information and Its Translation Into Policy" meeting, October 2014

- What biophysical data sets do you currently use?
- What observational climate data sets do you currently use?
- What projected climate data sets do you currently use?

What biophysical data sets do you currently use?

Water level (river, groundwater), River discharge, Soil properties, Remotely sensed vegetation, Salinity, Sediment concentration, Water quality, Digital elevation models, Arc GIS shapefiles, Hydrometeorological data, GIS data, Satellite images (land use data), Soil map, DEM, Social statistics data, Hydrological data (water flow), Water master plan, Heath, Population, Land cover, MODIS, Albedo, Land surface temperature, NDVI, Air temperature, Net radiation, Agro-ecological, ALT (Binational Authority of Titicaca lake basin) data, Cultivated area, Irrigated area, Fertilizers, Tubewells, Tractors, Area under crops, Water use of crops.

What climate data sets do you currently use?

In situ, National met synoptically stations data, TRMM, Worldclim, Chirps, CFSR, CRU, WATCH, WFDEI,RCM outputs, MeteoLiban (land surface stations), NCDC, Micrometeorological stations in experimental sites, APHRODITE and IMPAC-T projects, ERA-Interim, CSAG data sets, NCEP final analysis FNL, NCDC, GPCC, UDel, CLARIS Database.

What is Data Brokering

Science Discipline Interoperability

Two Complementary Approaches

- Standardization
  - Systems Federation
    - A group of people agreeing on a format
  - Controlled and mature environments
- Intermediation (i.e. System Brokering)
  - Complex data types supported
  - Allows rapidly evolving environments


Fu itie
International Telecommunication Union
CEOS
W3C
Semantic Web
Service Bus
Google
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Global Ocean Observing System
WEB
Geotiff
PNG
The HDF Group
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ICSU
International Council for Science
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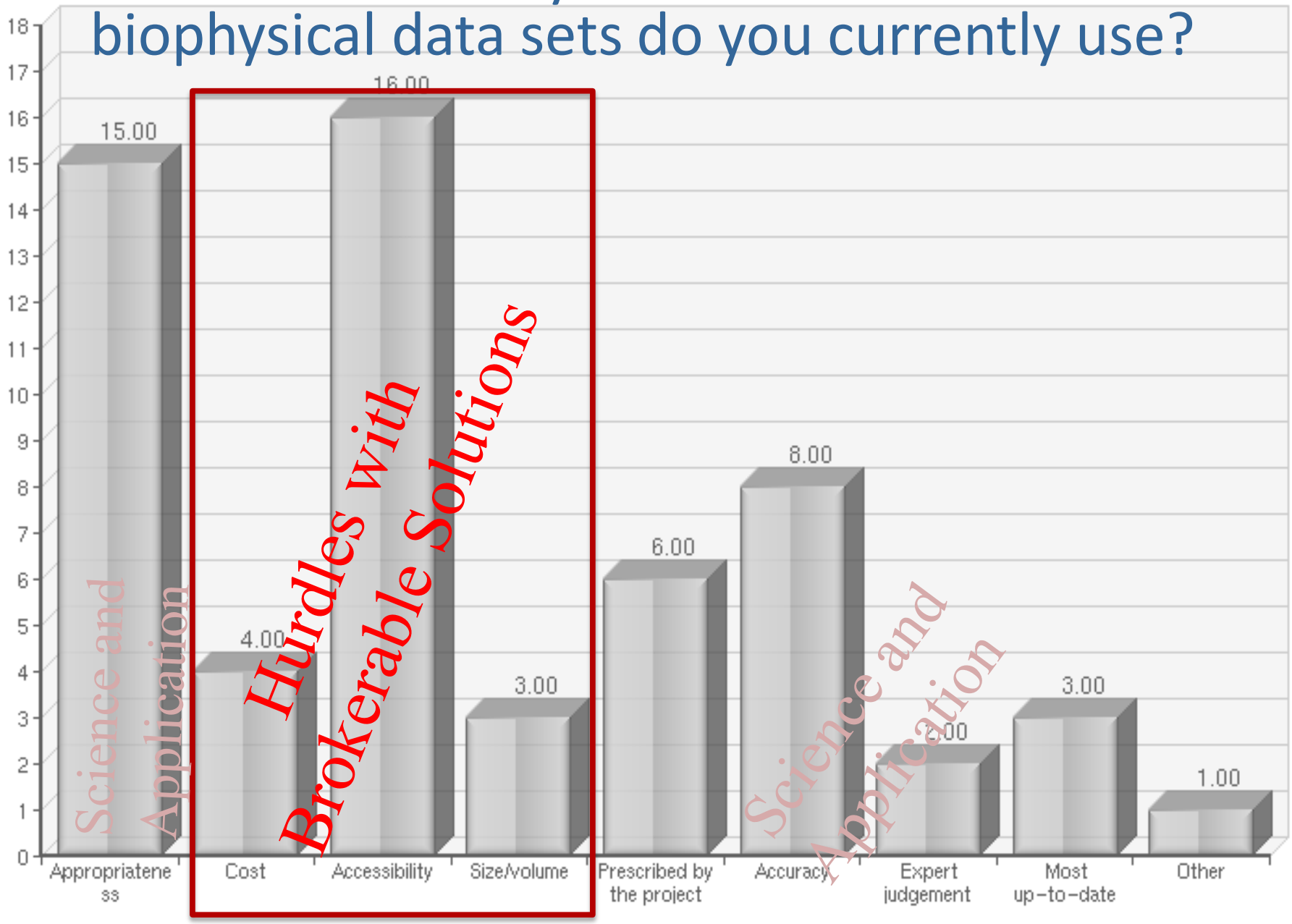
. . . a new technological revolution every year . . .

What are the key considerations for the biophysical data sets do you currently use?



EarthCube BCube… Born from GEOSS

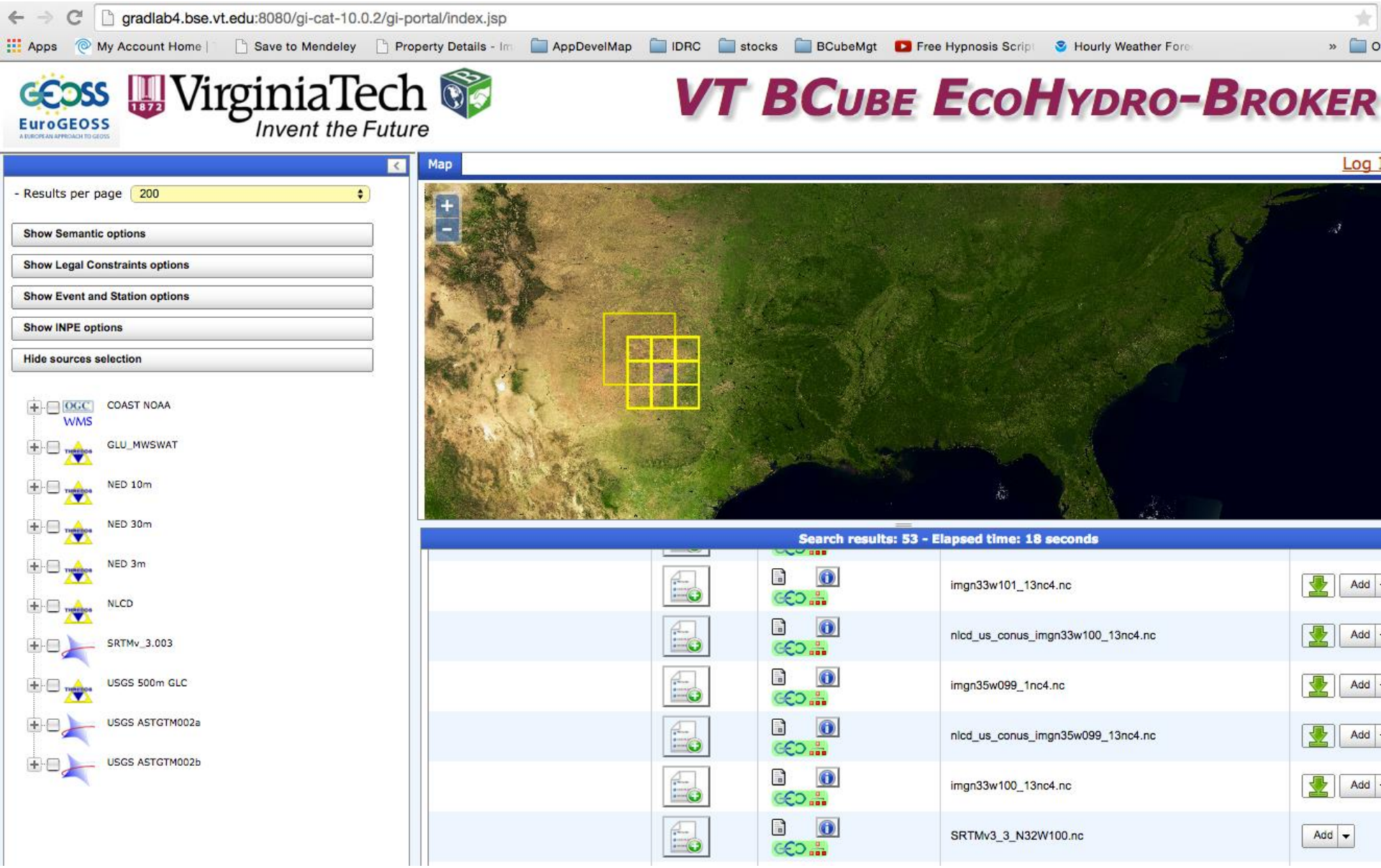
Global Earth Observation System of Systems (GEOSS)

Brokering for Hydrological Model Repeatability

If Brokering can find and provide disparate datasets, for new science, it can be used to validate data access in methods sections

Brokering Benefits

- Lowers barriers to participation in distributed systems for both users and resource providers
  - minimal burden or cost impact on existing systems;
- Accelerates interconnection of disparate systems;
- Facilitates sustainability, reusability, extensibility, and flexibility of the infrastructure
- Enhances multi-disciplinary interoperability via introduction of new capabilities across multiple domains;
- Removes need to impose common (e.g. federal, "top-down") specifications and software components enabling a more adaptive "bottom-up" evolution of the infrastructure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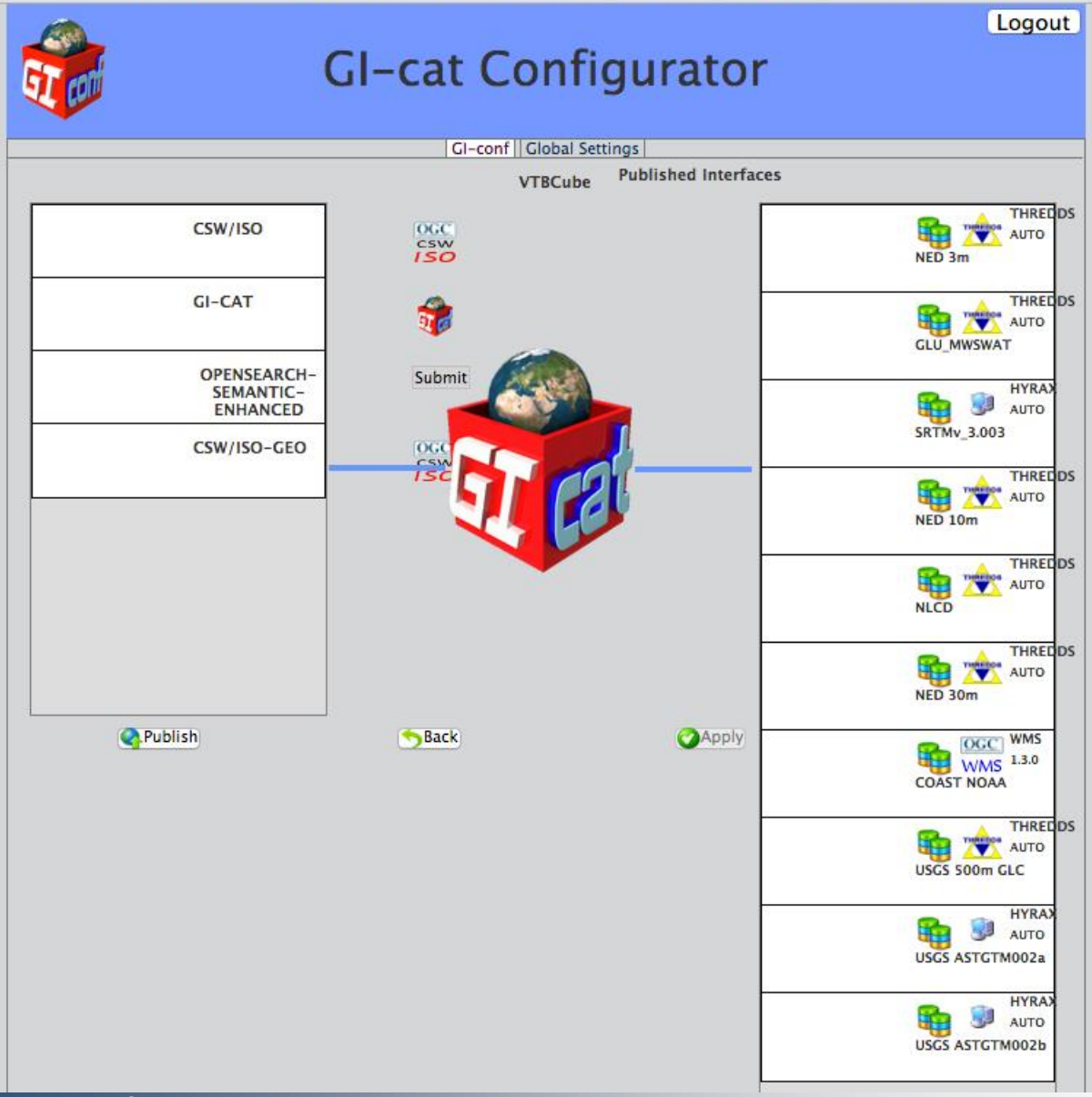

Eco-Hydro SWAT Use Case Datasets Brokered

- Elevation
  - Global SRTM
    - 30m, 90m
  - Global GDEM 30m
  - US 30m NED
  - US 10m NED
  - US 3m NED
- Landuse
  - Global MODIS
  - Global USGS NLCD
- Soils
  - Global FAO Vector
  - US SSURGO Vector
- Historical Daily Weather
  - Global CFSR Gridded
  - Global GHCN Point
- Forecasts
  - Daily Global 16day
- Climate
  - Global Last Century Gridded
  - Global Next Century Gridded

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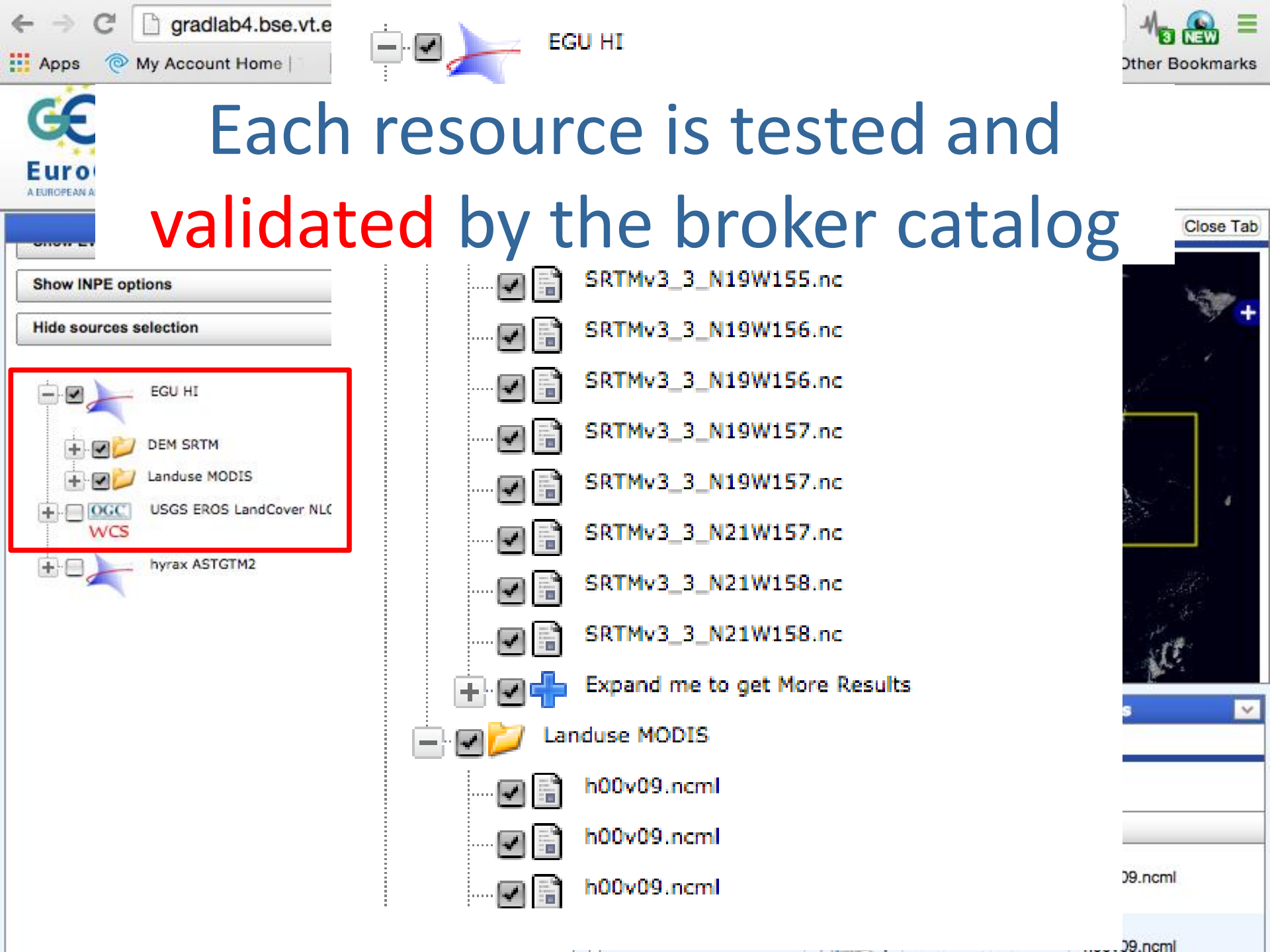
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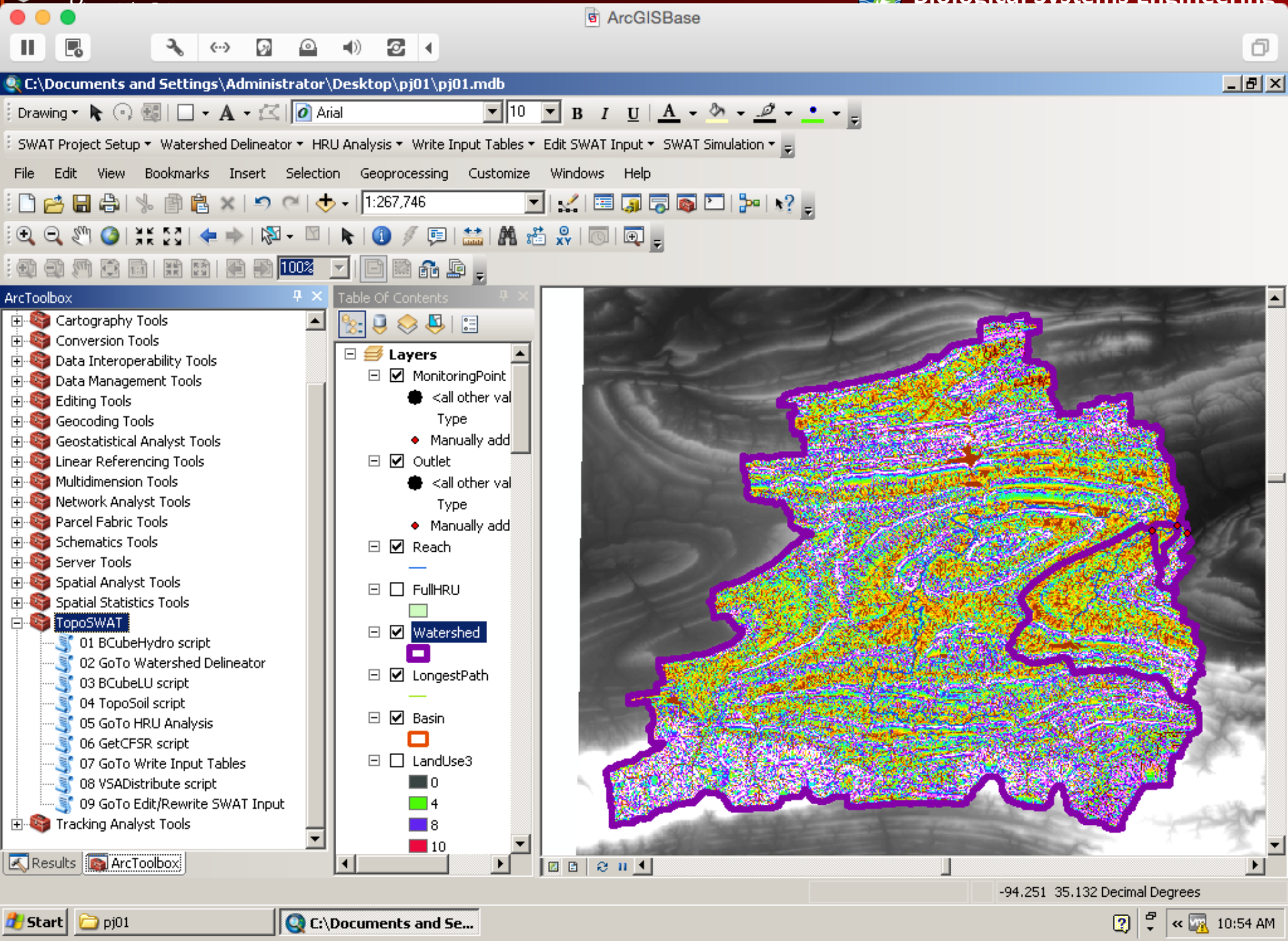
ArcSWAT Interface to BCube Broker in TopoSWAT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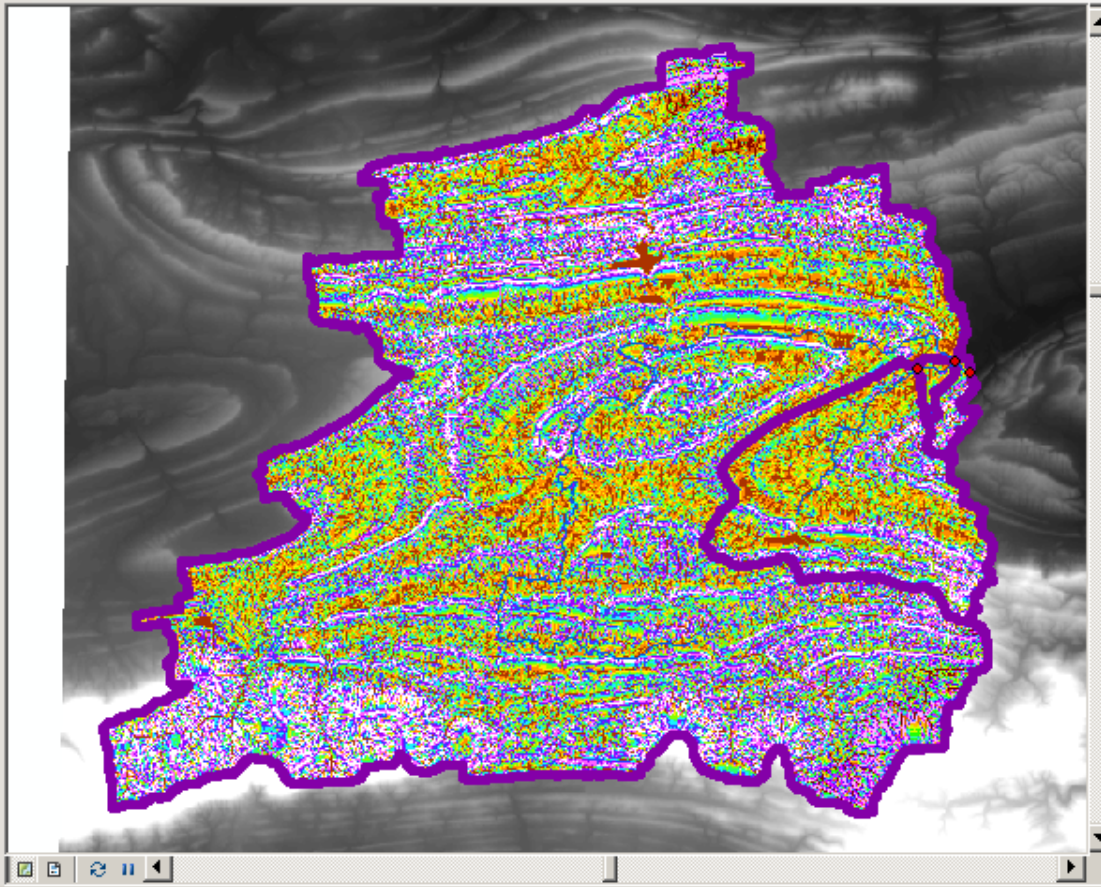

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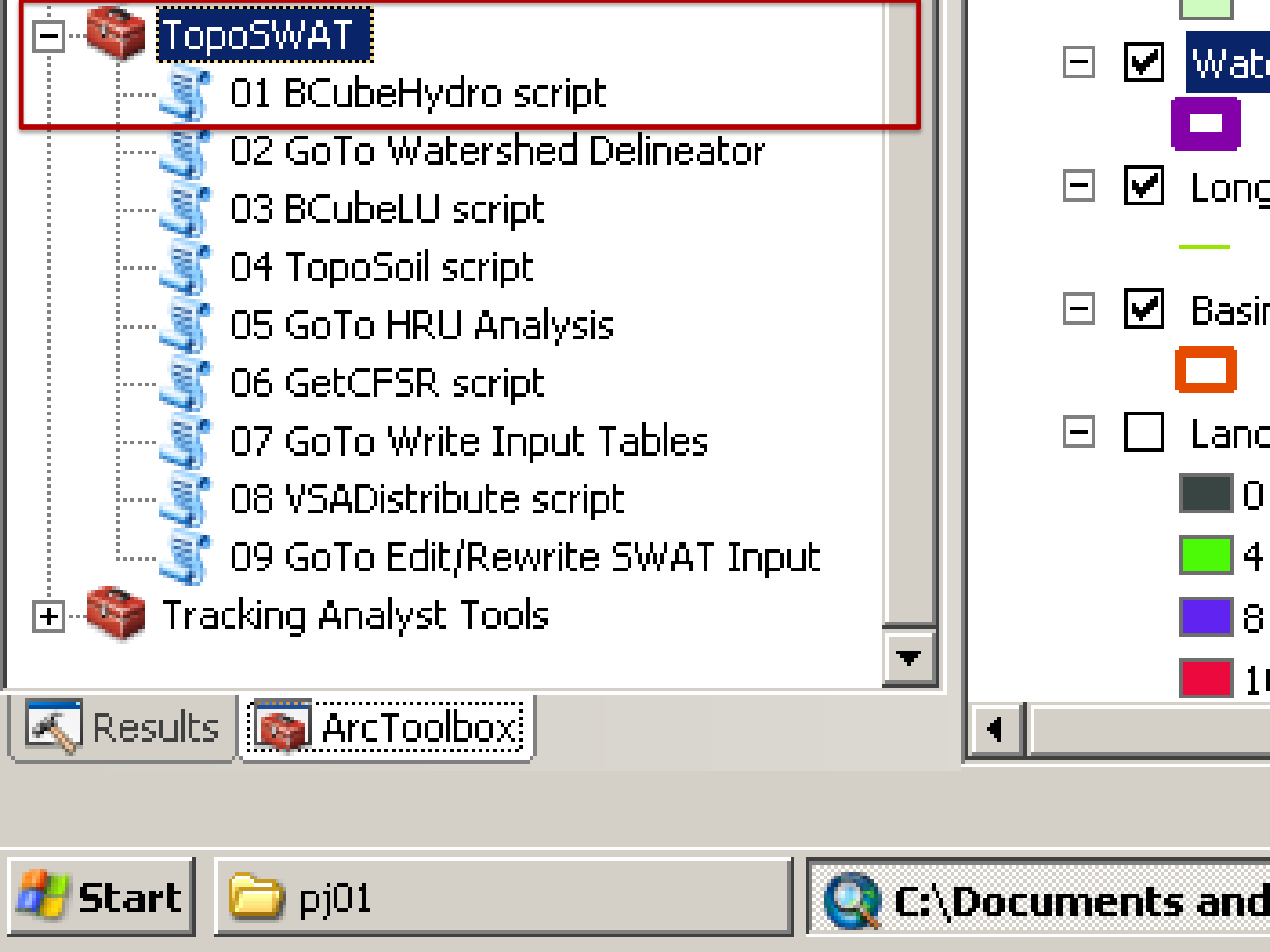
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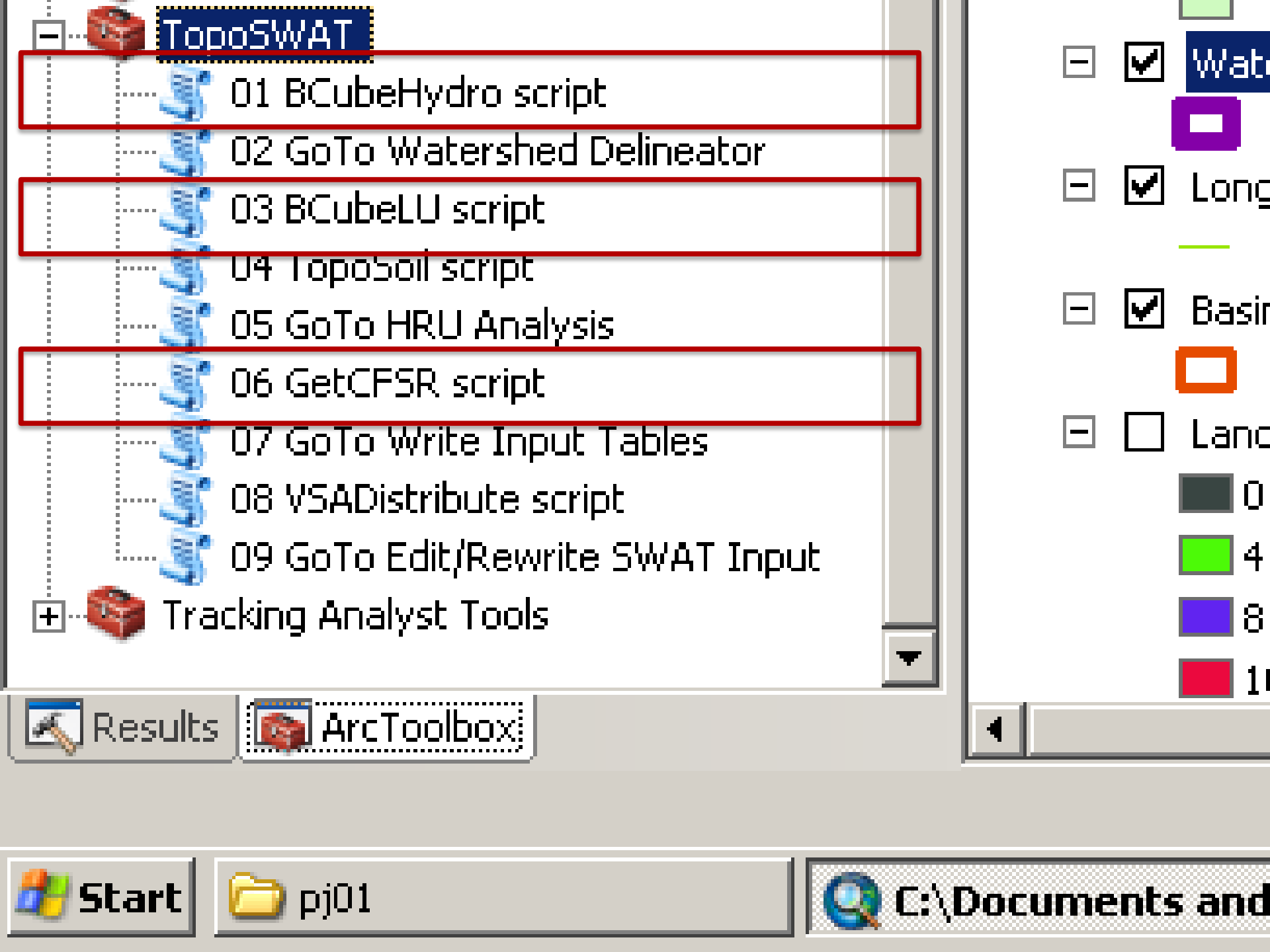
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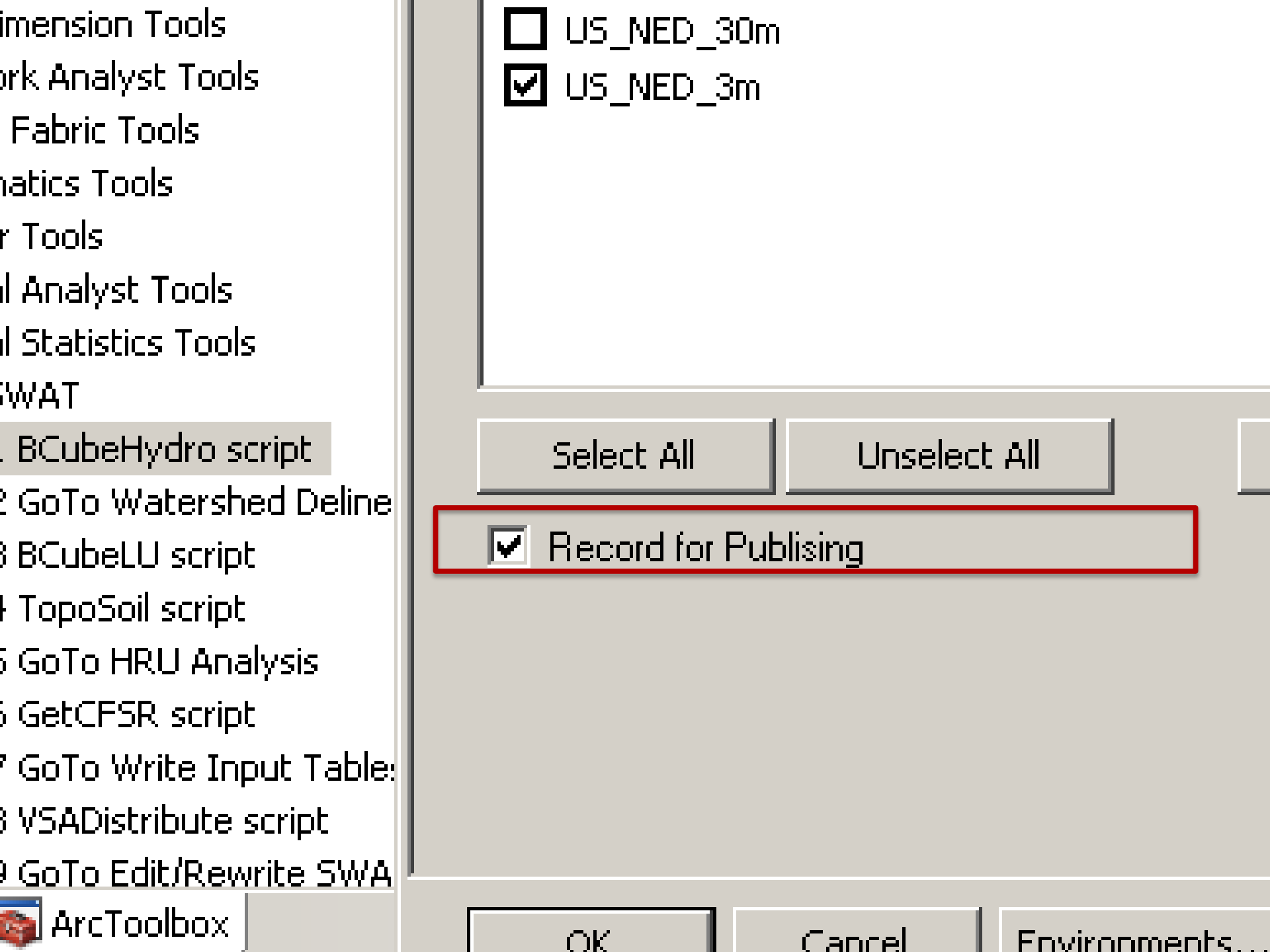
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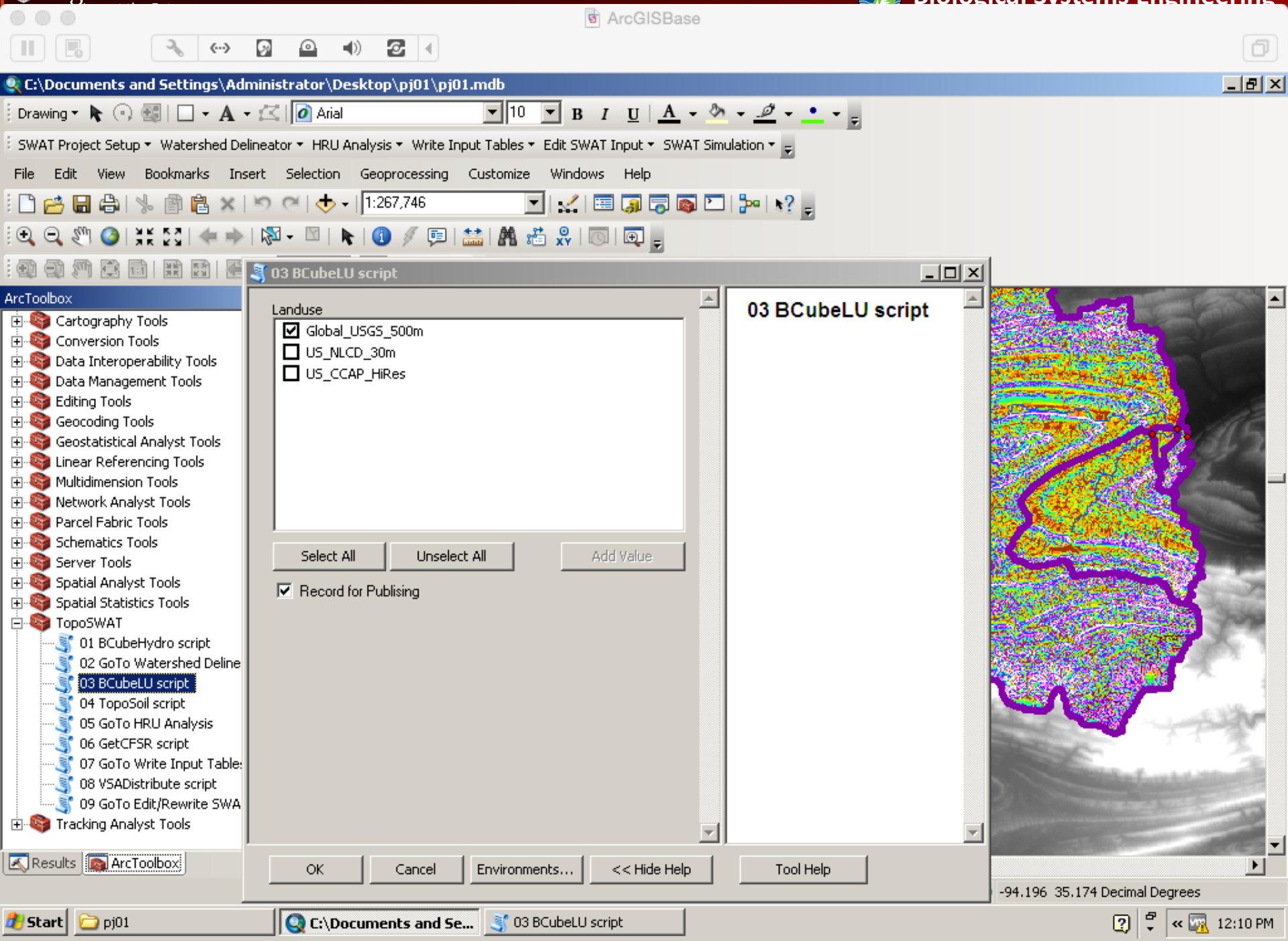
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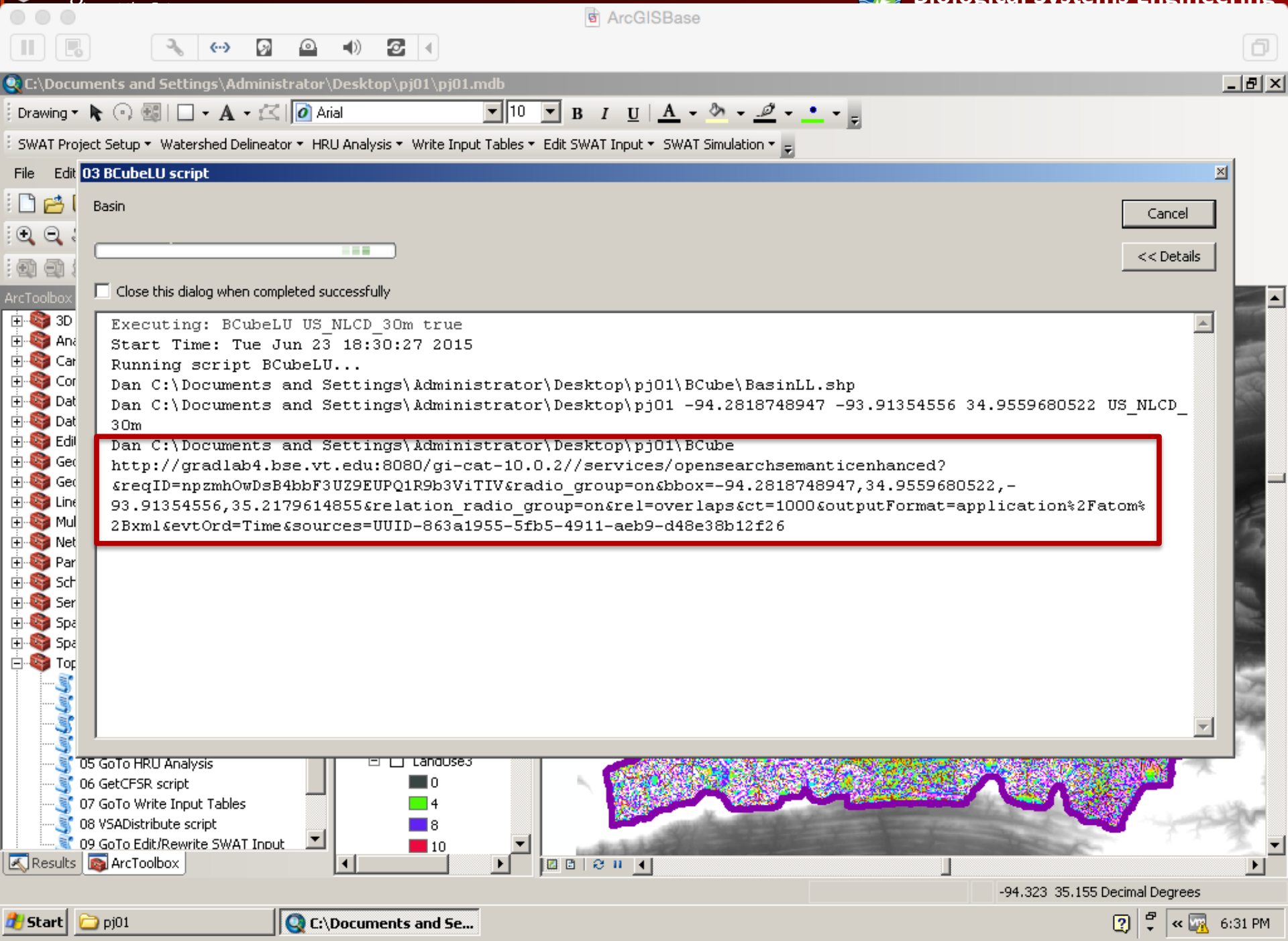
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From Modeling Project BACK to Broker

- Broker interfaces, and Broker can trace the requests
- Format and make available on website
- AutoMagically Picked up from Crawler

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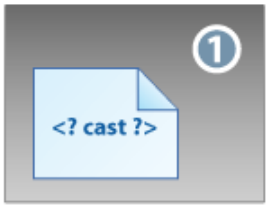
Elevation
http://gradlab4.bse.vt.edu:8080/gi-axe-11.0.5-0522/services/wcs?protocol=OPeNDAP&linkage=http://opendap.cr.usgs.gov
/opendap/hyrax/SRTMv3.003/SRTMv3_3_N38W080.nc?&name=Band1&SERVICE=WCS&VERSION=1.0.0
Elevation
http://gradlab4.bse.vt.edu:8080/gi-axe-11.0.5-0522/services/wcs?protocol=OPeNDAP&linkage=http://opendap.cr.usgs.gov
/opendap/hyrax/SRTMv3.003/SRTMv3_3_N38W079.nc?&name=Band1&SERVICE=WCS&VERSION=1.0.0
```

Congratulations, your data ad, edu.vt.bse.hydro1.xml, has been generated!

Next Steps

Note: It is very important to complete step 2 and 3 below. If you don't place the data ad file on a publicly available URL and don't link it on a web page, then none of the web crawlers will find your data.



Download or Copy Your Newly Created Data Ad

DOWNLOAD AD

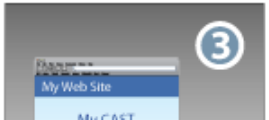
- or -

Cut and paste the ad below and create a file in your computer using any text editor. The current file name is edu.vt.bse.hydro1.xml.

```
<?xml version="1.0" encoding="UTF-8"?>
<feed xmlns="http://www.w3.org/2005/Atom" xmlns:time=" http://a9.com/-
/opensearch/extensions/time/1.0/" xmlns:dc="http://purl.org/dc/elements/1.1/"
xmlns:gml="http://www.opengis.net/gml"
xmlns:georss="http://www.georss.org/georss">
<title>VSA Hydrological Model for USDA WE38 Watershed</title>
<subtitle>Complete dataset basis for the USDA VSA WE38 Watershed modeling
```

Place Your Ad on a Publicly Accessible Web Hosting Server

For example, you can upload your ad to the `http://www.yoursite.org/feeds/` directory in your Web hosting server.



Create a Link that Points to Your Ad

For example: `<a`

Other Benefits of BCube Brokering

- Validate data sources
- Monitor past project data availability
  - Warn when a dataset no longer exists/available
- Pre-screen methods data availability for new modeling projects
- Source of information to retire previous methods/models