USGS
science for a changing world

GeoSUR Geospatial Application Workshop

An investigation and assessment of GeoSUR's geoprocessing services.

Cushing, W. M., Stinger Ghaffarian Technologies (SGT), Inc., contractor to the U.S. Geological Survey. Work performed under USGS contract O8HQCN0005

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

EROS Training and Education

Logistics

- **Daily schedule**
  - Workshop begins at 8:30 am
  - Morning break 10:30 am (15 min)
  - Lunch 12 pm (1 hour)
  - Afternoon break at 3 pm (15 min)
  - Daily wrap-up at 5 pm
  - Shuttle departs at 5:30 pm
- **Restrooms**
- **Refreshments**
- **Security**
- **Emergency evacuation procedure (fire, tornado)**

Objectives

- Understanding the SRTM data products
- How to acquire SRTM DEM data sets
- Acquiring SRTM Level 2 derivative products
- How to acquire remotely sensed data
- Overview of applying raster data sets
- Overview of managing spatial data
- Accessing and implementing GeoSUR's geoprocessing web services

SRTM Mission

Shuttle Radar Topography Mission (SRTM)

- Mission history
- Data post processing
- Data quality assessment

Information presented by Dean Gesch of the U.S. Geological Survey (USGS).

USGS

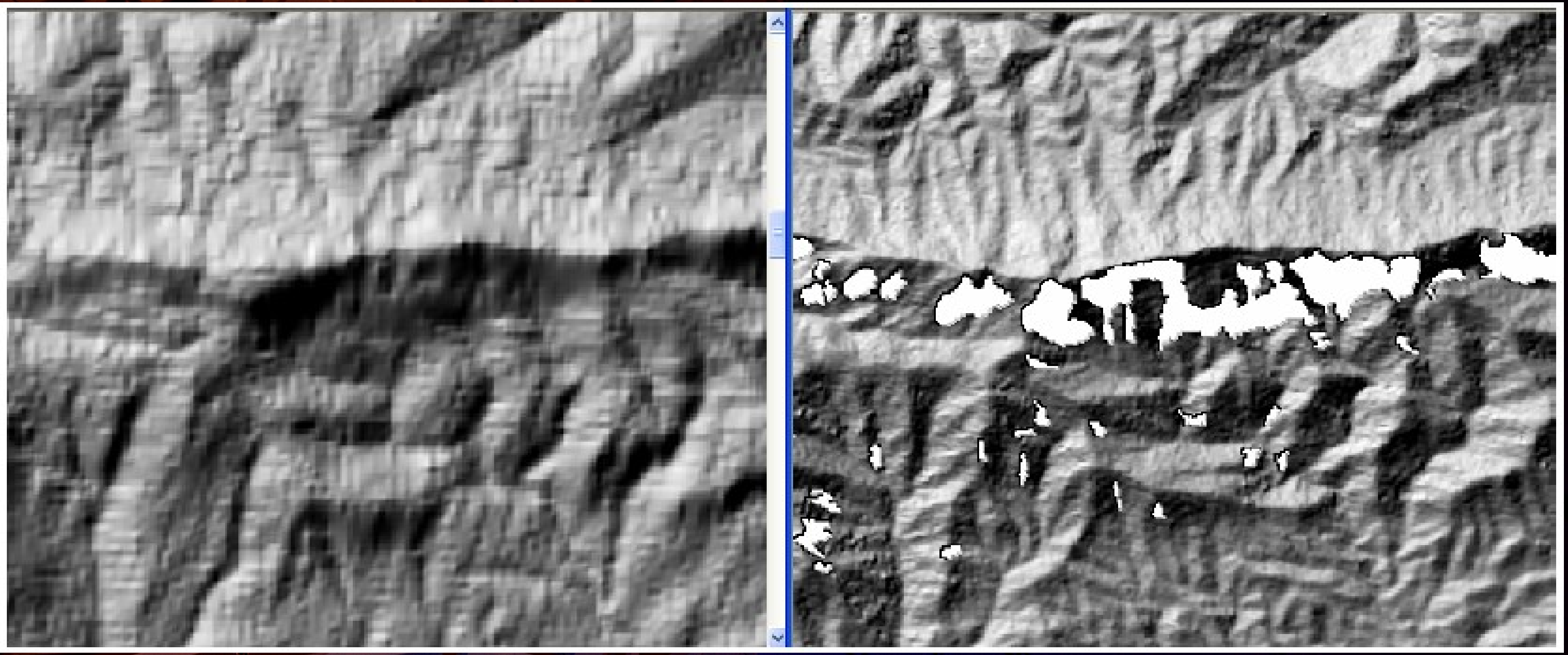
SRTM Data Characteristics

SRTM data characteristics to consider prior to including the DEM in data analysis.

- Data voids
- Phase noise
- Canopy bias
- Horizontal resolution

Data Voids

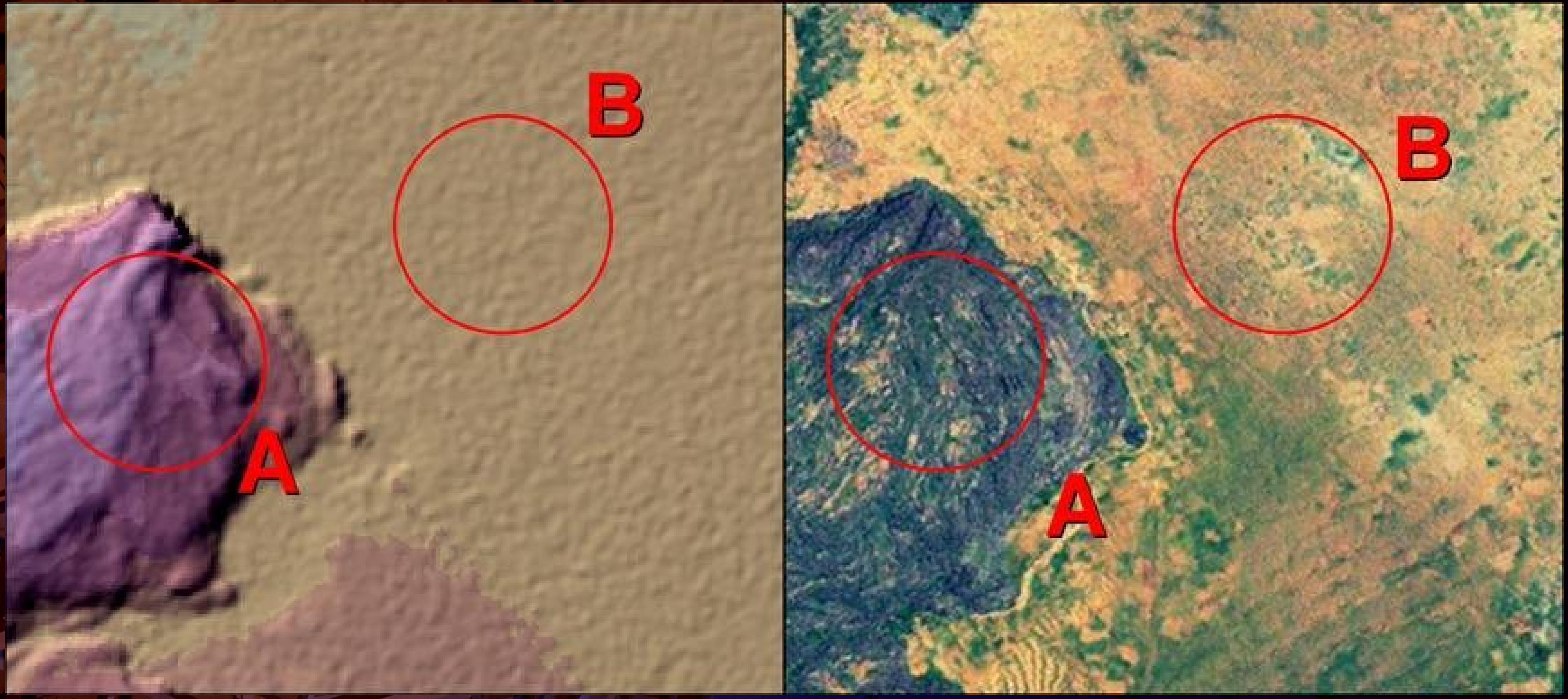
Shaded Relief of DTED 1 — SRTM with gaps (Voids)



(Grohman, 2006)

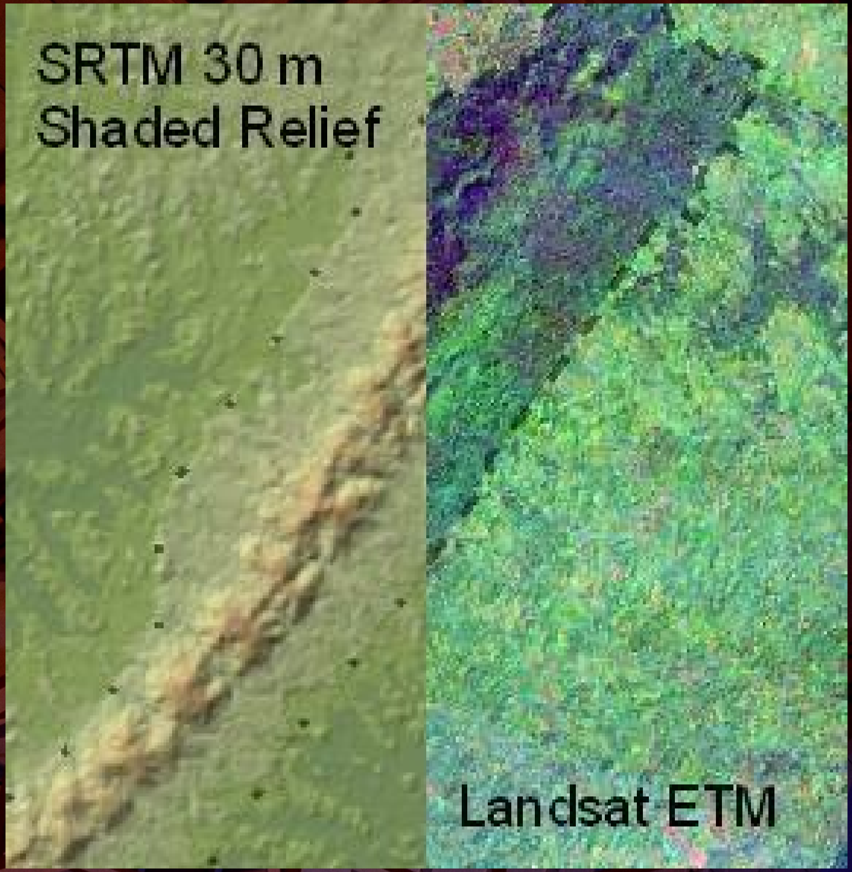
Phase Noise

An example of phase noise from two different surface types. **A** is from a rock outcropping, and **B** is bare soil with sparse vegetation



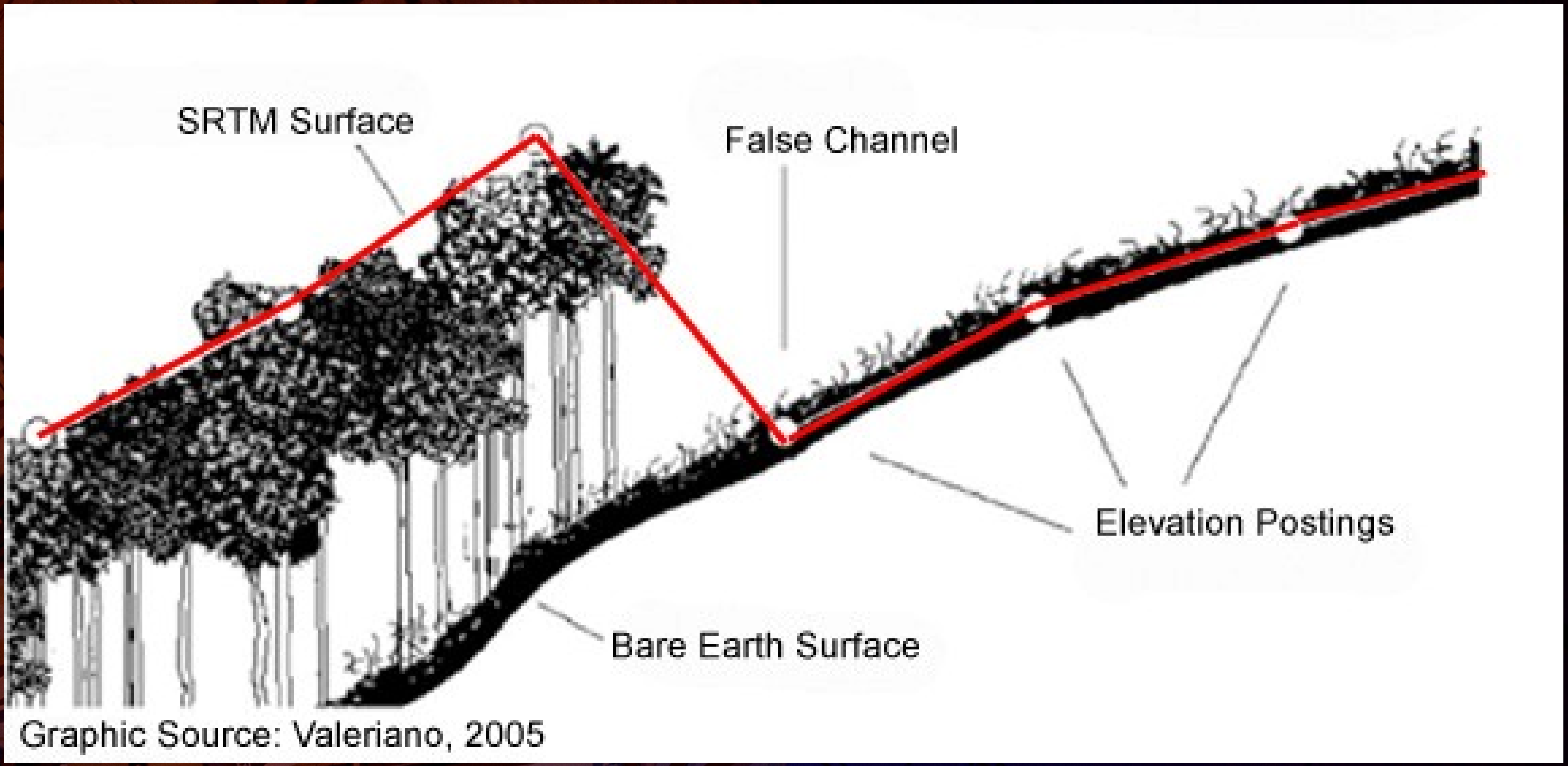
USGS

Canopy Bias



Shaded Relief / Landsat image mosaic illustrating canopy bias along the borders of a protected forest in Ghana, West Africa.

Canopy Bias



Example of potential false channel extraction using SRTM data.

Horizontal Resolution

- Original data collection was near 30 m.
- Increased usability and smoothing algorithm was applied reducing resolution to 45 and 60 meters (Farr, 2006).
- Other studies show the resolution may be between 30 and 48 meters (Pierce, 2006).

USGS

Slope

- Overestimates in areas of steep topography
- Overestimates in areas of little relief (Guth, 2006; Jarvis, 2004; Farr, 2006)
- There is a combined influence of the smoothing algorithm and the phase noise error (Farr, 2006)

USGS

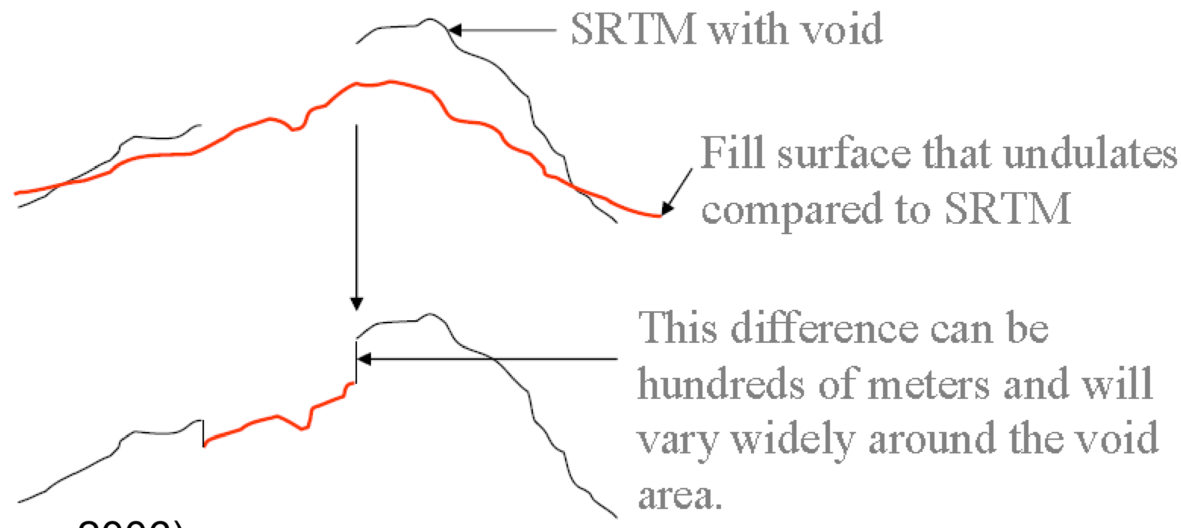
Overall SRTM Data Quality

The SRTM is an unprecedented collection of the world's topography and currently there is no global dataset that can match its versatility and quality (Guth, 2006).

SRTM Void Fill Processing

- Needs MORE

Feathering Method

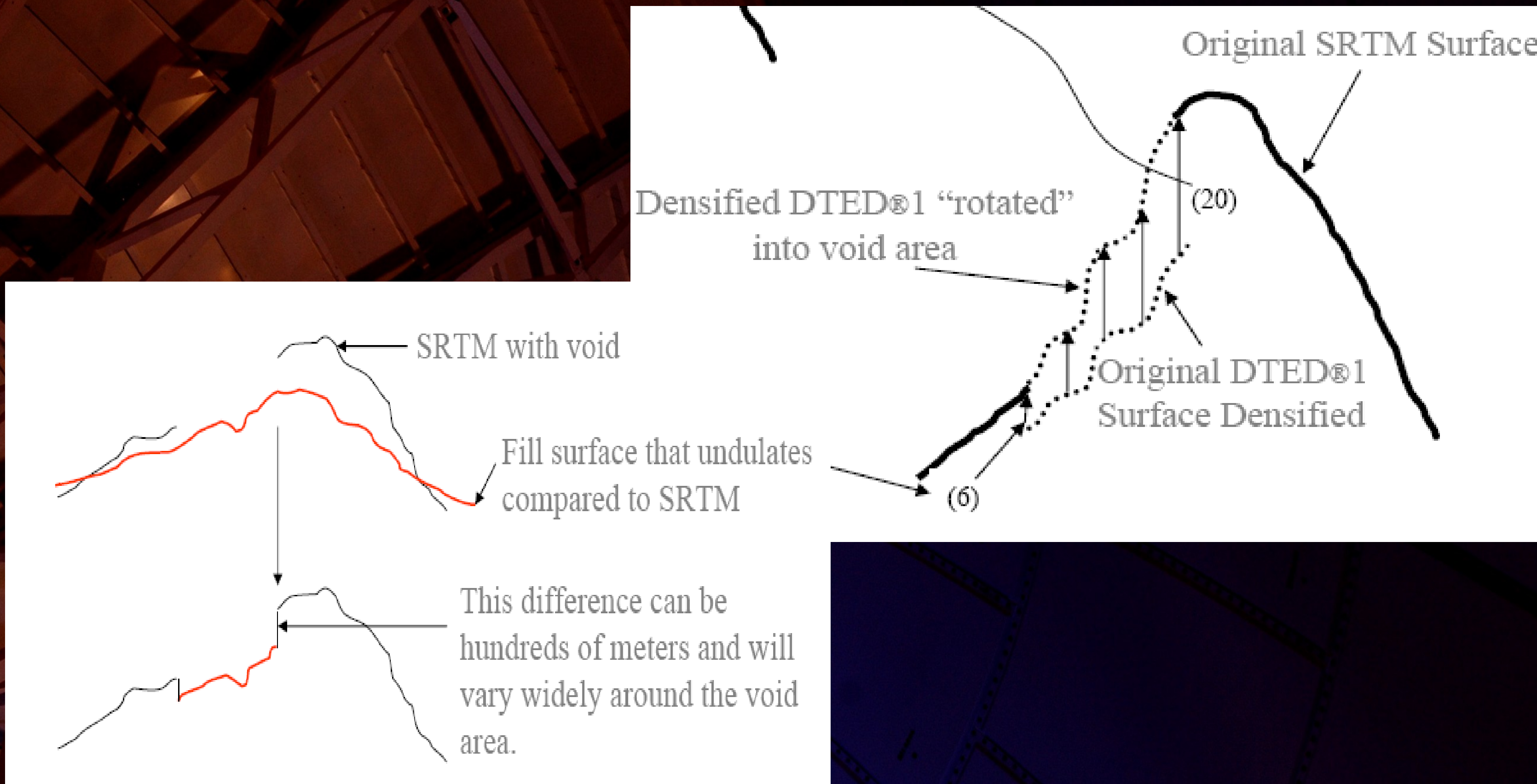


(Grohman, 2006)

The feather method uses a fill source pixel at the same geographic area without adjusting for the difference in elevation (*delta*) and then "feathers" the edges between the different data sources to mitigate the difference in elevation.

USGS

Delta Surface Fill



(Grohman, 2006)

SRTM Data Characteristics

Questions?

Next: GeoSUR SRTM Derivative Products

USGS

GeoSUR SRTM Derivative Products

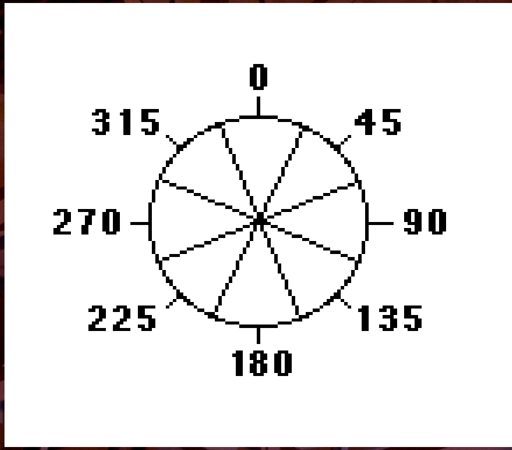
Initial Data offerings:

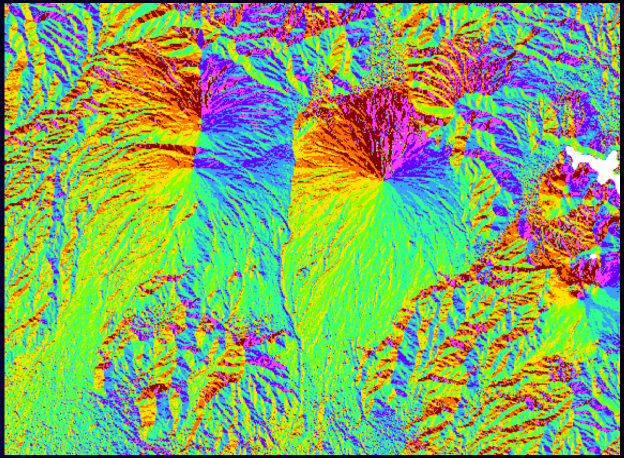
- **SRTM Level 1 (3 arc-second, ~90 m) and Level 2 (1 arc-second, ~30 m) derivatives:**
  - Aspect
  - Hillshade
  - Shaded Relief
  - Slope
- **Elevation Data**
  - SRTM Level 1 (90 m, 3 arc-second)
  - HydroSHEDs conditioned DEM
  - GTOPO30 (30 arc-second, ~1 km)

USGS

Aspect

The aspect data set describes the direction of maximum rate of change in the elevations between each cell and its eight neighbors. It is measured in positive integer degrees from 0 to 360, measured clockwise from north. Aspects of cells of zero slope (*flat areas*) are assigned values of -1 (ESRI, 2009a).

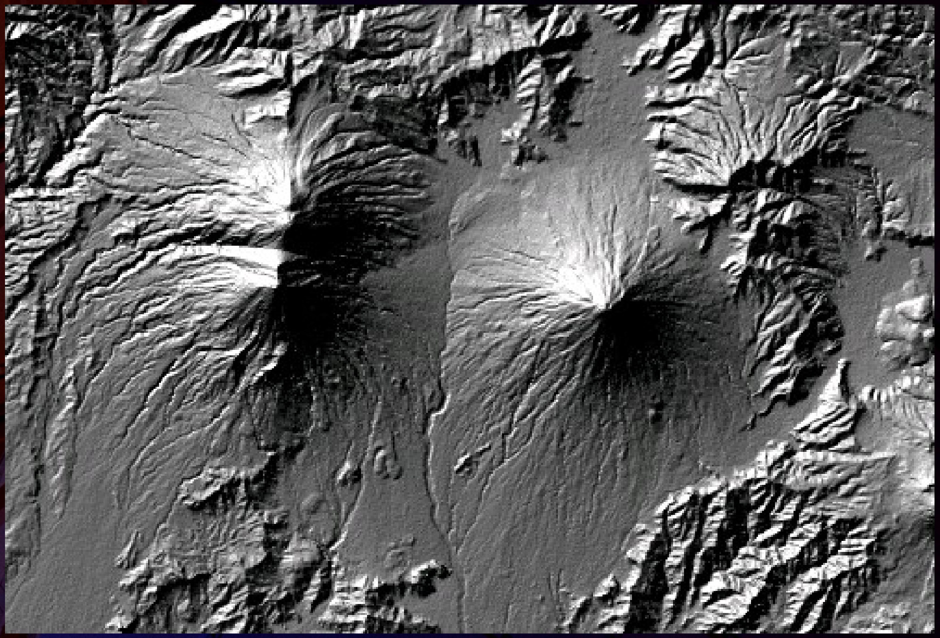




Hillshade

The Hillshade dataset contains shaded relief surface. The integer values enable the user to display a continuous surface of elevation, as opposed to topography which is broken into intervals (ESRI, 2009a).

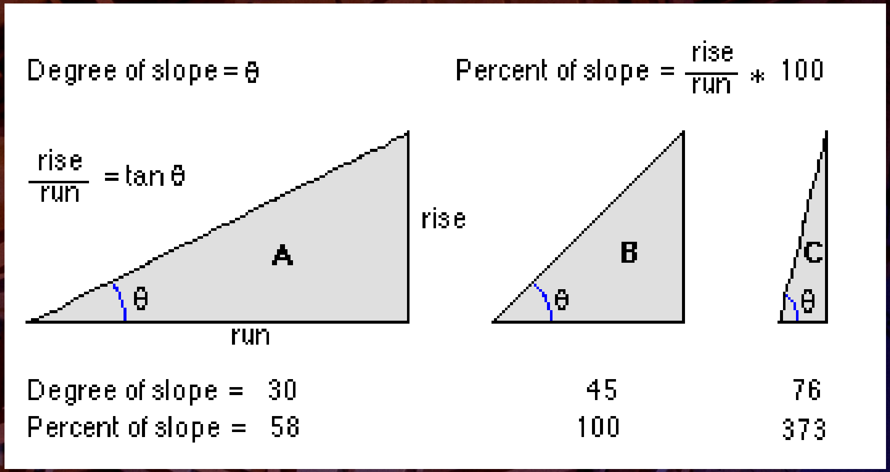
The cell values represent illumination, the values are from 0 to 255. Shaded relief surfaces are mainly used as background in maps and to illustrate elevation data.

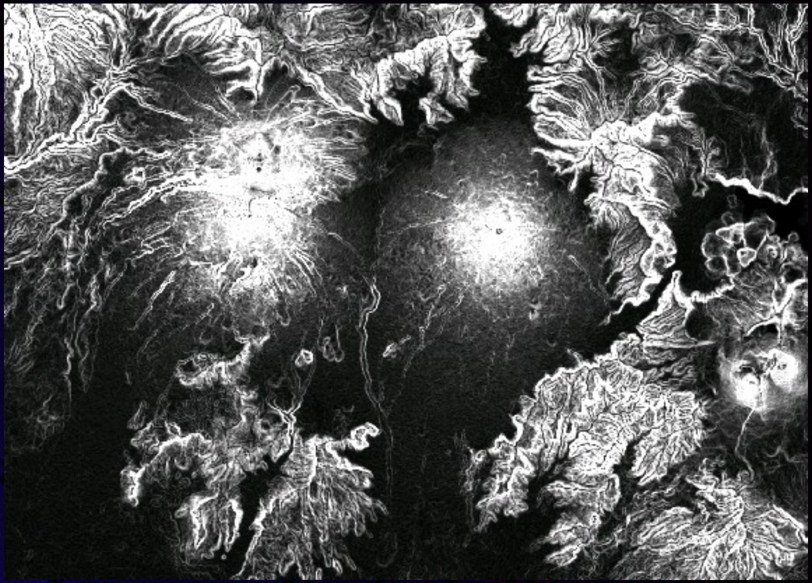


USGS

Slope

Slope identifies the maximum rate of change in value from each cell to its neighbors. An output slope raster can be calculated as percent slope or degree of slope (ESRI, 2009a).





GeoSUR SRTM Derivative Products

Dynamic Products

- Slope (degree, percent)
- Hillshade – define parameters
- Shaded Relief – (define shade symbology)
- Viewshed polygons
- Elevation profile model
- Slope classification
- Dynamic watershed delineation
- Raindrop trace

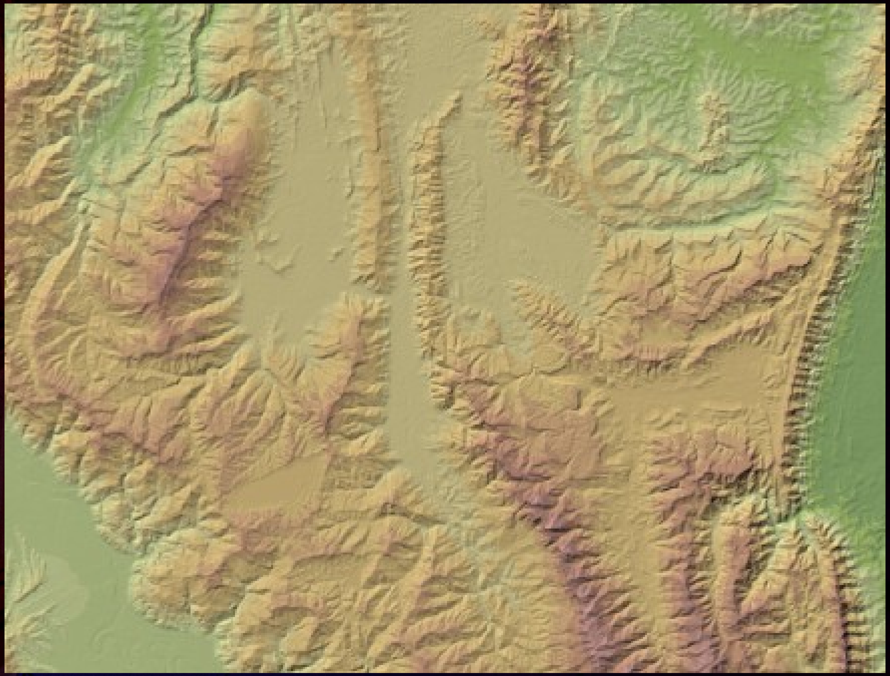
NOTE: *This dynamic processing environment is flexible and has opportunities to be modified to meet the user community needs.*

USGS

Shaded Relief

Dynamic Shaded Relief

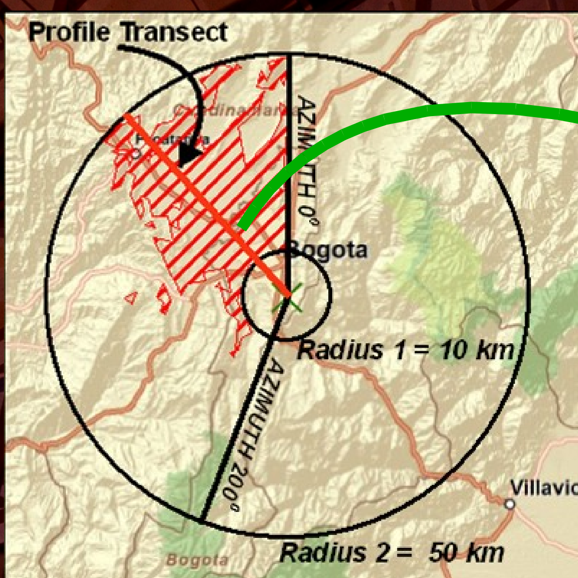
The cell values represent a composite illumination value from 0 to 255 and elevation classification. Color shaded relief surfaces are mainly used as background in mapping and displaying data.

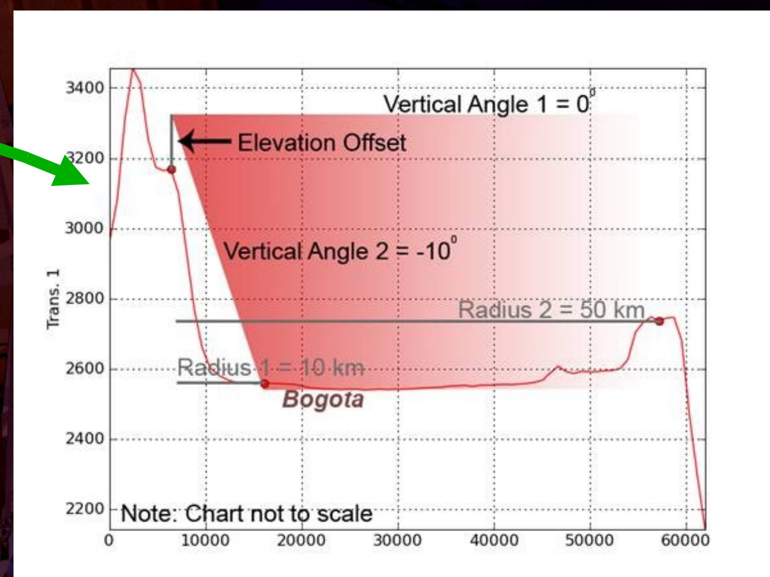


USGS

Viewshed Polygon Tool

- A Viewshed is an analysis that identifies all visible area from a given location.
- Viewshed allows the input of several parameters better isolate a visible area to meet user requirements.
  - Parameters: Elevation Offsets, Azimuths, Vertical Angles, and Radii.

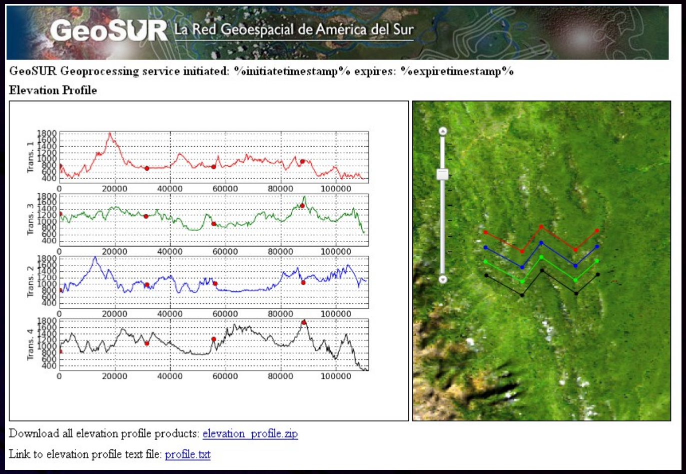




USGS

Elevation Profile Tool

- This tool allows you to input a series of transects and request elevation profiles for each transect.
- **The resulting profile information is returned in several formats:**
  - HTML format report
  - Comma delimited text file (*.txt)
  - Compressed archive file
    - Chart graphic (*.png)
    - Comma delimited text file (*.txt)
    - Transect line shapefile
    - Transect vertice shapefile

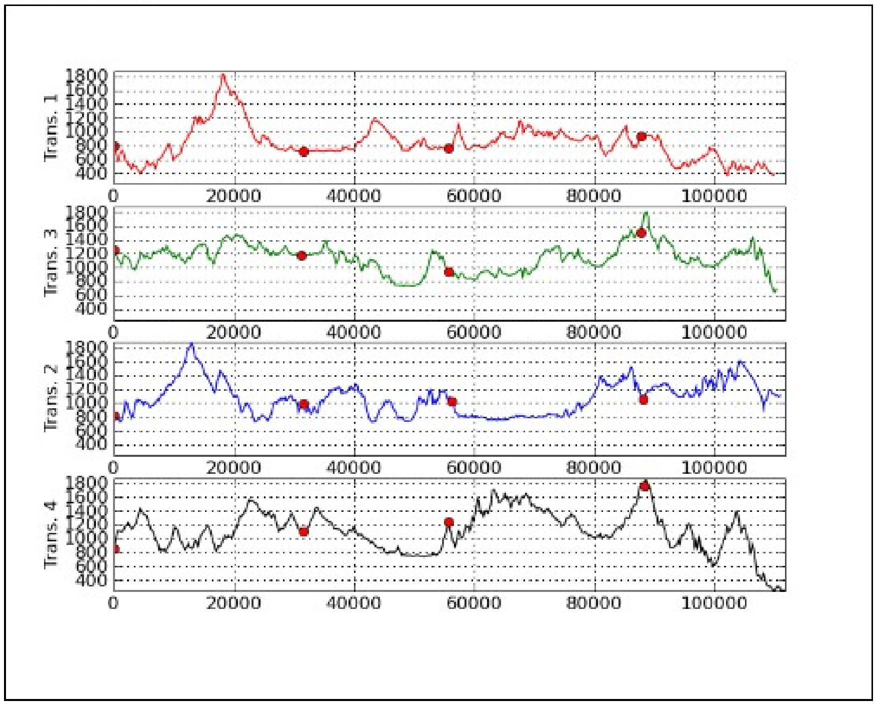


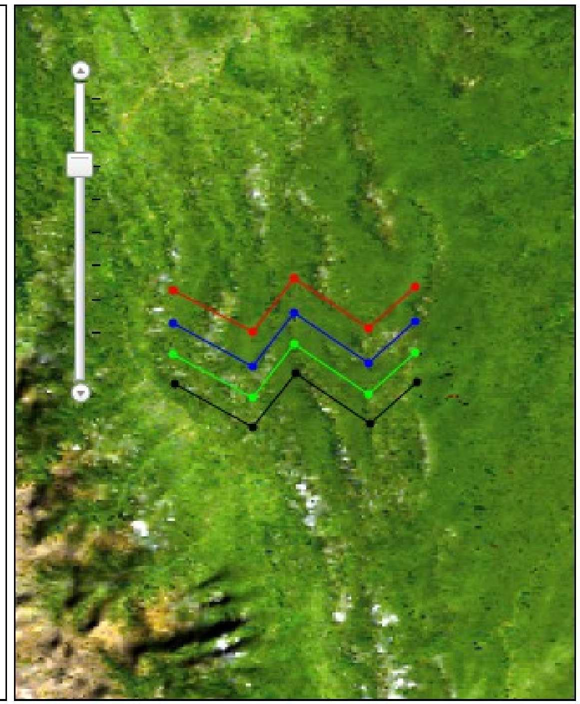
Elevation Profile Tool

GeoSUR La Red Geoespacial de América del Sur

GeoSUR Geoprocessing service initiated: %initiatetimestamp% expires: %expiretimestamp%

Elevation Profile





Download all elevation profile products: elevation_profile.zip

Link to elevation profile text file: profile.txt

Elevation Profile Tool

Profile comma delimited text file output:

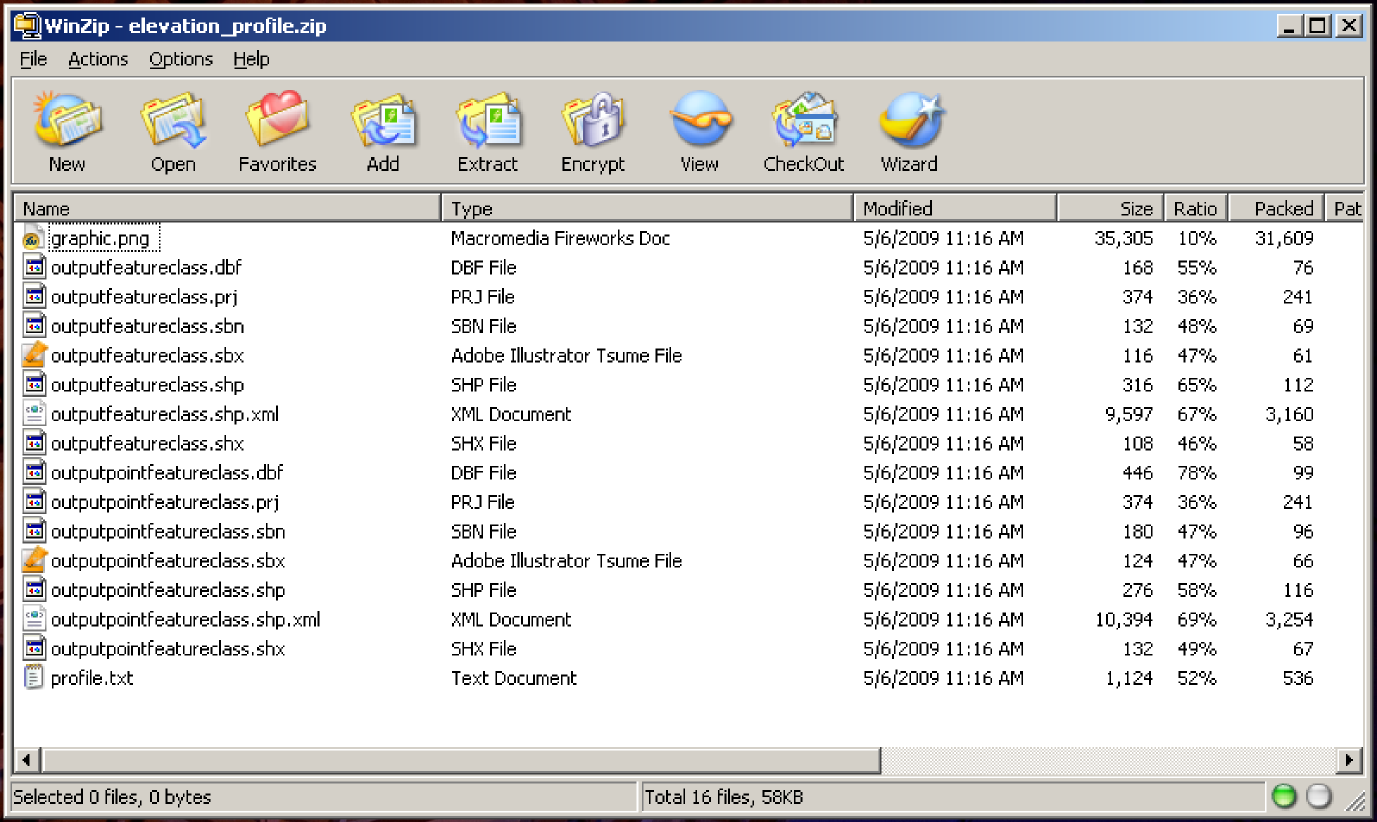
profile_example.txt - Notepad

File Edit Format View Help

ID	Pnt	Elevation
1	0	799.166314489
1	1	1592.07082393
1	2	2394.14641501
1	3	3182.70686517
1	4	3971.02926042
1	5	4765.25303637
1	6	5573.14125055
1	7	6377.54069566
1	8	7166.00108694
1	9	7961.74197202
1	10	8754.6850535
1	11	9544.59337276
1	12	10353.2098129
1	13	11156.9800353
2	24	22950.5962432
2	25	22742.6634623
2	26	23530.0824932
2	27	24328.4628242
2	28	25087.0607244
2	29	25855.6593963
2	20	26624.2582423
2	22	27392.8605276
2	22	28262.4589936
2	23	28930.057874
2	24	29698.6562962
2	25	20467.2546327
2	26	22235.8582092
2	27	22004.88222

Elevation Profile Tool

Profile compressed archive file contents:

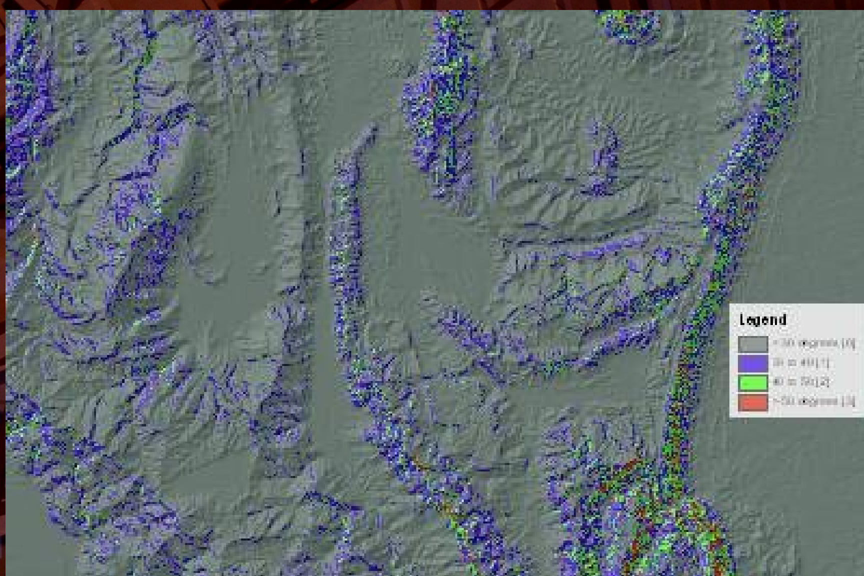


Name	Type	Modified	Size	Ratio	Packed	Pat
graphic.png	Macromedia Fireworks Doc	5/6/2009 11:16 AM	35,305	10%	31,609	
outputfeatureclass.dbf	DBF File	5/6/2009 11:16 AM	168	55%	76	
outputfeatureclass.prj	PRJ File	5/6/2009 11:16 AM	374	36%	241	
outputfeatureclass.sbn	SBN File	5/6/2009 11:16 AM	132	48%	69	
outputfeatureclass.sbx	Adobe Illustrator Tsume File	5/6/2009 11:16 AM	116	47%	61	
outputfeatureclass.shp	SHP File	5/6/2009 11:16 AM	316	65%	112	
outputfeatureclass.shp.xml	XML Document	5/6/2009 11:16 AM	9,597	67%	3,160	
outputfeatureclass.shx	SHX File	5/6/2009 11:16 AM	108	46%	58	
outputpointfeatureclass.dbf	DBF File	5/6/2009 11:16 AM	446	78%	99	
outputpointfeatureclass.prj	PRJ File	5/6/2009 11:16 AM	374	36%	241	
outputpointfeatureclass.sbn	SBN File	5/6/2009 11:16 AM	180	47%	96	
outputpointfeatureclass.sbx	Adobe Illustrator Tsume File	5/6/2009 11:16 AM	124	47%	66	
outputpointfeatureclass.shp	SHP File	5/6/2009 11:16 AM	276	58%	116	
outputpointfeatureclass.shp.xml	XML Document	5/6/2009 11:16 AM	10,394	69%	3,254	
outputpointfeatureclass.shx	SHX File	5/6/2009 11:16 AM	132	49%	67	
profile.txt	Text Document	5/6/2009 11:16 AM	1,124	52%	536	

USGS

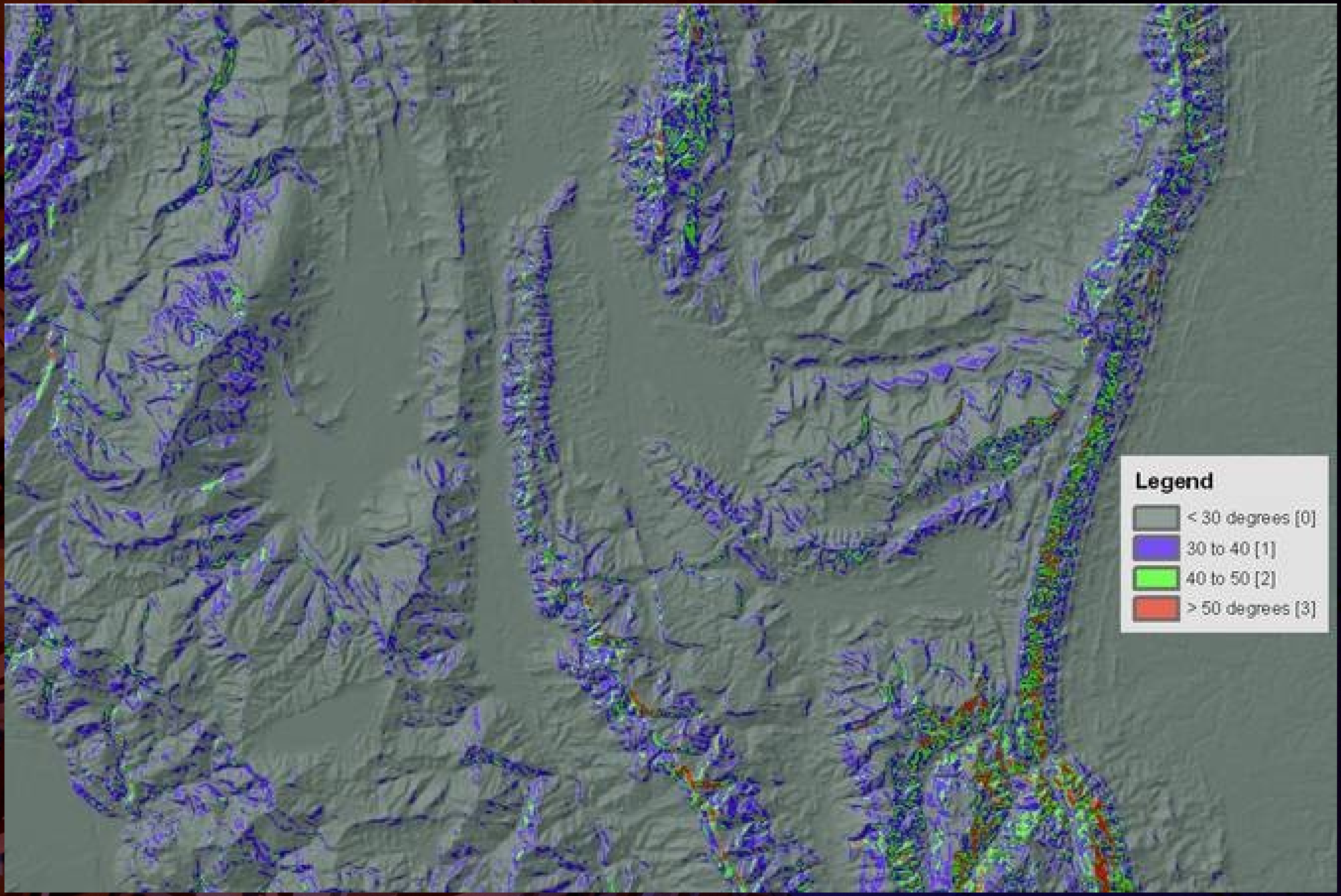
Slope Classification Tool

- Dynamic tool that allows you to define a slope classification scheme and submit the scheme to a selected elevation data source.
- This tool is a basic GIS model implemented to serve as a springboard for the discussion of online geoprocessing services.



Slope Classification Tool

Slope Classification example product.

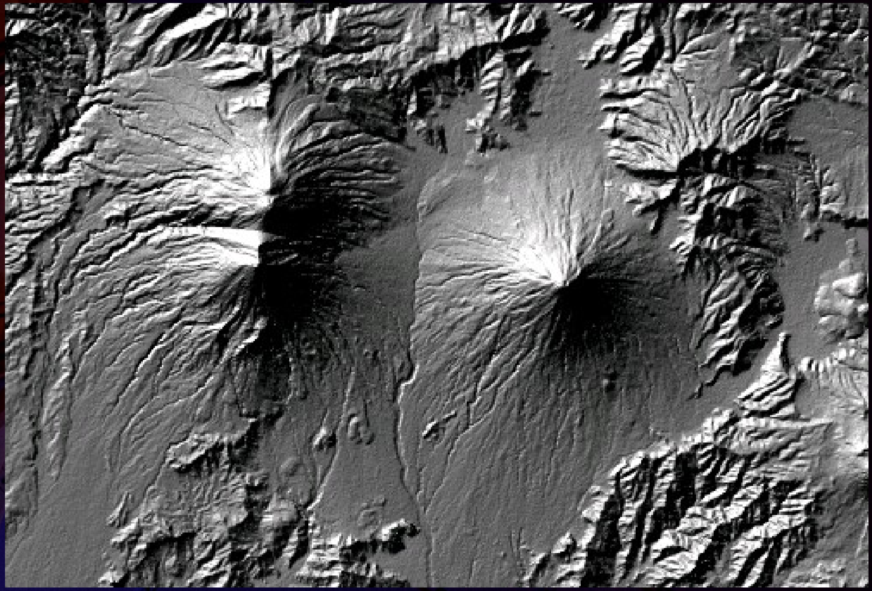


Dynamic Hillshade Tool

This dynamic tool provides the similar results as the prepocessed hillshade product, but it allows you to input desired illumination parameters.

Illumination Parameters:

- **Azimuth –** Angle of the light source (0 to 360).
- **Altitude –** Angle of the light source above the horizon (0 to 90).
- **Z factor (scaling) –** number of ground x,y units in one surface z unit.



USGS

GeoSUR Data Services

- SRTM 1 arc-second (30 m) Hillshade
- SRTM 1 arc-second Aspect
- SRTM 1 arc-second Slope
- ASTER 1 arc-second G-DEM (*tentative*)
- **HydroSHEDs**
  - Void filled 3 arc-second (90 m) DEM
  - Hydrologically conditioned 3 arc-second (90 m) DEM
  - Flow direction (3 arc-second)
- **USGS original GTOPO**
- **USGS / NGA enhanced GTOPO products**
  - 30 arc-second (1 km) break-line DEM (*tentative*)
  - 15 arc-second (500 m) break-line DEM (*tentative*)
  - 7.5 arc-second (250 m) break-line DEM (*tentative*)

USGS

GeoSUR Geoprocessing (GP) Services

- **DEM Derivatives Toolbox**
  - Elevation Profile
  - Slope Classification
  - Aspect
  - Color Shaded Relief
  - Hillshade
  - Slope
- **GTOPO30 Sample Hydro-modelling toolbox (30 arc-second)**
  - Viewshed Analysis
  - Watershed delineation
  - Raindrop Trace

GeoSUR SRTM Derivative Products

Questions?

Next: USGS/NGA new GTOPO products

USGS/NGA Enhanced GTOPO Products

Presented by Jeffrey J. Danielson of the USGS.

USGS

Objectives – Day 2

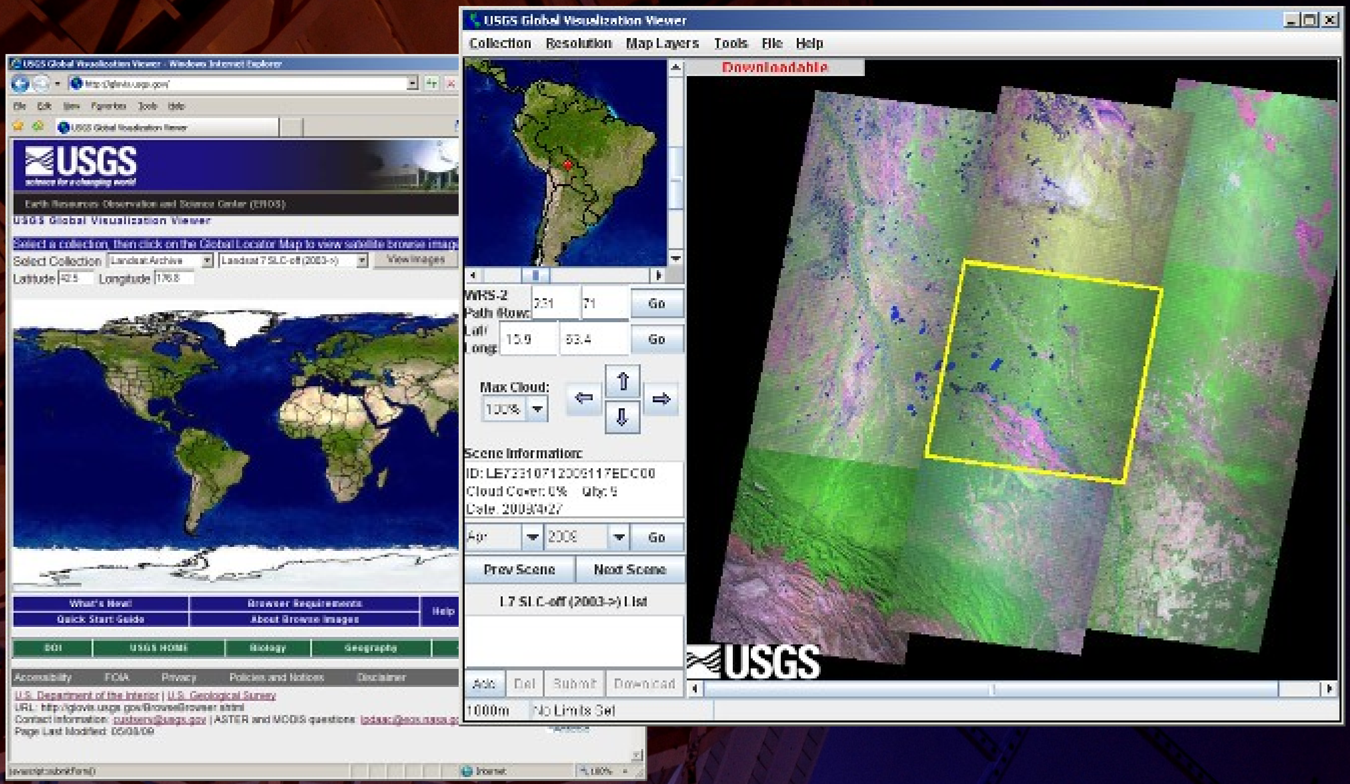
- Learn how to access and acquire remote sensing data via the Internet using resources made available by the USGS and other ....
- Gain a comprehensive understanding of working in ESRI's ArcGIS environment.
- Understand the concept of web services and where and how to use them.

Accessing Satellite Imagery

- **Landsat – Free!**
  - Landsat presentation by Eugene Fosnight for the USGS.
- **TerraLook – Free!**
  - TerraLook presentation by Claudia Young (SGT).
  - TerraLook presentation by Eugene Fosnight for the USGS.

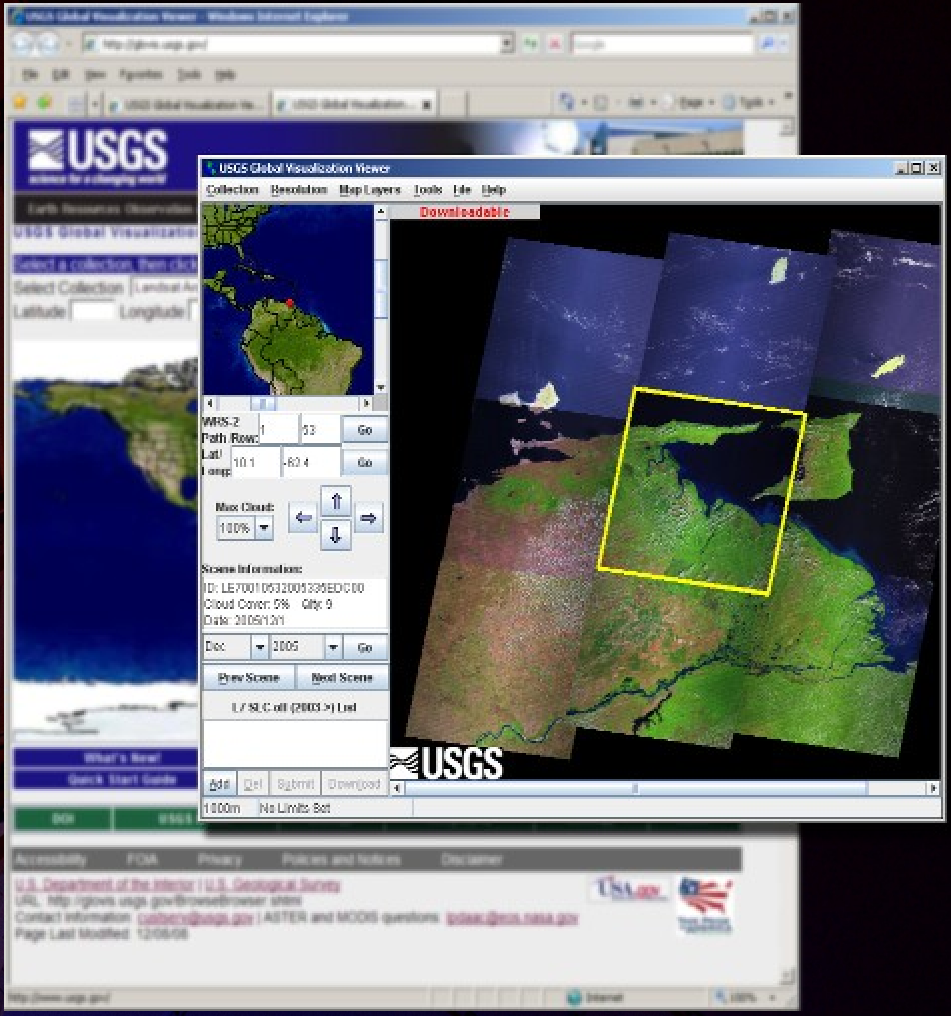
USGS Global Visualization Viewer

Overview of acquiring satellite imagery using USGS Global Visualization Viewer (GloVis) (glovis.usgs.gov)



GloVis Download Exercise

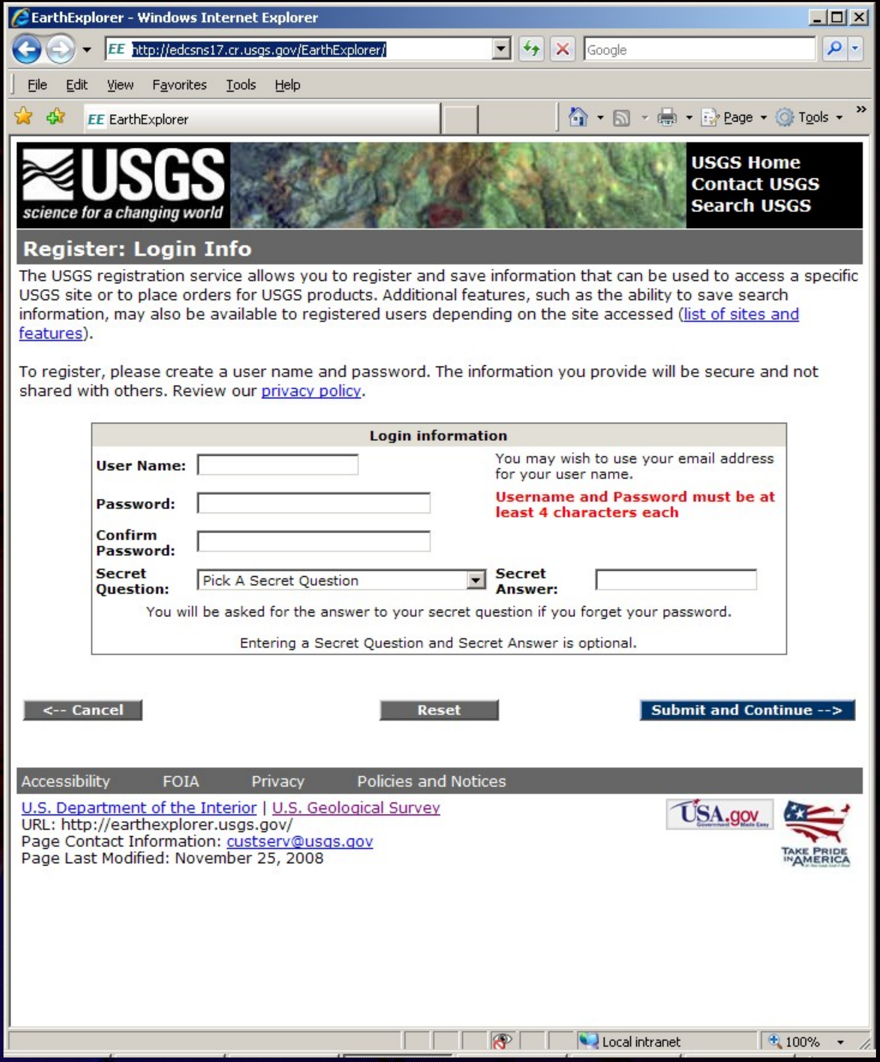
- **GloVis Exercise:**
- Download one complete Landsat scene of your choosing. Remember to download all bands.



Instructor lead

USGS Earth Explorer

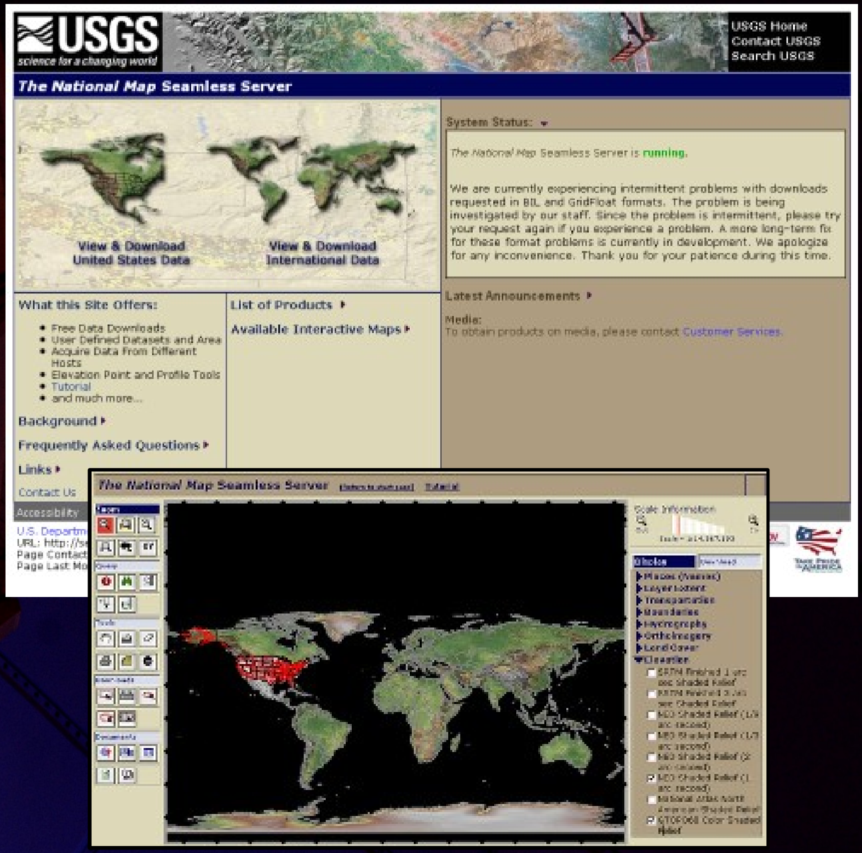
- Before acquiring data from GloVis, you must register with USGS's EarthExplorer.
- To register, open a web browser and go to http://*earthexplorer.usgs.gov* to begin the registration process.



USGS

Acquiring Elevation Datasets

- **USGS Seamless Data Distribution System (SDDS)**
- http://seamless.usgs.gov
- **Gobal Data available**
  - SRTM 3 arc-second DEM and Hillshade



Note: For help on using SDDS, visit the Seamless online tutorial site at http://seamless.usgs.gov/tutorial.php

Global Land Cover Facility (GLCF)

Data offered by the GLCF (http://glcf.umiacs.umd.edu)

- Landsat Imagery (ETM+, TM, and MSS)
- ASTER (very limited for South America)
- SRTM 3 arc-second (same product as USGS Seamless)
- SRTM 30 arc-second (1 km)
- MODIS Products
- AVHRR Products

USGS

Accessing Spatial Data Online

Questions?

Next: Web Services

Web Services

What are Web Services?

- There are many things that might be called "Web services" in the world at large. However, for the purpose of this Working Group and this architecture, and without prejudice toward other definitions, we will use the following definition:

- **“A Web service is a software system designed to support interoperable machine-to-machine interaction over a network**. It has an interface described in a machine-processable format (specifically WSDL). Other systems interact with the Web service in a manner prescribed by its description using SOAP-messages, typically conveyed using HTTP with an XML serialization in conjunction with other Web-related standards” - W3C, 2009.

Web Services

- **Web services in respect to the geospatial environment**
  - There several ways to build geospatial Web services that can either proprietary or open source. The Open Geospatial Consortium (OGC) is the governing body of the dominate open source standards. ESRI and Google are the dominate players in the proprietary geospatial Web services. Even though ESRI and Google have proprietary Web services, they are also members of OGC and contribute to the open source development.
- **Types of Web services**
  - Open Source OGC services
    - Web Map Service (WMS)
    - Web Features Service (WFS)
    - Web Coverage Service (WCS)
    - Web Processing Service (WPS)
  - For an in-depth look at each of the services, visit OGC standards Web site at http://www.opengeospatial.org/standards

USGS

Web Services

Types of Web Services

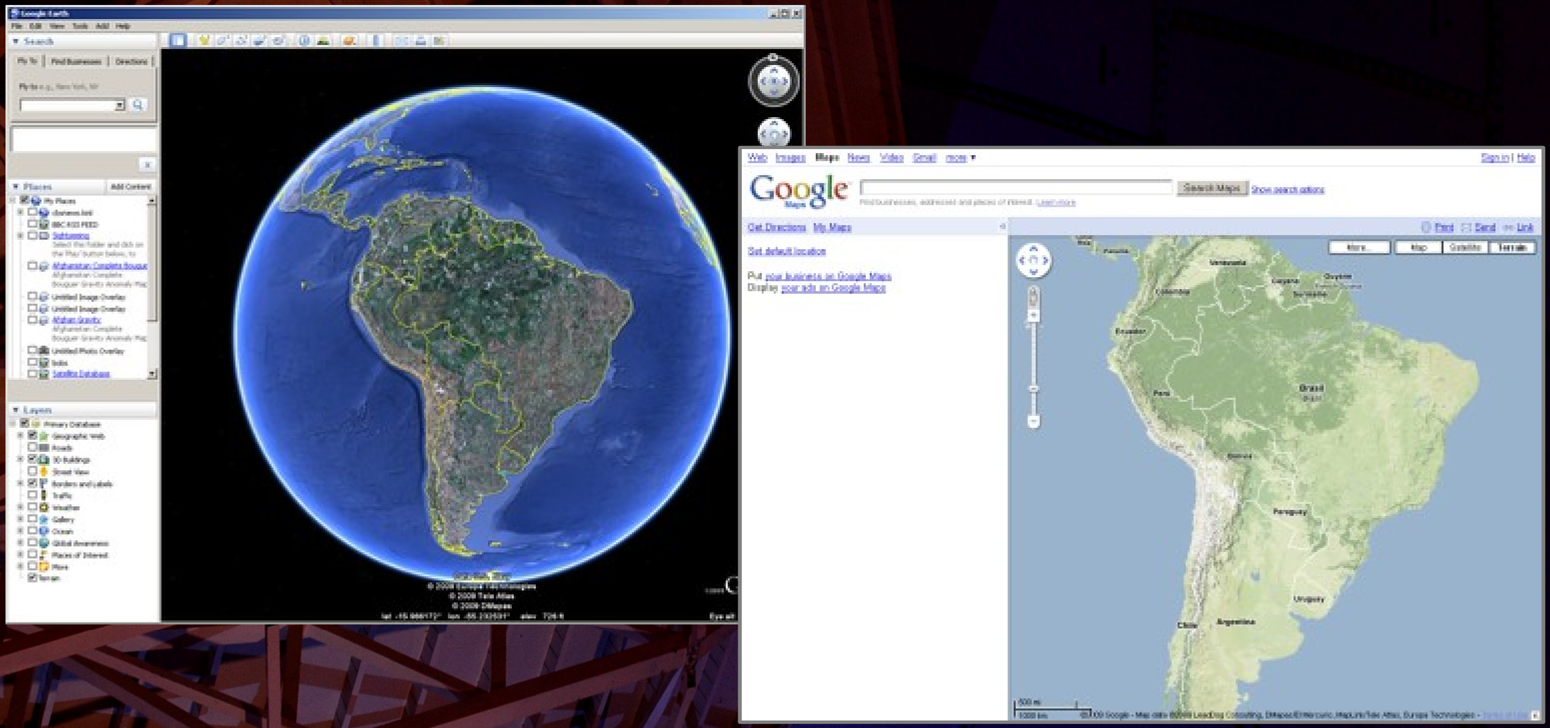
- ESRI Web Services currently applied by GeoSUR (Currently)
  - **Geoprocessing -** "ArcGIS Server is a comprehensive, Web-based GIS that provides a range of out-of-the-box applications and services for mapping, analysis, data collection, editing, and management of spatial information. A geoprocessing service contains geoprocessing tasks accessible by clients. Tasks are created by publishing geoprocessing toolboxes or map documents containing tool layers. When you execute a task in a geoprocessing service, it executes on the server computer, using resources of the server computer." (ESRI, 2009f)
  - **Image Service -** "An image service provides access to raster data through a Web service. The source of the raster data can be a raster dataset (from a geodatabase or file on disk), a layer file referencing a raster dataset, or a compiled image service definition (containing one or more raster datasets and defined processes) created using ArcGIS Image Server. Once you publish this raster data to your server, you can use the resulting image service in ArcGIS Desktop the same way you would add any other GIS service layer." (ESRI, 2009g)
  - **Map Service -** "A map service is the most common ArcGIS service and can contain many capabilities and functions. Map services certainly support mapping and map viewing, but can also support modeling and geoprocessing, mobile GIS services, and open publishing as OGC WMS, OGC WCS, and KML." (ESRI, 2009h)

USGS

Web Service Examples

Google Earth and Google Maps (Map)

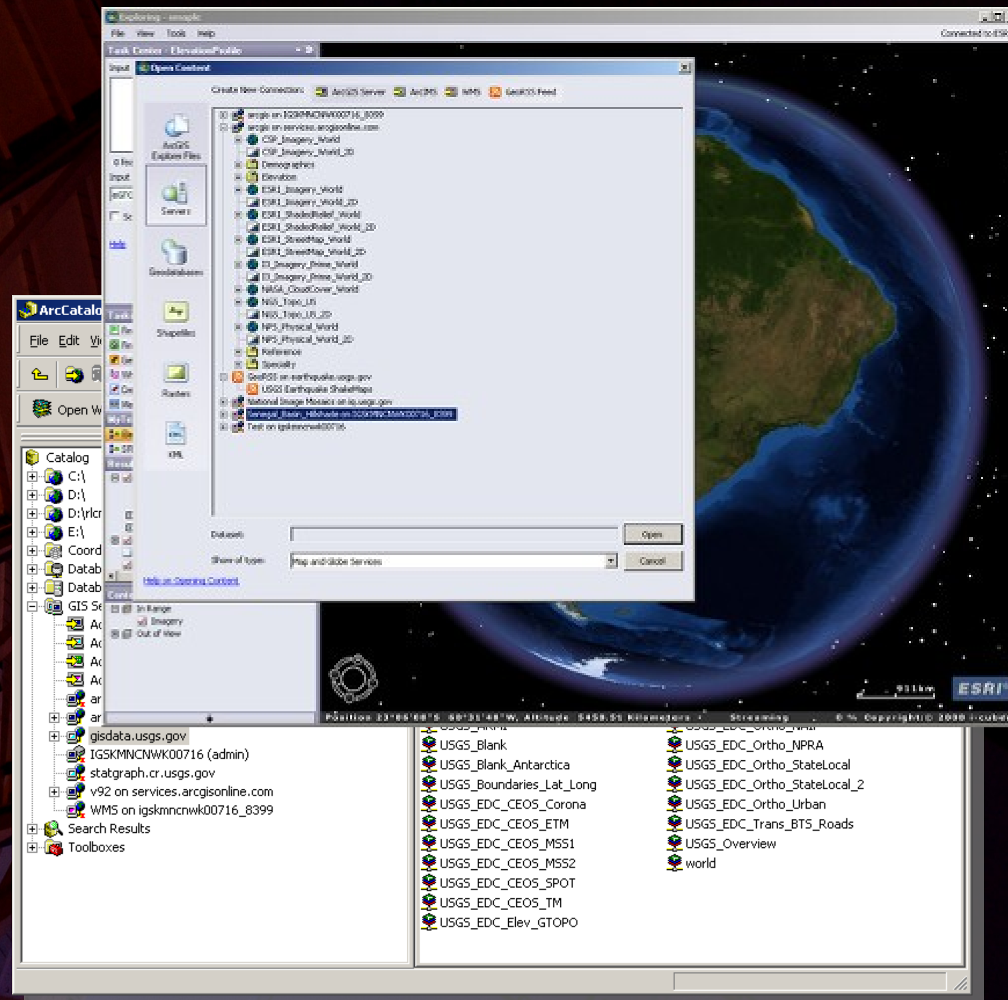
These applications are used to view the map services.



Web Service Examples

ESRI Services

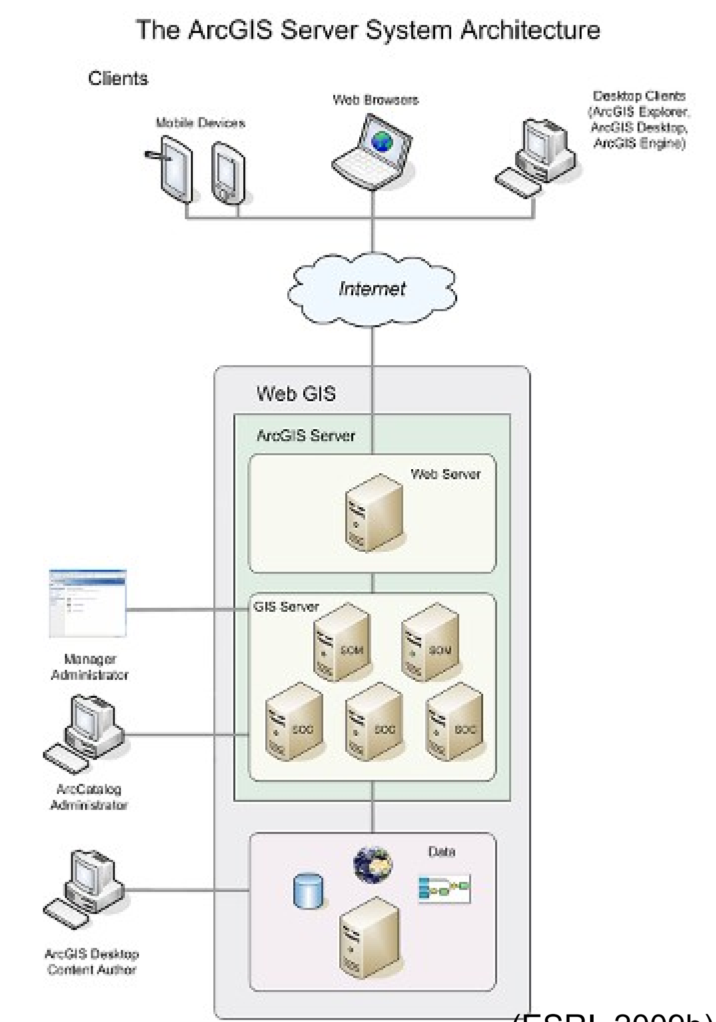
- ArcGIS Explorer
  - WMS
  - Image Services
  - GeoRSS Feeds
- ArcCatalog
  - WMS
  - WCS
  - Image Service
  - Map Service



USGS

GeoSUR ArcGIS Server Architecture

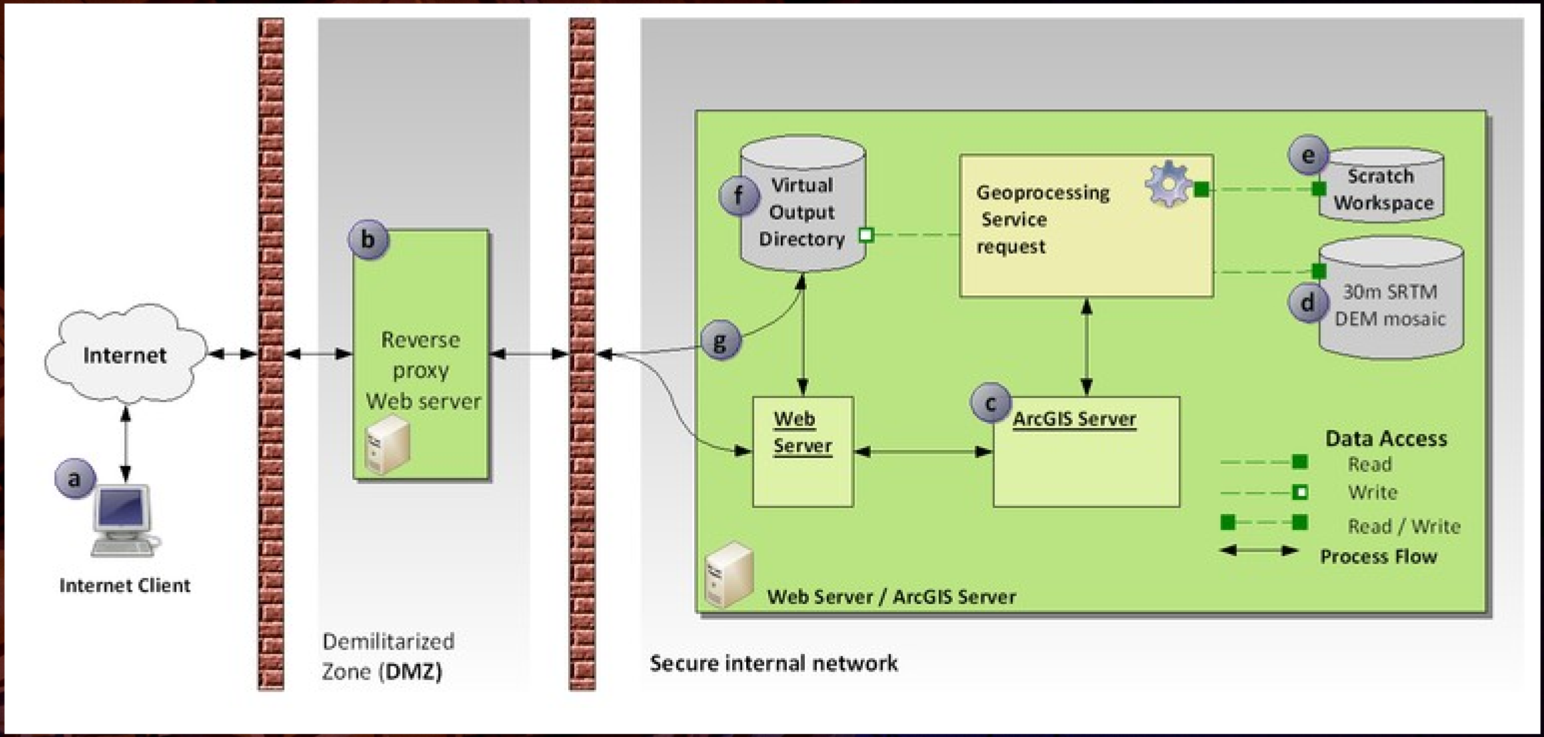
- **Web Clients**
  - Mobile devices, Web Browser, and desktop clients.
- **Web Server**
- **GIS Server(s)**
- **Administrative Client**
- **Desktop Clients**



(ESRI, 2009b)

USGS

GeoSUR ArcGIS Server Architecture



The ArcGIS Ecosystem

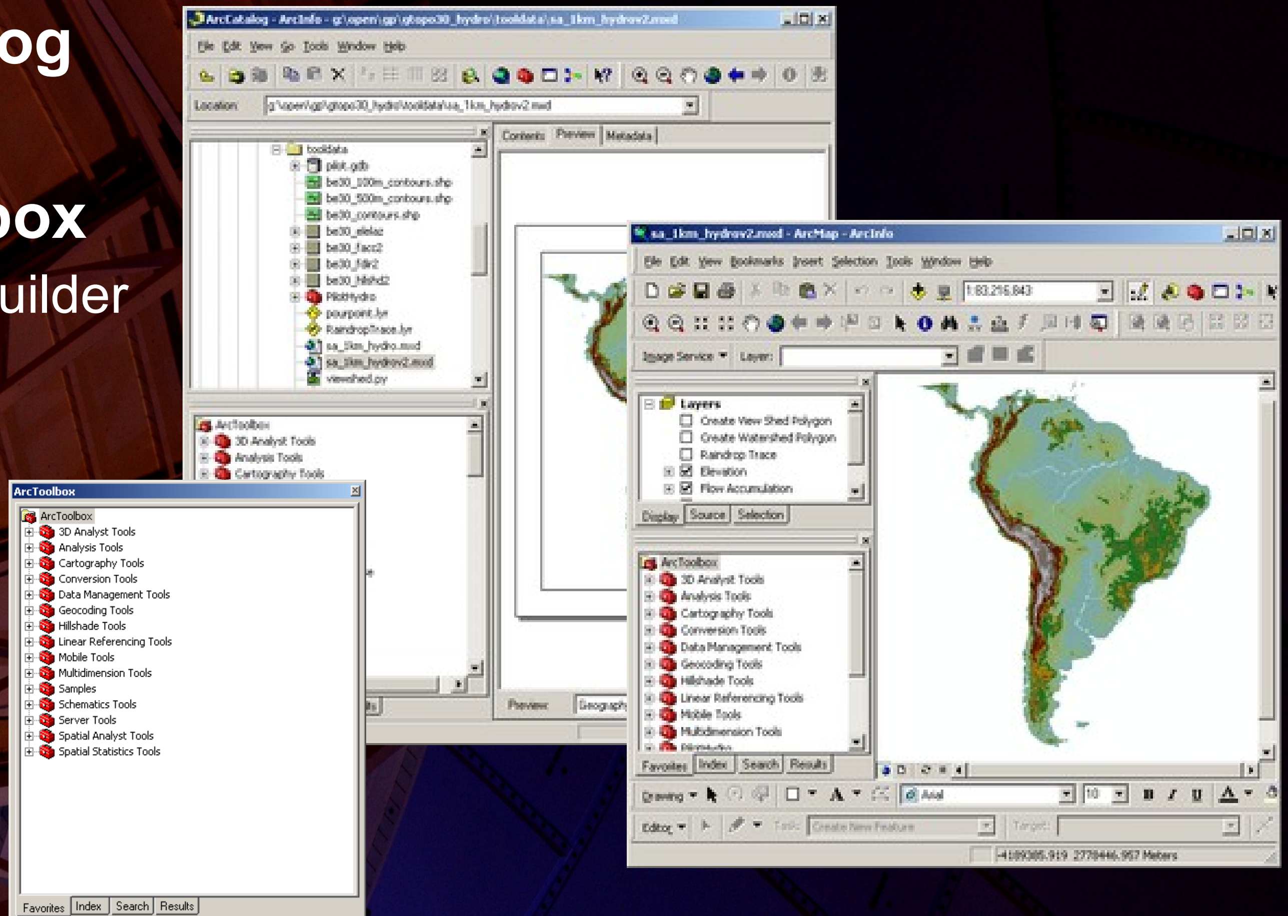
ArcGIS

- ArcGIS Explorer (Free)
- ArcGIS Desktop
- ArcGIS Server
- ArcGIS Engine (Developers)

ArcGIS Desktop

ArcGIS Desktop three core components

- ArcCatalog
- ArcMap
- ArcToolbox
  - ModelBuilder

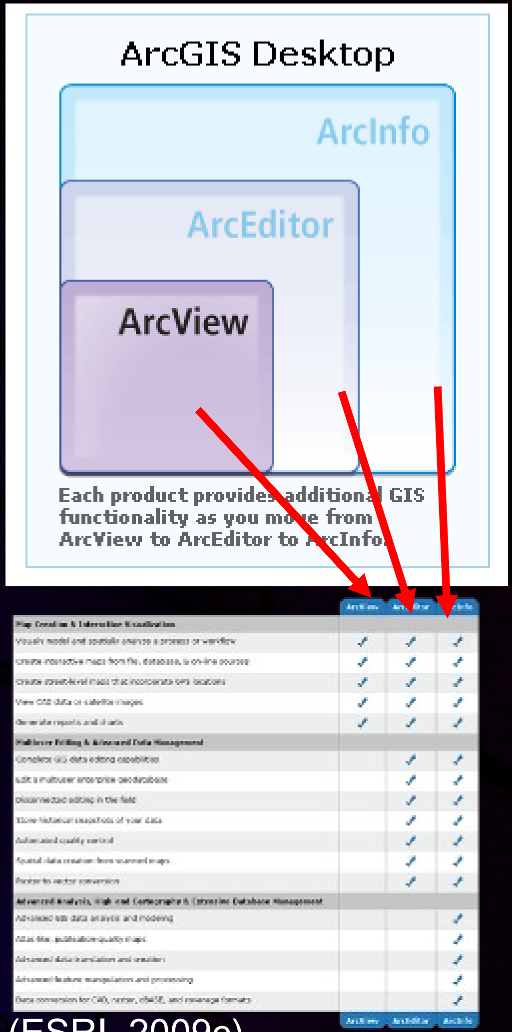


USGS

ArcGIS Licensing

ArcGIS Desktop has 3 licensing levels. The higher the level the greater the functionality. Parallel with functionality is cost.

- **ArcView $**
- **ArcEditor $$**
- **ArcInfo $$$**



(ESRI, 2009c)

ArcGIS Desktop

ArcCatalog

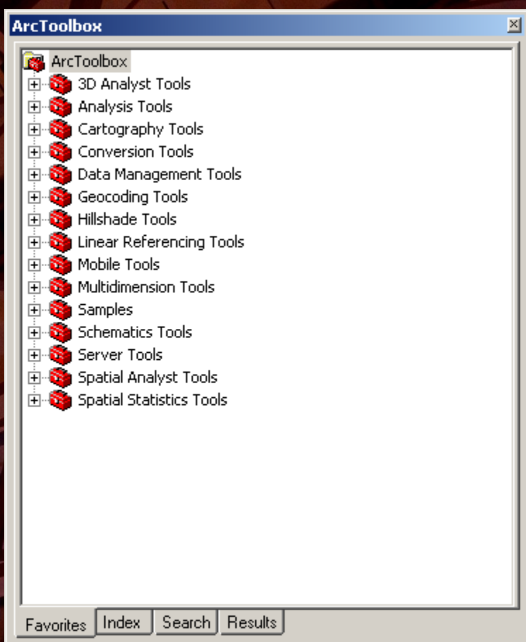
- ArcCatalog's main purpose is to assist you in managing geospatial data. The user interface is based on the common file tree structure, but provides access to all spatial properties of a given element.
- **Common tasks utilized:**
  - Create spatial data (Shapefile, Geodatabase, Raster, etc...)
  - Initialize geoprocessing analysis on spatial data (ArcToolbox)
    - Examples Include: Projecting data, buffering, zonal statistics, etc.
  - Access or interface with enterprise level spatial data such as ArcSDE and GIS Services.

USGS

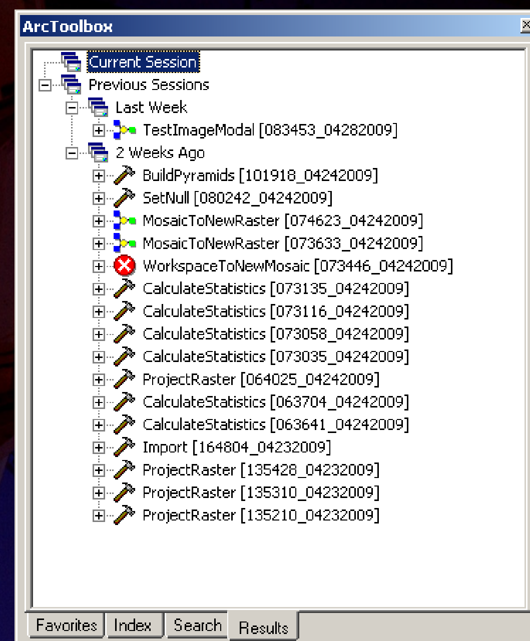
ArcToolbox

ArcToolbox is where you have access to all the <u>core</u> geoprocessing functions that are delivered with ArcGIS Desktop.

Toolbox Browser Window

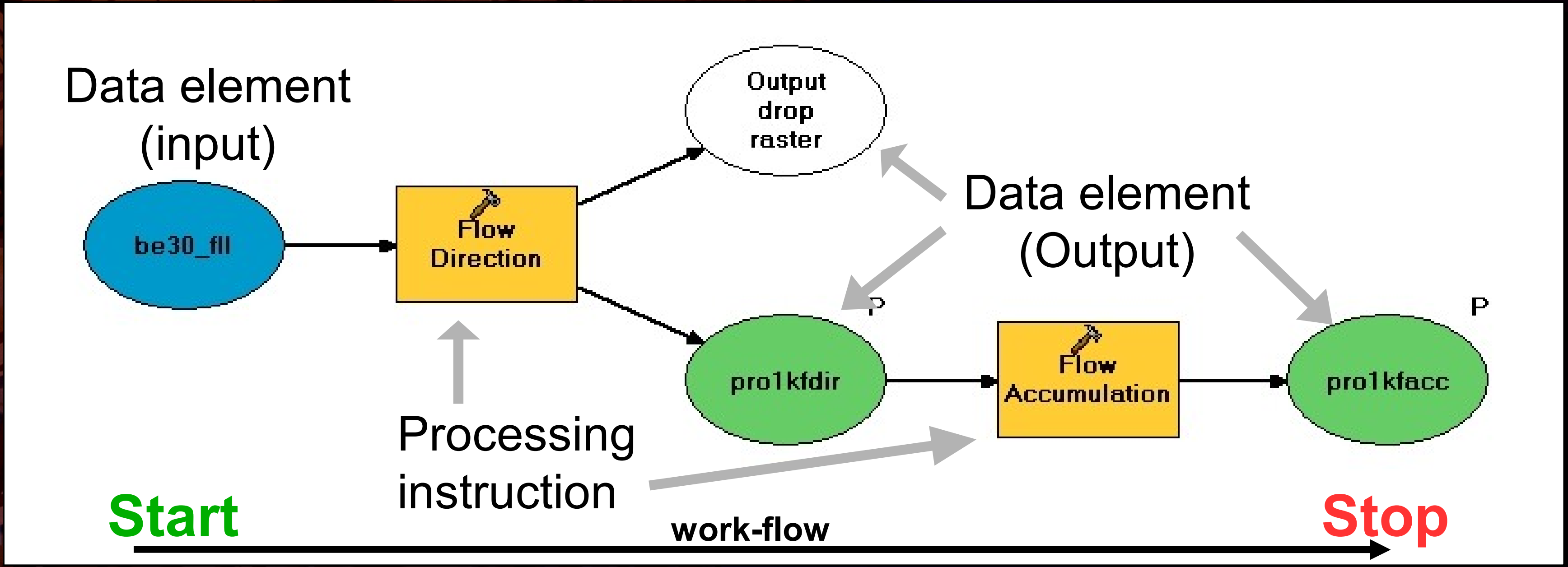


Toolbox Results Log



ModelBuilder

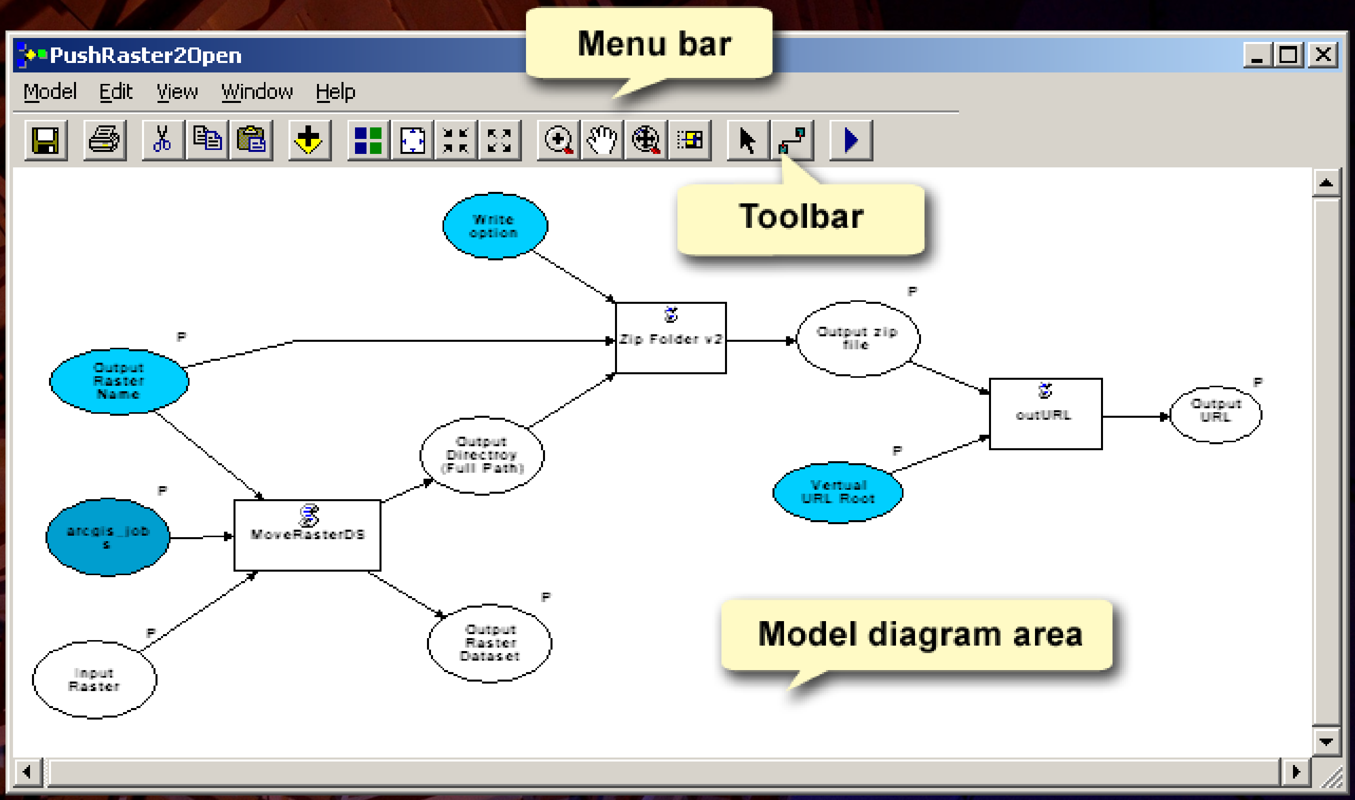
A model in respect to ArcGIS is a collection of processing instruction and data elements organized to execute in a defined sequence or workflow.



USGS

ModelBuilder

Use the *ModelBuilder* tool to organize instructions.



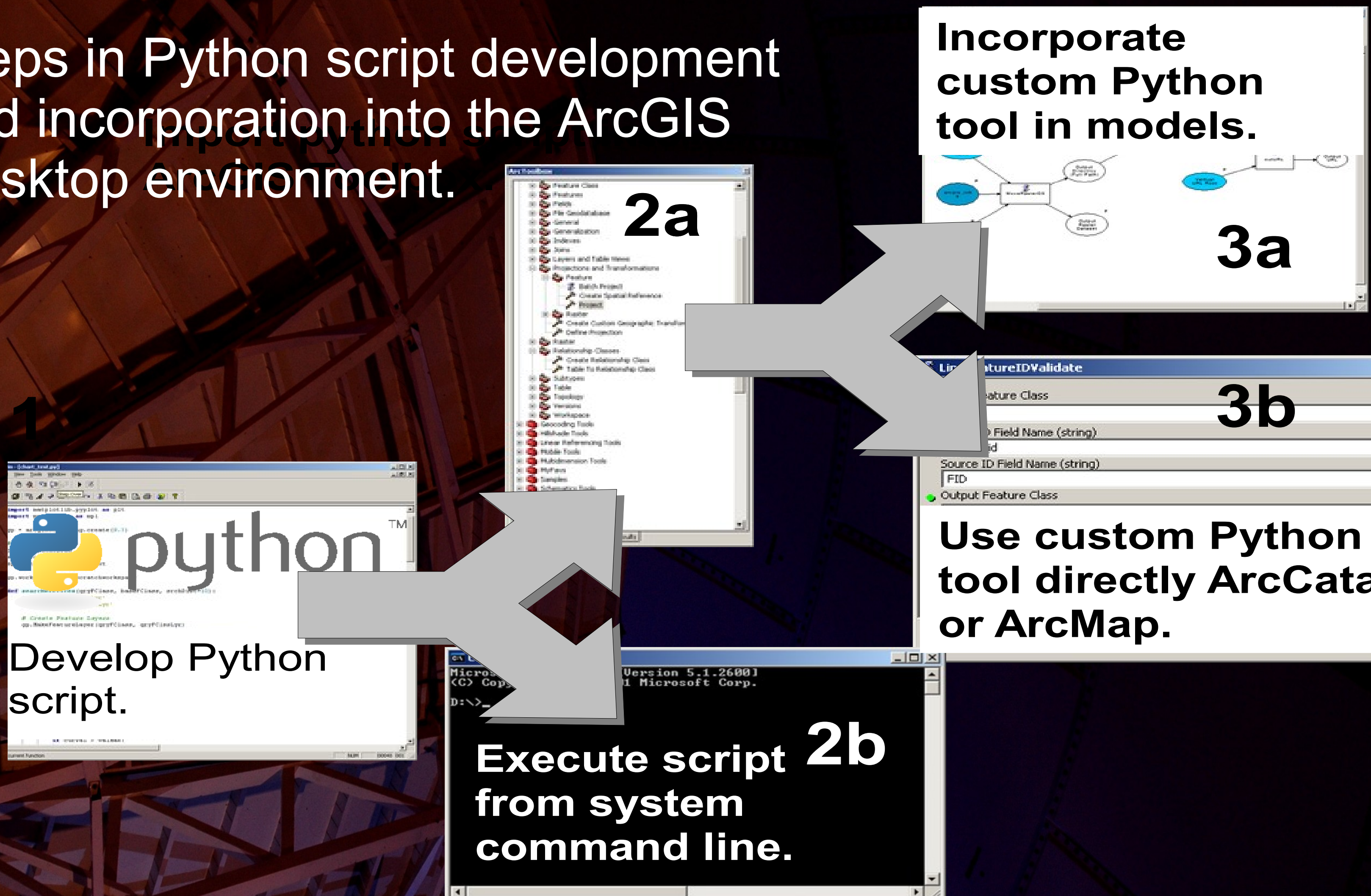
USGS

Extending Geoprocessing with Python

- ArcGIS allows you to extend the existing Toolboxes by leveraging the power and flexibility of the Python programming environment.
- You can write your own Python application using existing ArcGIS geoprocessing objects as well as incorporating other powerful Python objects into an application.

Python Develop Workflow

1) Steps in Python script development and incorporation into the ArcGIS Desktop environment.



ArcMap

ArcMap can be used in several unique ways. An obvious use of the application is the tool to produce maps. Other applications are as follows:

- Spatial analysis processing environment
- Development platform for creating GIS software applications (i.e. ArcObjects).
- Create map to be published online via ArcGIS Server.

Managing Raster Datasets

Basic questions to consider when defining a spatial data management scheme.

- **What type of raster data is being managed?**
  - Continuous or thematic?
  - Bit depth? (8, 16, 32, etc...)
  - Total disk storage space required?
- **What is its primary use?**
  - Archive or Active dataset?
- **Does the data require secure access?**
- **What are the access requirements of the users?**
  - Local, LAN, remote access, and/or Internet access?

USGS

Managing Raster Datasets

Storage options for raster datasets.

- **Flat file**
  - File formats: GRID, Tiff, ERDAS IMG, JPG2000, etc
- **Database storage**
  - Personal Geodatabase (Managed or unmanaged)
  - File Geodatabase (Managed or unmanaged)
  - ArcSDE Enterprise level
    - Platforms: Oracle, SQL Server, PostgreSQL (open source)
    - Informix, and IBM DB2.
- **Data access options**
  - Geodatabase access
  - Direct Access
  - Web Services Client access

The ArcGIS Ecosystem

Questions?

Next: Overview of ArcGIS Geodatabase

USGS

Overview of the Geodatabase

- **On a basic level a Geodatabase (GDB) is a container for storing spatial data and attributes.**
- **Data types that can be stored in a GDB**
  - Vector data
  - Raster
  - Tables (non-spatial)

USGS

Types of Geodatabases

- **Personal Geodatabases:**
  - Have .mdb extension.
  - Can be viewed by multiple users but edited by only one user at a time.
  - Have a maximum size of 2 Gigabytes.
  - Windows only.
- **File Geodatabases (New in 9.2)**
  - Have .gdb extension
  - Single users and small workgroups.
  - Have a maximum size of 1TB per dataset
  - Cross-platform
- **Multi-user Geodatabases:**
  - Require ArcSDE and a DBMS (Data Base Management Systems).
  - Can be read and edited by multiple users at the same time.
  - Versioning.

Geodatabase Elements

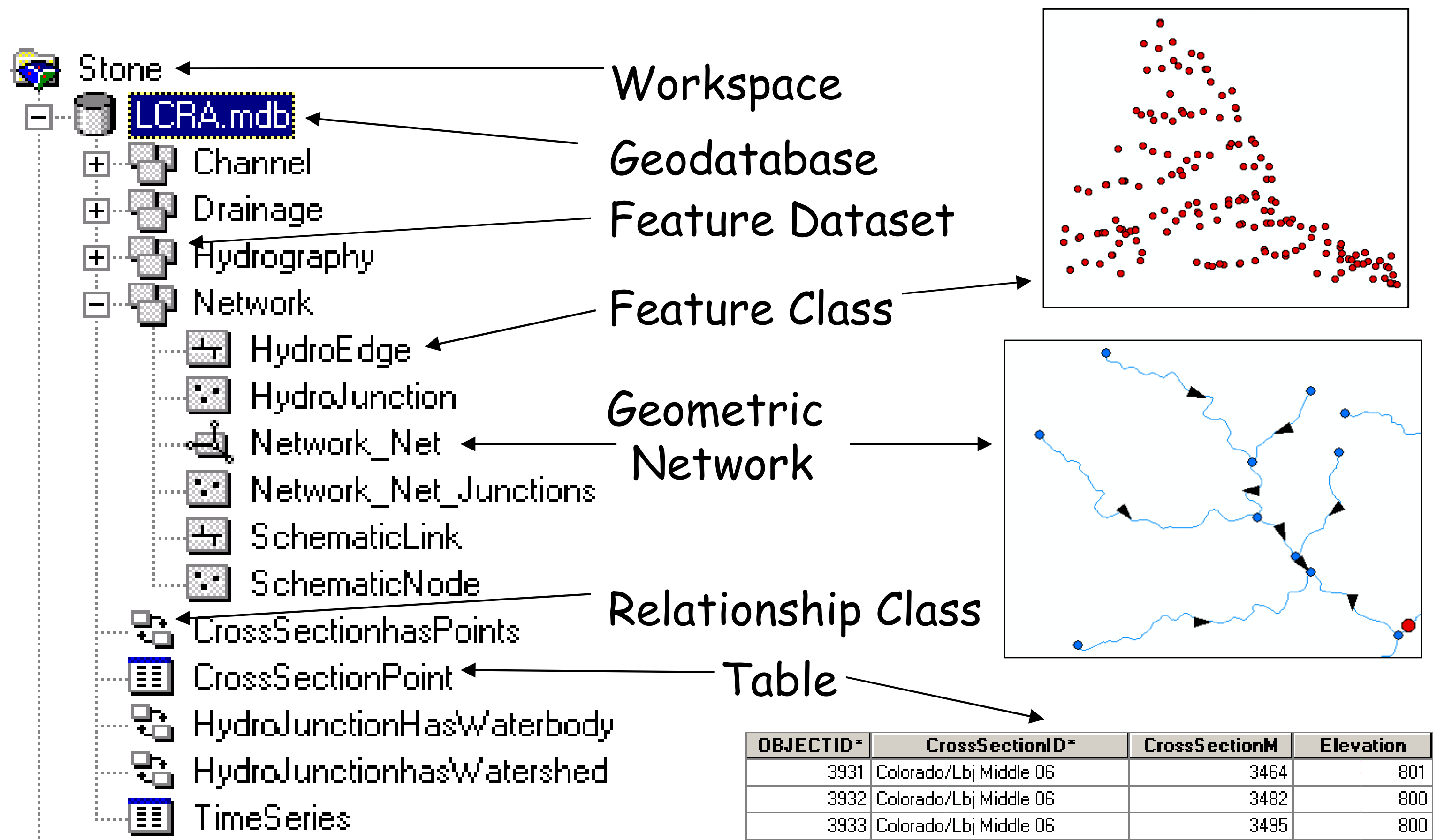
Table
A collection of rows, each containing the same fields. Feature classes are tables with shape fields.

Feature class
A table with a shape field containing point, line, or polygon geometries for geographic features. Each row is a feature.

Raster dataset
Contains rasters which represent continuous geographic phenomena.

(ESRI, 2009i)

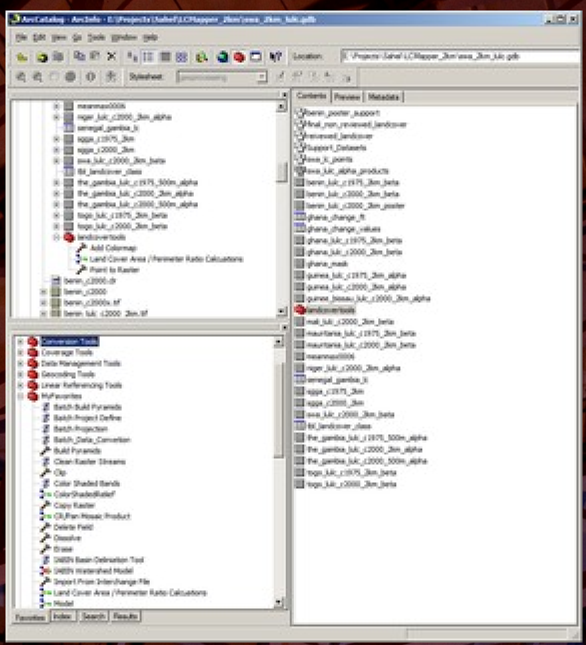
Geodatabase Elements

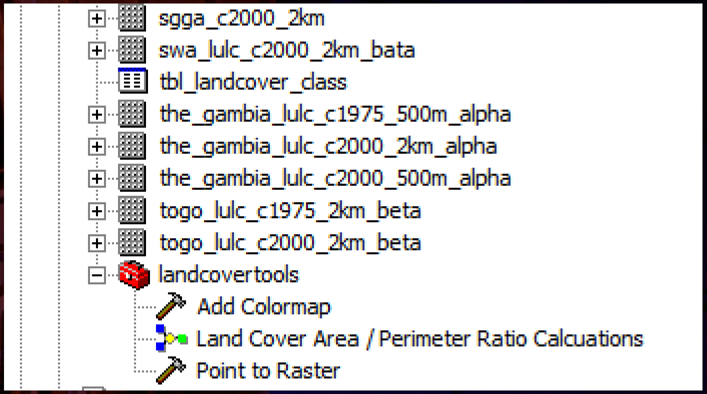


OBJECTID*	CrossSectionID*	CrossSectionM	Elevation
3931	Colorado/Lbj Middle 06	3464	801
3932	Colorado/Lbj Middle 06	3482	800
3933	Colorado/Lbj Middle 06	3495	800
3934	Colorado/Lbj Middle 06	3511	799
3935	Colorado/Lbj Middle 06	3527	799

Adding Toolboxes to Geodatabase

- Copying tools from ArcToolbox
- Creating models inside custom Toolboxes
- Adding custom scripts in Toolboxes





USGS

Geodatabase and Raster Datasets

Three methods to organize raster datasets in a Geodatabase

- **Raster Dataset**
  - Stored as a single multi band image
- **Raster Catalog**
  - Collection of raster datasets
- **Attributes of a feature**
  - Image is stored in the feature table as an attribute

Geodatabase Raster Datasets Comparison

	Raster dataset	Raster catalog
Description	A single picture of an object or a seamless image covering a spatially continuous area. This may be a single original image or the result of many images appended (mosaicked) together.	A collection of raster datasets displayed as a single layer. They can be in different coordinate systems and can have different data types.
	Raster dataset	Raster catalog

Chart Source: ESRI

USGS

Geodatabase Raster Datasets Comparison

	Raster dataset	Raster catalog
Homogeneous or heterogeneous data	Homogeneous data: a single format, data type, and file.	Heterogeneous data: multiple formats, data types, file sizes, and coordinate systems.
Metadata	Stored once and applies to complete dataset.	Stored as attribute columns for each raster dataset item in the raster catalog.
Chart Source: ESRI	Raster dataset	Raster catalog

USGS

Geodatabase Raster Datasets Comparison

	Raster dataset	Raster catalog
Pros	Fast to display at any scale. Mosaic saves space, since there is no overlapping data. Displays with better blending at mosaicked image seams.	Can manage multi-row raster tables for many purposes. Can specify one or more raster datasets for display.
Chart Source: ESRI	Raster dataset	Raster catalog

USGS

Overview of the Geodatabase

Questions?

Next: Exploring the concept of Geo-Browsing

USGS

Geo-Browsing

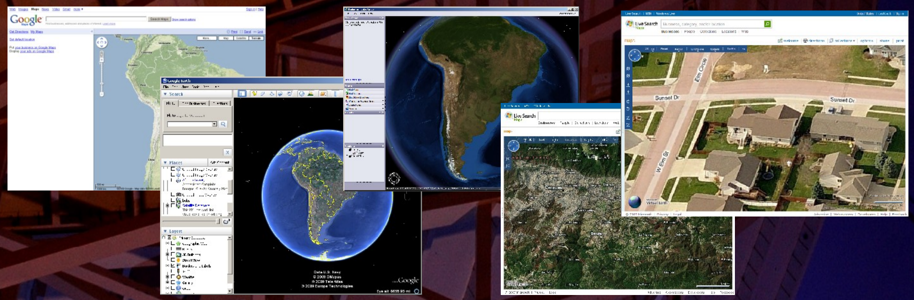
Geo-browsing is an evolving concept. Its basic premise is that a person can search or navigate through the Internet in geographic space.

USGS

Geo-Browsing

Geo-Browsing products

- Google Maps and Google Earth
- ArcGIS Explorer from ESRI
- Microsoft's Virtual Earth
- NASA World Wind
- Yahoo Maps
- **OpenLayers** (openlayers.org, mapfish.org)



USGS

Geo-Browsing and GeoSUR

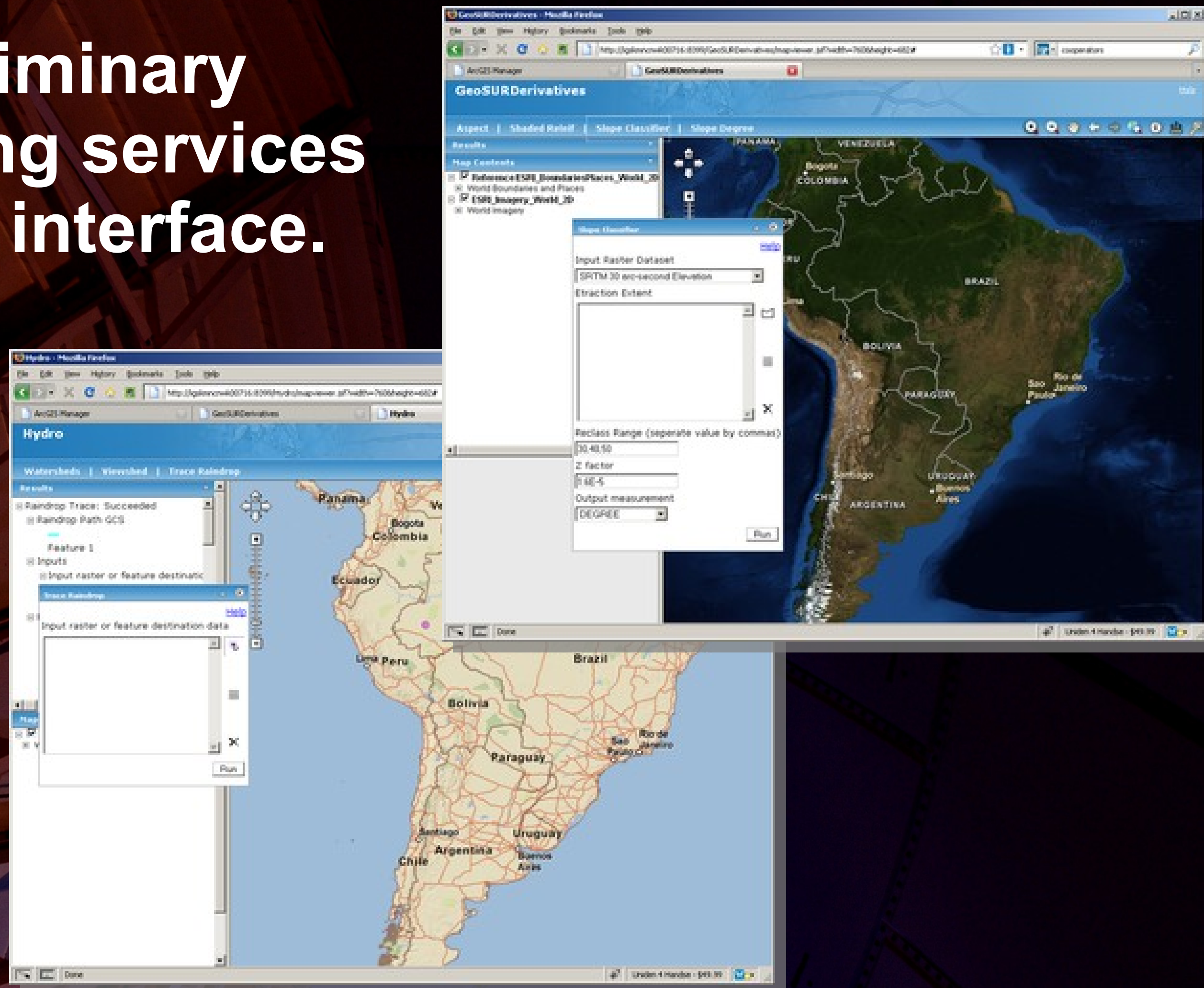
- **How can Geo-Browsing affect GeoSUR program?**
  - GeoSUR can use Geo-browsing technology as a tool to gather information
  - Leverage the technology to share and distribute your information!
    - Publish the information in as many web mapping services as resources allow.
    - If your product has value, build it and they will come.

H1N1 Map Example   *Weather Map Example*

USGS

GeoSUR Geoprocessing

GeoSUR preliminary geoprocessing services web browser interface.



USGS

Accessing GeoSUR Web Services

- Web Interface
- ArcGIS Explorer
- ArcGIS – ArcMap
- Google Earth
- Javascript APIs (Google, ESRI, OpenLayer)

Discovering Available Services

- **ArcGIS Services Directory**

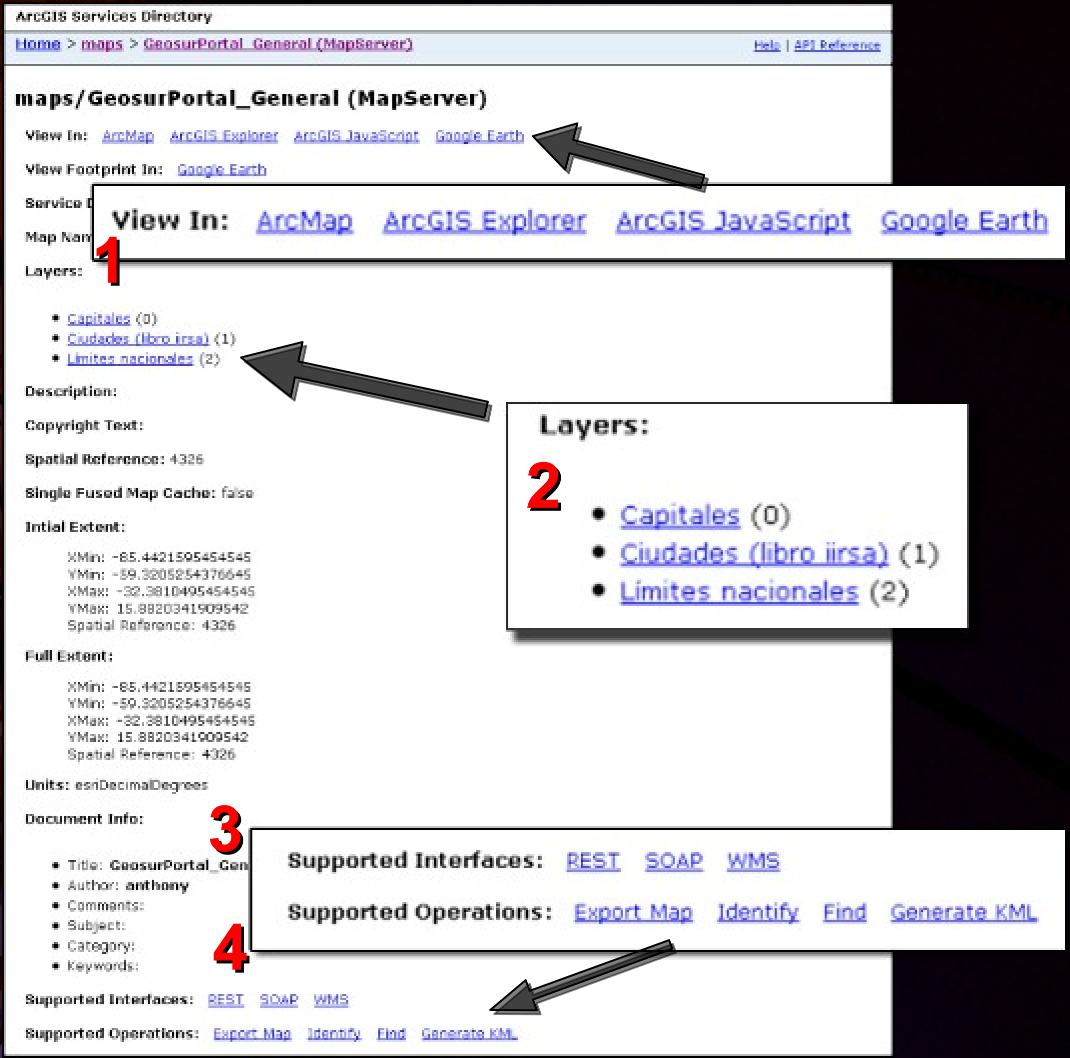
  Services Directory allows you to browse the contents of an ArcGIS Server and obtain information that can be useful to you when developing applications. Services Directory is a view of the ArcGIS Server REST API in HTML format. Each ArcGIS Server instance has Services Directory installed during the installation process (ESRI, 2009d).

- **Services Directory assist with:**
  - Browsing the contents of the GIS server and get service level metadata.
  - Getting information to help you develop applications.

USGS

ArcGIS Services Directory

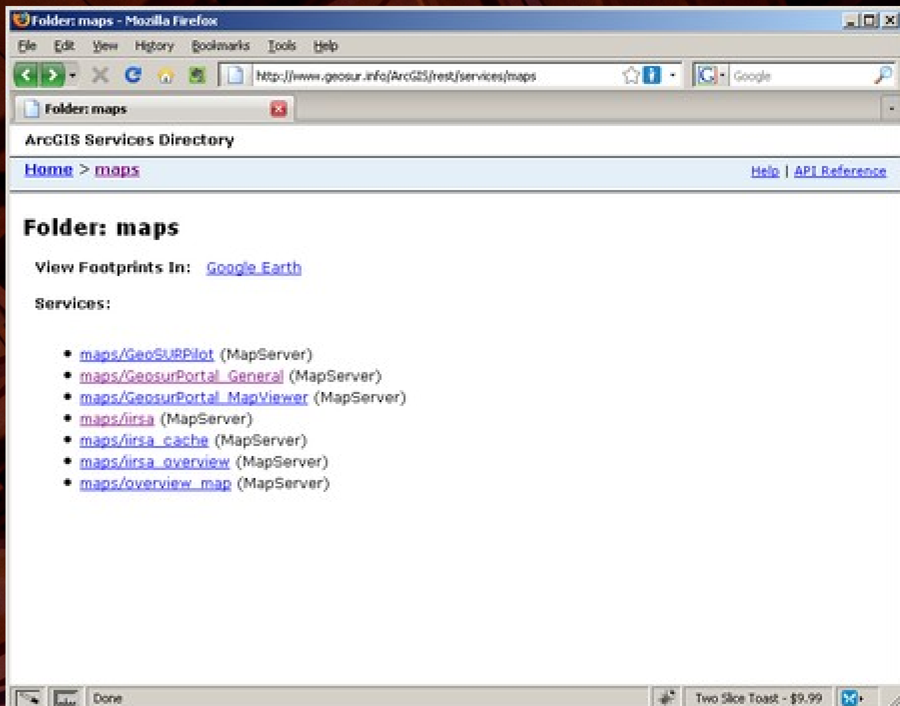
1) Viewing options
2) Available Layers
3) Supported development interfaces
4) Supported operations



USGS

GeoSUR's Service Directory

http://www.geosur.info/ArcGIS/rest/services



Geo-Browsing

Questions?

Next: Spatial Analyst Map Algebra

Analyzing Spatial Data Exercises

- Map Algebra
- Topographic surface models
- Viewshed Analysis
- Viewshed ModelBuilder
- Vulnerability ModelBuilder
- Hydrological Derivatives
- Drainage Basin Delineation using ModelBuilder

Spatial Analyst Map Algebra

Map Algebra

A language that defines a syntax for combining map themes by applying mathematical operations and analytical functions to create new map themes. In a map algebra expression, the operators are a combination of mathematical, logical, or Boolean operators (+, >, AND, tan, and so on), and spatial analysis functions (slope, shortest path, spline, and so on) and the operands are spatial data and numbers (ESRI, 2009a).

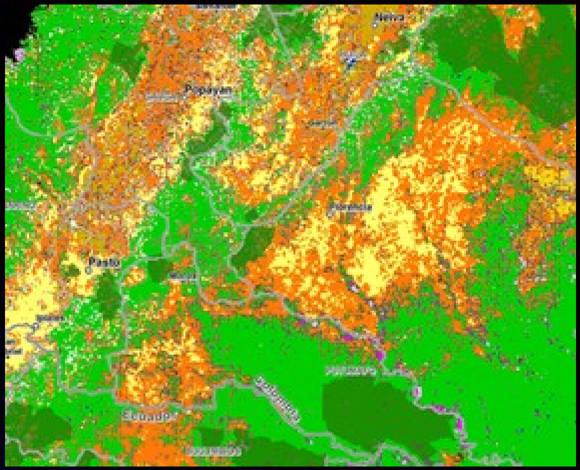
Example:

output_raster = con([elevation] > 2000, 0, [elevation])

Spatial Analyst Map Algebra

Ex01

- **Protected Area Vulnerability Exercise**
- **Question:** Recent activity in the region covering Colombia and Ecuador's border suggests an expansion of intensive agriculture into the closed tropical evergreen forest. Areas of highest vulnerability are southern facing slopes with a slope of between 0 and 15 degrees between the elevation of 1000 m and 2000 m. Your task is to identify these vulnerable areas within the protected areas of this region.

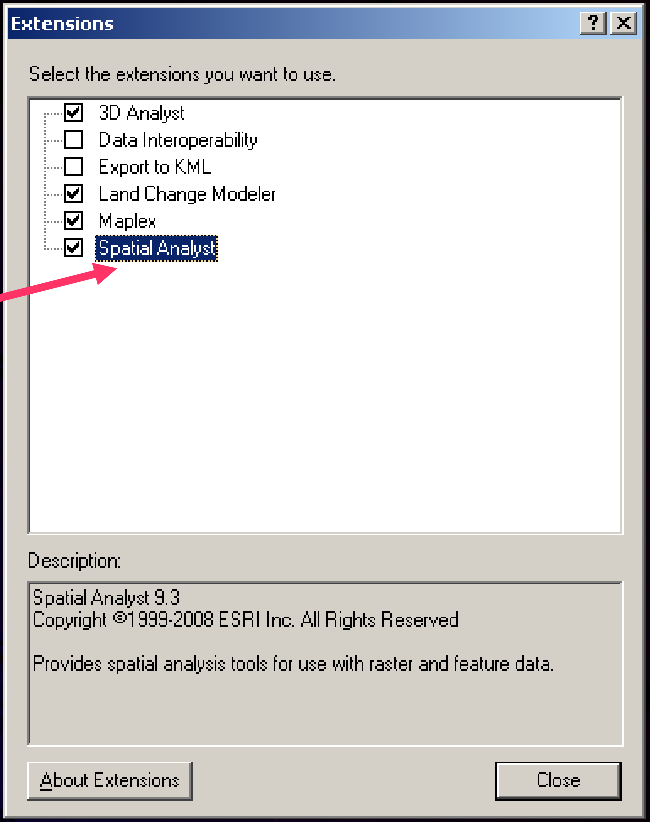


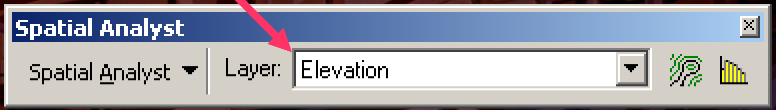
Instructor lead

Spatial Analyst Map Algebra

Ex01

- Open ArcMap
- **Load the** ...\exercise01\exercise01.mxd **project file**
- Verify that the Spatial Analyst extension is activated in ArcGIS.
- Verify that the Spatial Analyst toolbar is visible in ArcMap.





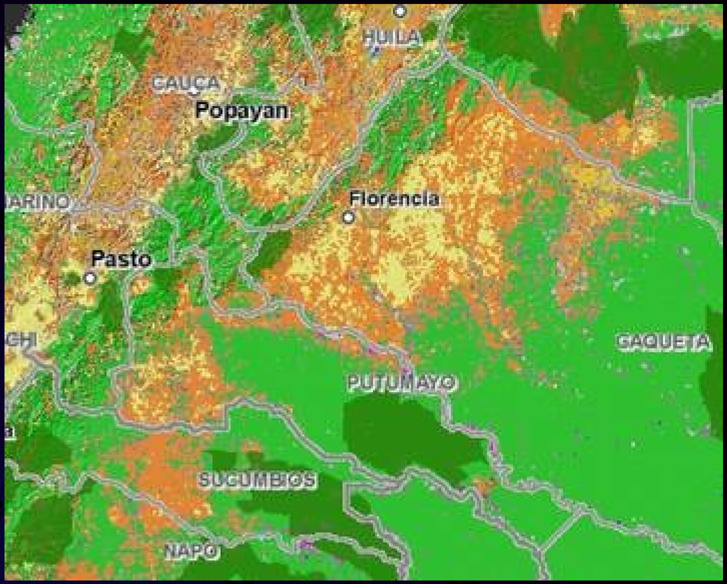
Instructor lead

USGS

Spatial Analyst Map Algebra

Ex01

- **Protected Area Vulnerability Exercise**
- **Project Setup**
  1. Set spatial analyst options
  2. Working directory = ...\exercises\exercise01
  3. Analysis Mask = NONE
  4. Analysis extent = “Elevation”
  5. Cell Size = “Elevation”

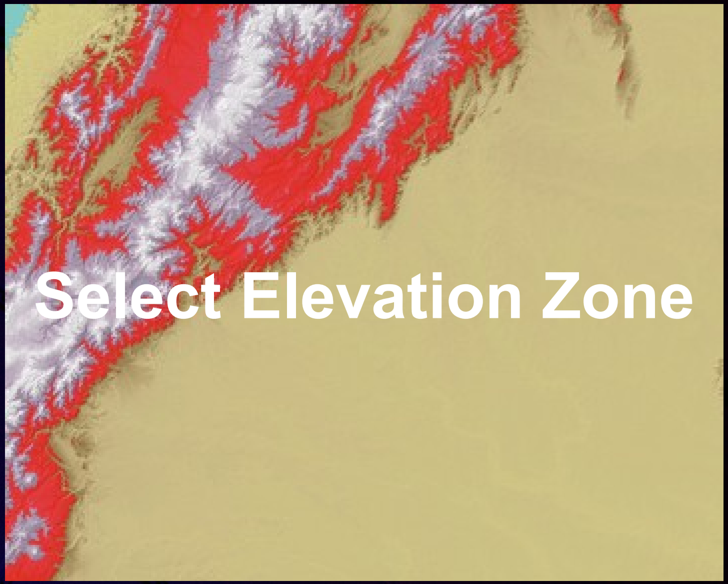


Instructor lead

Spatial Analyst Map Algebra

Ex01

- **Protected Area Vulnerability Exercise**
- **Create elevation derivative - RECLASSIFY**
  1. **Reclass elevation** Tool: Reclass by ASCII File, (elevation_reclass.rmp)
  2. **Select Elevation zone =** *[sel_elev] = setnull([elev_reclass] ne 4, 1)*

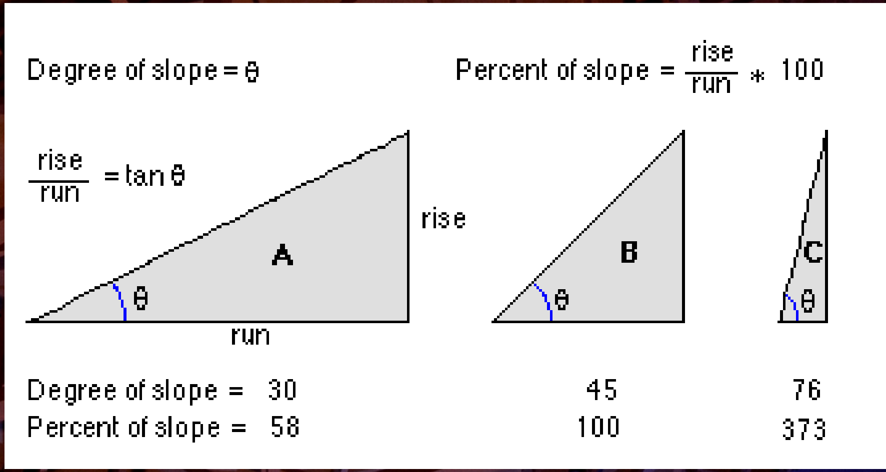


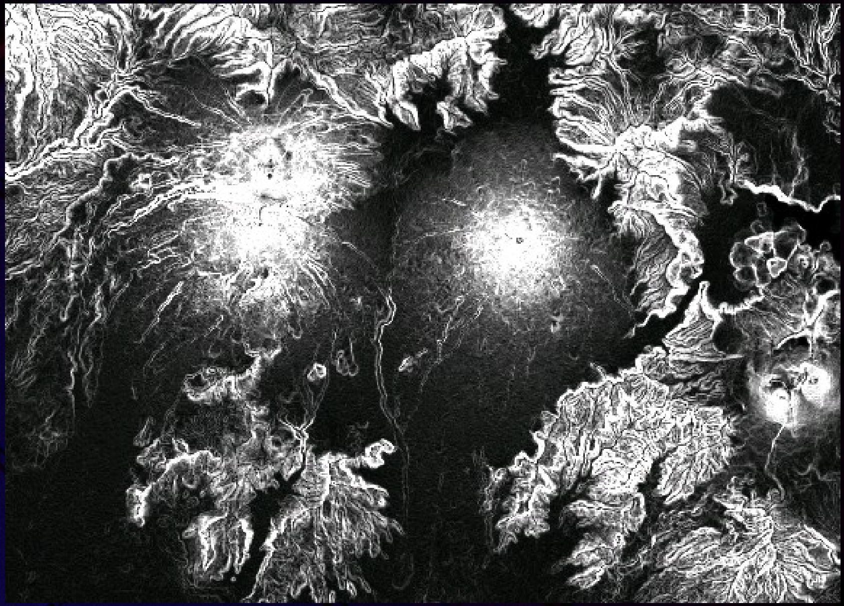
Instructor lead

USGS

Slope

Slope identifies the maximum rate of change in value from each cell to its neighbors. An output slope raster can be calculated as percent slope or degree of slope (ESRI, 2009a). Ex01

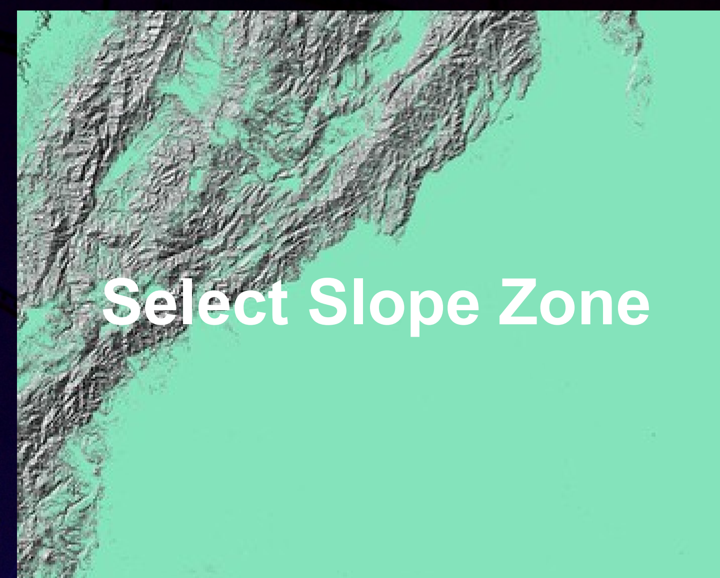




Spatial Analyst Map Algebra

Ex01

- Protected Area Vulnerability Exercise
- Create elevation derivative - SLOPE
    1. **Create Slope =** scaler factor 0.000016 (four zeros)
    2. **Select Slope Zone =** *[sel_slope] = setnull([slope] gt 15, 1)*



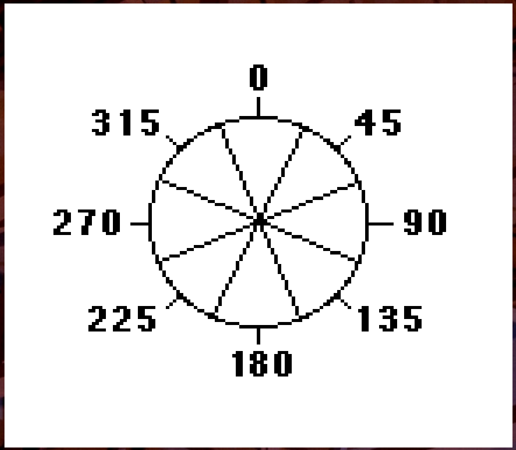
Instructor lead

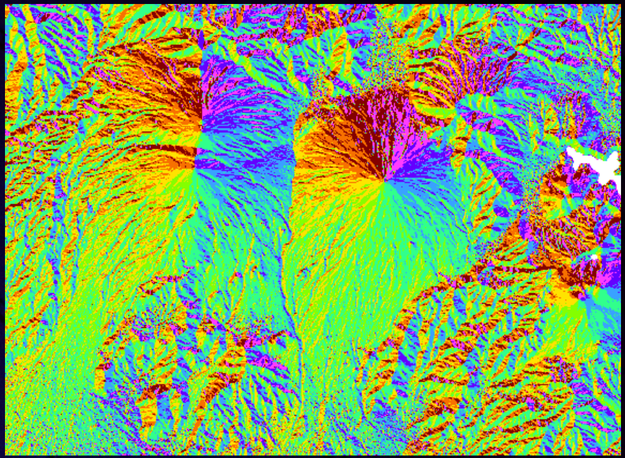
USGS

Aspect

Ex01

The aspect data set describes the direction of maximum rate of change in the elevations between each cell and its eight neighbors. It is measured in positive integer degrees from 0 to 360, measured clockwise from north. Aspects of cells of zero slope *(flat areas*) are assigned values of -1 (ESRI, 2009a)**.**

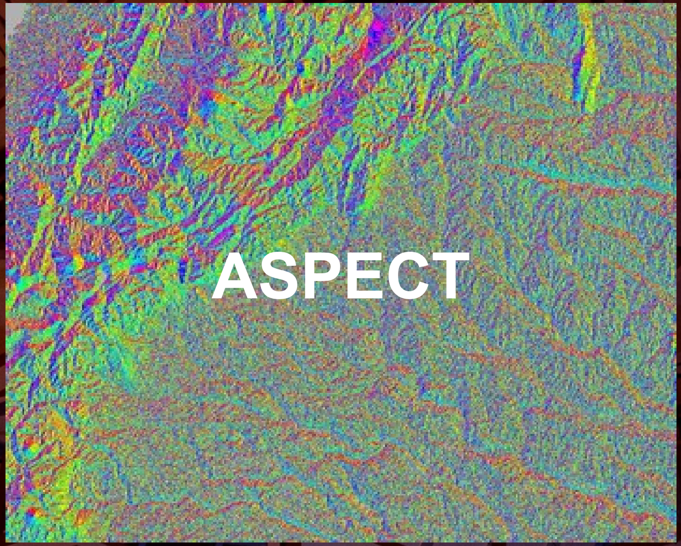


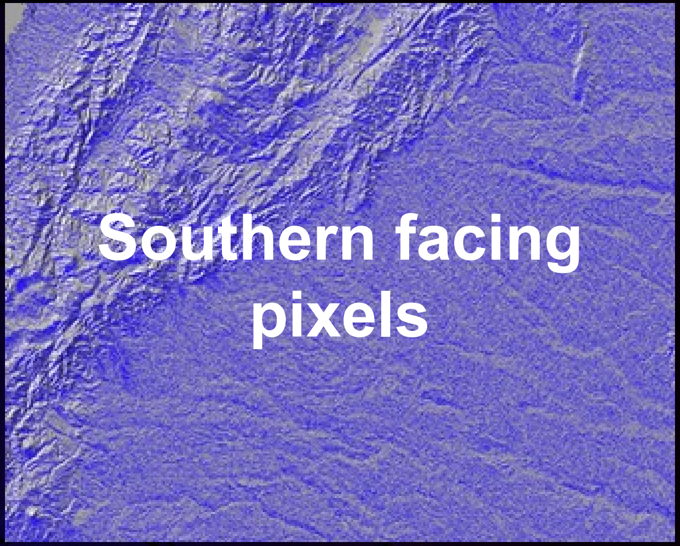


Spatial Analyst Map Algebra

Ex01

- **Protected Area Vulnerability Exercise**
- **Create elevation derivative - ASPECT**
  1. **Create Aspect**
  2. **Select Aspect Zone =** *[sel_aspect] = setnull([aspect] lt 112.5 or [aspect] gt 247.5, 1)*





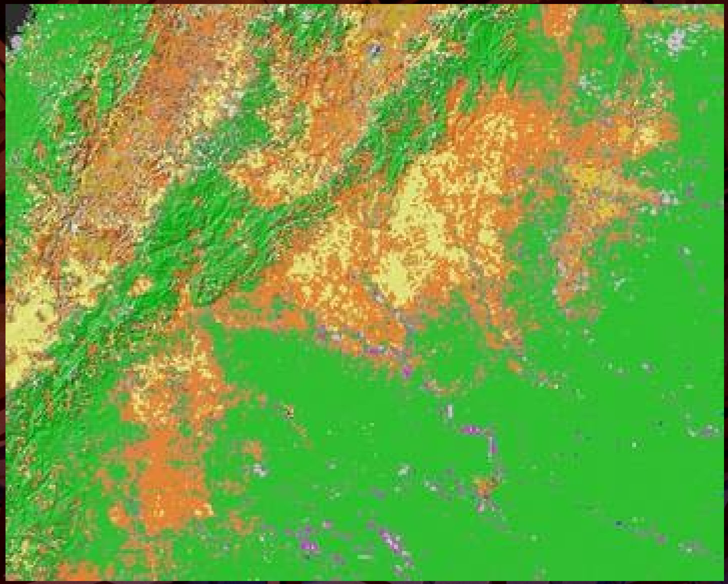
Instructor lead

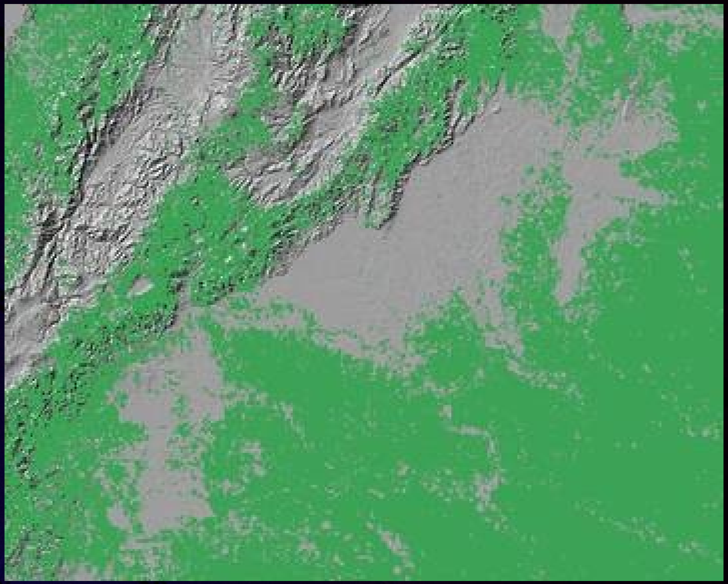
USGS

Spatial Analyst Map Algebra

Ex01

- **Protected Area Vulnerability Exercise**
- **Create Land-Cover derivative:**
  - **Select land-cover Zone**: *[sel_landcover] = setnull([Landcover] ne 10, 1)*





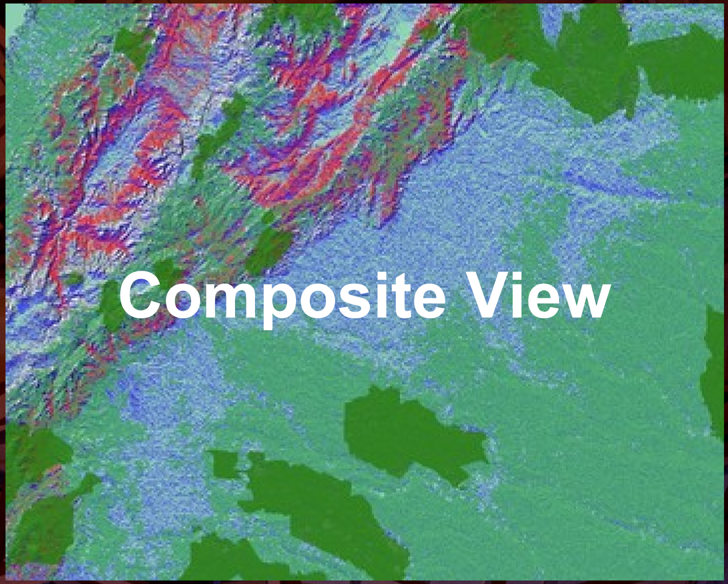
Instructor lead

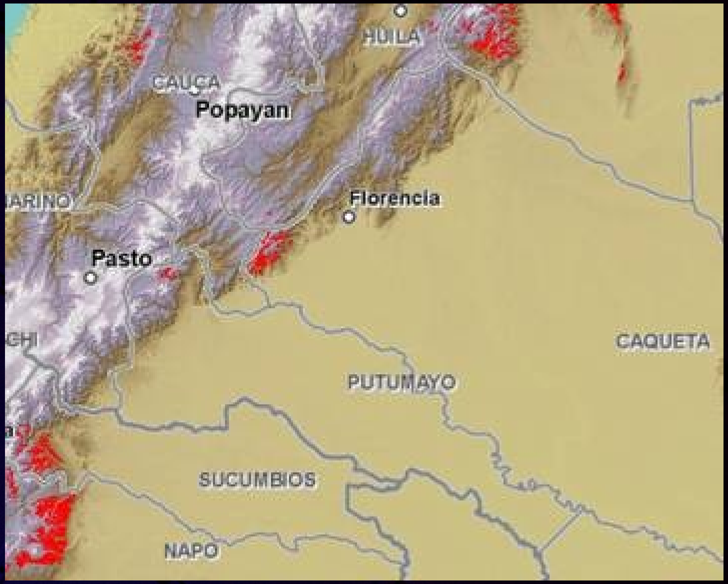
USGS

Spatial Analyst Map Algebra

Ex01

- **Protected Area Vulnerability Exercise**
- **Create Land-Cover derivative:**
  - **Select land-cover Zone**: *[VulArea] = con([sel_elev] eq 3 & [Protected] eq 1 & [sel_aspect] eq 1 & [sel_slope] eq 1 & [Landcover] eq 10, 1, 0)*



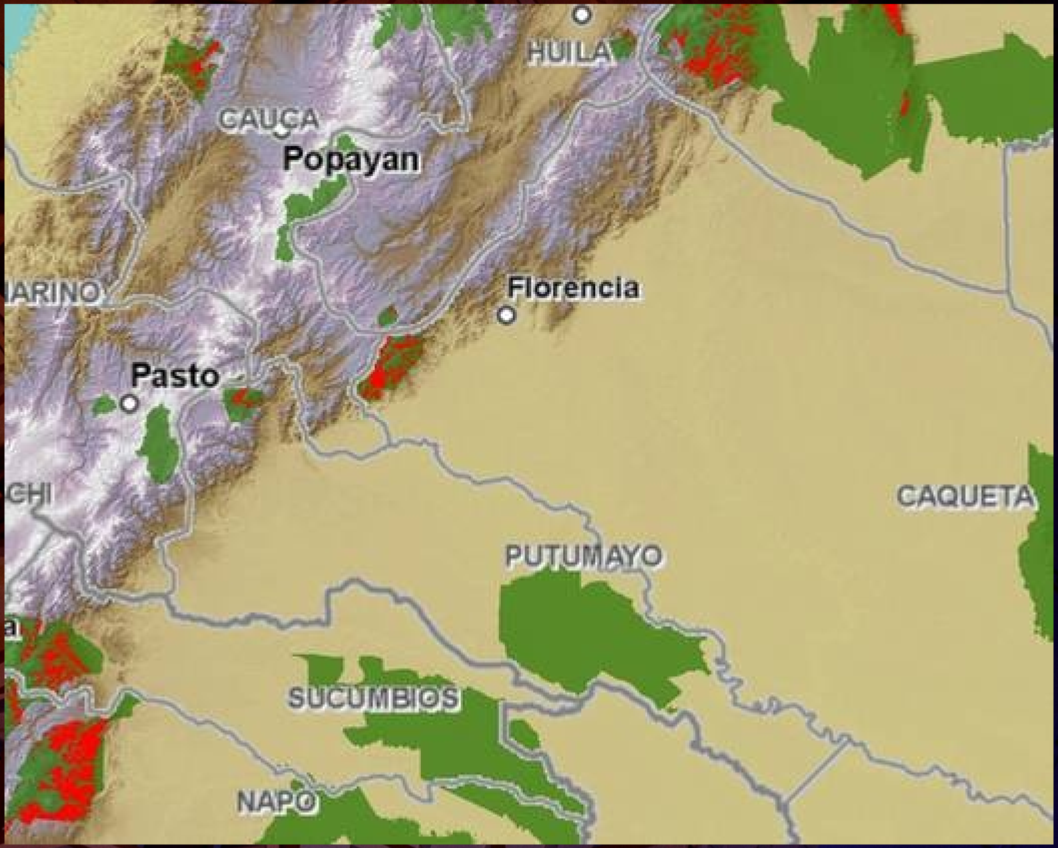


Instructor lead

Spatial Analyst Map Algebra

Ex01

Protected Area Vulnerability Exercise



Instructor lead

USGS

Spatial Analyst Map Algebra

Questions?

Next Exercise: Advanced Hillshade Toolbox

USGS

Advanced Hillshade Toolbox

- Common Hillshade
- Swiss Hillshade Effect
- Multi-directional, oblique-weighted, shaded-relief algorithm (MDOW)

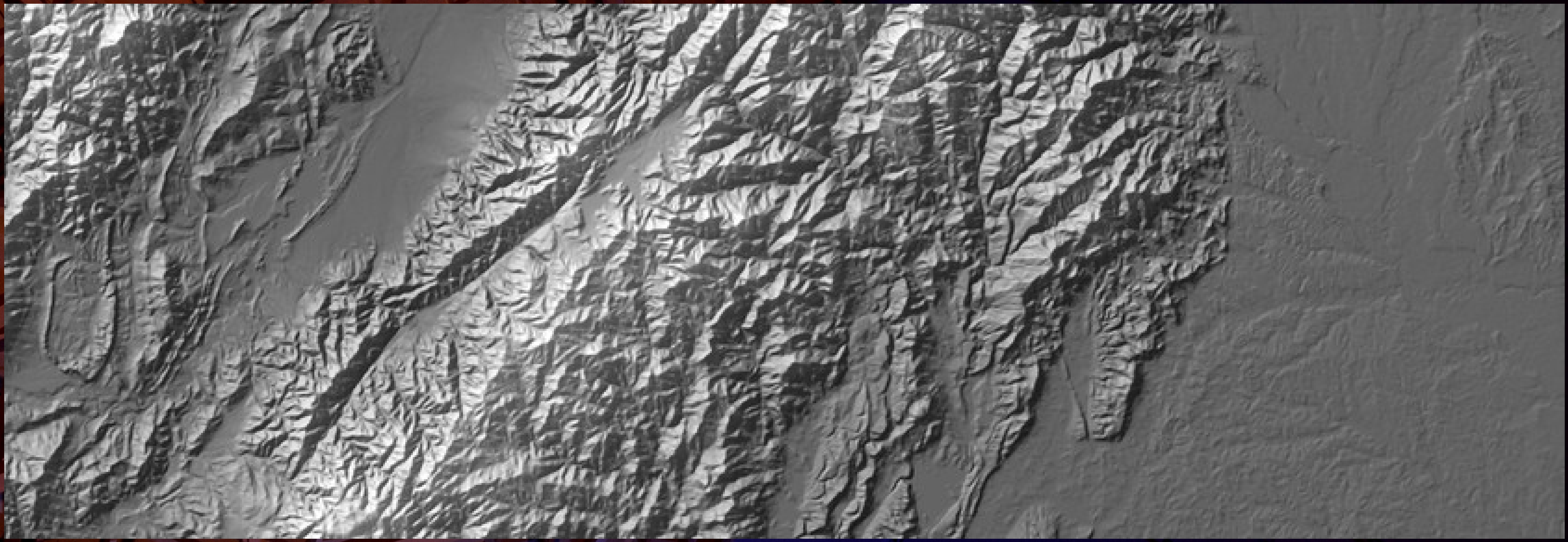
USGS

Advanced Hillshade Toolbox

Common Hillshade - The Hillshade dataset contains shaded relief surface. The integer values enable the user display a continuous surface of elevation, as opposed to topography which is broken into intervals (ESRI, 2009a).

Advanced Hillshade Toolbox

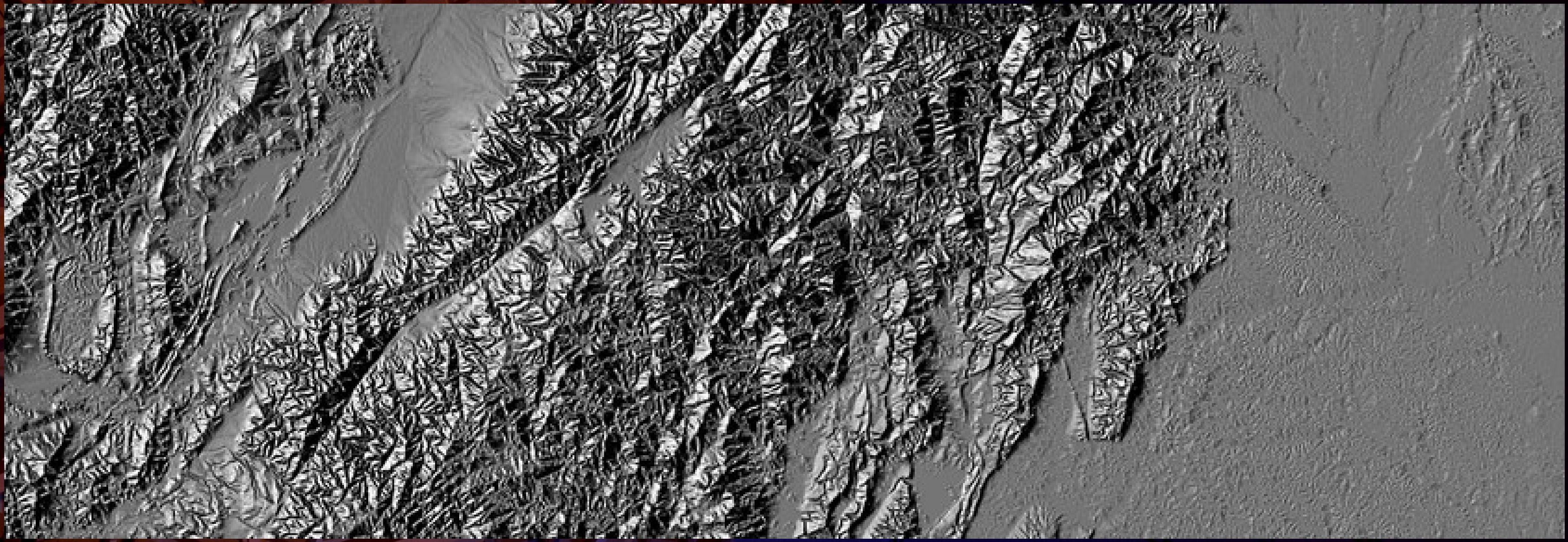
Swiss Hillshade Effect – This method of hillshading uses a layering technique to emphasize major elevation features, minimize minor features, and smooth out irregularities (Maples, 2007).



USGS

Advanced Hillshade Toolbox

Multi-directional, oblique-weighted, shaded-relief algorithm (MDOW) - This method produces a surface that emphasizes oblique illumination on all surfaces, ... providing more detail in areas of an image that would otherwise be illuminated by direct light or left in darkness by a single source illumination.

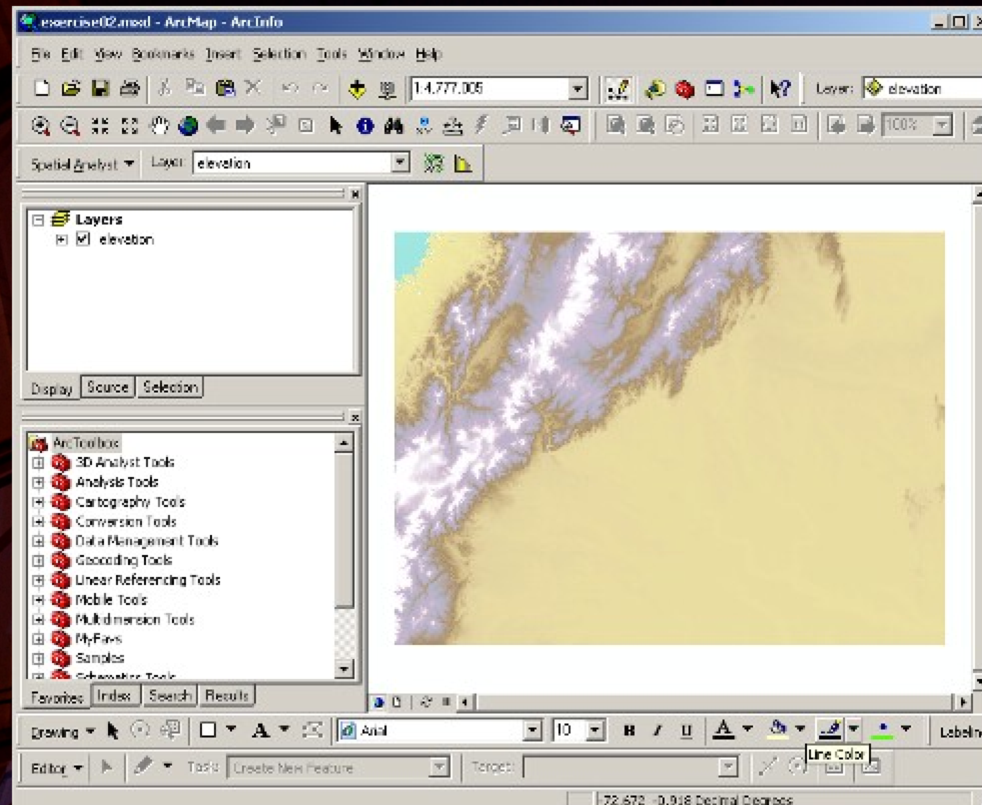


USGS

Basic Hillshade Dataset

Ex02

- Open ArcMap
- Load ...\exercise02\exercise02.mxd project file



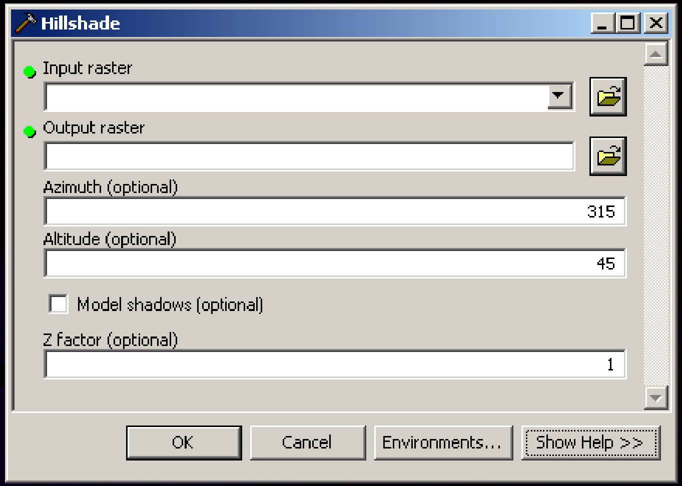
Instructor lead

USGS

Basic Hillshade Dataset

- Open ArcToolbox in ArcMap
- Locate the Spatial Analyst Toolset
- Open the Hillshade tool with the Surface toolset.

Ex02



- Input Parameters:
- Input Raster: ...\exercises\exercise02\data\elevation
- Output raster: ...\exercises\exercise02\hillshade
- Azimuth (Angle of the light source in degrees)
- Altitude (Altitude of the light source on the horizon)
- Z-factor (number of ground x, y units in one surface z unit)

Instructor lead

USGS

Z-factor

- **A conversion factor used to adjust vertical and horizontal measurements into the same unit of measure. Specifically, the number of vertical units (z-units) in each horizontal unit (ESRI, 2009e)**
- **For a detailed explanation of the Z-factor visit the ESRI's Mapping Center Blog.**

Ex02

Latitude	Z-factor in meters
[illegible]	0.00000898
10	0.00000912
20	0.00000956
30	0.00001036
40	0.00001171
50	0.00001395
60	[illegible]00001792
70	0.00002[illegible]19
80	0.00005156

Note: *Z-factor Calculation*

1 degree = 0.0174532925 radians

Z-factor = 1.0 / (113200 * cos(<input latitude in radians>))

Swiss Hillshade Effect

Ex02

- **Load Toolbox:**
  ...\exercises\exercise02\Hillshade_Tools_9.3
- **Open Swiss Hillshade Model**
  - Input DEM: ...\exercises\exercise02\data\elevation
  - Z-factor: 0.00000898
  - Filtered Hillshade (output): ...\exercises\exercise02\fltrhlshd
  - Aerial Perspective (output): ...\exercises\exercise02\arlprsp
- **Create Layer Group**
  - Set Filtered Hillshade transparency to 35%
  - Verify Aerial Perspective transparency is at 0%

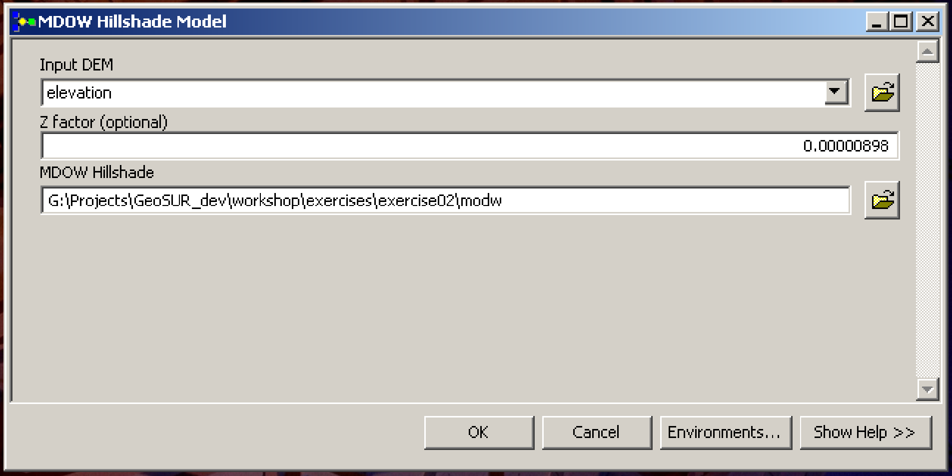
Instructor lead

USGS

MDOW Hillshade

Ex02

- Open MDOW Hillshade Model
  - Input DEM: ...\exercises\exercise02\data\elevation
  - Z factor: 0.00000898
  - MDOW Hillshade (output): ...\exercises\exercise02\modw
- Overlay elevation dataset with 30% transparency



Instructor lead

Advanced Hillshade Toolbox

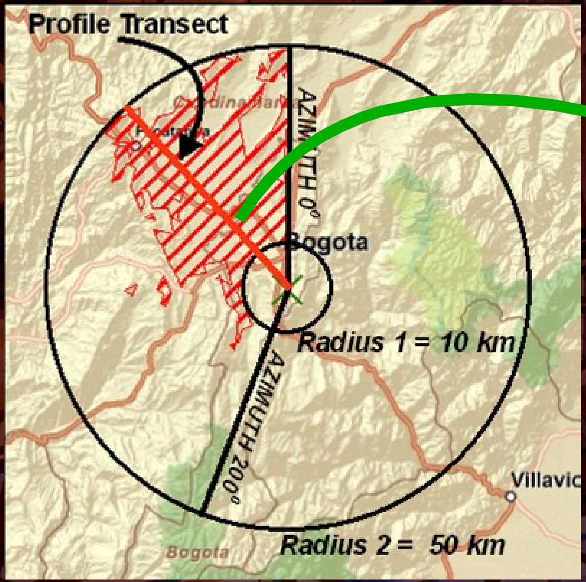
Questions?

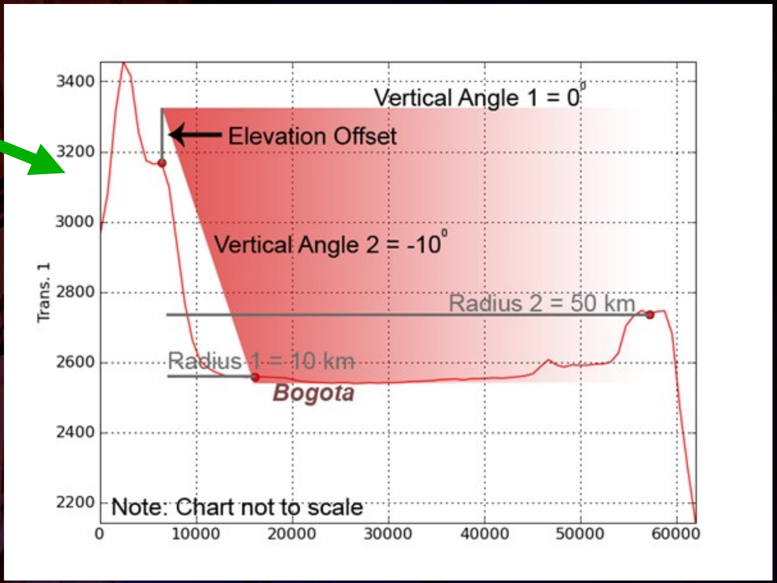
Next Exercise: Viewshed Analysis

Viewshed Analysis

Ex03

A Viewshed analysis identifies the surface area visible from a given location based on its elevation.





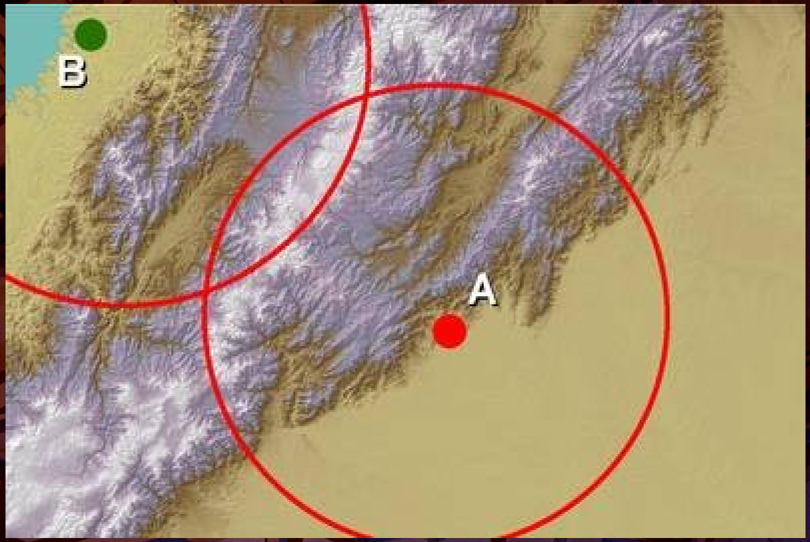
Instructor lead

USGS

Viewshed Analysis

Ex03

- **Viewshed analysis task.**
- Identify potential sites for a relay transmission tower between site A and B with a slope no greater than 10 degrees.



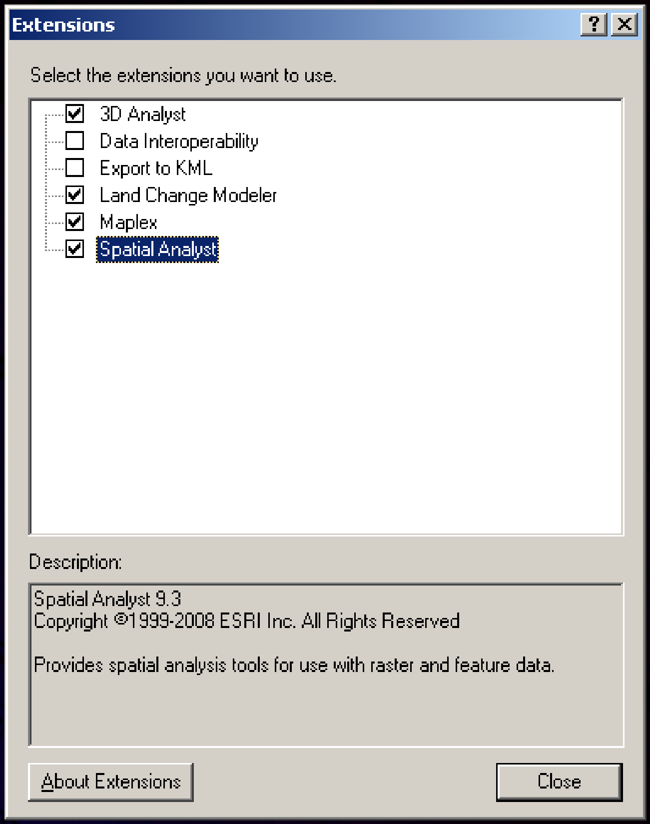
Instructor lead

USGS

Viewshed Analysis

Ex03

- **Open ArcMap**
- **Load the** ...\exercise03\exercise03.mxd **project file**
- **Verify that the Spatial Analyst extension is activated in ArcGIS.**
- **Verify that the Spatial Analyst toolbar is visible in ArcMap.**



Instructor lead

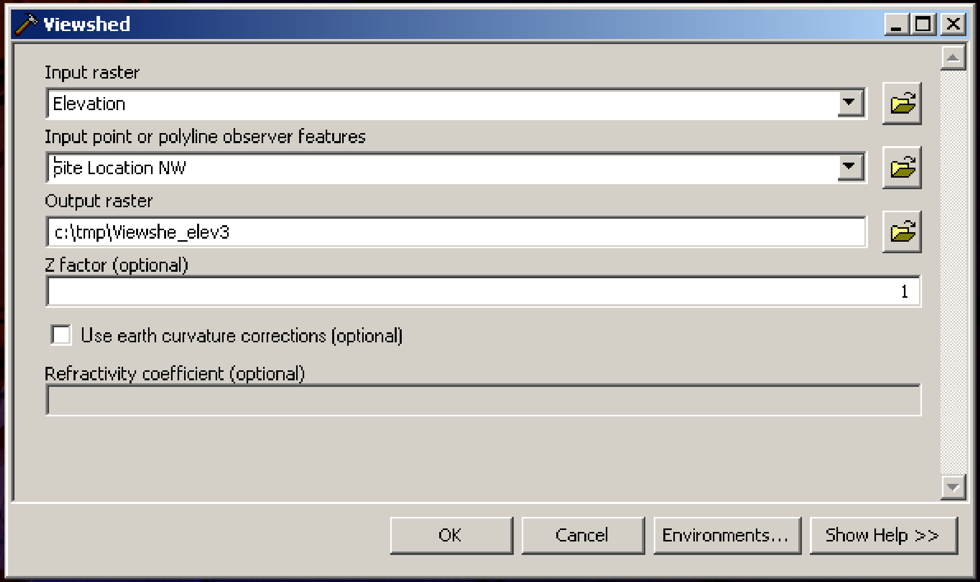
USGS

Viewshed Analysis

Ex03

- Viewshed Analysis parameters:
  - Input raster: Elevation (DEM)
  - Input point or polyline observation features
    - *Observation feature parameters defined in attribute table*
  - Output raster dataset
  - Z-factor

Note: Z-factor will be **1** in this exercise because the elevation dataset is in an equal-area projection.



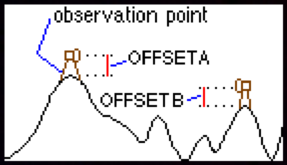
Instructor lead

USGS

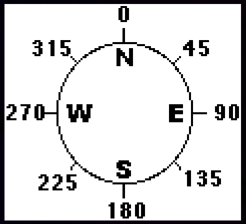
Viewshed Analysis

Ex03

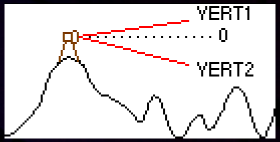
- **Viewshed observation feature input parameters**
  - *Site location SE (A):*
    - **OFFSETA = 300 m**
    - **OFFSETB = 30 m**
    - **AZIMUTH1 = 285°**
    - **AZIMUTH2 = 330°**
    - **VERT1 = 90°**
    - **VERT2 = -90°**
    - **RADIUS1 = 50 km (50 000 m)**
    - **RADIUS2 = 150 km (150 000 m)**



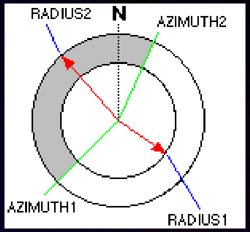
OFF SETS



AZIMUTH



VERTICAL ANGLE



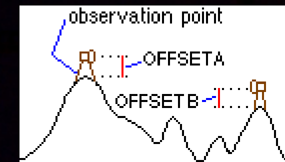
RADIUS
(ESRI, 2009a)

Instructor lead

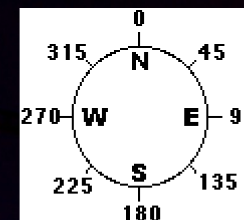
Viewshed Analysis

Ex03

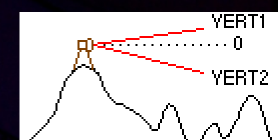
- **Viewshed observation feature input parameters**
  - *Site location NW (B):*
    - **OFFSETA = 300 m**
    - **OFFSETB = 30 m**
    - **AZIMUTH1 = 120°**
    - **AZIMUTH2 = 150°**
    - **VERT1 = 90°**
    - **VERT2 = -90°**
    - **RADIUS1 = 50 km (50 000 m)**
    - **RADIUS2 = 150 km (150 000 m)**



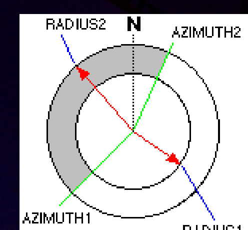
OFF SETS



AZIMUTH



VERTICAL ANGLE



RADIUS
(ESRI, 2009a)

Instructor lead

USGS

Viewshed Analysis

Ex03

1. Run Viewshed analysis on points A and B independently.
2. Apply conditional statement to identify intersecting locations.
3. From the intersection location, identify the areas with less than 10 degree slope.
4. *Clean-up* results to only show potential tower site locations.
5. Convert the raster output to a vector point format.

Instructor lead

USGS

Viewshed Analysis

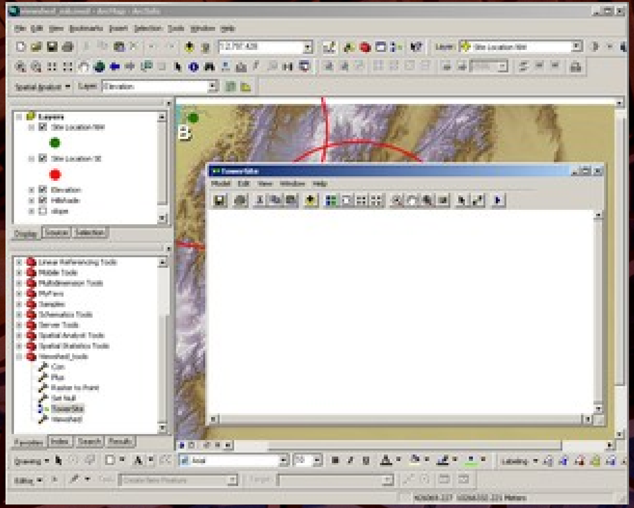
Questions?

Next Exercise: Viewshed ModelBuilder Exercise

Viewshed ModelBuilder Exercise

Ex04

- **Open** .../exercise04/exercise04.mxd project **file.**
- **Open Toolbox in ArcMap.**
- **Expand the Viewshed_tools toolset.**
- **Open the TowerSite model in edit mode.**



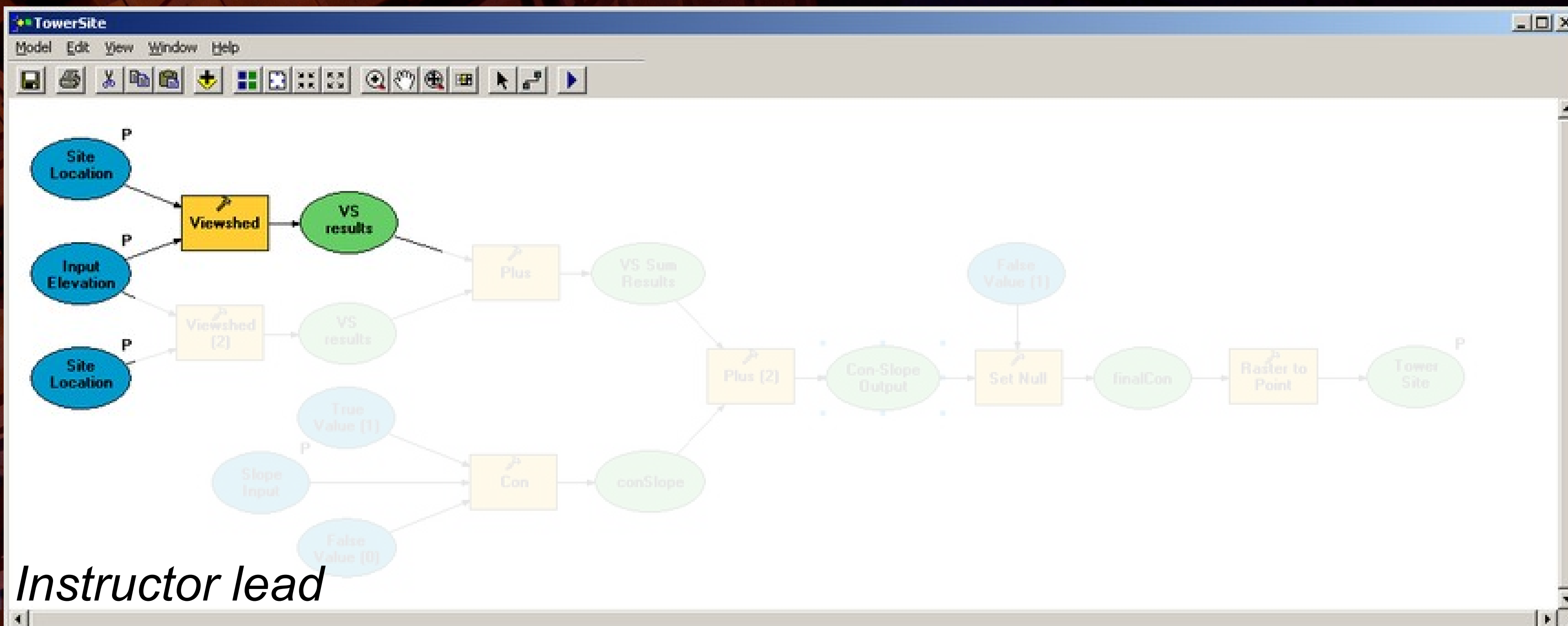
Instructor lead

USGS

Viewshed ModelBuilder Exercise

Ex04

Add <u>Viewshed</u> tool (*hint: drag and drop tool from the toolbox*)**.**



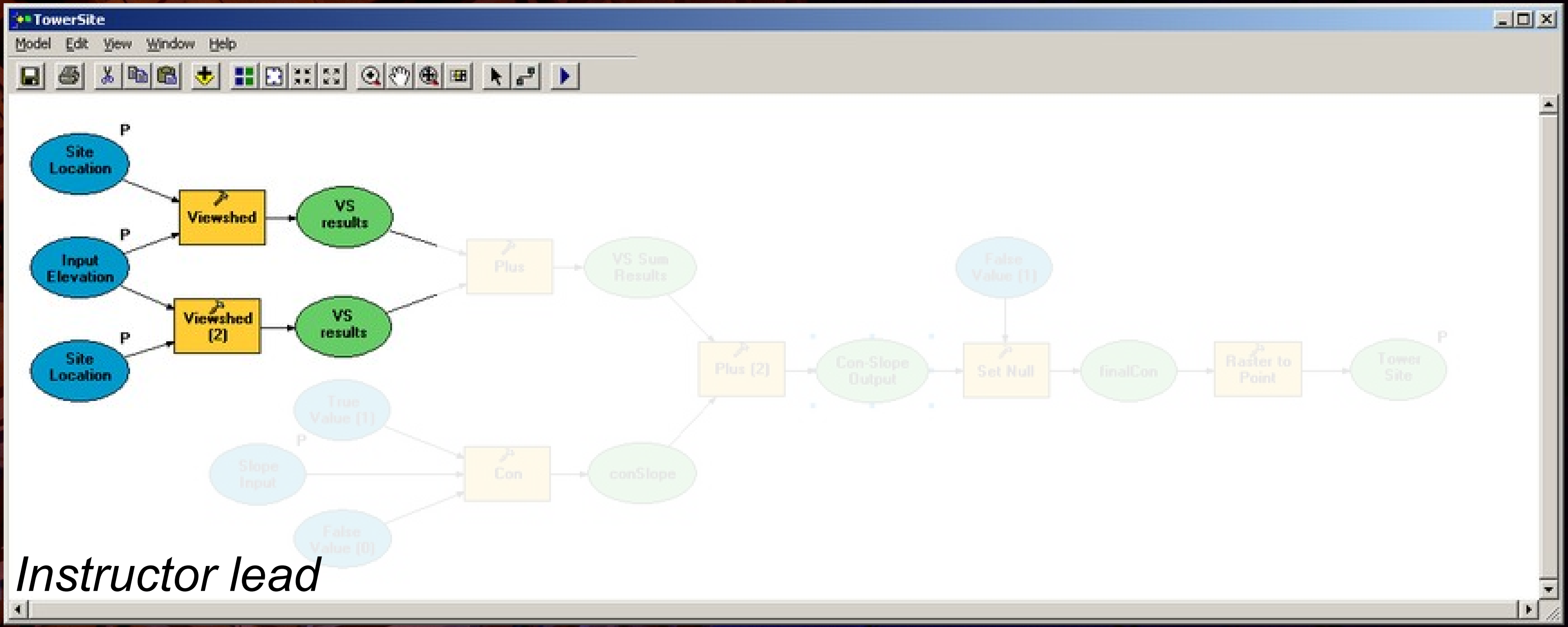
Instructor lead

USGS

Viewshed ModelBuilder Exercise

Ex04

Add a second Viewshed tool.

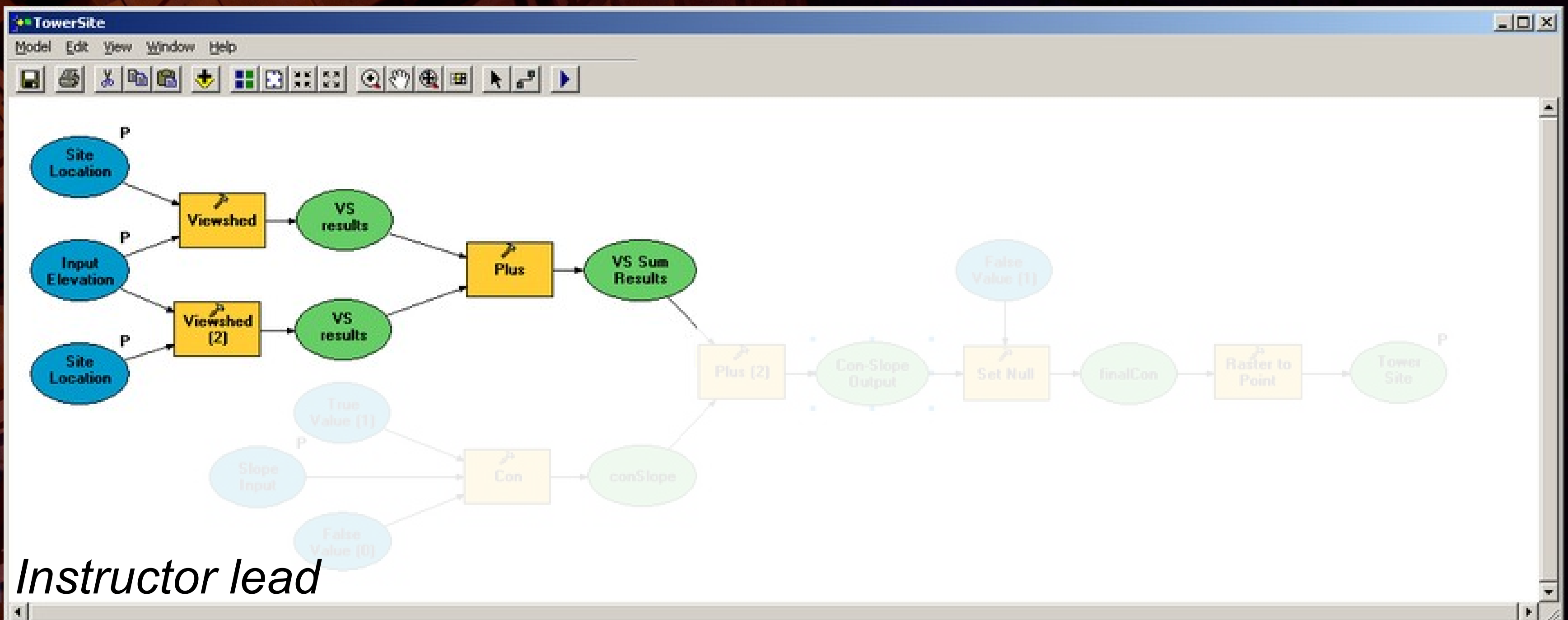


Instructor lead

Viewshed ModelBuilder Exercise

Ex04

Add the <u>Plus</u> tool to identify potential tower locations. The resulting raster with pixel values equal to 2 that represents intersecting locations between both Viewshed analyses.



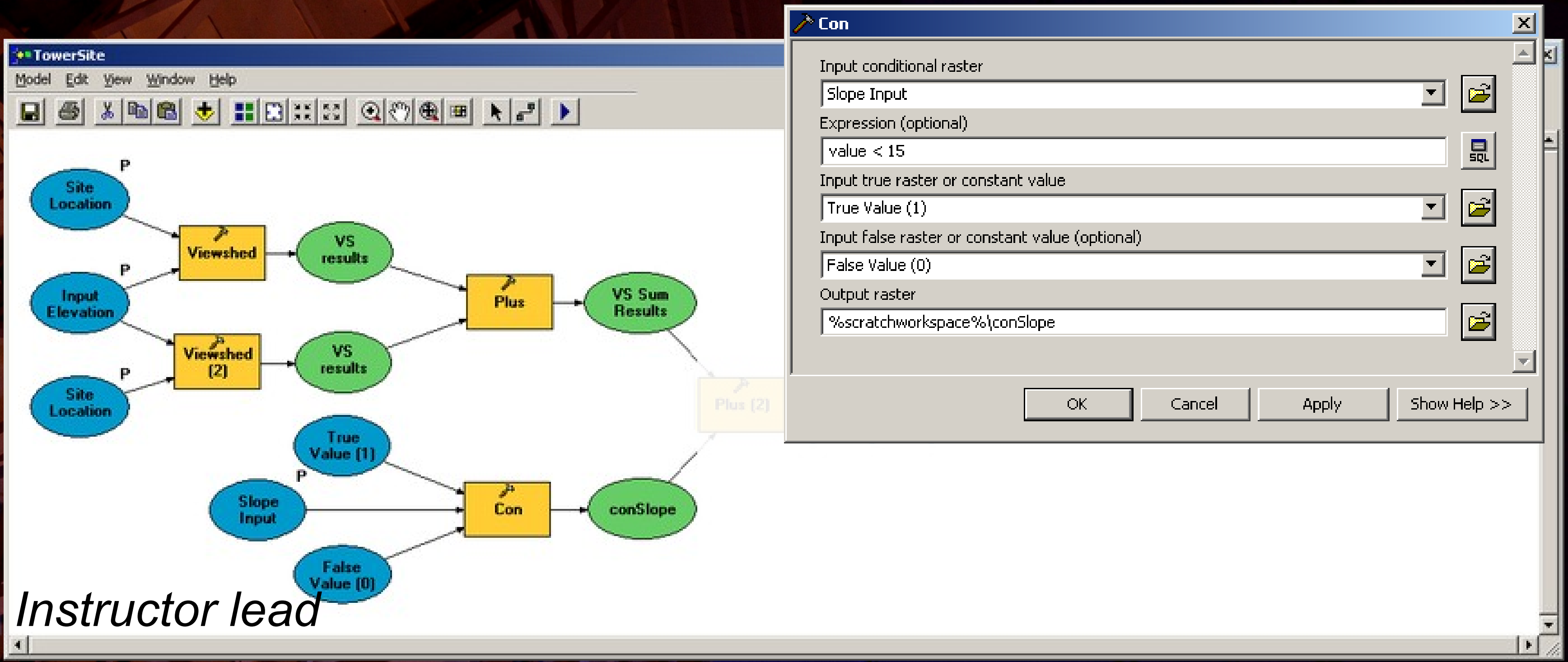
Instructor lead

USGS

Viewshed ModelBuilder Exercise

Ex04

Add the <u>conditional</u> *(<u>Con</u>)* tool to evaluate slope raster to identify the pixels that satisfy the slope requirements *(degree slope < 10)*.



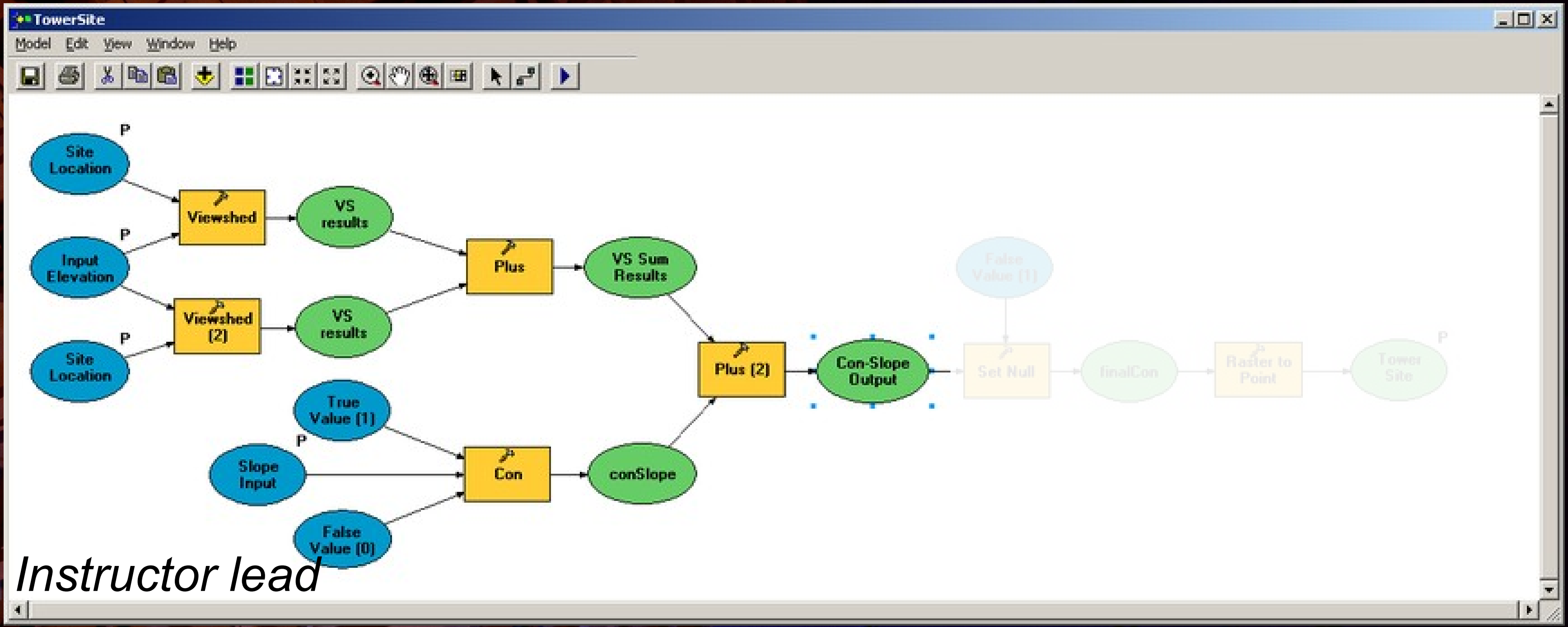
Instructor lead

USGS

Viewshed ModelBuilder Exercise

Ex04

Add another <u>Plus</u> tool to sum the results from the Viewshed analyses and the slope conditional statement.

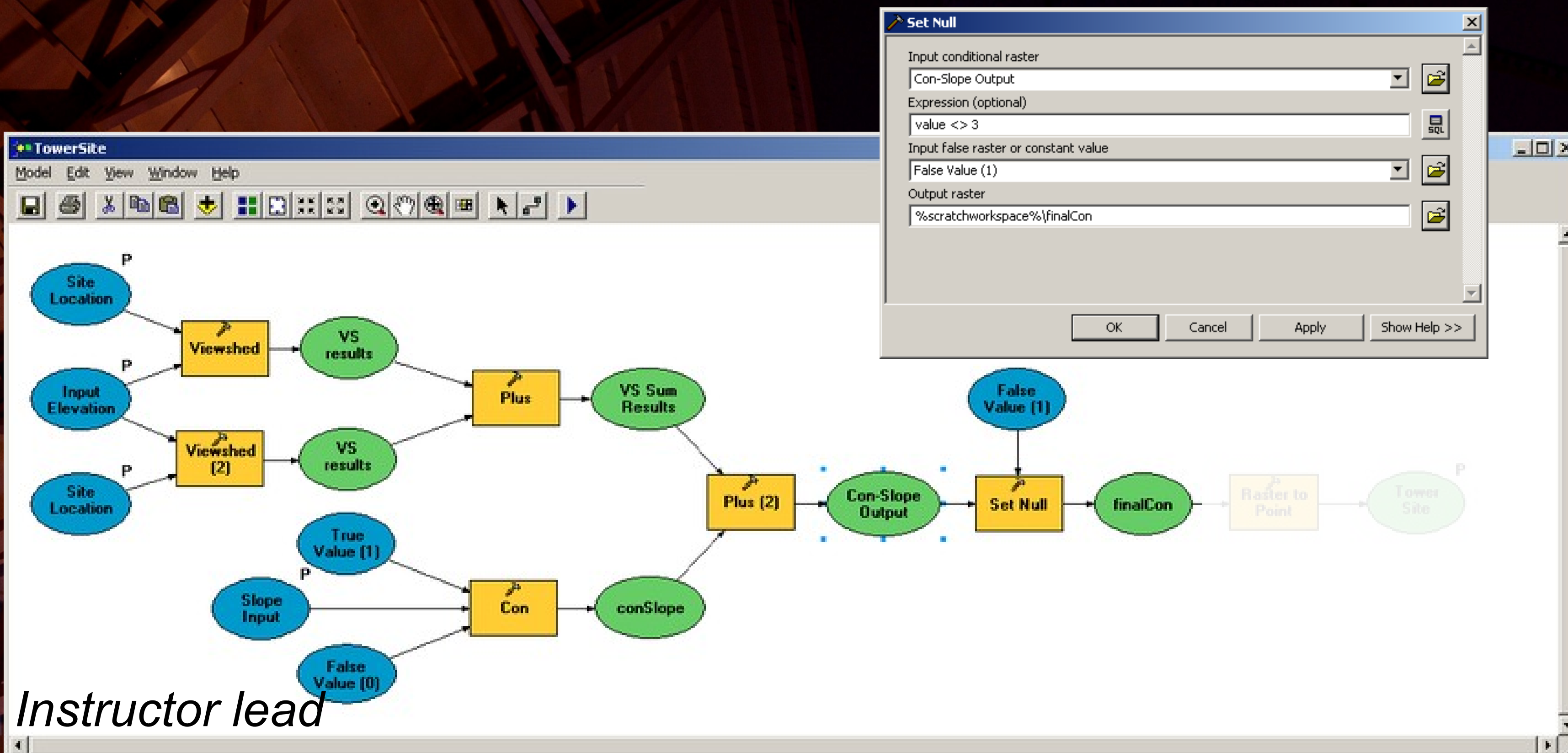


Instructor lead

Viewshed ModelBuilder Exercise

Ex04

Add the Set Null tool to remove the extraneous pixels not meeting the analysis requirements



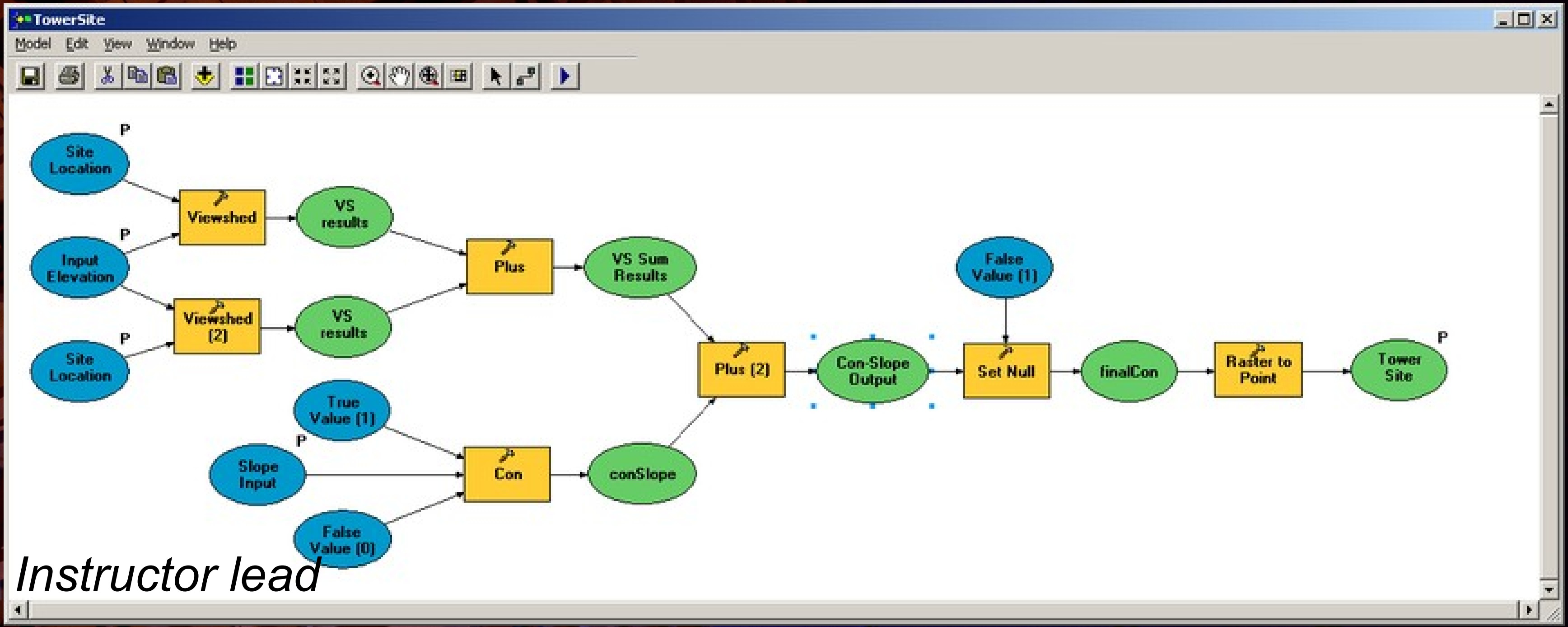
Instructor lead

USGS

Viewshed ModelBuilder Exercise

Ex04

Add the <u>Raster to Point</u> tool to convert the qualifying pixels to a point vector layer.

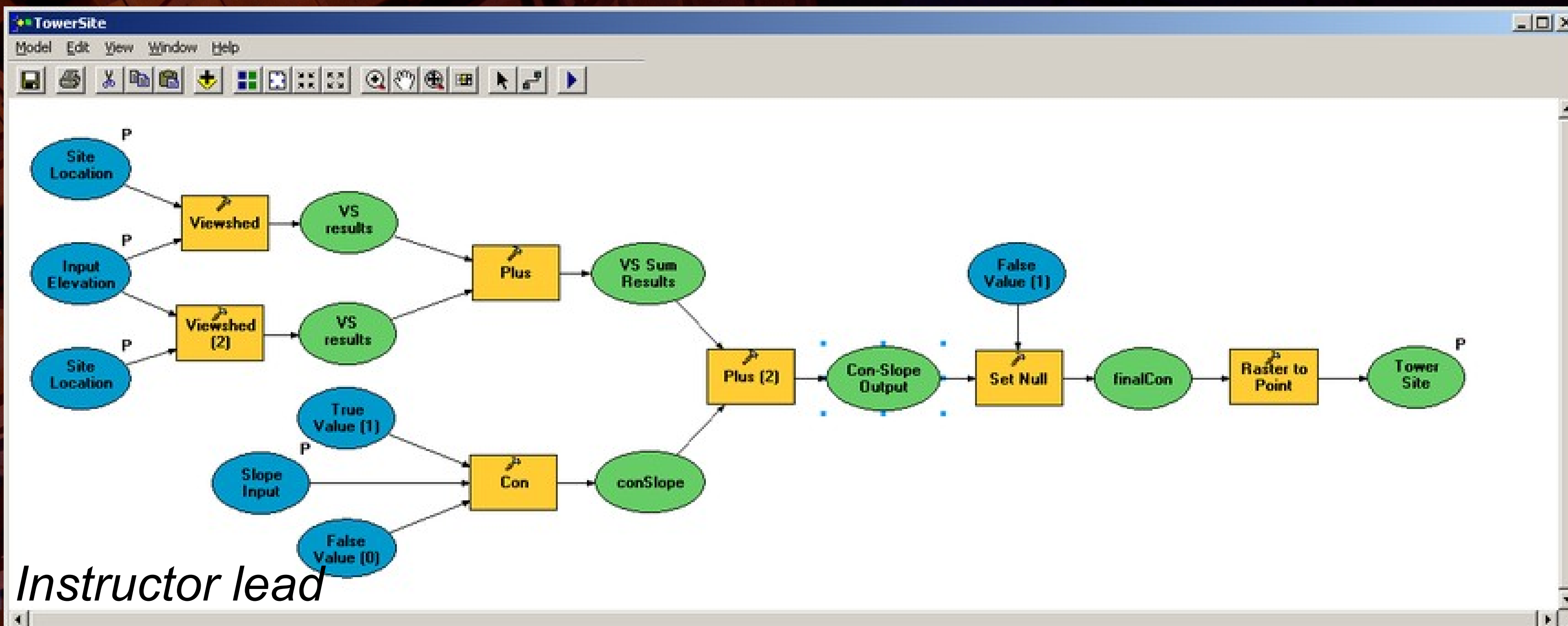


Instructor lead

Viewshed ModelBuilder Exercise

Ex04

Save TowerSite model.

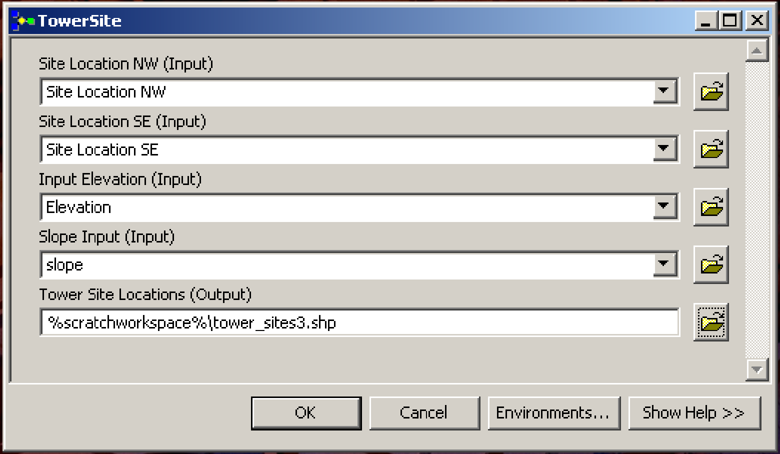


Instructor lead

Viewshed ModelBuilder Exercise

Ex04

- Open the TowerSite model in the Run mode by double clicking the model icon in toolbox or right click on the icon and select the "Open" option.
- Confirm that the input and output information is accurate.
- Click the OK button to execute the model.

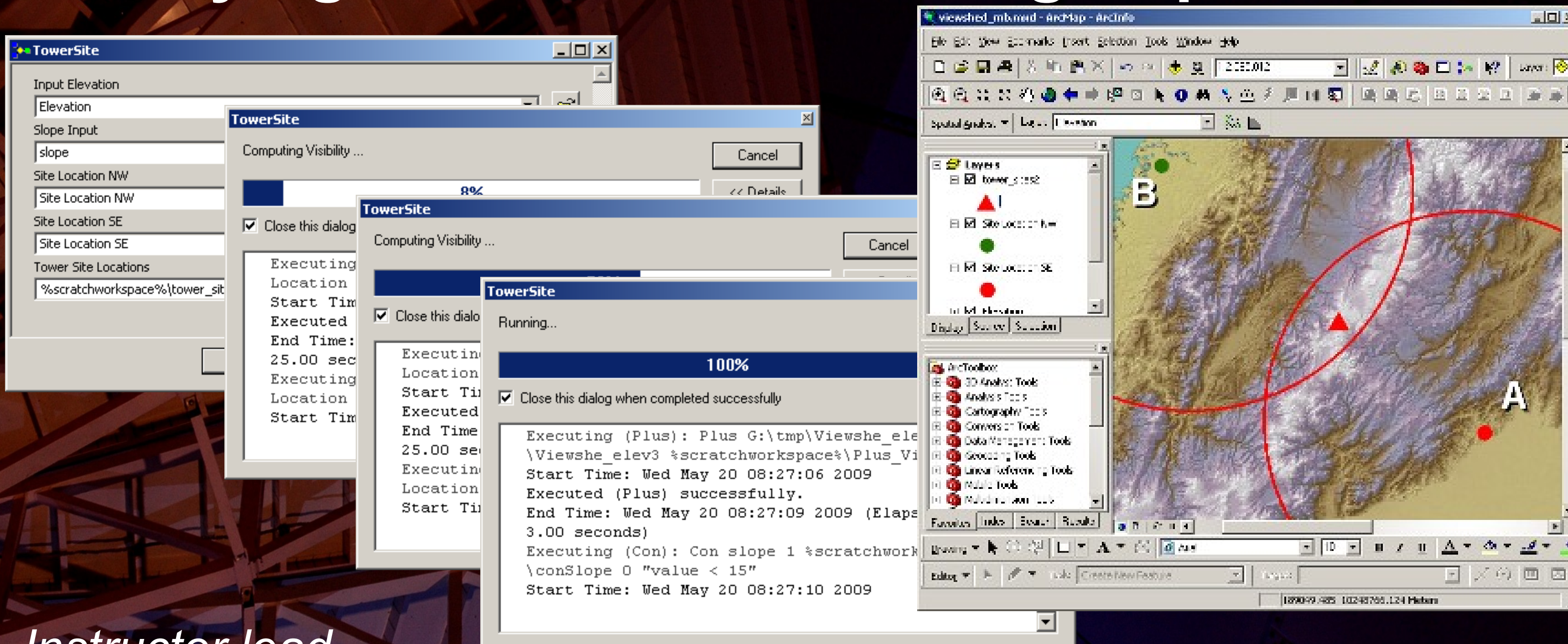


Instructor lead

Viewshed ModelBuilder Exercise

Ex04

Once the model has successfully executed, the vector points layer will be added to the map identifying the locations meeting requirements.



Instructor lead

USGS

Viewshed ModelBuilder Exercise

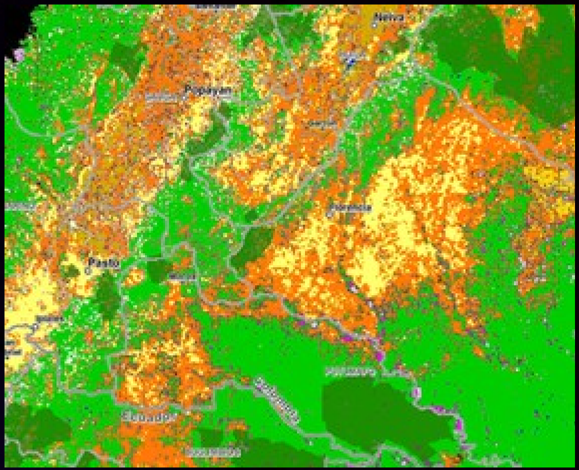
Questions?

Next Exercise: Vulnerability ModelBuilder Exercise

Vulnerability ModelBuilder Exercise

Ex05

- **Protected Area Vulnerability Exercise**
- **Question:** Recent activity in the region covering Colombia and Ecuador's border suggests an expansion of intensive agriculture into the closed tropical evergreen forest. The areas of highest vulnerability are southern facing slopes with a slope of between 0 and 10 degrees between the elevation of 1000 m and 2000 m. Your task is to identify these vulnerable areas within the protected areas of this region.



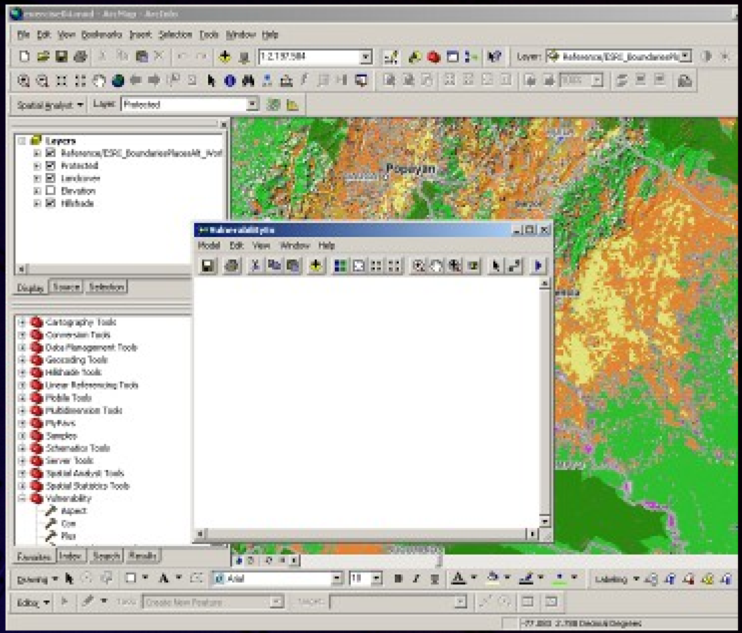
Instructor lead

USGS

Vulnerability ModelBuilder Exercise

Ex05

- Open .../exercise04/exerise04.mxd.
- Open Toolbox in ArcMap.
- Expand the Vulnerability toolset.
- Open the <u>VulnerabilityEx</u> model in edit mode.



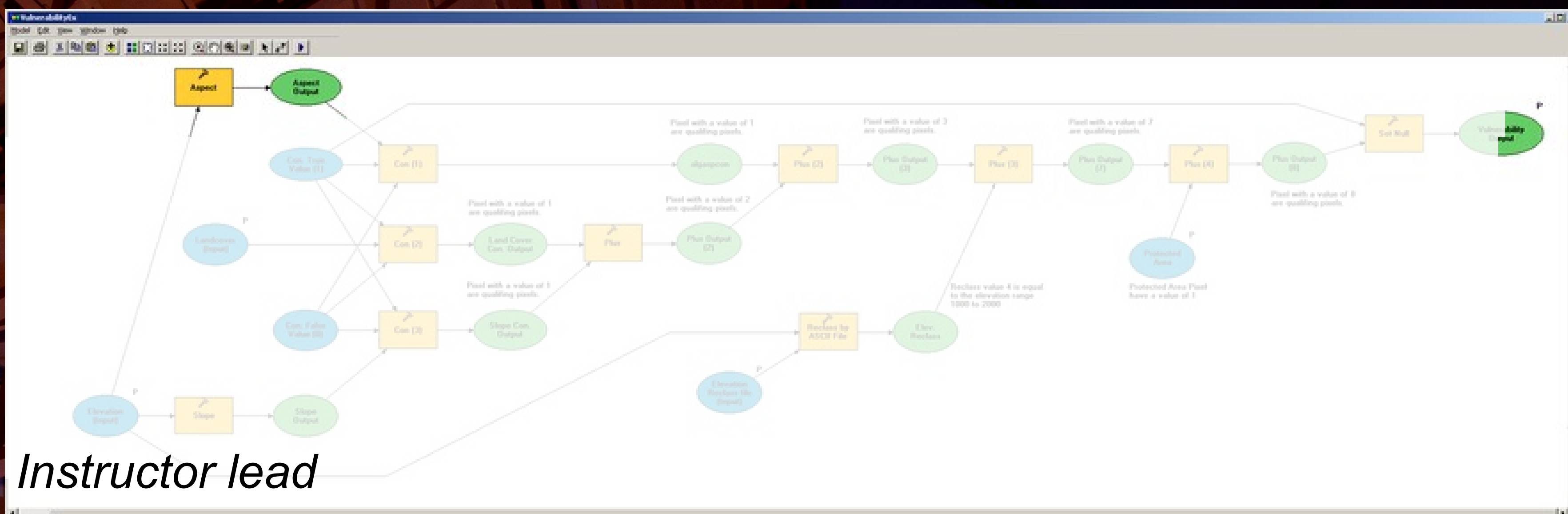
Instructor lead

USGS

Vulnerability ModelBuilder Exercise

Ex05

Add ASPECT tool.



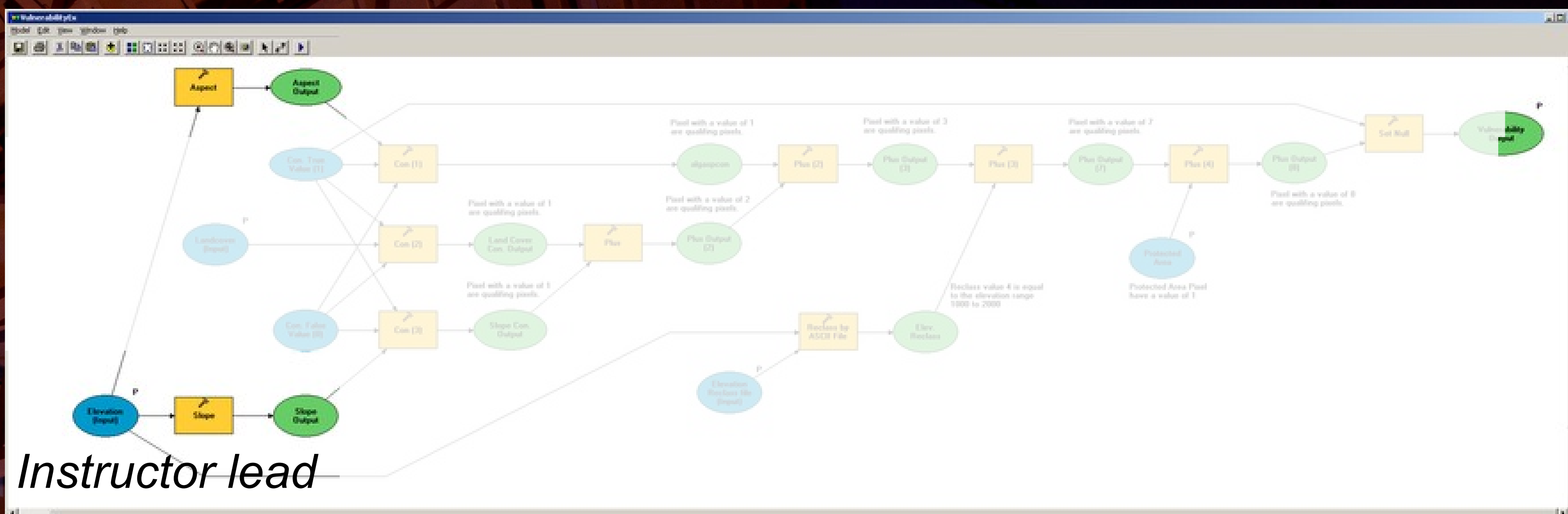
Instructor lead

USGS

Vulnerability ModelBuilder Exercise

Ex05

Add Slope tool.



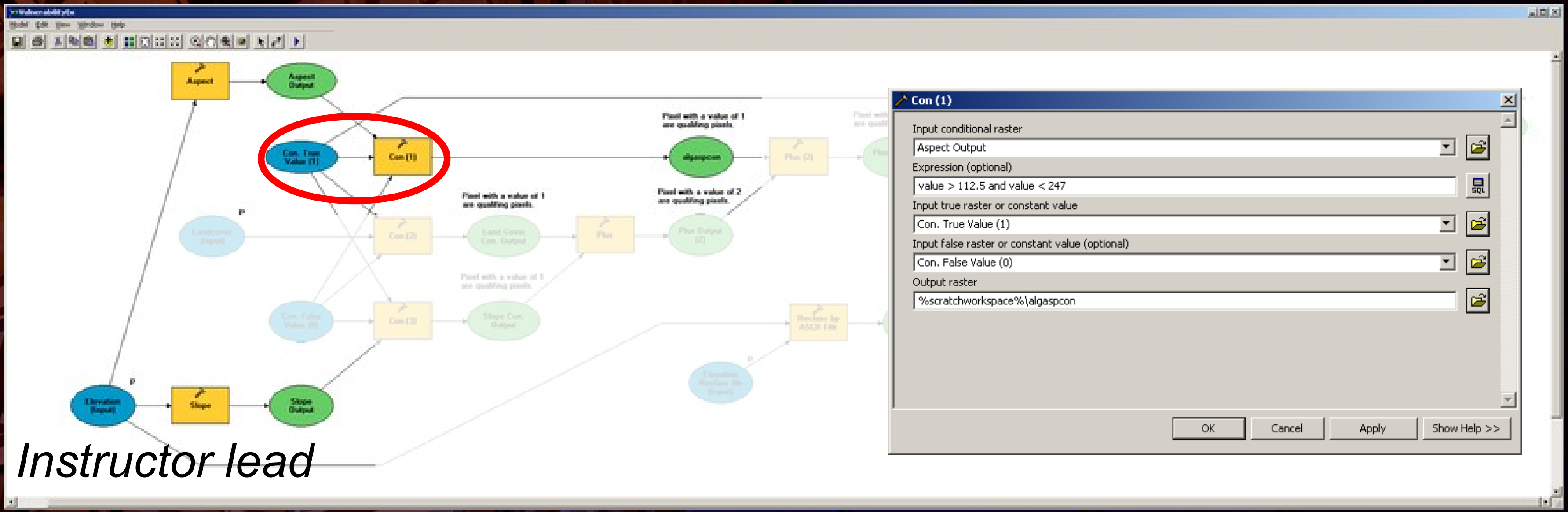
Instructor lead

USGS

Vulnerability ModelBuilder Exercise

Ex05

Add the first of three conditional (Con) statement tool. Set this Con tool to select the pixels that satisfy the southern facing slopes (ASPECT) requirements *(Expression: Value > 112.5 and value < 247).*



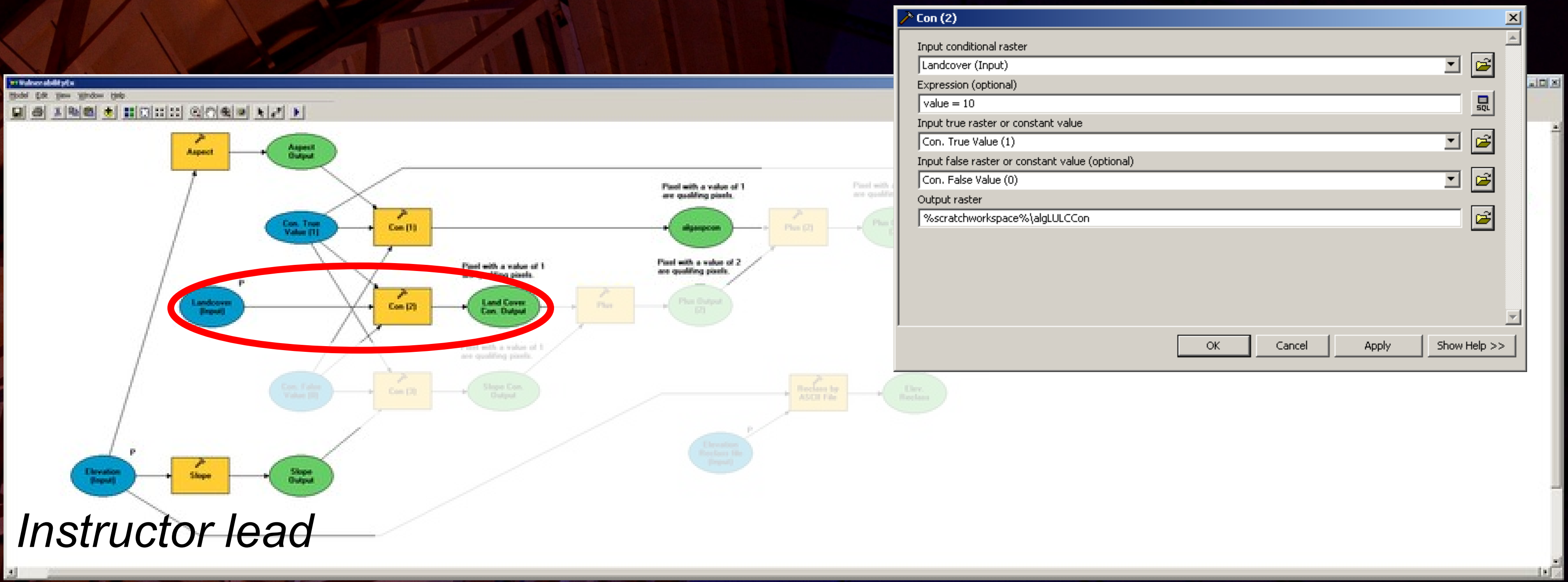
Instructor lead

USGS

Vulnerability ModelBuilder Exercise

Ex05

Add a second Con statement tool. Set this Con tool to select the pixels that satisfy the land cover requirement *(Expression: value = 10).*



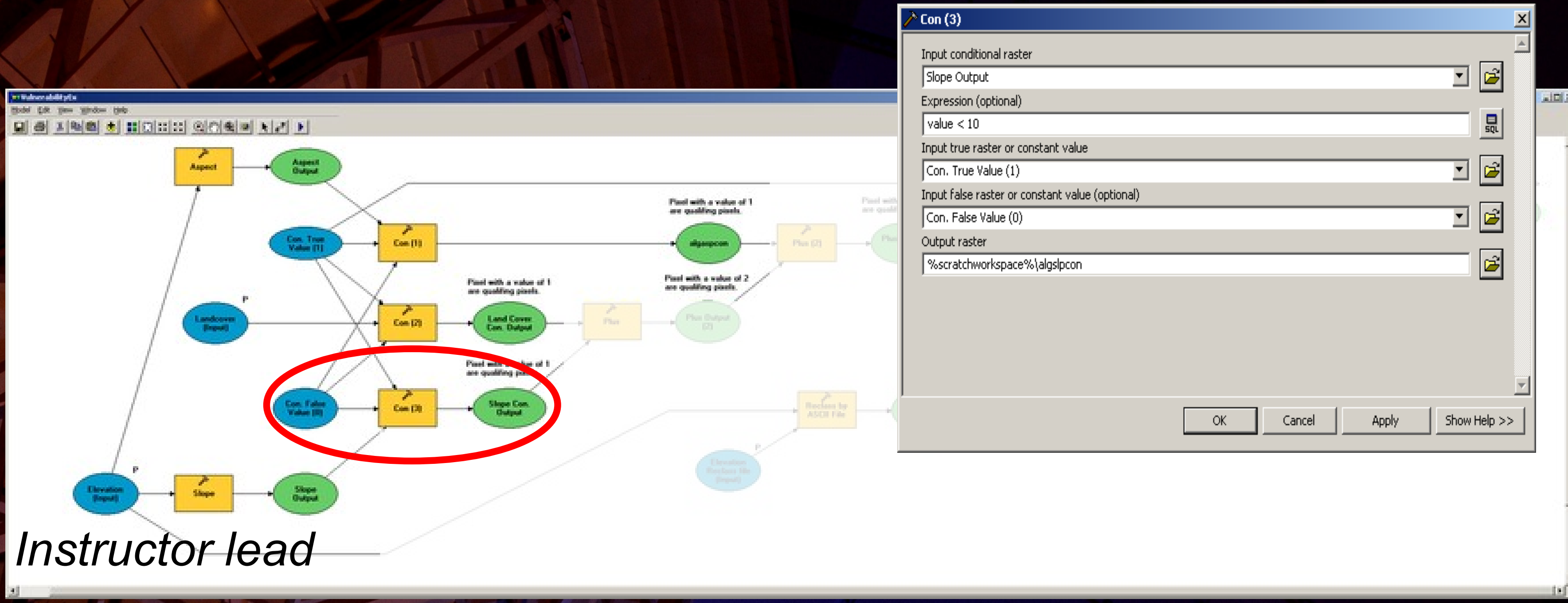
Instructor lead

USGS

Vulnerability ModelBuilder Exercise

Ex05

Add a third Con statement tool. Set this tool to select the pixels that satisfies the slope requirement *(Expression: value < 10).*



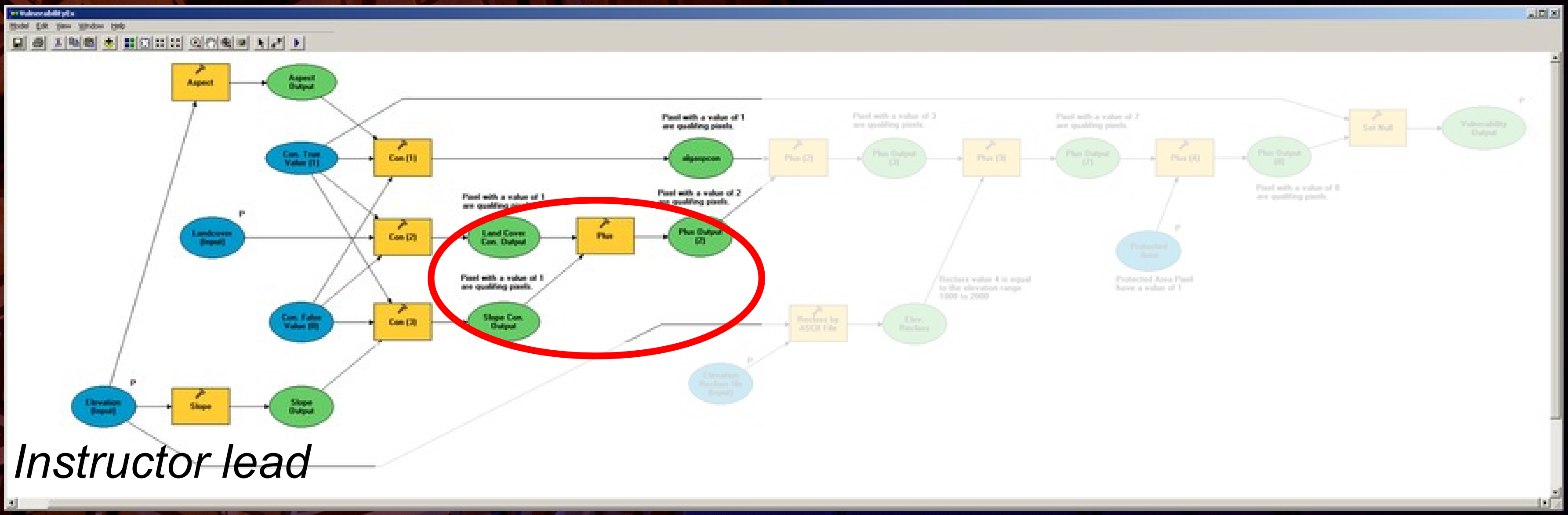
Instructor lead

USGS

Vulnerability ModelBuilder Exercise

Ex05

Add a <u>Plus</u> tool that sums the results from the land cover and slope conditional tools.



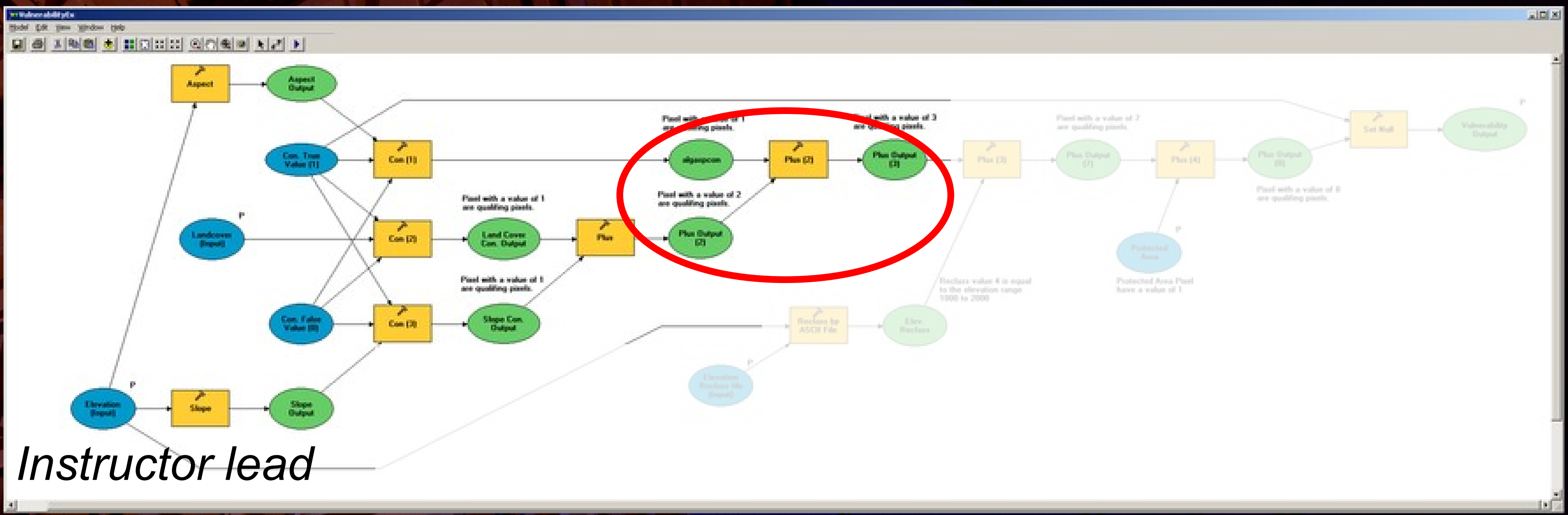
Instructor lead

USGS

Vulnerability ModelBuilder Exercise

Ex05

Add a <u>Plus</u> tool to sum the results from the preceding *Plus* and *Aspect conditional* results.



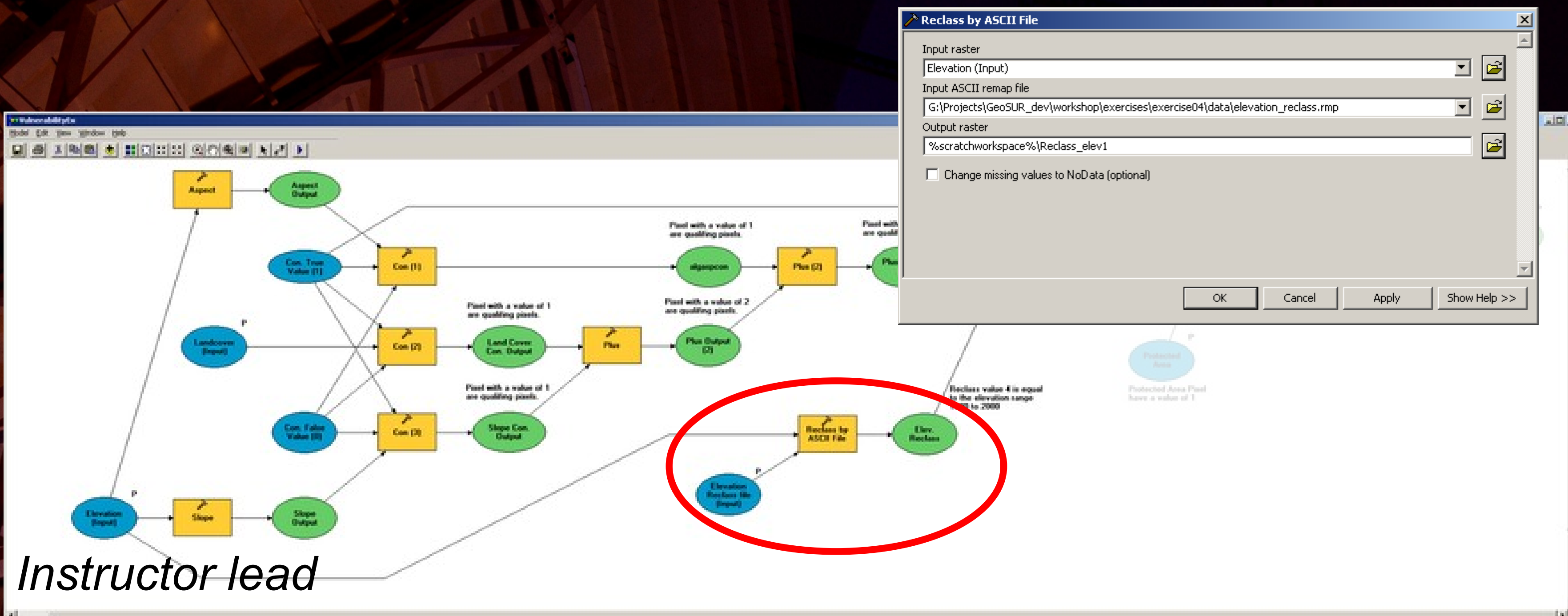
Instructor lead

USGS

Vulnerability ModelBuilder Exercise

Ex05

Add the Reclass by ASCII File to classify the elevation dataset into discrete classes.



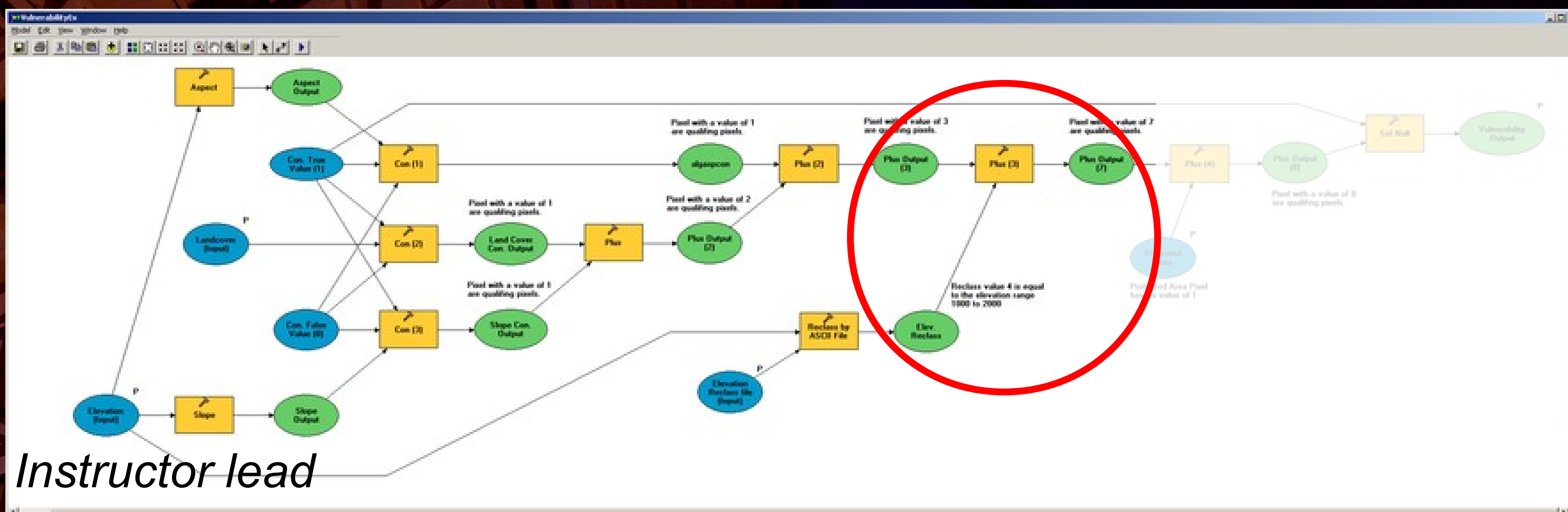
Instructor lead

USGS

Vulnerability ModelBuilder Exercise

Ex05

Add a <u>Plus</u> tool to sum the results from the preceding *Plus* tool and the elevation reclassification results.



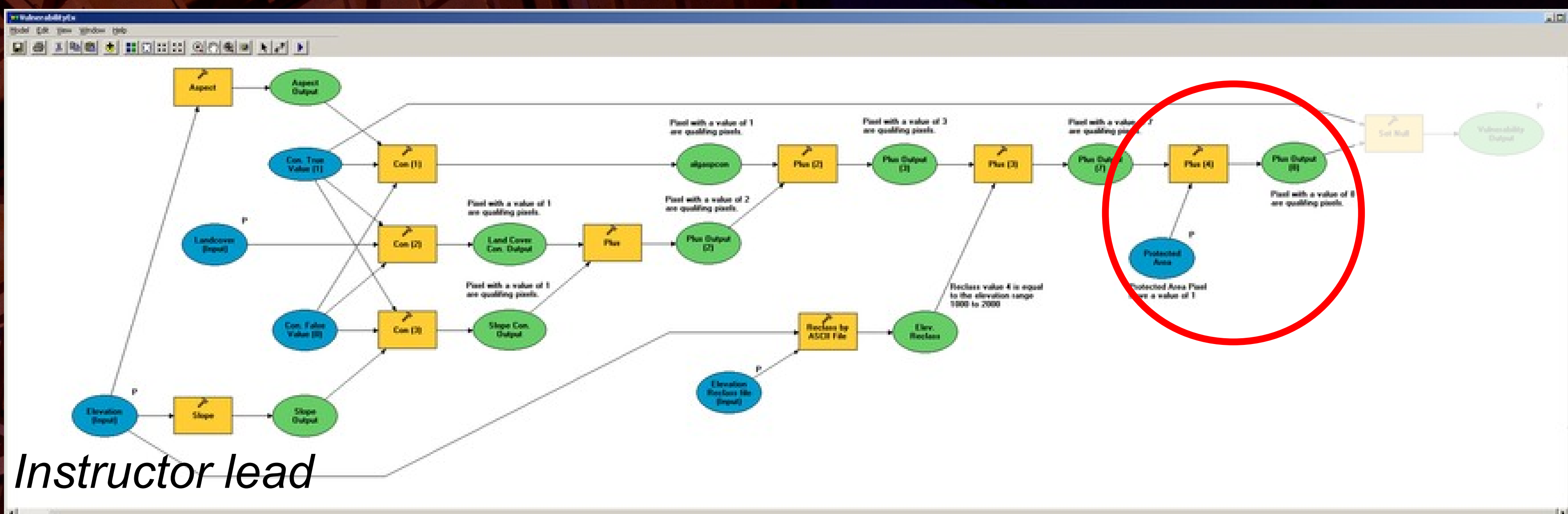
Instructor lead

USGS

Vulnerability ModelBuilder Exercise

Ex05

Add a <u>Plus</u> tool to sum the results from the preceding *Plus* and Protected Area raster dataset *(Protected Area pixel values equal 1)***.**



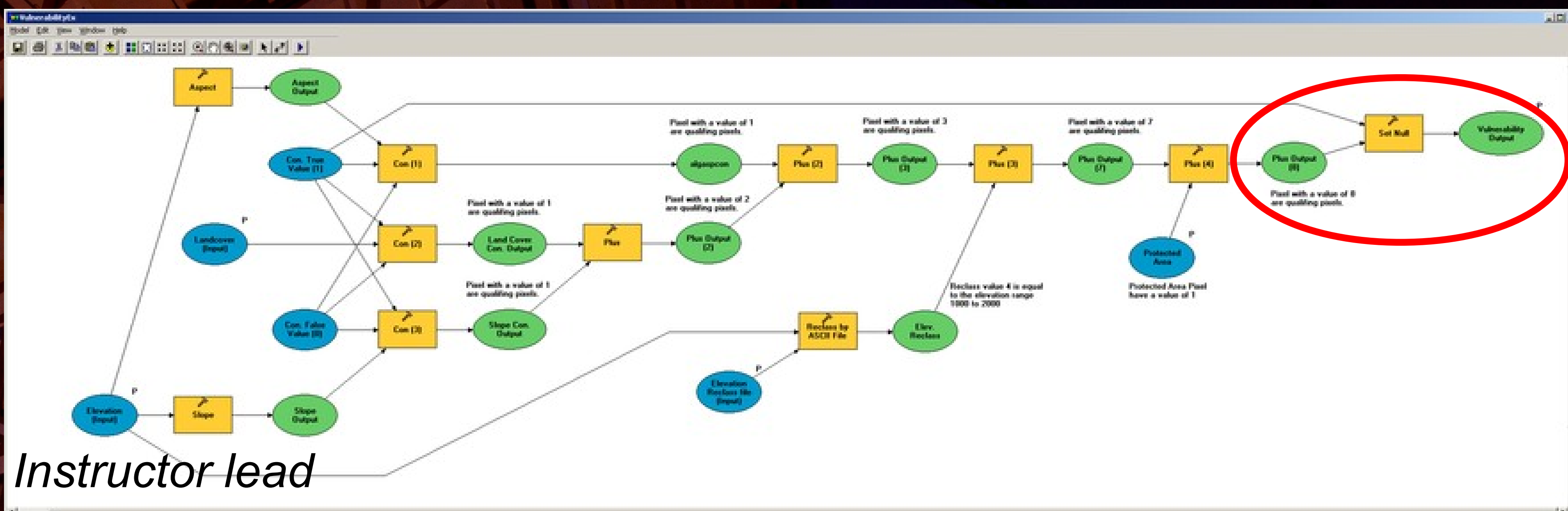
Instructor lead

USGS

Vulnerability ModelBuilder Exercise

Ex05

Add a <u>Set Null</u> tool to remove all pixels not equal to 8. The value 8 is the sum of the *true* results of the conditional statements, the elevation reclassification, and protected area rasters that satisfy the requirements.



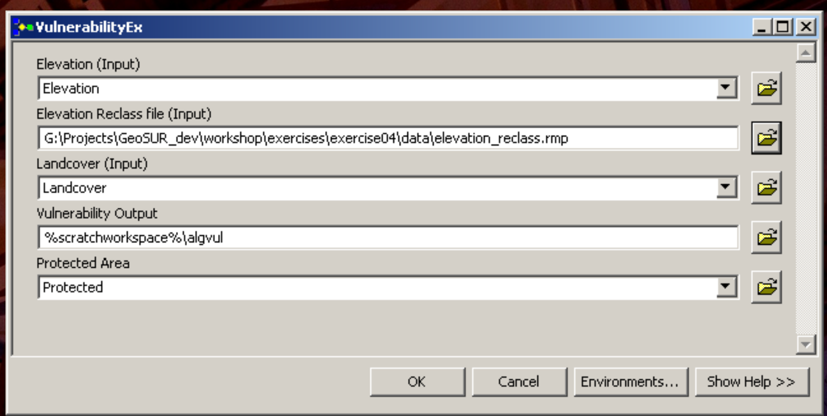
Instructor lead

USGS

Vulnerability ModelBuilder Exercise

Ex05

- Open the VulnerabilityEx model in the Run mode by double clicking the model icon in toolbox or right click on the icon and select the “Open” option.
- Confirm that the input and output information is correct.
- Click the OK button to execute the model.

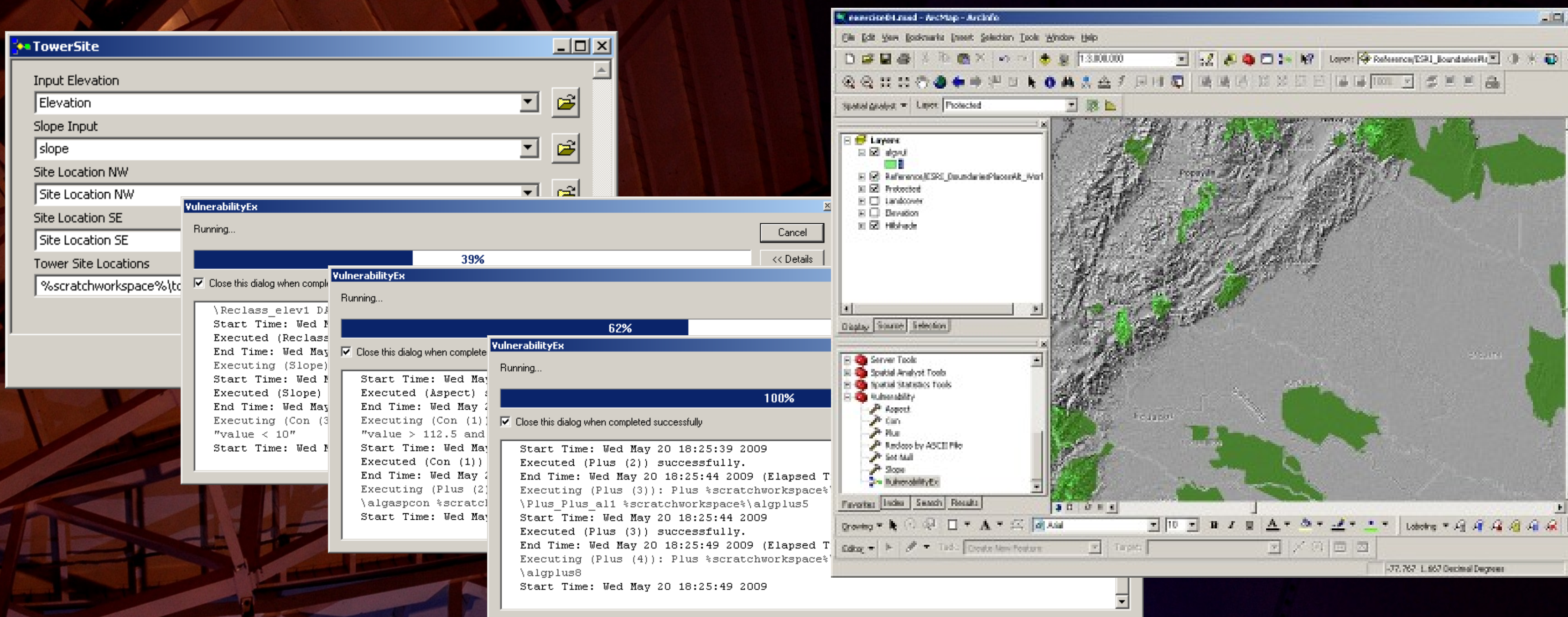


Instructor lead

Vulnerability ModelBuilder Exercise

Ex05

Once the model has successfully executed, a raster layer will be added to the map identifying the locations meeting the vulnerability requirements.



Instructor lead

Vulnerability ModelBuilder Exercise

Questions?

Next Exercise: Generating hydrological derivatives from the SRTM Level-1 (90 m) Dataset

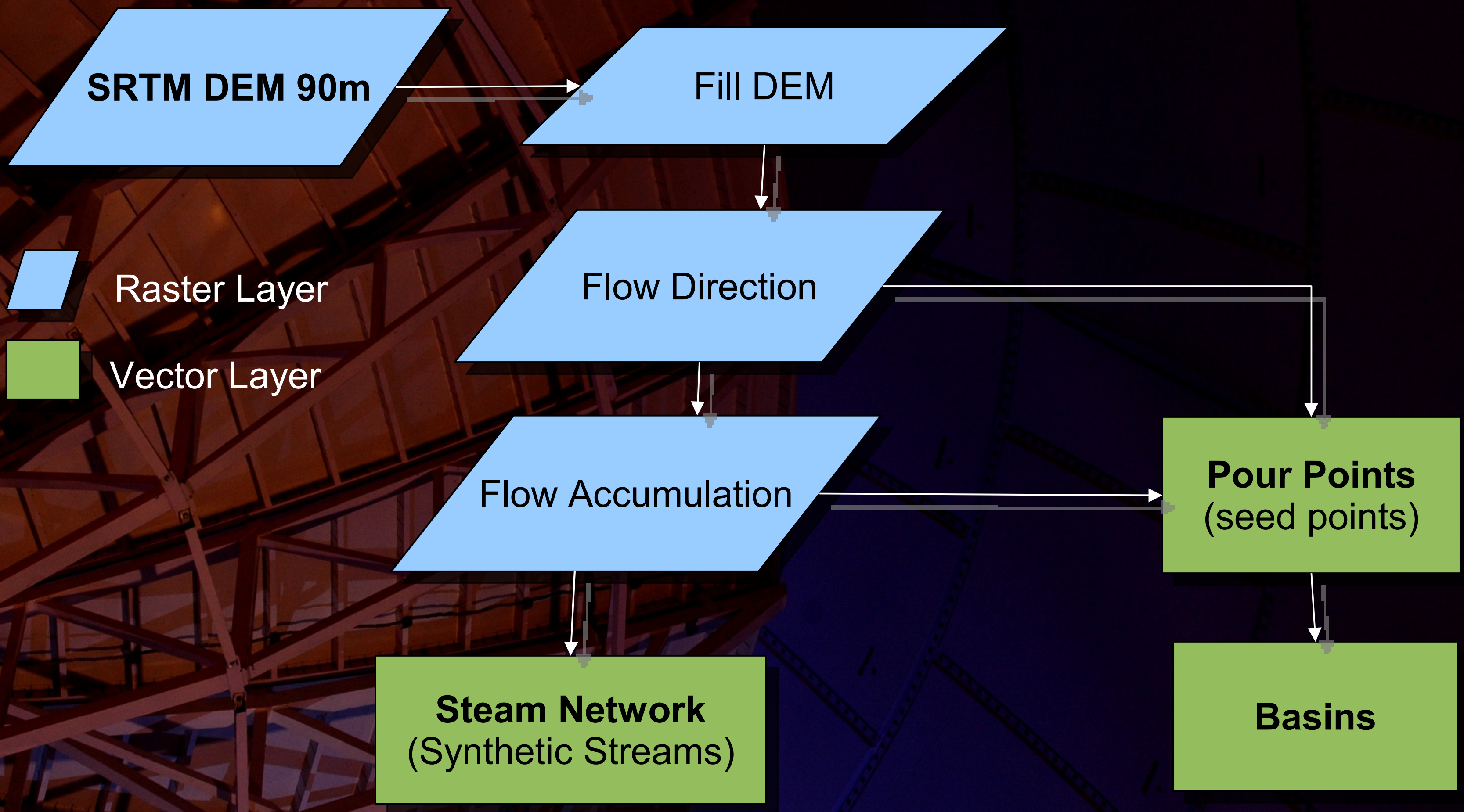
USGS

Hydrological Derivative Development

- **After completing this exercise, participants should:**
  - Understand how hydrological derivative products can be developed for GeoSUR project.
  - Be familiar with ESRI's ArcGIS Toolsets and Models.
  - Have a general understanding of simple hydrology modeling.

Hydrological Derivative Development

Task Flow Diagram

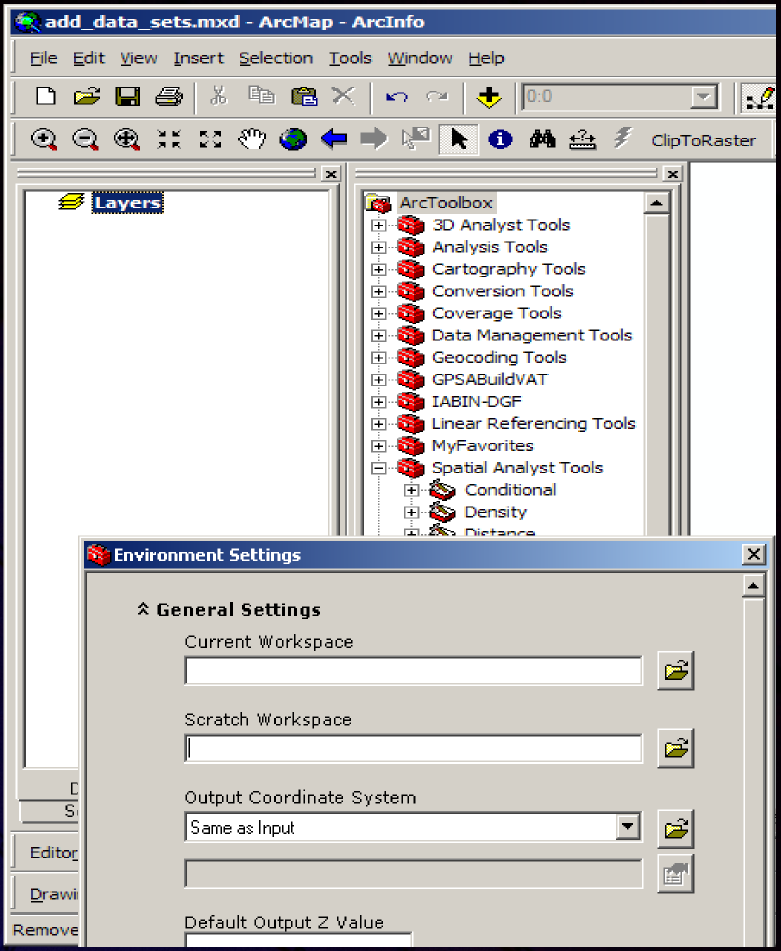


Hydrological Derivative Development

Ex06

Set Environment Variables

- Open ArcMap (New Project).
- Open ArcToolbox window.
- Open Toolset Environment Settings Dialog.
- Expand “General Settings”
- Set Current Workspace to “...\exercise\workspace”.
- Set Scratch Workspace to “...\exercises\scratch”.

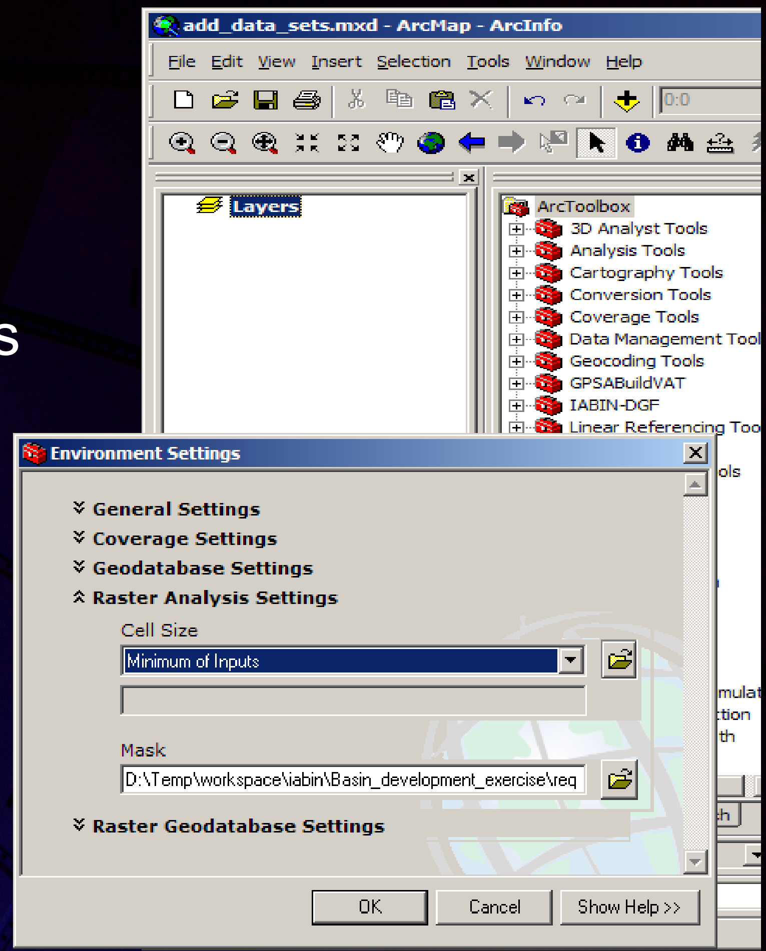


Hydrological Derivative Development

Ex06

Set Environment Variables

- Defining Processing Mask.
- Collapse “General Settings”
- Expand “Raster Analysis Setting”
- Set Cell Size to Minimum of inputs
- Mask to “…\exercise06\data\ sample_dem” raster.
- Click “OK”



USGS

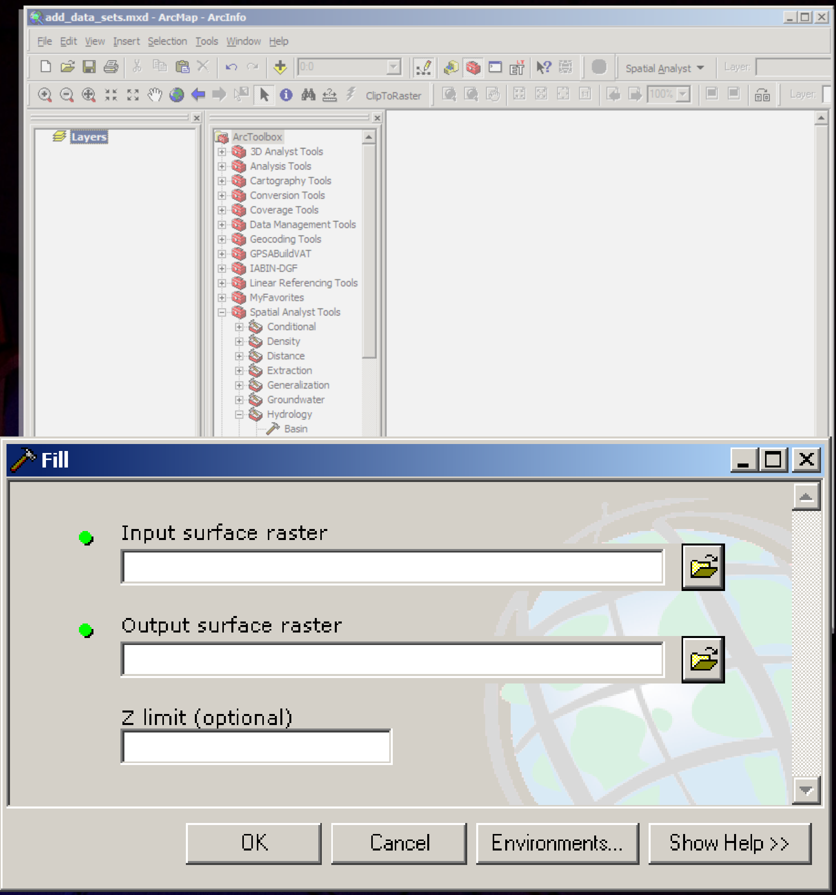
Hydrological Derivative Development

Ex06

Fill Sinks

- Locate Hydrology Toolset

  (Spatial Analyst Tools > Hydrology > Fill)
- Open the Fill Tool (double click).
- Select “sample_dem” as input surface raster
- Enter “sample_fll” as output surface
- Click “OK”



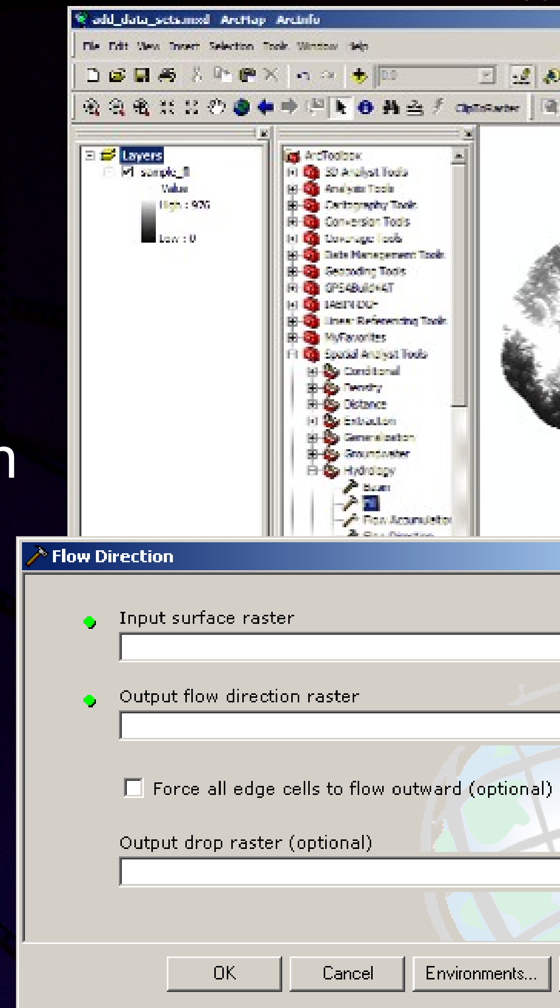
USGS

Hydrological Derivative Development

Ex06

Calculate Flow Direction

- Locate and open "Flow Direction" Tool
  (Spatial Analyst Tools > Hydrology > Flow Direction)
- Select the "Sample_fll" grid as the input surface raster.
- Enter "sample_fdir" as output flow direction raster.
- Allow the remaining options to default.
- Click "OK"



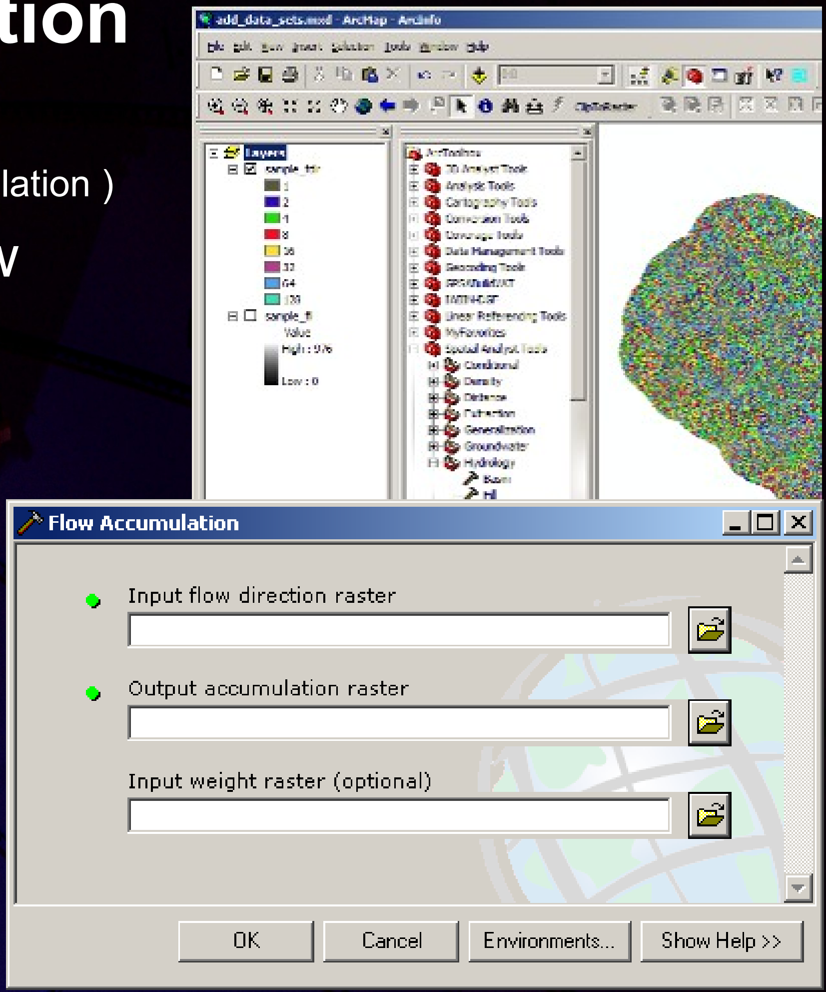
USGS

Hydrological Derivative Development

Ex06

Calculate Flow Accumulation

- Open Flow Accumulation Tool
  (Spatial Analyst Tools > Hydrology > Flow Accumulation)
- Select “sample_fdir” as Input flow direction raster.
- Enter “sample_facc” as Output accumulation raster.
- Leave “weight raster” blank.
- Click “OK”.



NOTE: *For large data sets the flow accumulation processing will take considerable time to complete.*

Hydrological Derivative Development

Ex06

Create Drainage Network

- **Using Map Algebra to create drainage network.**
- **Use "Set Null" tool to query a drainage network.**

(ArcToolbox > Spatial Analyst > Conditional > Set Null)

This function extracts the cells with the highest accumulation flow value. The drainage network detail is defined by a desired flow accumulation threshold set by the null expression variable. This tool selects all cells satisfying the expression, sets their value to NODATA, then sets the remaining cells equal to the input false value.

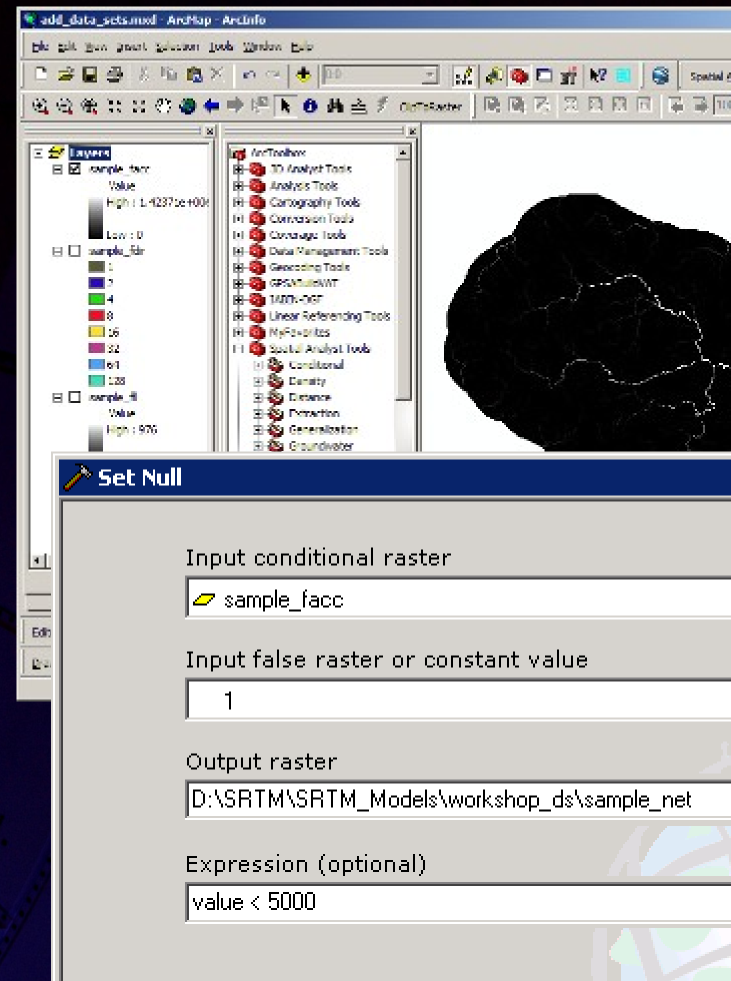
The output raster dataset will be all the cell values NOT satisfied by the expression. The density of the network is dependent on the value in the expression. The higher the value the less "*streams*" in the network.

Hydrological Derivative Development

Ex06

Create Drainage Network

- In the tool, set “sample_facc” as Input conditional raster.
- Set “Input false” to 1.
- Enter “sample_net” as Output raster.
- Enter “value < 5000” as the expression.
- Click “OK”



Hydrological Derivative Development

Ex06

Enhancing drainage network information

- **Once the initial network is generated attribute values can be added.**
  - Classify Stream Order (*SHRAHLER*)
  - Add Network Attributes (FromNode & ToNode)
- **Enhancement Steps**
  - Stream Link Function
  - Stream Order Function
  - Convert Raster Streams to Vector and add networking attributes.

USGS

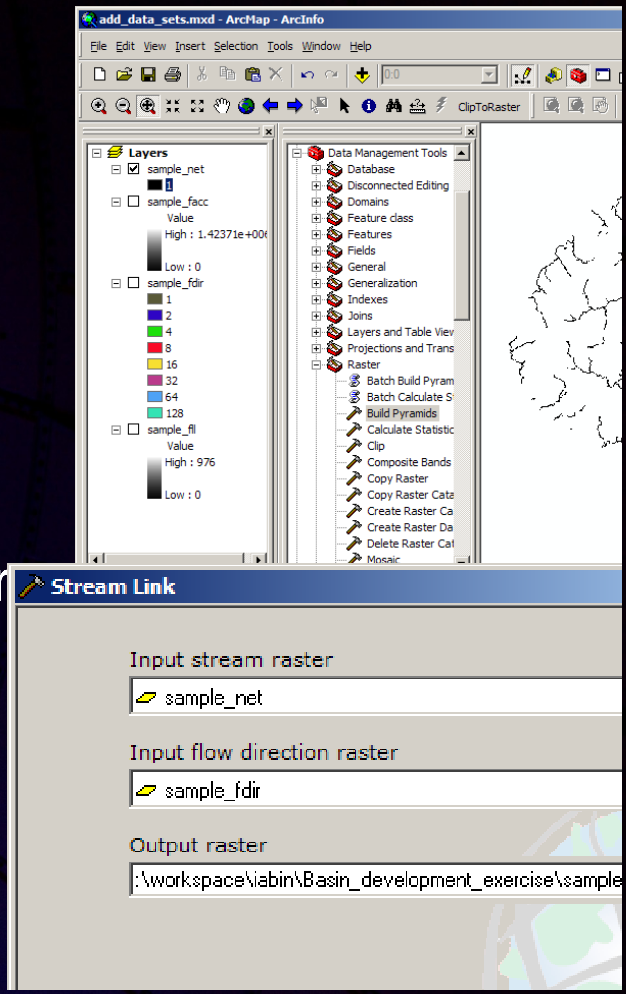
Hydrological Derivative Development

Ex06

Stream Link

- Open “Stream Link” tool

  (ArcToolbox > Spatial Analyst > Hydrology > Stream Link)
- Set the Input stream raster to “sample_net”.
- Set the Input flow direction raster to “sample_fdir”.
- Enter “sample_lnk” as the Output raster
- Click “OK”



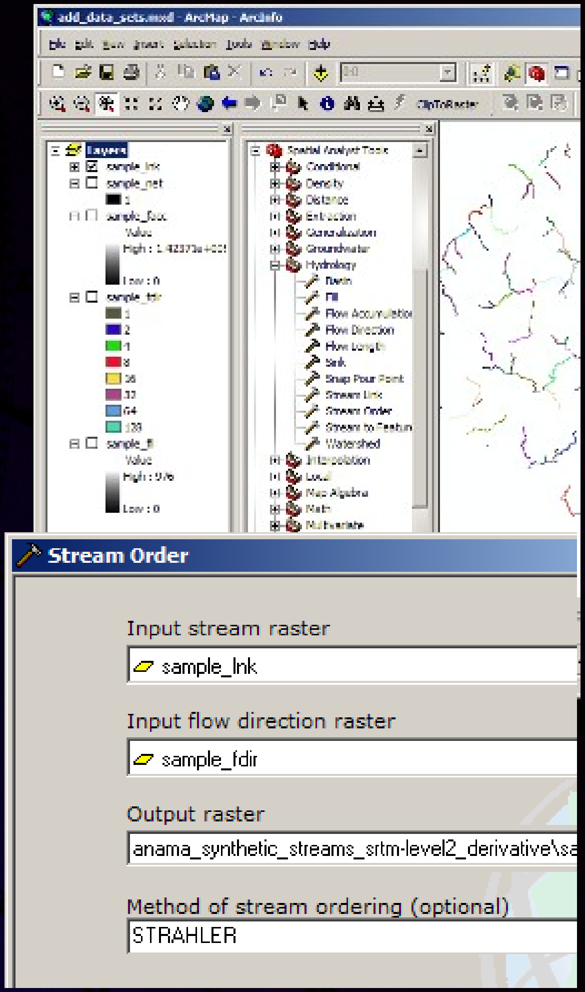
USGS

Hydrological Derivative Development

Ex06

Stream Order

- Open “Stream Order” tool (ArcToolbox > Spatial Analyst > Hydrology > Stream Order)
- Set Input stream raster to “sample_lnk”.
- Set Input flow direction raster to “sample_fdir”.
- Enter “sample_ord” as Output raster.
- Select “STRAHLER” as the ordering method.
- Click “OK”.



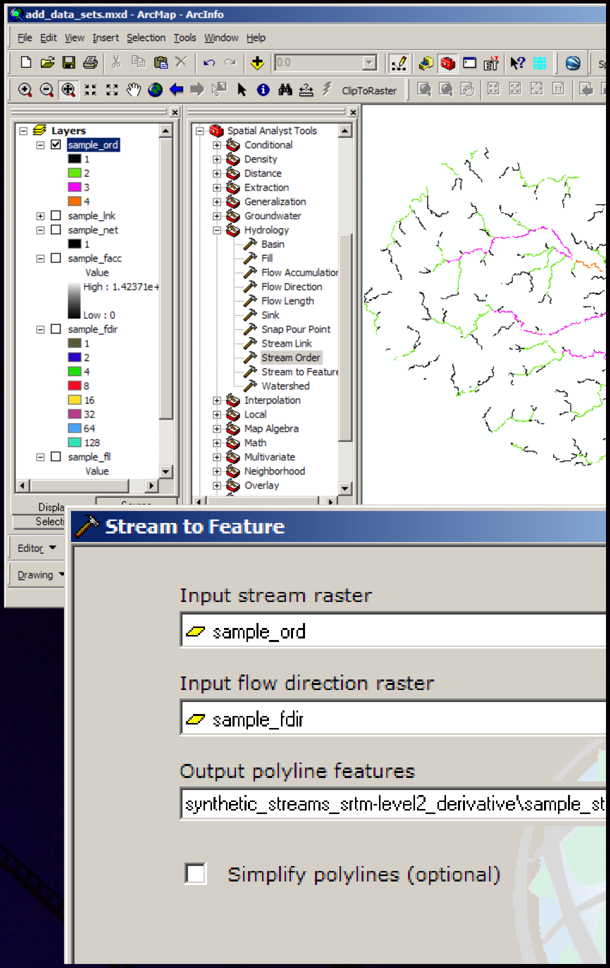
USGS

Hydrological Derivative Development

Ex06

Vectorize Network

- Open “Stream to Feature” tool (ArcToolbox > Spatial Analyst > Hydrology > Stream to Feature).
- Set Input stream raster to “sample_ord”.
- Set Input flow direction raster to “sample_fdir”.
- Enter “sample_streams.shp” as Output polyline features
- Uncheck “Simplify polylines”
- Click “OK”



USGS

Hydrological Derivative Development

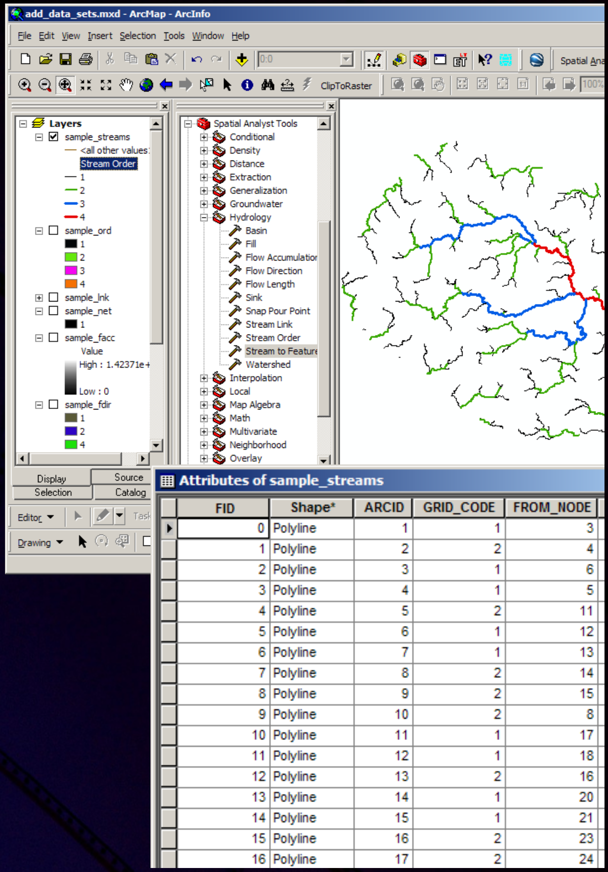
Ex06

Drainage Network Attributes

- Open "sample_streams.shp" attribute table.
- Identifying Feature Attributes

GRID_CODE shows the resulting stream order values. *The higher the value the more tributaries the segment has upstream.*

FROM_NODE & ***TO_NODE*** defines the stream flow direction.



FID	Shape*	ARCID	GRID_CODE	FROM_NODE
0	Polyline	1	1	3
1	Polyline	2	2	4
2	Polyline	3	1	6
3	Polyline	4	1	5
4	Polyline	5	2	11
5	Polyline	6	1	12
6	Polyline	7	1	13
7	Polyline	8	2	14
8	Polyline	9	2	15
9	Polyline	10	2	8
10	Polyline	11	1	17
11	Polyline	12	1	18
12	Polyline	13	2	16
13	Polyline	14	1	20
14	Polyline	15	1	21
15	Polyline	16	2	23
16	Polyline	17	2	24

USGS

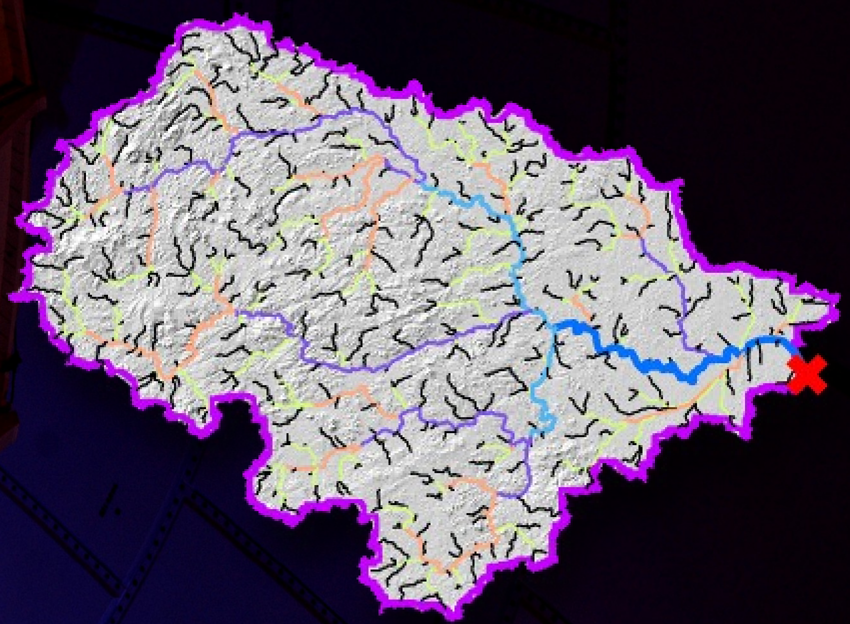
Hydrological Derivative Development

Ex06

Drainage Basin Polygon Delineation

- The method covered in this exercise for defining drainage basins is designed to delineate the entire geographic extent of a basin based on a pour point *(sink)* intersection.

- **Benefits to this approach:**
  - Provides controls to set minimum basin size.
  - Provides output of pour points.



USGS

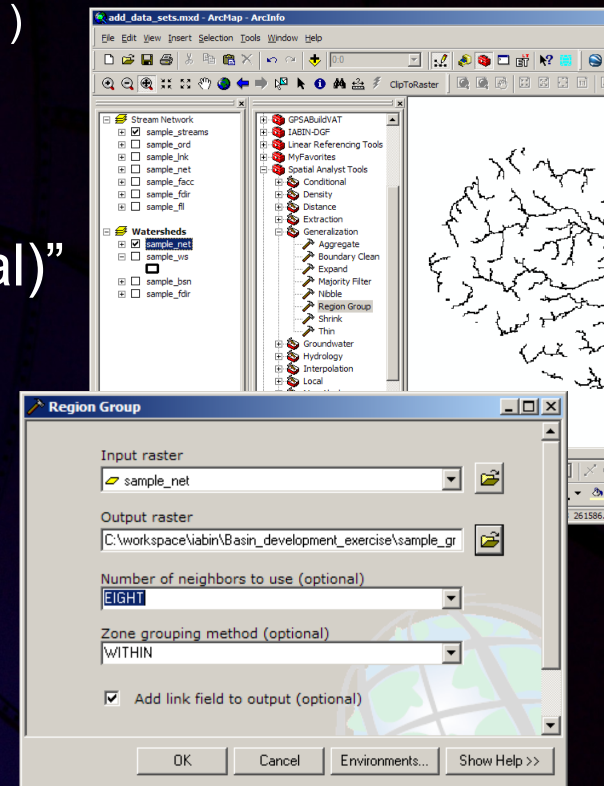
Hydrological Derivative Development

Ex06

Determine Drainage Basin

- Open “Region Group” tool

  (Spatial Analyst Tools > Generalization > Region Group)
- Set Input raster to “sample_net”.
- Enter “sample_grp” as Output raster.
- Set “Number of neighbors to use (optional)” to EIGHT.
- Set “Zone grouping...” to WITHIN.
- Check “Add link field..” option.
- Click “OK”.

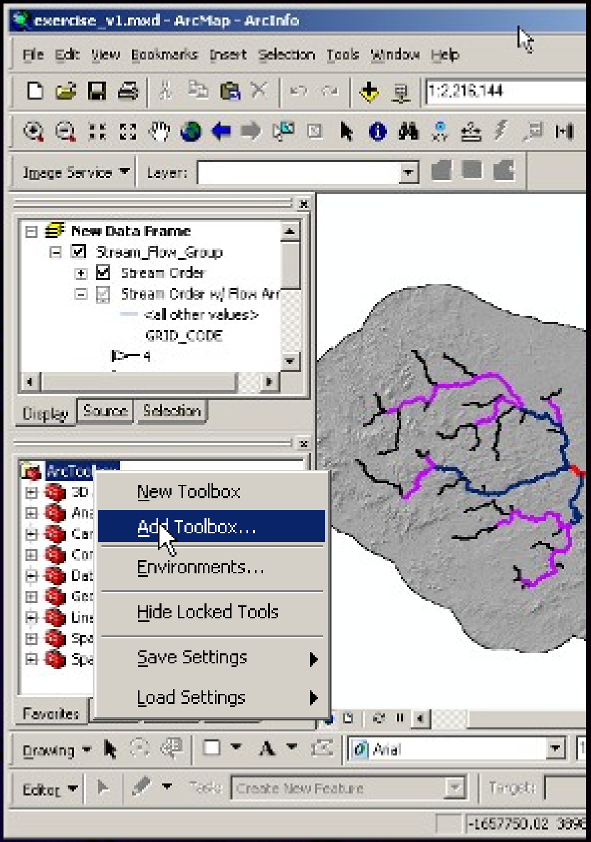


Hydrological Derivative Development

Ex06

Determine Drainage Basin

- Load the “Pour Point Model” toolset.
- Right click on “ArcToolbox” select “Add Toolbox...” option.
- Open “HydroDerivativeToolset” from the “...\exercise06” folder.

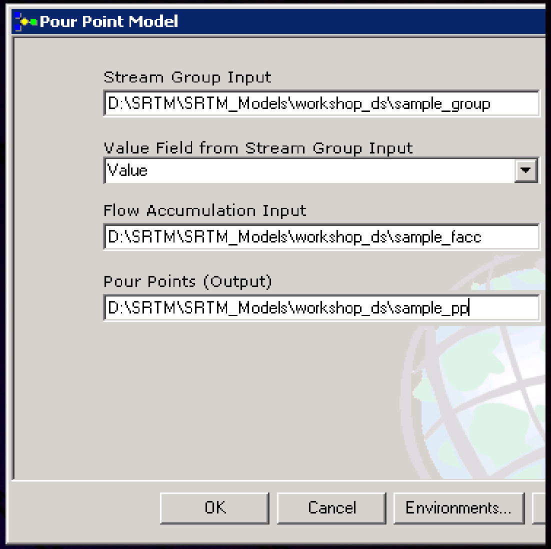


Hydrological Derivative Development

Ex06

Calculate Pour Points

- Open “Pour Point Model” tool within the newly loaded Toolset.
- Set Stream Group Input to “sample_grp”
- Set Value Field from Stream Group Input to “Value”.
- Set Flow Accumulation Input to “sample_facc”.
- Enter “sample_pp” as Pour Points (Output).



USGS

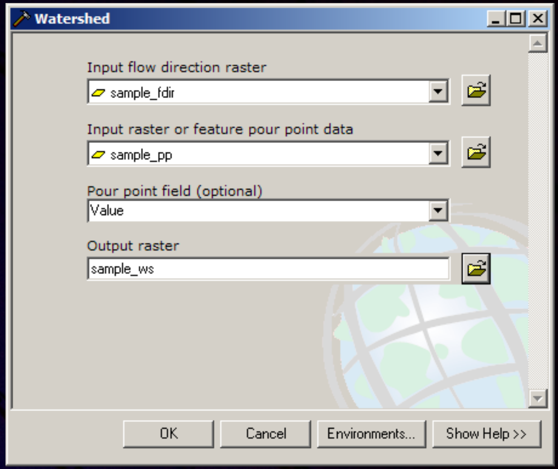
Hydrological Derivative Development

Ex06

Calculating Watersheds

- Open “Watershed” tool

  (ArcToolbox > Spatial Analyst > Hydrology > Watershed)
- Set “sample_fdir” as <u>Input Flow Direction</u>.
- Set “sample_pp” as <u>Input raster or…</u>
- Set <u>Pour point field</u> to “Value”.
- Enter “sample_ws” as <u>Output raster</u>.
- Click “OK”.

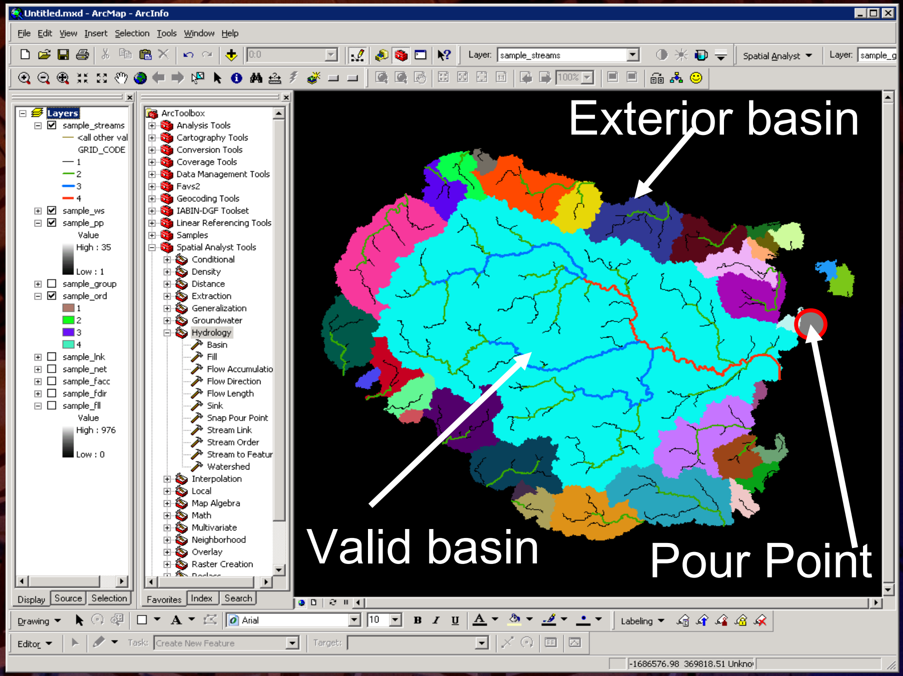


USGS

Hydrological Derivative Development

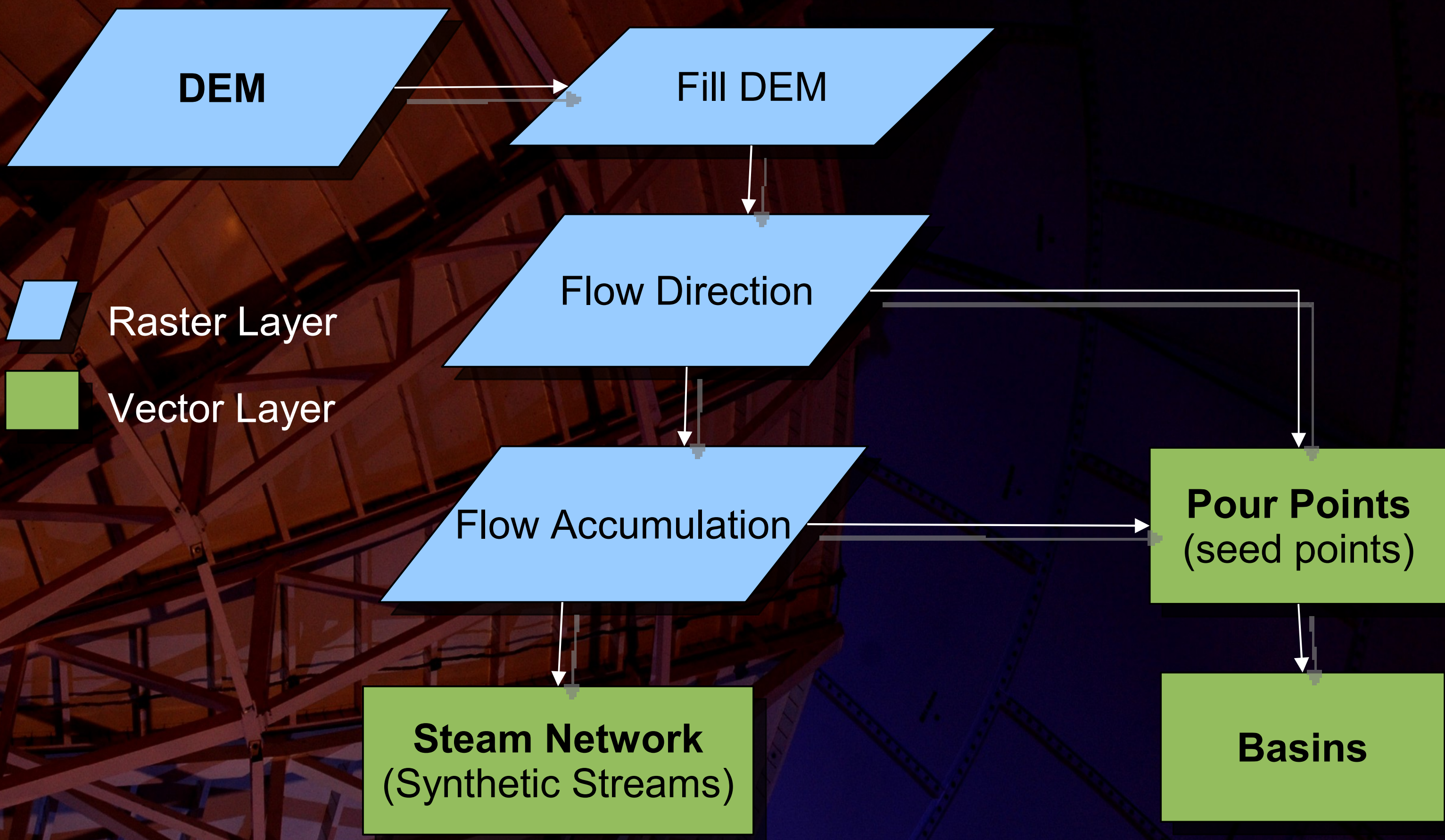
Ex06

- **Review Results**
- Review valid basins and exterior basins
- Pour point location



Hydrological Derivative Development

Task Flow Diagram: *Review*



Hydrological Derivative Development

Alternative Methods

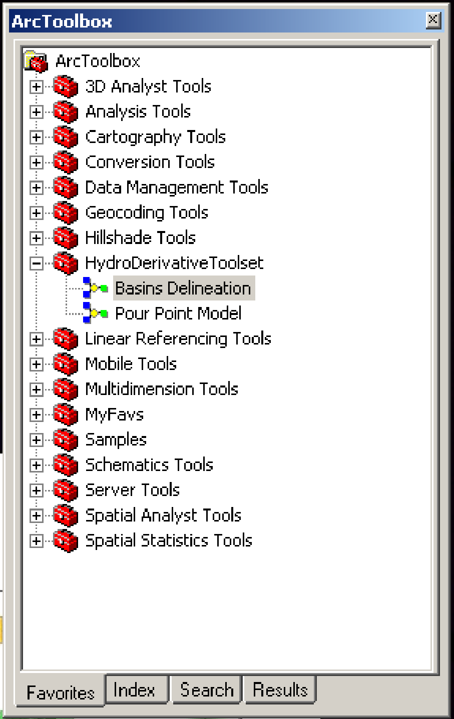
- **Use the "Basin" tool which only requires flow direction data sets.**
- *No control of pour point location and can not limit size of basins.*
- **Using ArcGIS Model Builder to combine all the process together.**
- **HydroDerivative Toolset**

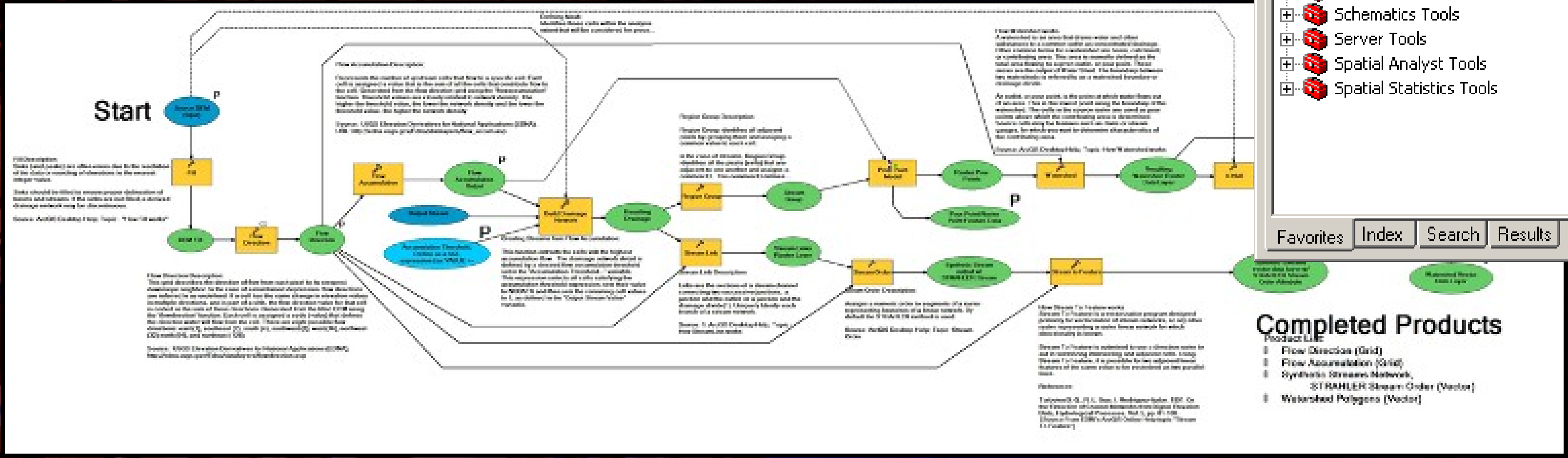
USGS

Hydrological Derivative Development

Hydro Derivative Toolset

- **Basins Delineation Model:**
- Used to Generate basins and synthetic streams (drainage network).
- **Pour Point Model:**
- Used within the Basin Delineation model as well as independently.

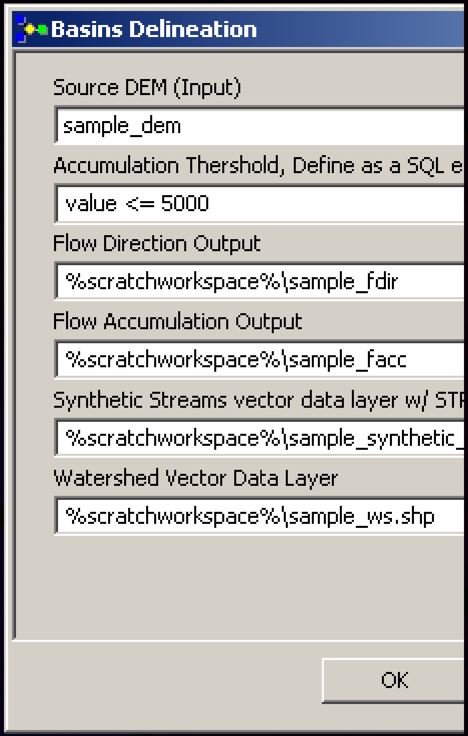




Hydrological Derivative Development

Running the Basins Delineation model

- Open ArcMap and load the "..\exercise06\exercise06.mxd" project.
- Activate ArcToolbox and open the "Basin Delineation" model.
- Verify input information and alter if desired.
- Click "OK".
- Once the model has successfully executed, the hydrological derivatives will be loaded into map's Data Frame.



<u>NOTE</u>: *Be careful - depending on the size of your input DEM, the process can take several hours.*

USGS

Hydrological Derivative Development

Questions?

Next Exercise: Drainage Basin delineation from SRTM Level-2 Derivatives

USGS

Drainage Basin Delineation

Ex07

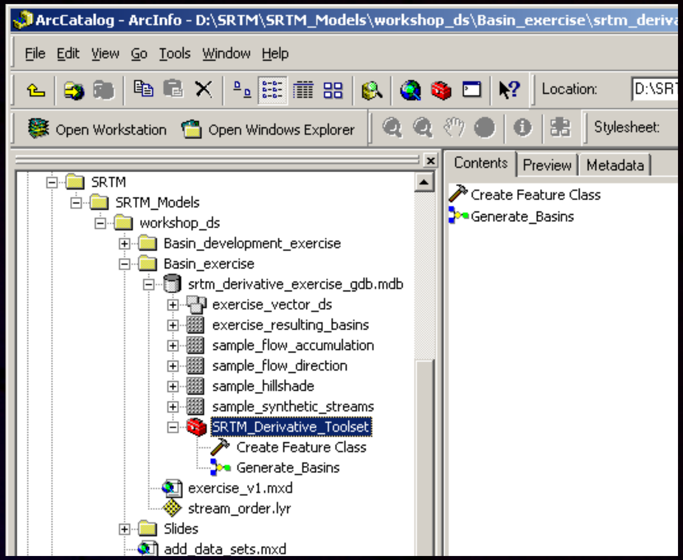
Exercise Overview

- Determine the best location for source points *(pour points)* for drainage basins.
  - This process will vary depending on development purposes (*management practice, politics*).
- Determine basin naming convention.
  - Unique names
  - Nested basins
- Build look up table (LUT) to relate numeric ID to meaningful name.
- Delineate drainage basins based on the location of pour points.

Drainage Basin Delineation

Ex07

- **Basin tools included.**
  - Create Feature Class
  - Generate Basins
- **<u>Create Feature Class:</u>** Creates an empty point feature class that has source points added.
- **<u>Generate Basins:</u>** This model takes source points and calculates basin polygons.



Drainage Basin Delineation

Ex07

Create Source Point Feature Class

- Open ArcCatalog
- Open the “Feature Class” tool in ArcToolbox
- Open “Create Feature Class” tool (...\exercise07\srtm_derivative_exercise_gdb.mdb\SRTM_Derivative_Toolset\Create Feature Class).
- Click the folder icon and browse to “*....\exercise07*\srtm_derivative_exercise_gdb.mdb” and select “exercise_vector_ds” feature data set and click “Add”
- Enter “my_sample_points” as the “Output feature class”
- Select POINT as geometry type.
- In the Spatial Reference field select the same spatial reference “...\exercise07\exercise07.prj”

Instructor lead

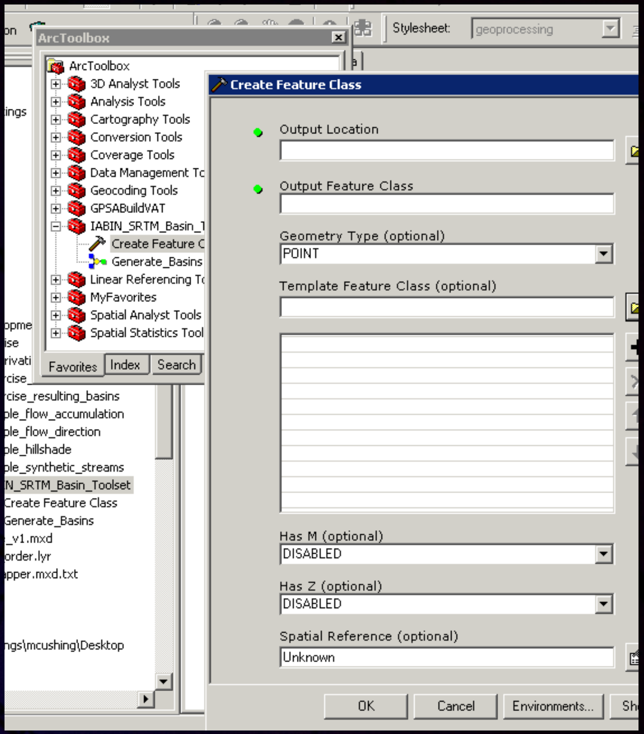
USGS

Drainage Basin Delineation

Ex07

Create Source Point Feature Class

- Allow the remaining items to use their default settings.
- Click on “OK”.



Instructor lead

USGS

Drainage Basin Delineation

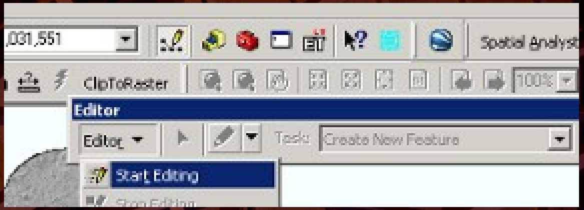
Ex07

Add Pour Point Locations in ArcMap

- **Open ArcMap and load project file:** "...\exercise07\exercise07.mxd"

- **Add your new "my_sample_points" point feature class.**

- **Make Editor Toolbar active and start an editing session.**



- **Set "my_sample_points" as target edit feature.**

Instructor lead

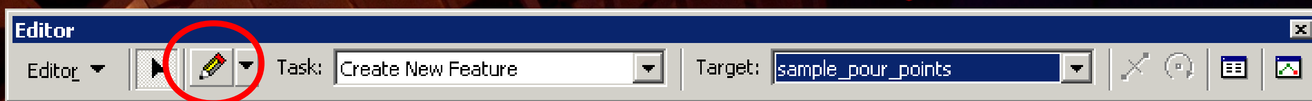
Drainage Basin Delineation

Ex07

Add Pour Point Locations in ArcMap

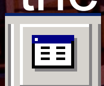
- To add point features, select the “sketch tool” on the Editor tool bar.

Editor Tool bar



- Zoom/Pan to the location you want to start adding features.
- Click (left) on the location. Keep in mind you need the point to fall on a synthetic stream raster cell.

- Add an attribute to a feature. Click the “Attributes” button on the Editor tool bar to open the attribute editor tool.



Instructor lead

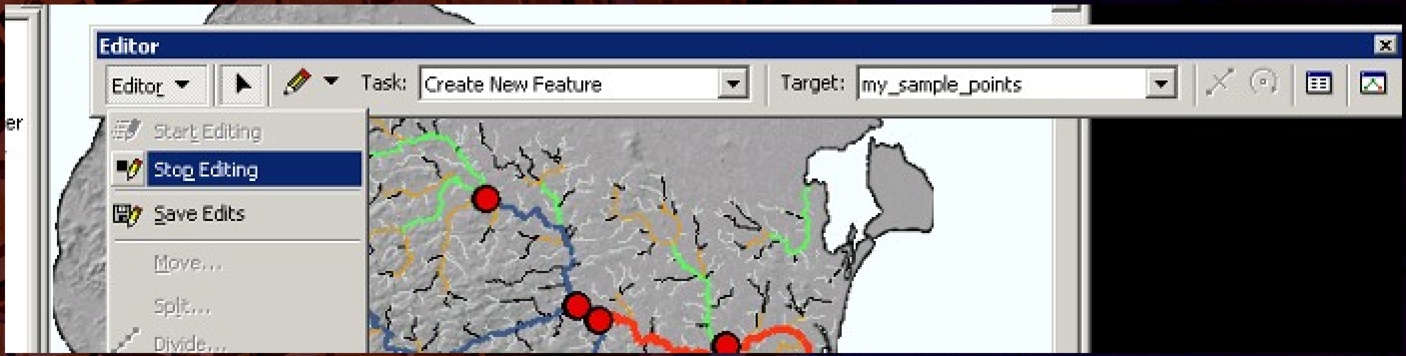
USGS

Drainage Basin Delineation

Ex07

Add Pour Point Locations in ArcMap

- Continue to add points and assigning attributes until all points are added. **Don't forget to save**.
- Once all points are added and attributed, close the edit session by selecting "Stop Editing" from Editor menu.



Instructor lead

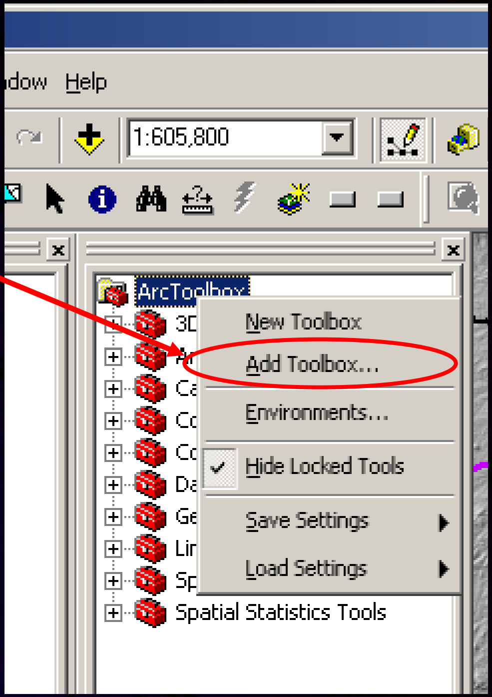
Drainage Basin Delineation

Ex07

Adding a Toolset to ArcGIS Toolbox.

- In ArcMap click on the Show/Hide ArcToolbox Window button.
- Select the ArcToolbox item at the top of the list. Right click the mouse and select the "Add Toolbox…" option.
- In the Add Toolbox browse dialog, navigate to "…\exercise07\srtm_derivative_exercise_gdb.mdb" and select "SRTM_Derivative_Toolset" then click "Open".
- This will add the selected toolset into the ArcToolbox catalog.

Instructor lead



USGS

Drainage Basin Delineation

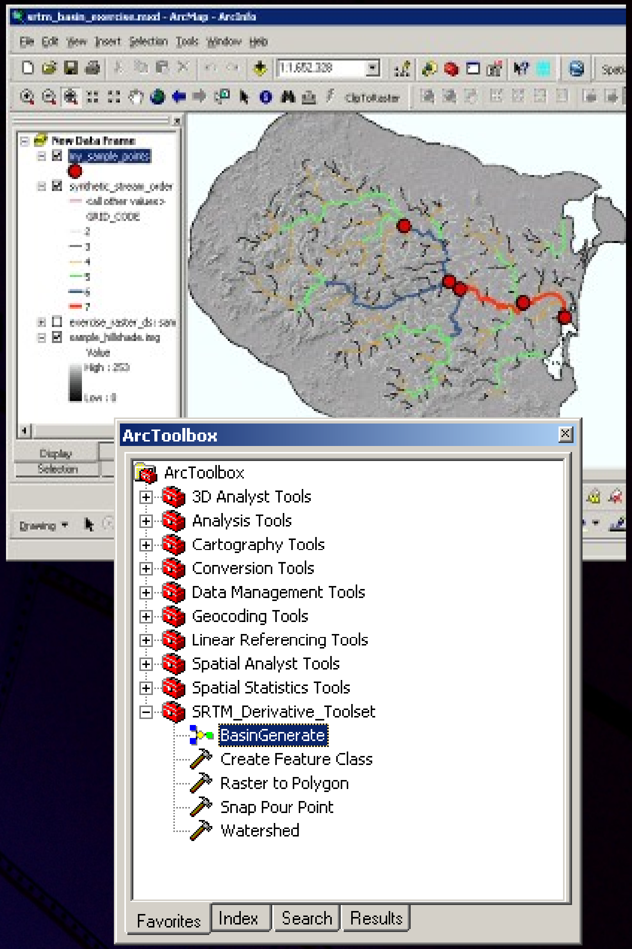
Ex07

Building Basin Model

- In ArcToolbox open the BasinGenerate model for *editing* from the *SRTM_Derivative_Toolset*.
- In the empty model build your own model to delineate basins from the pour points that you just added.
- All the tools required to build the model, are in the SRTM_Derivative_Toolset.

  Hint: Process flow is *Snap Pour Point > Watershed > Raster to Polygon.*
- When completed Run model

Self Guided

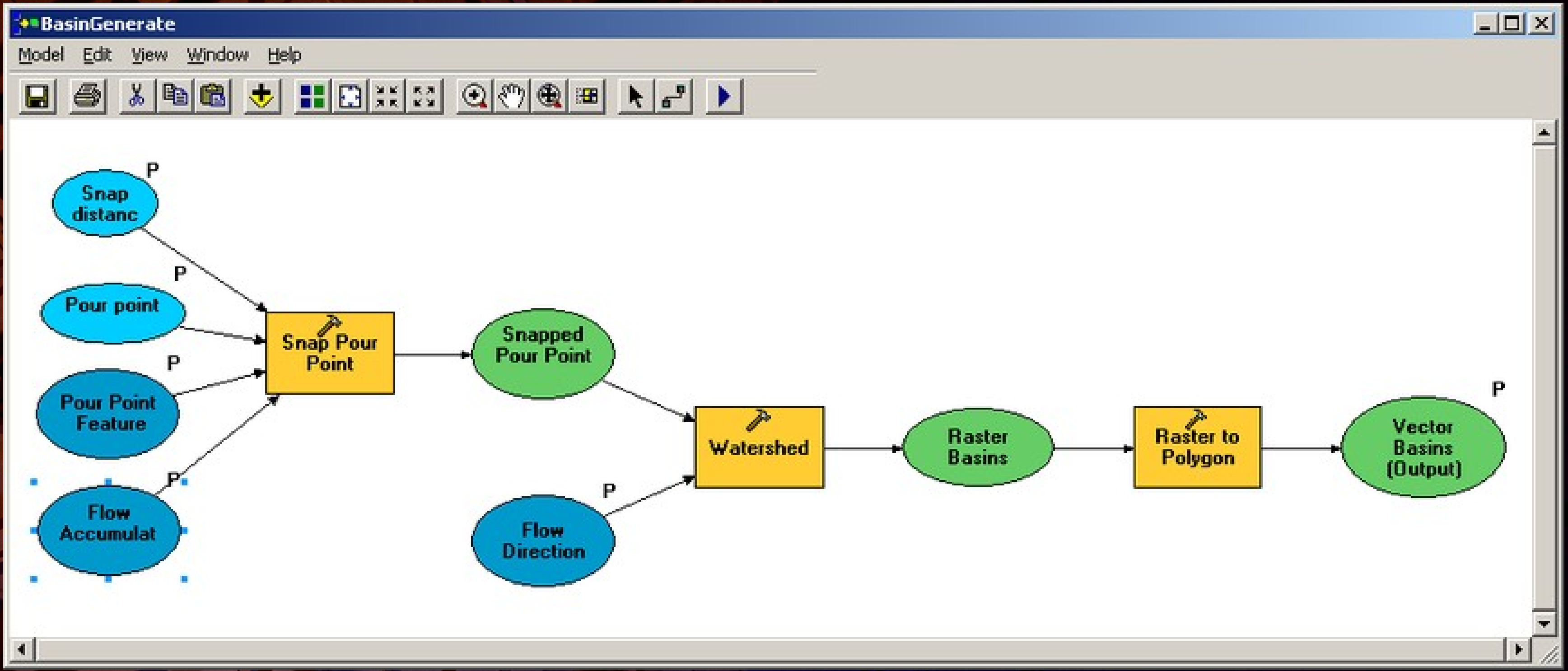


USGS

Drainage Basin Delineation

Ex07

ModelBuilder diagram of BasinGenerate toolset



Instructor lead

USGS

Drainage Basin Delineation

Questions?

Next Exercise: Access and use GeoSUR GP Web Services

USGS

Accessing GeoSUR Web Services

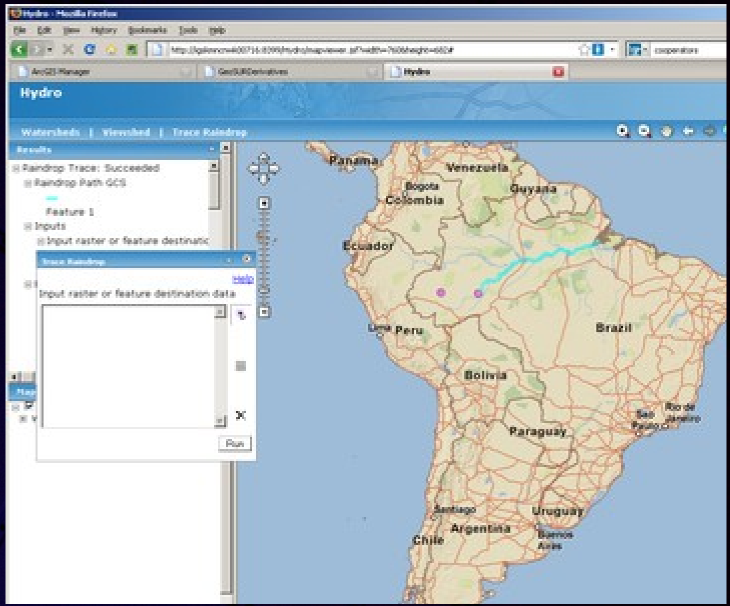
- **Access GeoSUR Geoprocessing (GP) Web Service**
  - **Web browser interface**
    - **www.geosur.info**
  - **Google Earth**
  - **ArcGIS Explorer**
    - Loading Map Layer
    - Access GP tool
  - **ArcGIS Desktop application**
    - ArcCatalog
    - ArcMap
    - Python

USGS

Accessing GeoSUR Web Services

GeoSUR Web Browser Exercise

1. Open a web browser and navigate to the GeoSUR GP services page (www.geosur.info/).
2. Click the Rain Drop tool
3. Provide the appropriate input
4. Execute the tool
5. Review Results



USGS

Accessing GeoSUR Web Services

Load Map Service into Google Earth (GE)

1. Determine available **KML** services from GeoSUR's ArcGIS Services Directory
2. (http://www.geosur.info/ArcGIS/rest/services)
3. Choose a Google Earth (KML) service from the directory and load it into GE.

USGS

Accessing GeoSUR Web Services

Loading Map Services into ArcGIS Explorer

1. Determine available **map** services from GeoSUR's ArcGIS Services Directory
2. (http://www.geosur.info/ArcGIS/rest/services)
3. Choose a service from the directory and load that service into ArcGIS Explorer's Toolbox.

Accessing GeoSUR Web Services

ArcGIS Explorer GP Services Exercise

1. Determine available GP services from GeoSUR's ArcGIS Services Directory in a Web browser.
2. (http://www.geosur.info/ArcGIS/rest/services)
3. Choose a service from the directory and load that service into ArcGIS Explorer's Toolbox.
4. Execute that service in ArcGIS Explorer.

USGS

Accessing GeoSUR Web Services

Loading Map Service into ArcMap

1. Open ArcCatalog and connect to GeoSUR ArcGIS Server (www.geosur.info/arcgis/services).
2. Connect to the service as a <u>user</u>, not as a <u>manager</u>.
3. Close ArcCatalog
4. Open ArcMap and load both the maps/iirsa and maps/iirsa_cache layers into a data-frame.
5. Determine the difference between the two layers.
6. ***NOTE***: *DON'T close ArcMap when you are finished*

USGS

Accessing GeoSUR Web Services

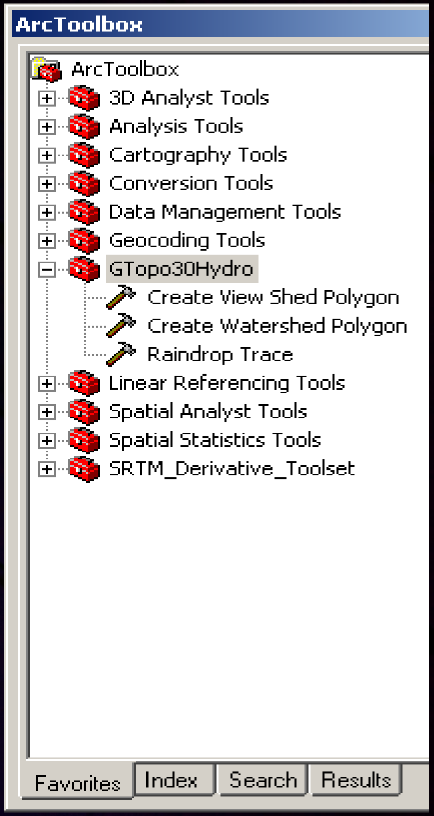
Loading GP Service into ArcMap

1. In the current ArcMap session, open the ArcToolbox.
2. In ArcToolbox, open the “Add Toolbox...” dialog.
3. Within the dialog, navigate to the GIS Servers folder and open the “www.geosur.info” connection.
4. Once connected, open the Models folder and add the Gtopo30Hydro toolset.

Accessing GeoSUR Web Services

Loading GP Service into ArcMap

1. With ArcToolbox, locate the newly add “GTopo30Hydro” toolset and open the Raindrop Trace tool.
2. Provide the appropriate inputs and execute.
3. Open the Create Watershed Polygon tool.
4. Provide the appropriate inputs and execute.
5. Examine the result from both tools.



USGS

Accessing GeoSUR Web Services

Advanced Web Service Demonstrations

1. Exploring the GP Web service Viewshed tool.
2. Exploring tools available in the **GeoSUR_Derivatives** Web service.
3. Incorporating GP Web services into local GP Models using ModelBuilder.
4. Accessing GP Web services in Python.
5. Basic image format conversion.
6. Requests from the audience.

USGS

References

ESRI, 2009a: ArcGIS 9.3 Desktop Help: An overview of Spatial Analyst Toolsets and Tools, http://webhelp.esri.com/arcgisdesktop/9.3/index.cfm TopicName=An_overview_of_Spatial_Analyst_Toolsets_and_Tools (version 22 May 2009)

ESRI, 2009b: ArcGIS Server 9.3 Help: Components of an ArcGIS Server system http://webhelp.esri.com/arcgisserver/9.3/dotNet/index.htm#components_of_server.htm (version 22 May 2009)

ESRI, 2009c: ArcGIS Desktop: Which GIS Software Is Right For You http://www.esri.com/software/arcgis/about/gis_for_me.html (version 22 May 2009)

ESRI, 2009d: ArcGIS Server REST API - Overview: http://resources.esri.com/help/9.3/arcgisserver/apis/rest/index.html (version 22 May 2009)

ESRI, 2009e: GIS Dictionary: http://support.esri.com/index.cfm?fa=knowledgebase.gisDictionary.search&searchTerm=z-factor (version 22 May 2009)

ESRI, 2009f: An overview of geoprocessing with ArcGIS Server http://webhelp.esri.com/arcgisdesktop/9.3/body.cfm?tocVisable=1&ID=1120&TopicName=An%20ove # (version 22 May 2009)

ESRI, 2009g: Image services http://webhelp.esri.com/arcgisserver/9.3/dotNet/index.htm#image_service.htm (version 22 May 2009)

References

ESRI, 2009h: Map services http://webhelp.esri.com/arcgisserver/9.3/Java/index.htm#map_service.htm (version 22 May 2009)

ESRI, 2009i: An overview of the geodatabase http://webhelp.esri.com/arcgisdesktop/9.3/index.cfm?TopicName=An_overview_of_the_geodatabase (version 2 June 2009)

Farr, T. G., et al. (2007), The Shuttle Radar Topography Mission, Rev. Geophys., 45, RG2004, doi:10.1029/2005RG000183. P 21- 22.

Grohman, Greg, Kroenung, George and Strebeck, John, (2006): Filling SRTM Voids: The Delta Surface Fill Method: Photogrammertric Engineering & Remote Sensing, v. 72, no. 3, p 213 – 217.

Maples, S. 2007, Classic Cartographic Techniques in ArcMap, Yale University Library Available on-line: (version 14 May 2009)

Pierce, L., Kellndorf, J., Walker, W., and Barros, O., Evaluation of the Horizontal Resolution of SRTM Elevation Data: Photogrammetric Engineering and Remote Sensing, v. 72, no. 11, p 1235 - 1244

Valeriano, M. M., Kuplich, T. M., Storino, M, Amaral, B. D., Medes Jr., J. N, and Lima, D. J., 2005, Modeling small watersheds in Brazilian Amazoia with shuttle radar topographic mission-90 m data: Computers and Geosciences, v. 32, p. 1169 – 1181.

Guth, P. L. 2006, Geomorphometry from SRTM: Comparison to NED: Photogrammetric Engineering and Remote Sensing, v. 72, no. 3, p 269 – 277.

W3C, 2009: Web Services Glossary: http://www.w3.org/TR/ws-gloss/ (version 22 May 2009)

USGS
science for a changing world

GeoSUR Geospatial Application Workshop

An investigation and assessment of GeoSUR's geoprocessing services.

Cushing, W. M., Stinger Ghaffarian Technologies (SGT), Inc., contractor to the U.S. Geological Survey. Work performed under USGS contract O8HQCN0005

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

EROS Training and Education

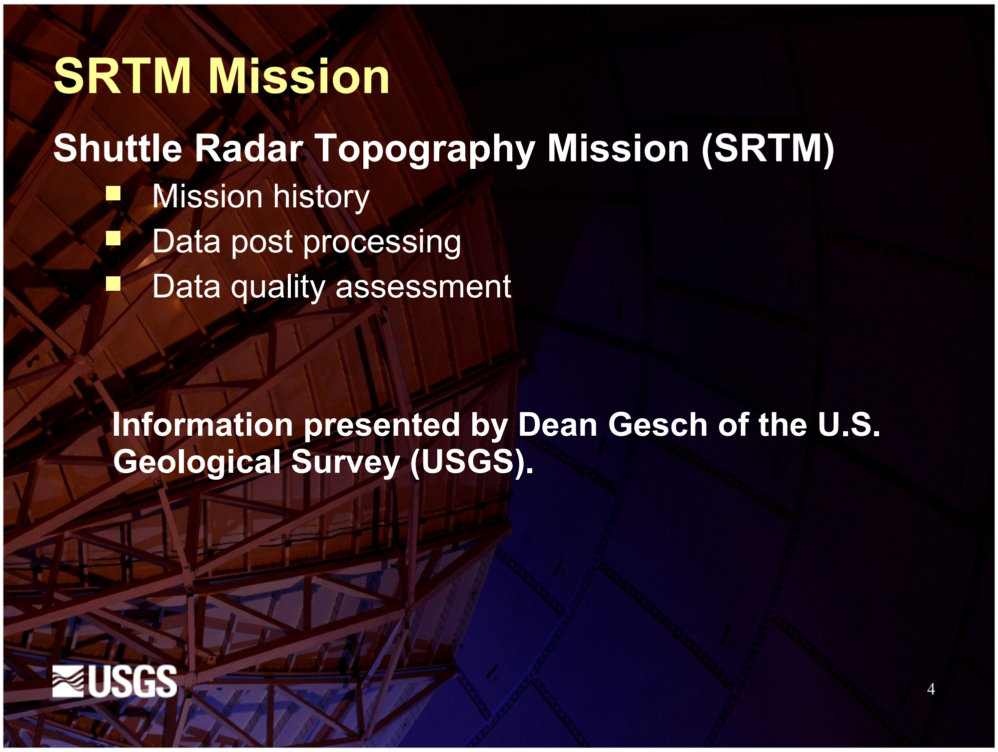
Logistics

- **Daily schedule**
  - Workshop begins at 8:30 am
  - Morning break 10:30 am (15 min)
  - Lunch 12 pm (1 hour)
  - Afternoon break at 3 pm (15 min)
  - Daily wrap-up at 5 pm
  - Shuttle departs at 5:30 pm
- **Restrooms**
- **Refreshments**
- **Security**
- **Emergency evacuation procedure (fire, tornado)**

USGS

Objectives

- Understanding the SRTM data products
- How to acquire SRTM DEM data sets
- Acquiring SRTM Level 2 derivative products
- How to acquire remotely sensed data
- Overview of applying raster data sets
- Overview of managing spatial data
- Accessing and implementing GeoSUR's geoprocessing web services

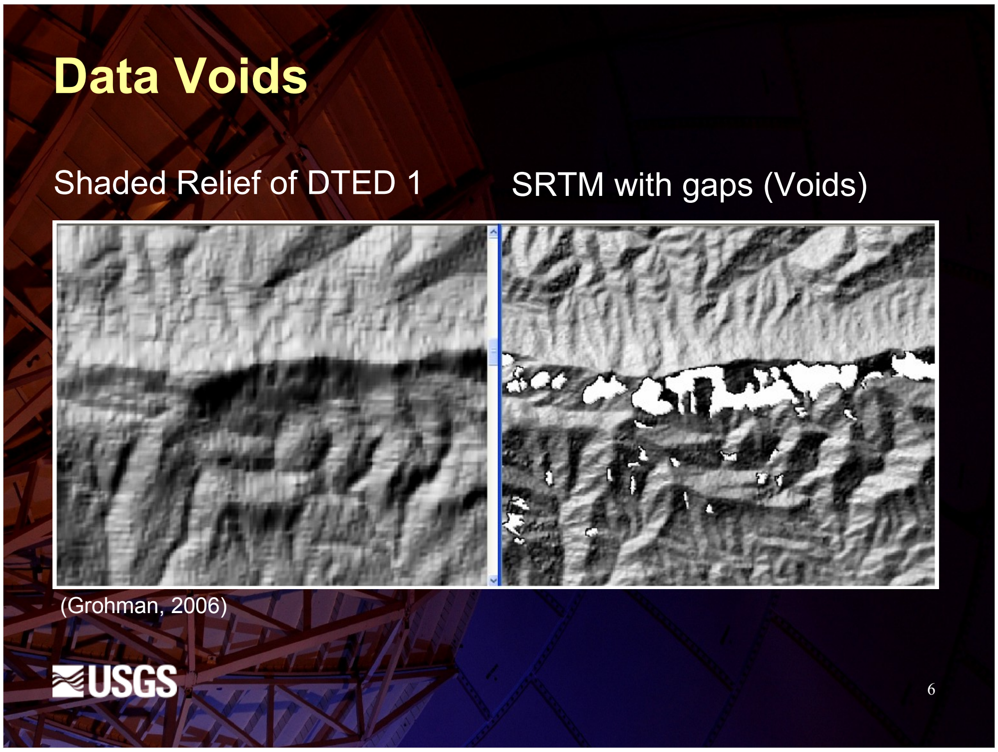


Introduce Dean Gesch (10pm)

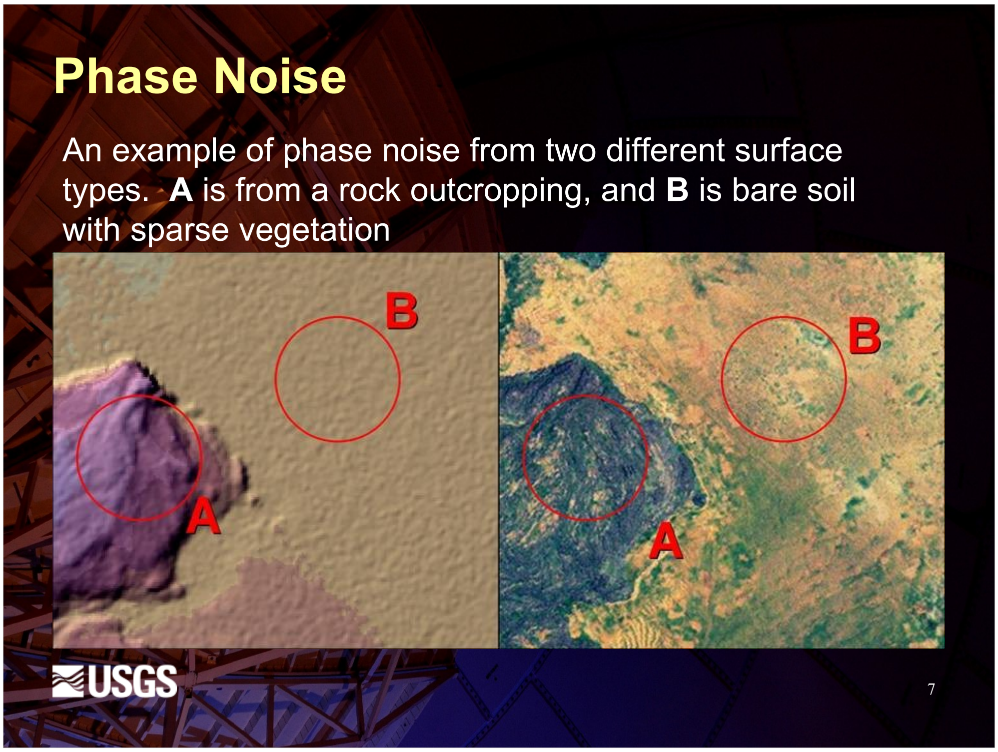
SRTM Data Characteristics

SRTM data characteristics to consider prior to including the DEM in data analysis.

- Data voids
- Phase noise
- Canopy bias
- Horizontal resolution

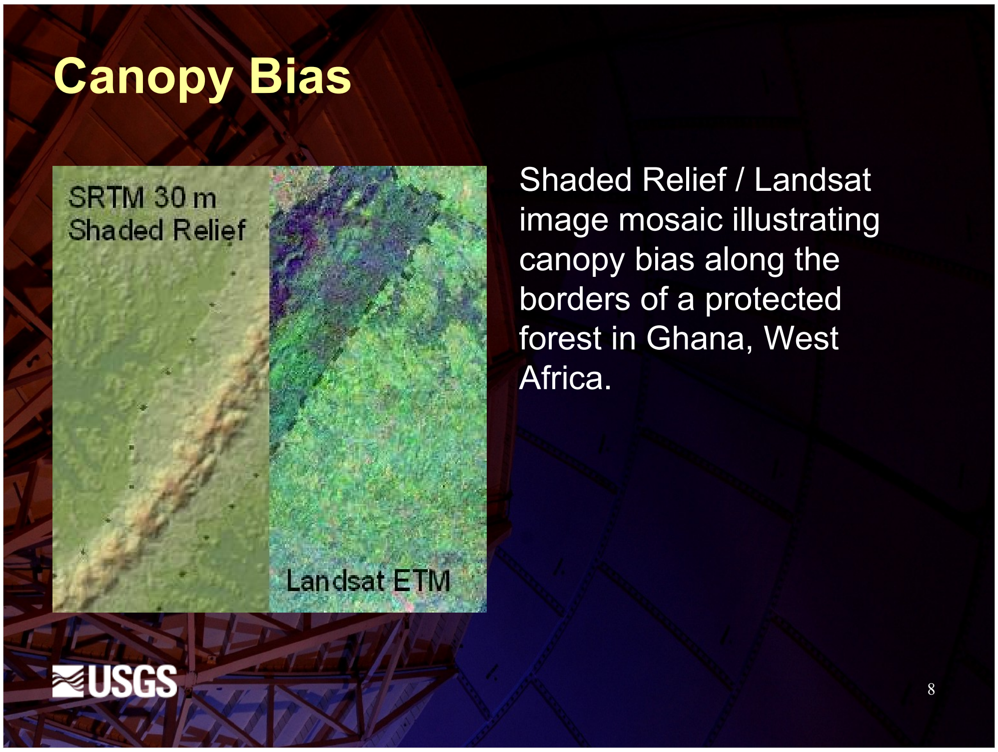


Data voids are areas in the dataset that were found to have either extreme error during processing or no radar signal returned. After a preliminary analysis of the SRTM for South America it is estimated that there are about 500 1 degree tiles with data voids

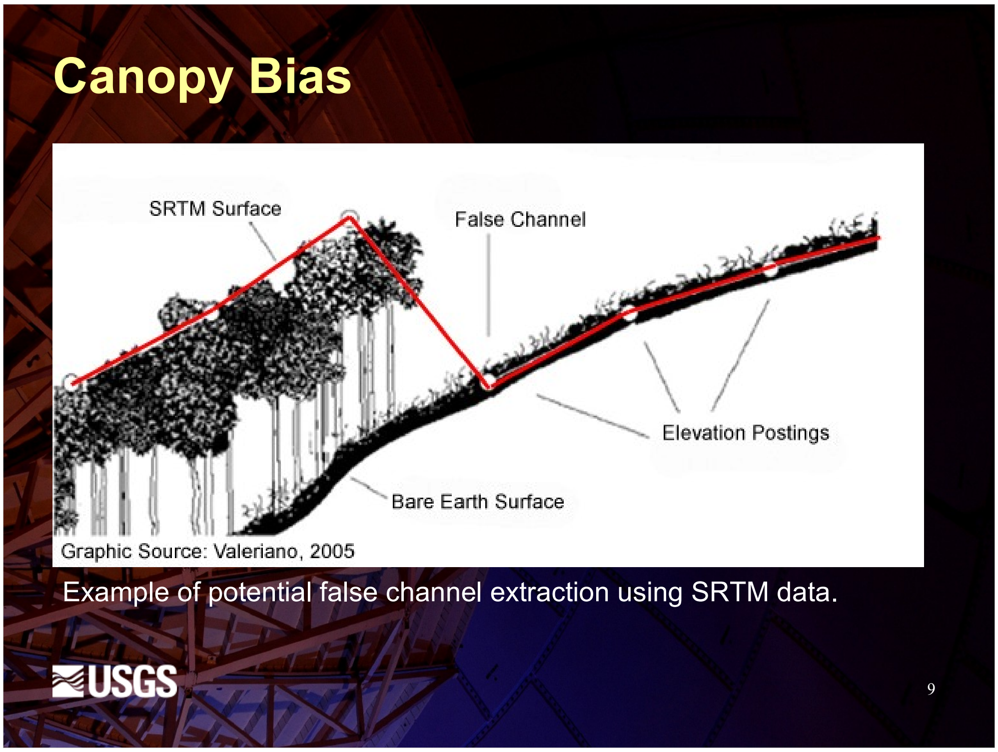


Simple stated, phase noise is a minimal neighboring pixel by pixel height variation, and this variation was influenced by the type of surface the radar transmission was reflecting off. For example, an area with forest cover will have less noise than agricultural lands due to how the radar signal is bounced off the surface (Walker, 2006).

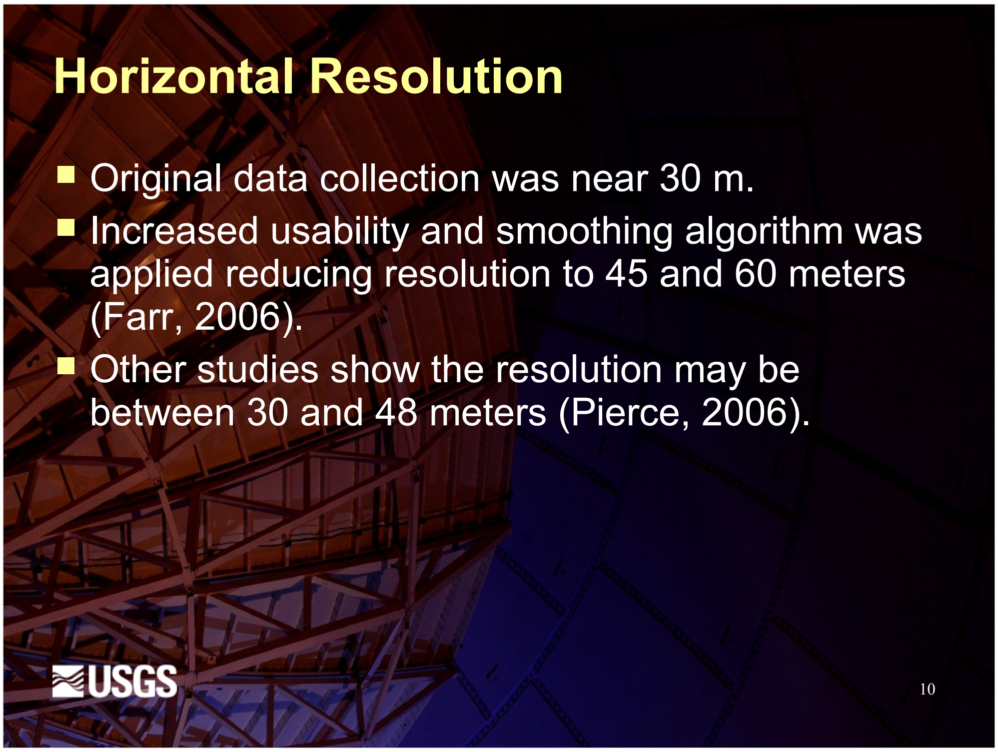
Walker, W. S., Kellndorfer, J. M. and Pierce, L. E. 2007: Quality assessment of SRTM C- and X-band interferometric data: Implications for the retrieval of vegetation canopy height: Remote Sensing of Environment, v 106, p. 428 - 448



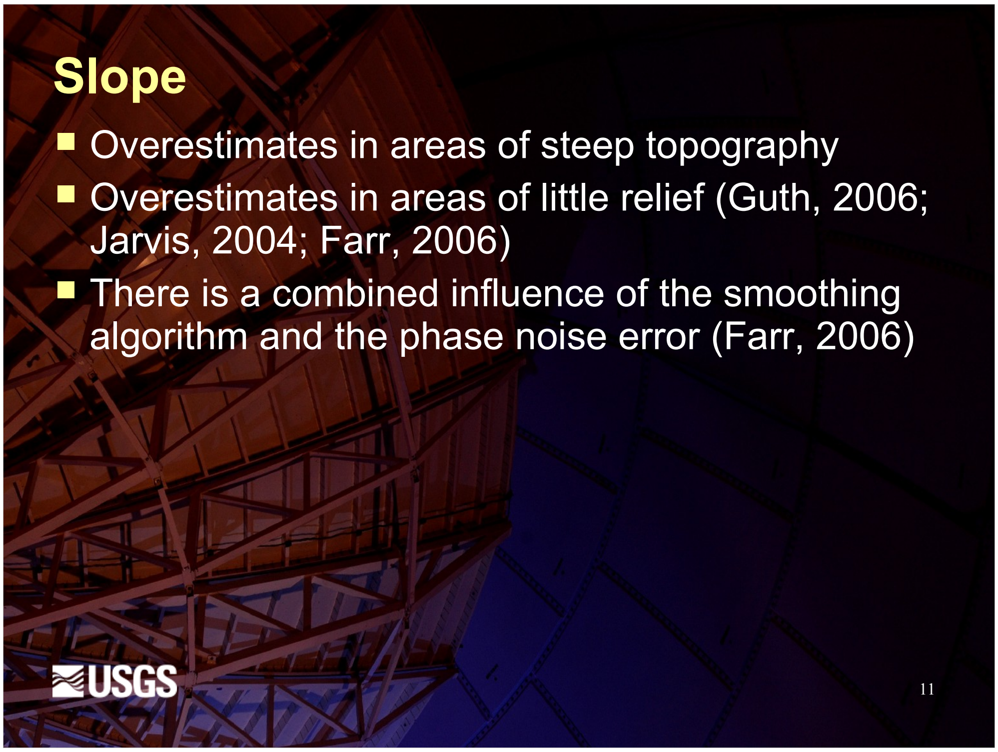
A highly disputed characteristic of the SRTM DEM is the **canopy bias**. Because of the short wavelength (5.6 cm) of the C-Band, the majority of the received radar waves over heavy vegetative areas (**Figure 7**) are reflected back within the canopy, well above the bare Earth surface (Kellndorfer, 2004). For this reason many geologist and hydrology find the SRTM DEM a less than desirable dataset for large scale use, were as ecologists are finding it an invaluable tool to aid in estimating canopy height and biomass (Kellndorfer, 2004; Simard, 2006). One reason this is problematic for hydrologists is when modeling, for example, a drainage network in an area of dense forest were deforestation is occurring. Sometimes false channel networks are created because of the contrasting elevation values between the forest and the cleared areas (**Figure 8**) (Valeriano, 2005). For that same reason ecologists find it very useful because it can estimate a forest height and potentially extrapolate biomass (Kellndorfer, 2004).



A highly disputed characteristic of the SRTM DEM is the **canopy bias**. Because of the short wavelength (5.6 cm) of the C-Band, the majority of the received radar waves over heavy vegetative areas (**Figure 7**) are reflected back within the canopy, well above the bare Earth surface (Kellndorfer, 2004). For this reason many geologist and hydrology find the SRTM DEM a less than desirable dataset for large scale use, were as ecologists are finding it an invaluable tool to aid in estimating canopy height and biomass (Kellndorfer, 2004; Simard, 2006). One reason this is problematic for hydrologists is when modeling, for example, a drainage network in an area of dense forest were deforestation is occurring. Sometimes false channel networks are created because of the contrasting elevation values between the forest and the cleared areas (**Figure 8**) (Valeriano, 2005). For that same reason ecologists find it very useful because it can estimate a forest height and potentially extrapolate biomass (Kellndorfer, 2004).



Another area of contention with the SRTM 30 m DEM is its **true horizontal resolution**. The intrinsic resolution of SRTM interferometric product was very close to 30 m, but because of the point-to-point sampling there would be considerable height error variability (noise) between pixels (Farr, 2006). While still falling within the requirements, the product would not have been very useful to the end user (Farr, 2006). In order to increase the usability of the product a smoothing algorithm was applied to reduce the noise, and as a result the final product had a sampling resolution of between 45 and 60 meters, depending on whether the data was collected in high terrain or in relatively flat terrain respectively (Smith, 2003, Farr, 2006). These figures are not final, however, and a more recent study (Pierce, 2006) suggests that the horizontal resolution is closer to 30 m. The results indicate that the resolution is 30 to 48 m pixels, depending on the local variability or the elevation data; with a higher resolution near sharp edges and corners (e.g., mountainous areas) and a lower resolution in smoother areas (e.g., flood plains) (Pierce, 2006).



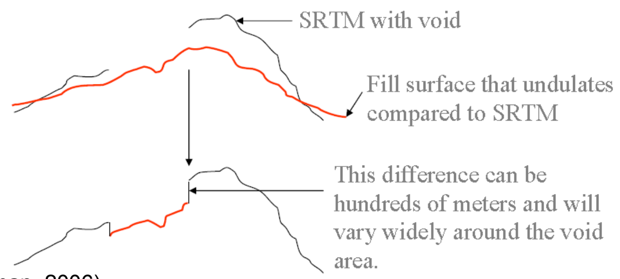
Slope is a valuable derivative product of any DEM and is involved in many of the earth surface process models, such as in modeling for landslides. It has been documented in several studies that slope is underestimated in areas of steep topography and overestimated in areas of little relief (Guth, 2006; Jarvis 2004; Farr 2006). Both the underestimation of slope on steep areas and its overestimation on smoother location is a combined influence of the smoothing algorithm and phase noise error (Farr, 2006).

Overall SRTM Data Quality

The SRTM is an unprecedented collection of the world's topography and currently there is no global dataset that can match its versatility and quality (Guth, 2006).


SRTM Void Fill Processing
Needs MORE
USGS
13

Feathering Method

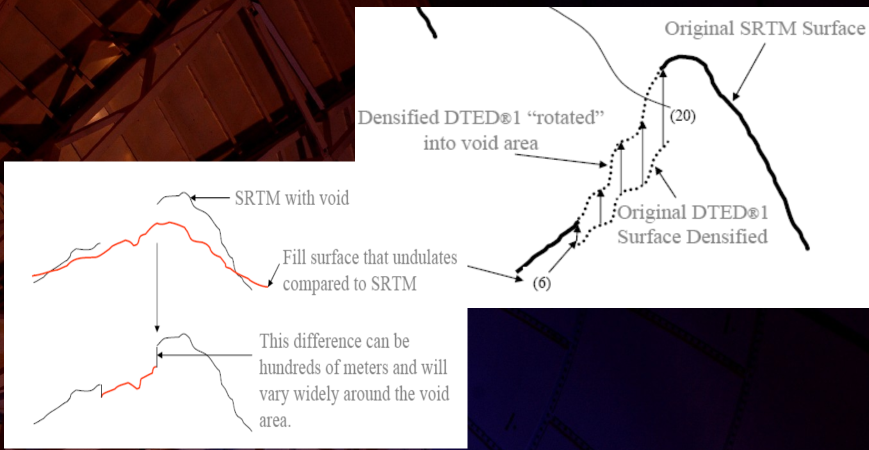


(Grohman, 2006)

The feather method uses a fill source pixel at the same geographic area without adjusting for the difference in elevation (*delta*) and then "feathers" the edges between the different data sources to mitigate the difference in elevation.

USGS

Delta Surface Fill



(Grohman, 2006)

USGS

SRTM Data Characteristics

Questions?

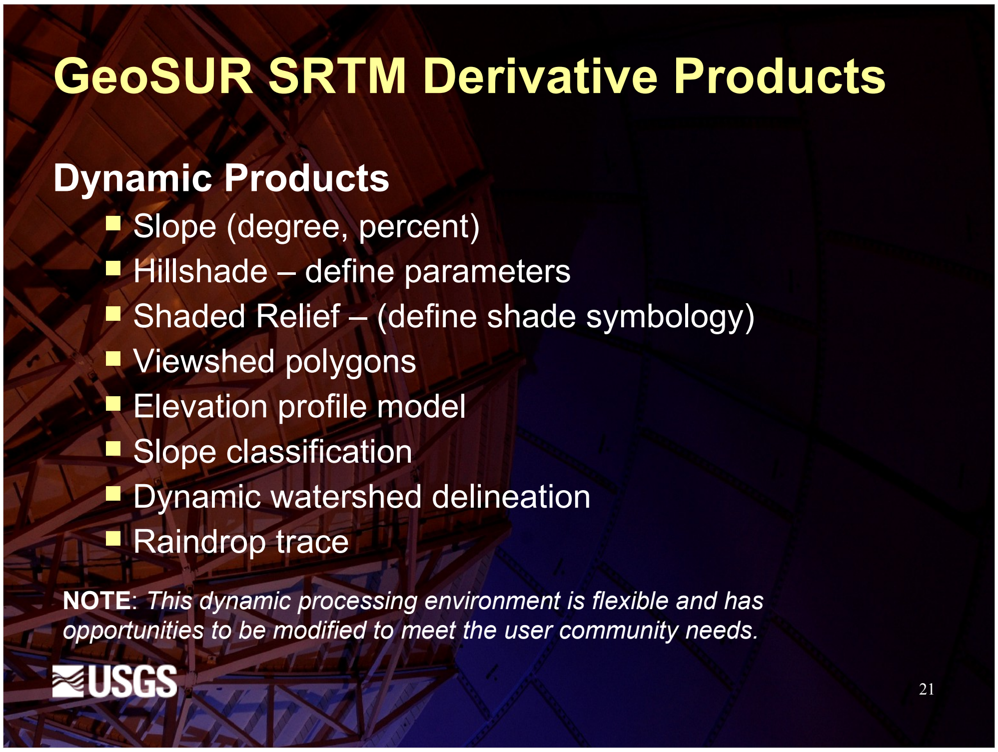
Next: GeoSUR SRTM Derivative Products

GeoSUR SRTM Derivative Products

Initial Data offerings:

- **SRTM Level 1 (3 arc-second, ~90 m) and Level 2 (1 arc-second, ~30 m) derivatives:**
  - Aspect
  - Hillshade
  - Shaded Relief
  - Slope
- **Elevation Data**
  - SRTM Level 1 (90 m, 3 arc-second)
  - HydroSHEDs conditioned DEM
  - GTOPO30 (30 arc-second, ~1 km)

USGS



Show both Dynamic watershed and Raindrop trace demo

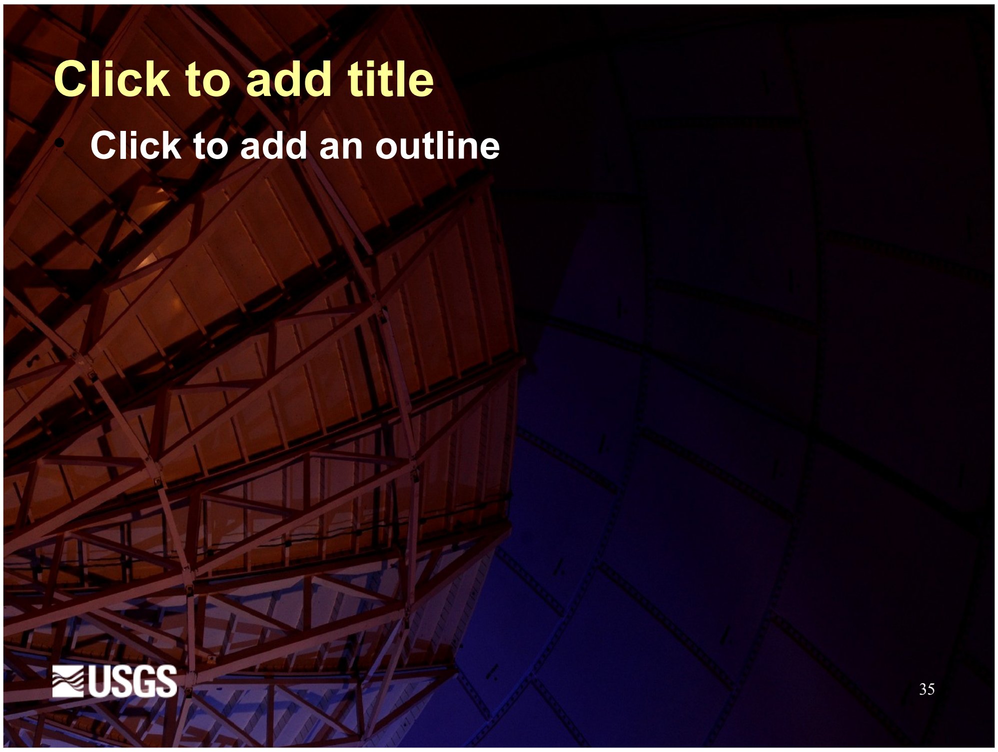
GeoSUR SRTM Derivative Products

Questions?

Next: USGS/NGA new GTOPO products

USGS

Introduce Jeff Danielson (3 pm)



Blank

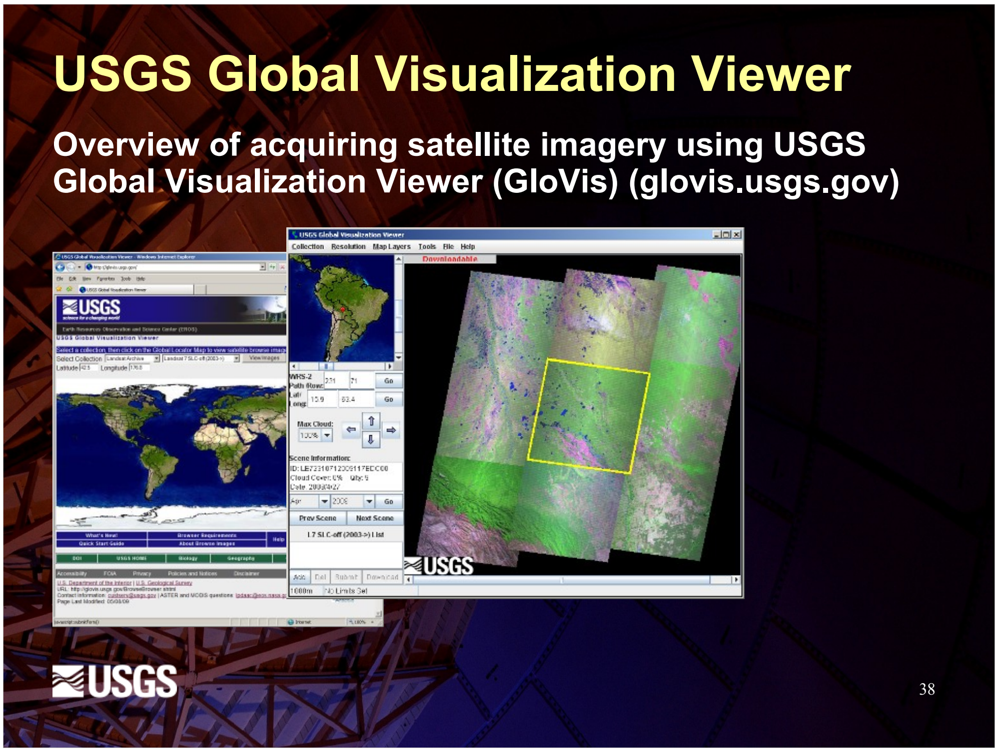
Objectives – Day 2

- Learn how to access and acquire remote sensing data via the Internet using resources made available by the USGS and other ....
- Gain a comprehensive understanding of working in ESRI's ArcGIS environment.
- Understand the concept of web services and where and how to use them.

USGS

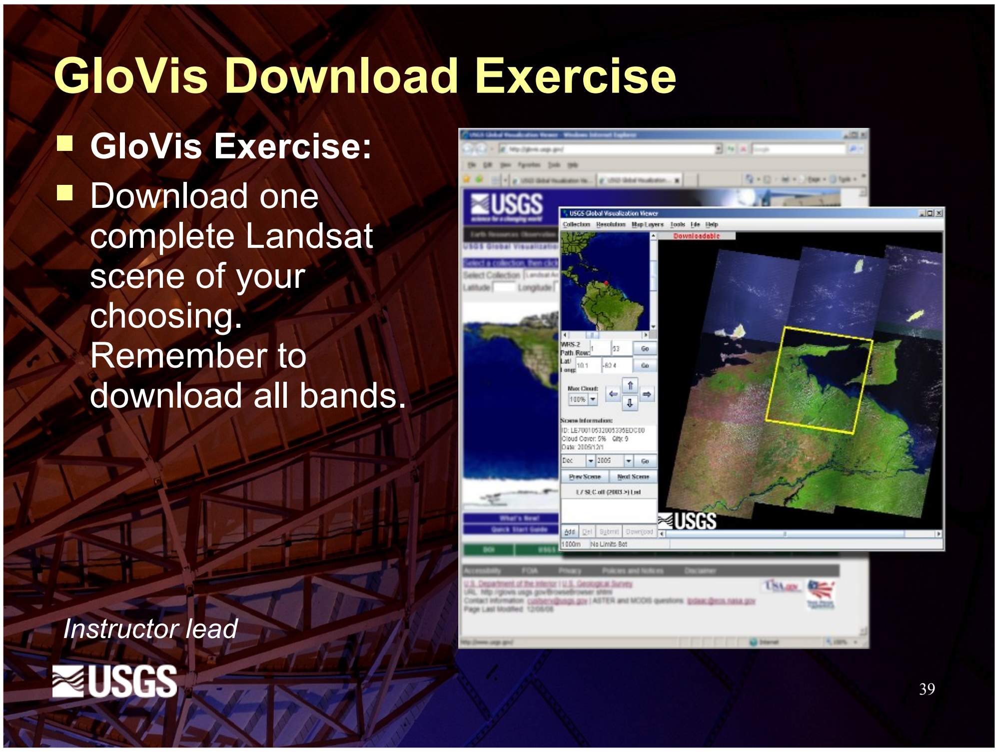
Accessing Satellite Imagery

- **Landsat – Free!**
  - Landsat presentation by Eugene Fosnight for the USGS.
- **TerraLook – Free!**
  - TerraLook presentation by Claudia Young (SGT).
  - TerraLook presentation by Eugene Fosnight for the USGS.



GloVis Demo:

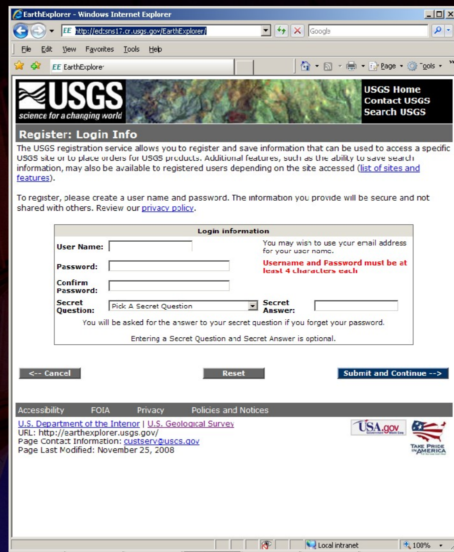
- Review Collection
- Select Collection
- Review Map Layers
- Select Landsat data – Explain the “Downloadable” notification
- Select several datasets from the TerraLook collection and submit the order.
    - Email notification of receiving order (confirmation).
    - Email notification of order completion



This exercise should be run through once by instructor.

USGS Earth Explorer

- Before acquiring data from GloVis, you must register with USGS's EarthExplorer.
- To register, open a web browser and go to http:// *earthexplorer.usgs.gov* to begin the registration process.



USGS

Acquiring Elevation Datasets

- **USGS Seamless Data Distribution System (SDDS)**
- http://seamless.usgs.gov
- **Gobal Data available**
  - SRTM 3 arc-second DEM and Hillshade

Note: For help on using SDDS, visit the Seamless online tutorial site at http://seamless.usgs.gov/tutorial.php

USGS

Global Land Cover Facility (GLCF)

Data offered by the GLCF (http://glcf.umiacs.umd.edu)

- Landsat Imagery (ETM+, TM, and MSS)
- ASTER (very limited for South America)
- SRTM 3 arc-second (same product as USGS Seamless)
- SRTM 30 arc-second (1 km)
- MODIS Products
- AVHRR Products

USGS

Accessing Spatial Data Online

Questions?

Next: Web Services

Web Services

What are Web Services?

- There are many things that might be called "Web services" in the world at large. However, for the purpose of this Working Group and this architecture, and without prejudice toward other definitions, we will use the following definition:

- **“A Web service is a software system designed to support interoperable machine-to-machine interaction over a network**. It has an interface described in a machine-processable format (specifically WSDL). Other systems interact with the Web service in a manner prescribed by its description using SOAP-messages, typically conveyed using HTTP with an XML serialization in conjunction with other Web-related standards” - W3C, 2009.

Web Services

- **Web services in respect to the geospatial environment**
  - There several ways to build geospatial Web services that can either proprietary or open source. The Open Geospatial Consortium (OGC) is the governing body of the dominate open source standards. ESRI and Google are the dominate players in the proprietary geospatial Web services. Even though ESRI and Google have proprietary Web services, they are also members of OGC and contribute to the open source development.
- **Types of Web services**
  - Open Source OGC services
    - Web Map Service (WMS)
    - Web Features Service (WFS)
    - Web Coverage Service (WCS)
    - Web Processing Service (WPS)
  - For an in-depth look at each of the services, visit OGC standards Web site at http://www.opengeospatial.org/standards

USGS

Web Services

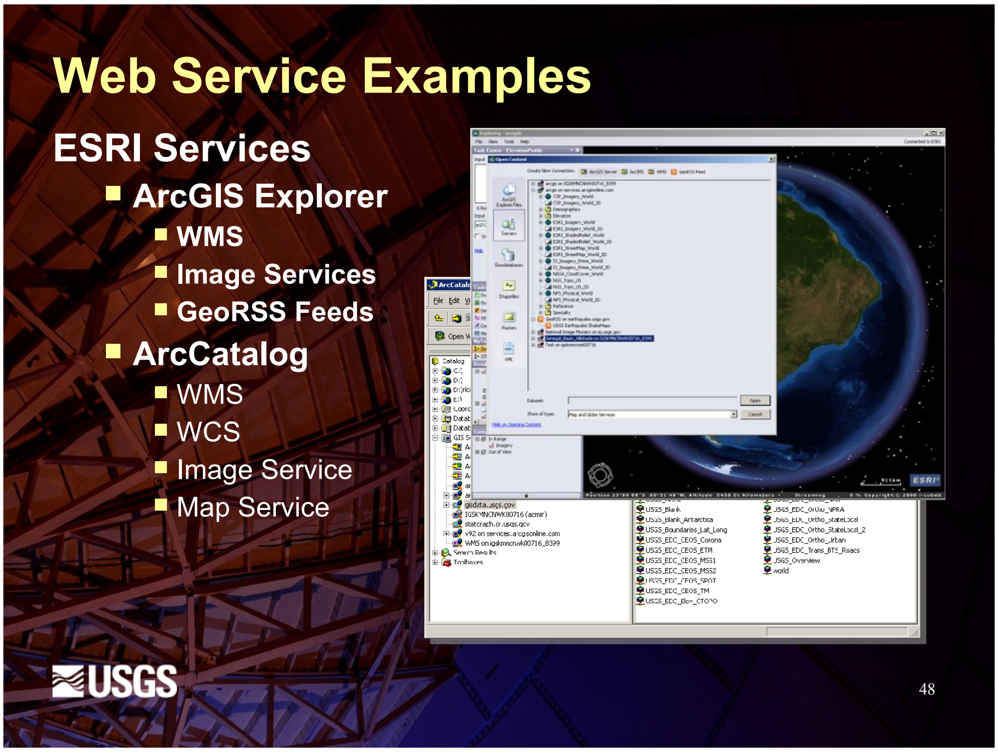
Types of Web Services

- ESRI Web Services currently applied by GeoSUR (Currently)
  - **Geoprocessing** - "ArcGIS Server is a comprehensive, Web-based GIS that provides a range of out-of-the-box applications and services for mapping, analysis, data collection, editing, and management of spatial information. A geoprocessing service contains geoprocessing tasks accessible by clients. Tasks are created by publishing geoprocessing toolboxes or map documents containing tool layers. When you execute a task in a geoprocessing service, it executes on the server computer, using resources of the server computer." (ESRI, 2009f)
  - **Image Service** - "An image service provides access to raster data through a Web service. The source of the raster data can be a raster dataset (from a geodatabase or file on disk), a layer file referencing a raster dataset, or a compiled image service definition (containing one or more raster datasets and defined processes) created using ArcGIS Image Server. Once you publish this raster data to your server, you can use the resulting image service in ArcGIS Desktop the same way you would add any other GIS service layer." (ESRI, 2009g)
  - **Map Service** - "A map service is the most common ArcGIS service and can contain many capabilities and functions. Map services certainly support mapping and map viewing, but can also support modeling and geoprocessing, mobile GIS services, and open publishing as OGC WMS, OGC WCS, and KML." (ESRI, 2009h)

USGS

- Open Google Earth Or Maps (Map)
- Open Layer example of OGS Service (Open Layers Map)

- ArcCatalog Demo
    - WMS
    - WCS
    - Image Service
    - Map Service

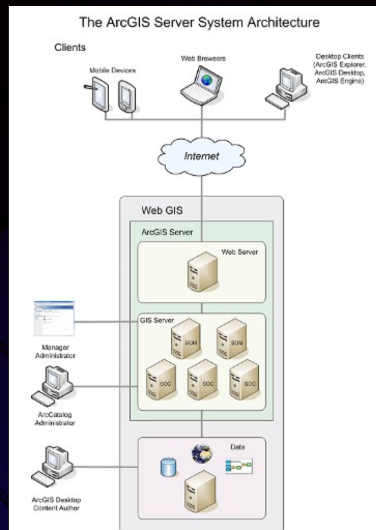


- Open Google Earth Or Maps (Map)
- Open Layer example of OGS Service (Open Layers Map)

- ArcCatalog Demo
  - WMS
  - WCS
  - Image Service
  - Map Service

GeoSUR ArcGIS Server Architecture

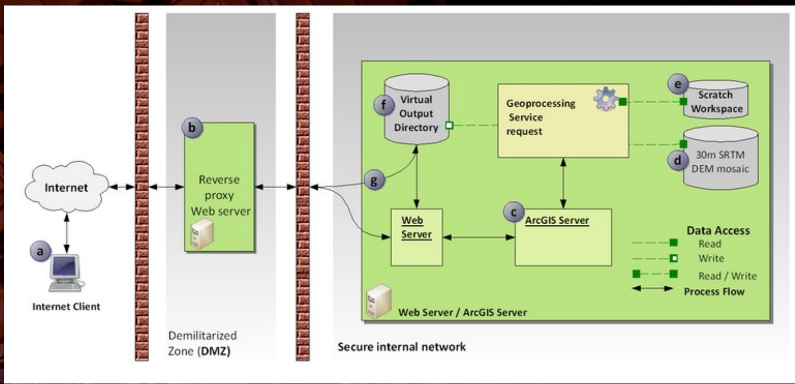
- **Web Clients**
  - Mobile devices, Web Browser, and desktop clients.
- **Web Server**
- **GIS Server(s)**
- **Administrative Client**
- **Desktop Clients**



(ESRI, 2009b)

USGS

GeoSUR ArcGIS Server Architecture



The ArcGIS Ecosystem

ArcGIS

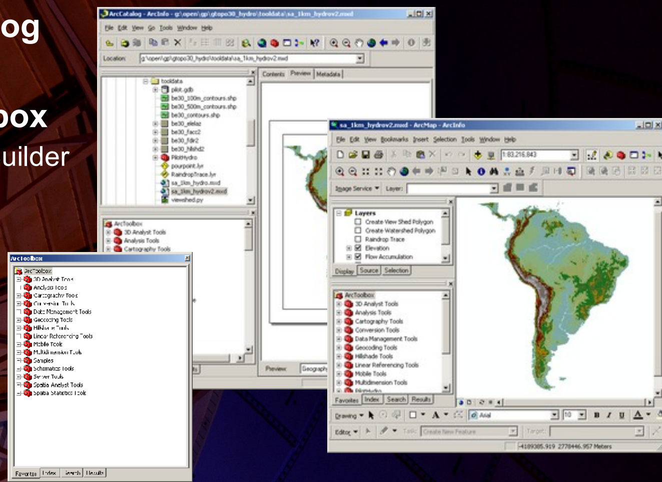
- ArcGIS Explorer (Free)
- ArcGIS Desktop
- ArcGIS Server
- ArcGIS Engine (Developers)

USGS

ArcGIS Desktop

ArcGIS Desktop three core components

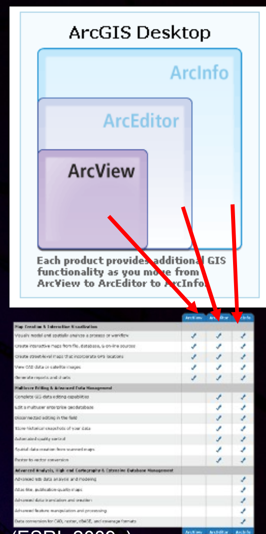
- ArcCatalog
- ArcMap
- ArcToolbox
  - ModelBuilder



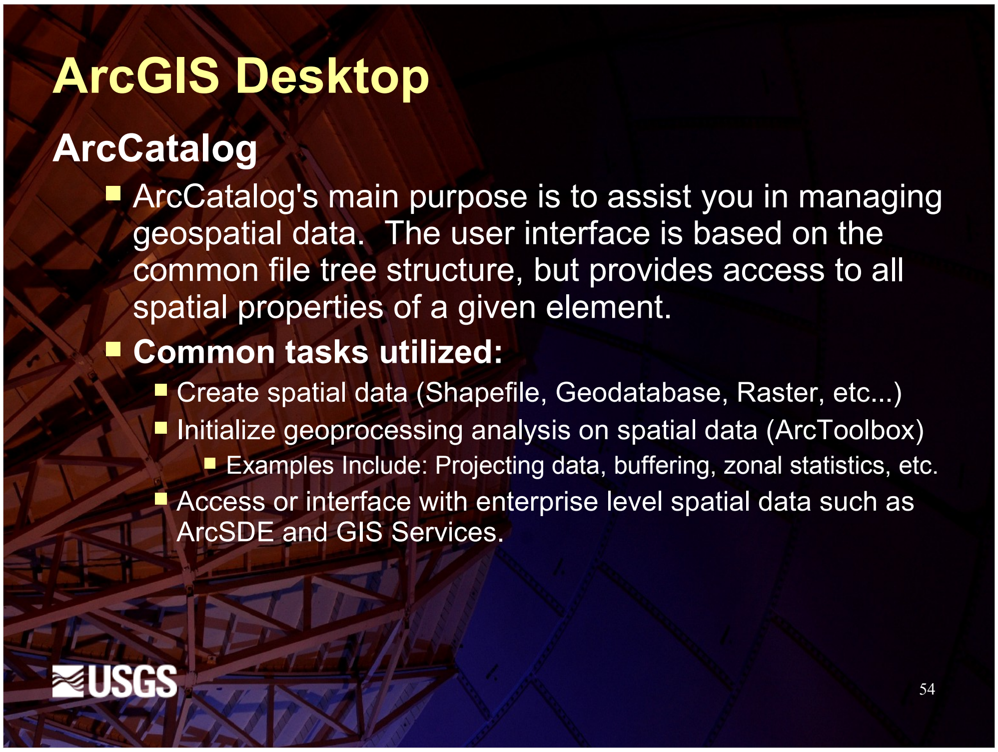
ArcGIS Licensing

ArcGIS Desktop has 3 licensing levels. The higher the level the greater the functionality. Parallel with functionality is cost.

- **ArcView** $
- **ArcEditor** $$
- **ArcInfo** $$$



(ESRI, 2009c)



Do a live demo of ArcCatalog

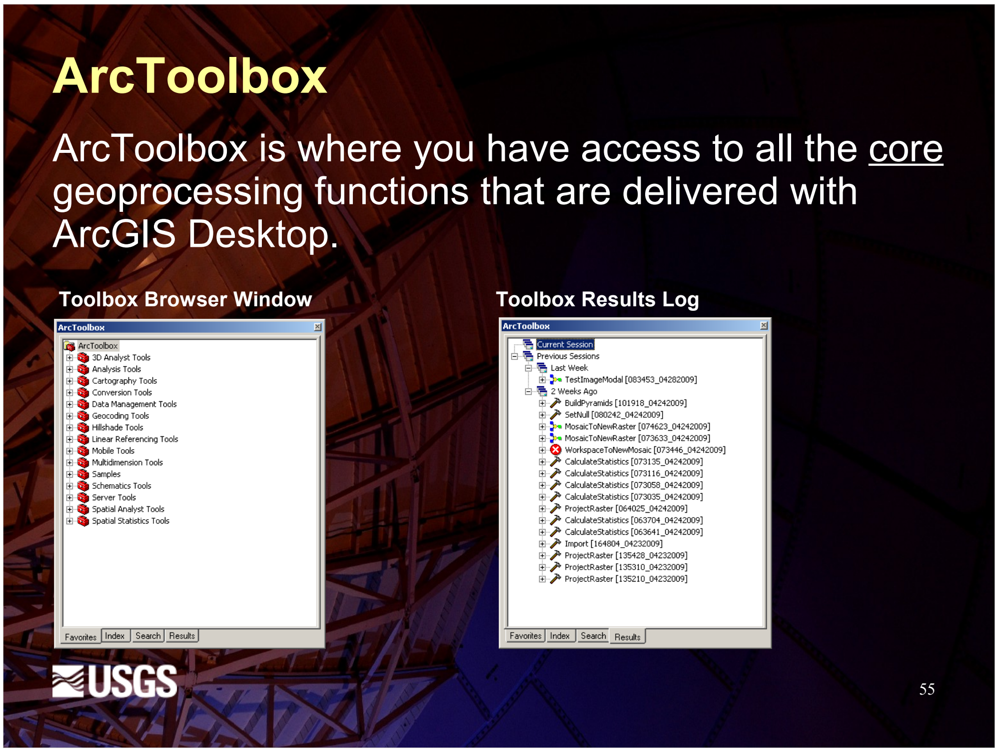
Create Shapefile

Browser Geodatabase

Open Toolbox

Browse ArcGIS Service

Go into ArcGIS Service Admin Tool.



Browse, open and run a tool (relates to results later in results tab)

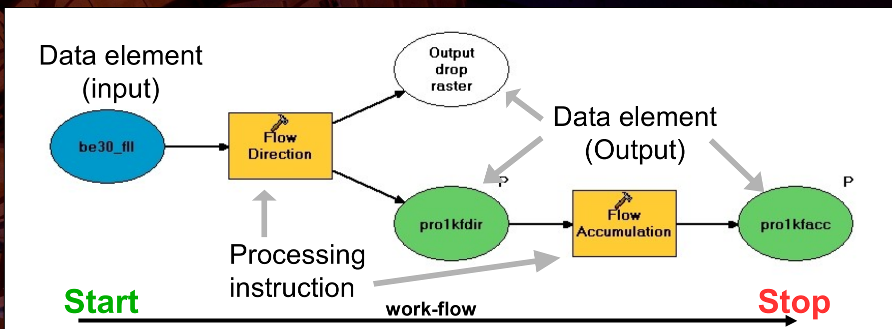
Find a tool in the index tab (search index for DISSOLVE)

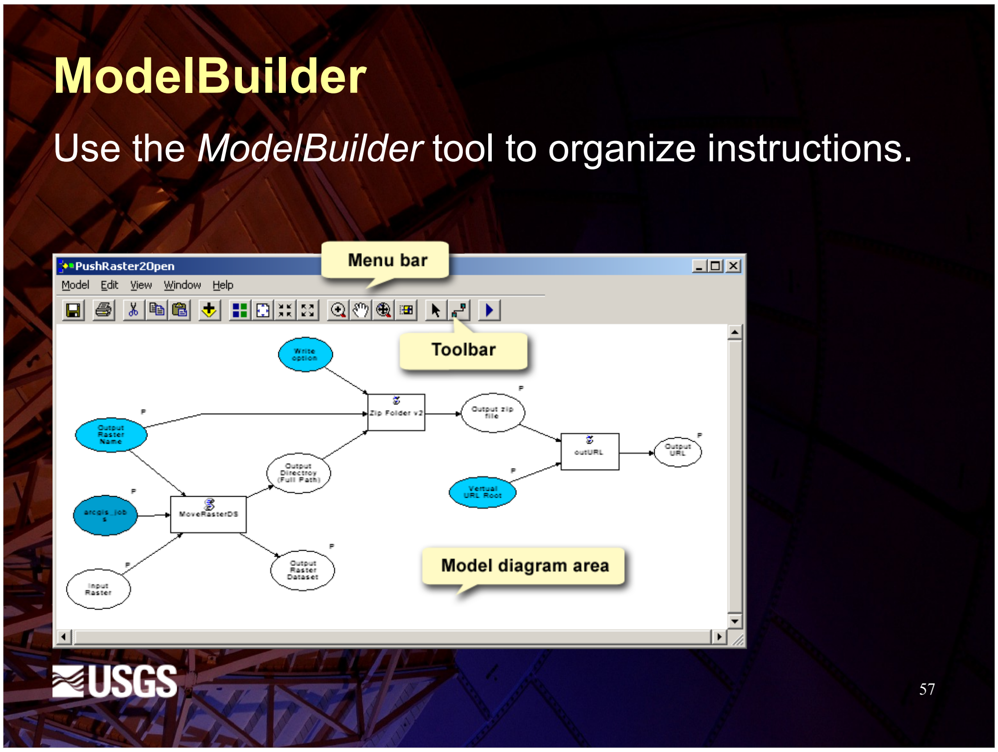
Show the search tab (search for BUFFER)

Review the result

ModelBuilder

A model in respect to ArcGIS is a collection of processing instruction and data elements organized to execute in a defined sequence or workflow.





Build a simple raster to vector idea (ie raster streams to vector) and reproject to geo
Inputs Raster streams, flow direction

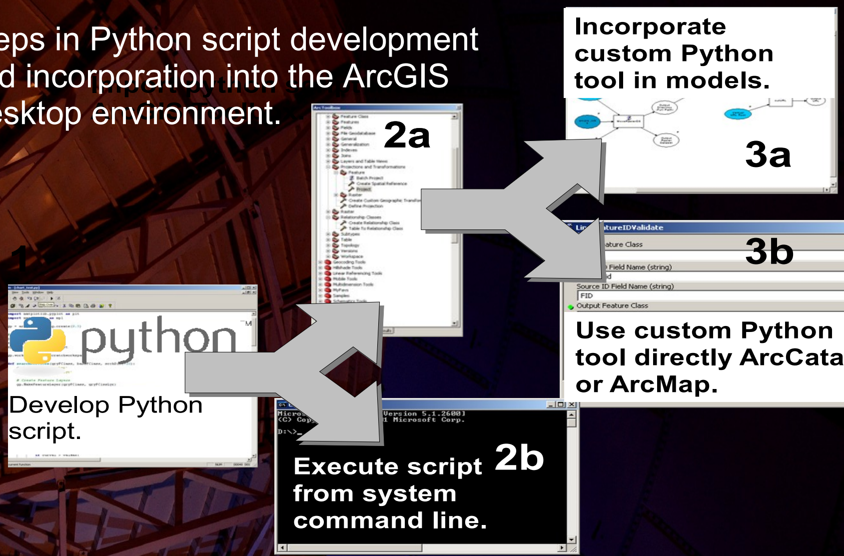
Functions: hydrology/stream to feature, Data man..\projections...\features\Project

Extending Geoprocessing with Python

- ArcGIS allows you to extend the existing Toolboxes by leveraging the power and flexibility of the Python programming environment.
- You can write your own Python application using existing ArcGIS geoprocessing objects as well as incorporating other powerful Python objects into an application.

Python Develop Workflow

1) Steps in Python script development and incorporation into the ArcGIS Desktop environment.



USGS

ArcMap

ArcMap can be used in several unique ways. An obvious use of the application is the tool to produce maps. Other applications are as follows:

- Spatial analysis processing environment
- Development platform for creating GIS software applications (i.e. ArcObjects).
- Create map to be published online via ArcGIS Server.

USGS

Managing Raster Datasets

Basic questions to consider when defining a spatial data management scheme.

- **What type of raster data is being managed?**
  - Continuous or thematic?
  - Bit depth? (8, 16, 32, etc...)
  - Total disk storage space required?
- **What is its primary use?**
  - Archive or Active dataset?
- **Does the data require secure access?**
- **What are the access requirements of the users?**
  - Local, LAN, remote access, and/or Internet access?

USGS

Managing Raster Datasets

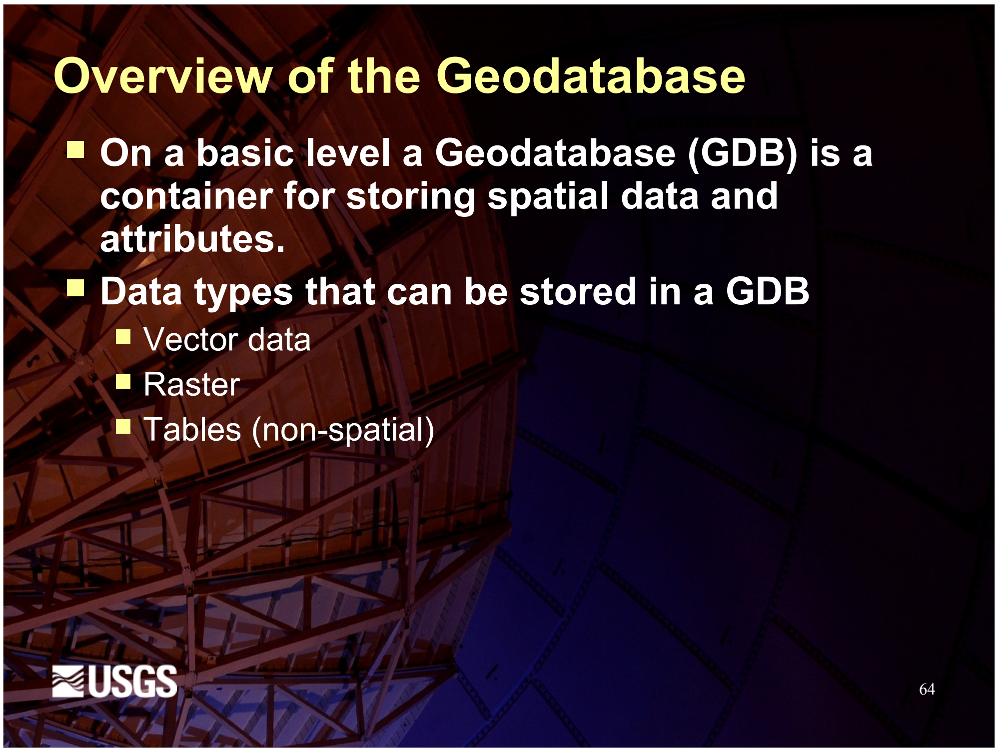
Storage options for raster datasets.

- **Flat file**
  - File formats: GRID, Tiff, ERDAS IMG, JPG2000, etc
- **Database storage**
  - Personal Geodatabase (Managed or unmanaged)
  - File Geodatabase (Managed or unmanaged)
  - ArcSDE Enterprise level
    - Platforms: Oracle, SQL Server, PostgreSQL (open source)
    - Informix, and IBM DB2.
- **Data access options**
  - Geodatabase access
  - Direct Access
  - Web Services Client access

The ArcGIS Ecosystem

Questions?

Next: Overview of ArcGIS Geodatabase

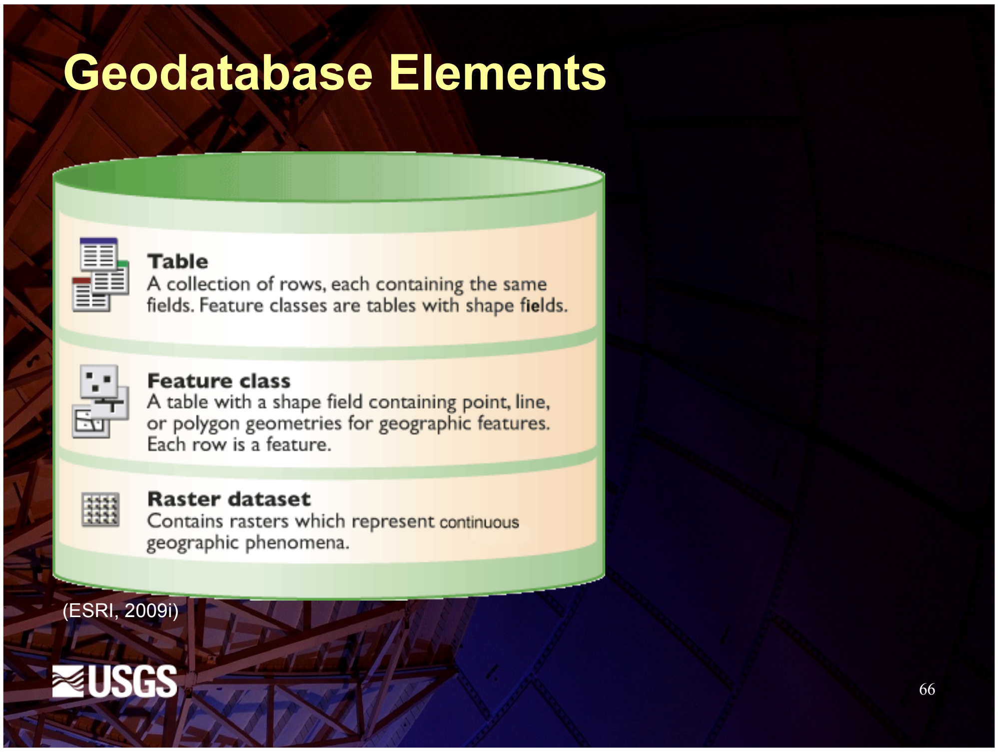

Overview of the Geodatabase
On a basic level a Geodatabase (GDB) is a container for storing spatial data and attributes.
Data types that can be stored in a GDB
Vector data
Raster
Tables (non-spatial)
USGS
64

Optional

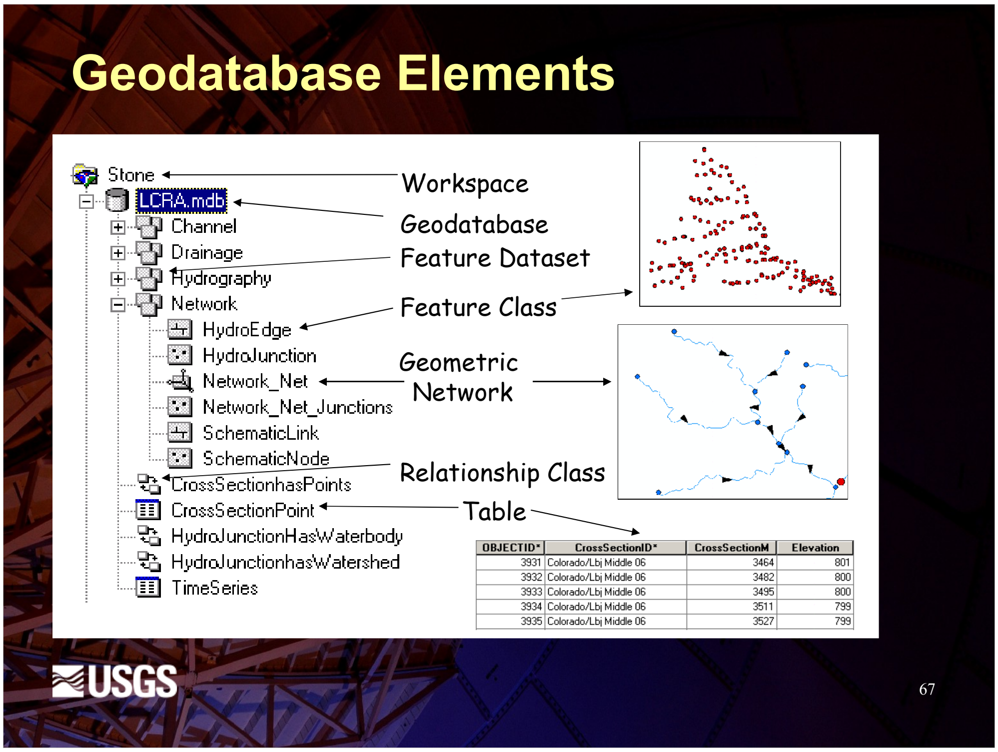
Optional

Note Personal Geodatabase size and access limitations

File Geodatabase Raster size limits (large), Multiple spatial indexing.


Geodatabase Elements
Table
A collection of rows, each containing the same fields. Feature classes are tables with shape fields.
Feature class
A table with a shape field containing point, line, or polygon geometries for geographic features. Each row is a feature.
Raster dataset
Contains rasters which represent continuous geographic phenomena.
(ESRI, 2009i)
USGS
66

Optional


Geodatabase Elements
Stone
LCRA.mdb
Channel
Drainage
Hydrography
Network
HydroEdge
HydroJunction
Network_Net
Network_Net_Junctions
SchematicLink
SchematicNode
CrossSectionhasPoints
CrossSectionPoint
HydroJunctionHasWaterbody
HydroJunctionhasWatershed
TimeSeries
Workspace
Geodatabase
Feature Dataset
Feature Class
Geometric Network
Relationship Class
Table

OBJECTID*	CrossSectionID*	CrossSectionM	Elevation
3931	Colorado/Lbj Middle 06	3464	801
3932	Colorado/Lbj Middle 06	3482	800
3933	Colorado/Lbj Middle 06	3495	800
3934	Colorado/Lbj Middle 06	3511	799
3935	Colorado/Lbj Middle 06	3527	799

USGS
67

Optional

Optional

Demo adding tools to Geodatabases, using LCMapper 2km GDB.
E:\Projects\Sahel\LCMapper_2km\swa_2km_lulc.gdb

Optional

E:\Projects\Sahel\LCMapper_2km\swa_2km_lulc.gdb

Optional

Demonstrate on the LCMapper Geodatabase
E:\Projects\Sahel\LCMapper_2km\swa_2km_lulc.gdb

Geodatabase Raster Datasets Comparison

	Raster dataset	Raster catalog
Homogeneous or heterogeneous data	Homogeneous data: a single format, data type, and file.	Heterogeneous data: multiple formats, data types, file sizes, and coordinate systems.
Metadata	Stored once and applies to complete dataset.	Stored as attribute columns for each raster dataset item in the raster catalog.
Chart Source: ESRI	Raster dataset	Raster catalog

USGS

Optional

Geodatabase Raster Datasets Comparison

	Raster dataset	Raster catalog
Pros	Fast to display at any scale. Mosaic saves space, since there is no overlapping data. Displays with better blending at mosaicked image seams.	Can manage multi-row raster tables for many purposes. Can specify one or more raster datasets for display.
Chart Source: ESRI	Raster dataset	Raster catalog

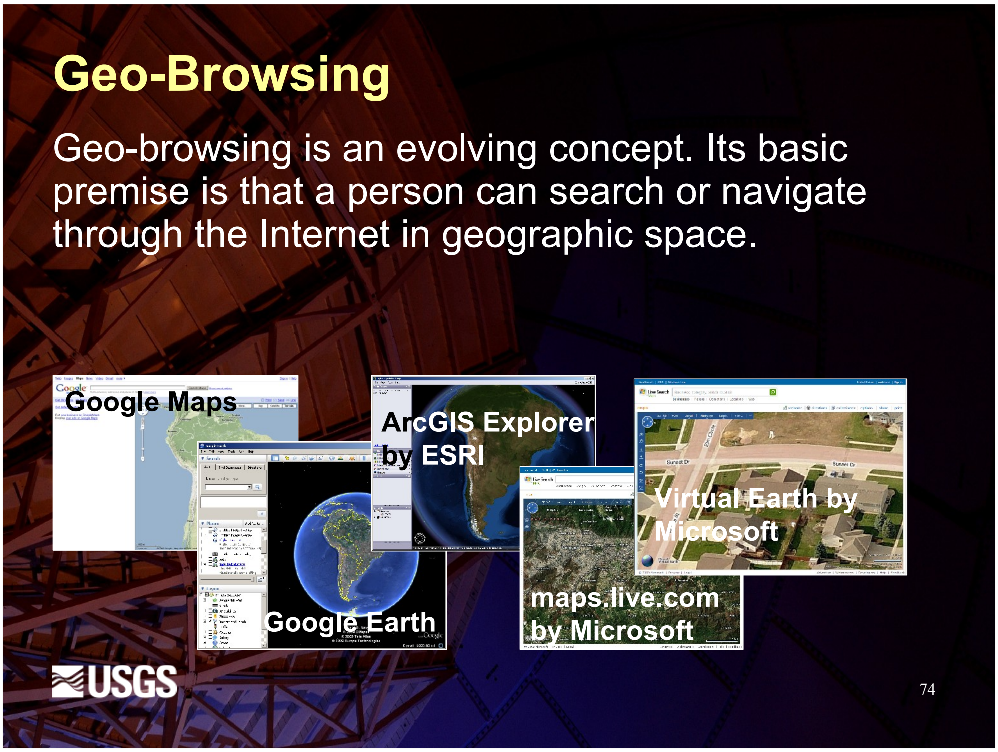
Optional

Overview of the Geodatabase

Questions?

Next: Exploring the concept of Geo-Browsing

USGS



Discuss it's evolution

From task specific software to freely distributed application, Internet application and "Mash-ups" to the use in "smart-phones".

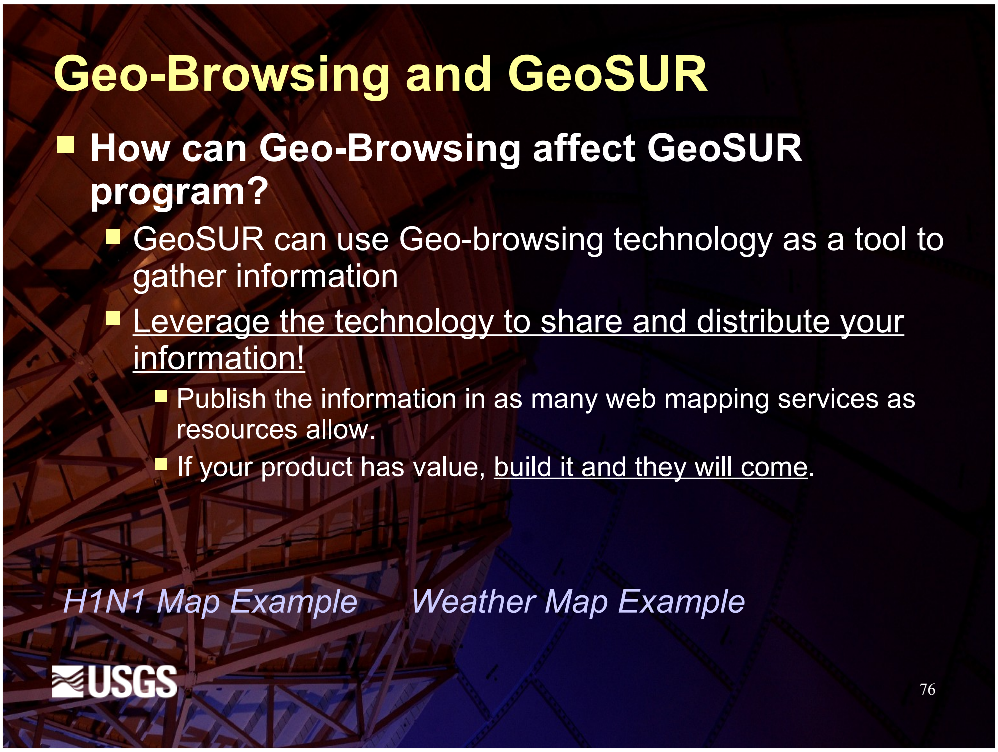
Show highlights of each product.

Google map - the value of the use in mash-ups and common man uses (directions)

Google Earth – Do the time series demo

ArcGIS Explorer – Run a geoprocessing model from GeoSUR server? Rain Drop.

Virtual Earth – so the bird's-eye view.



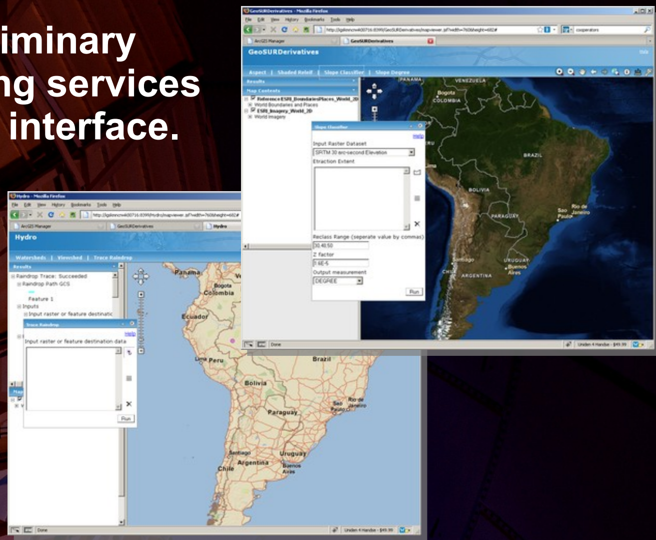
Address the concept that the primary agency doesn't necessarily need to construct the a user interface for a web service. If the service as value and is implemented well other will build the interface.

Maybe show an example of the SWINE FLU maps

http://healthmap.org/swineflu

GeoSUR Geoprocessing

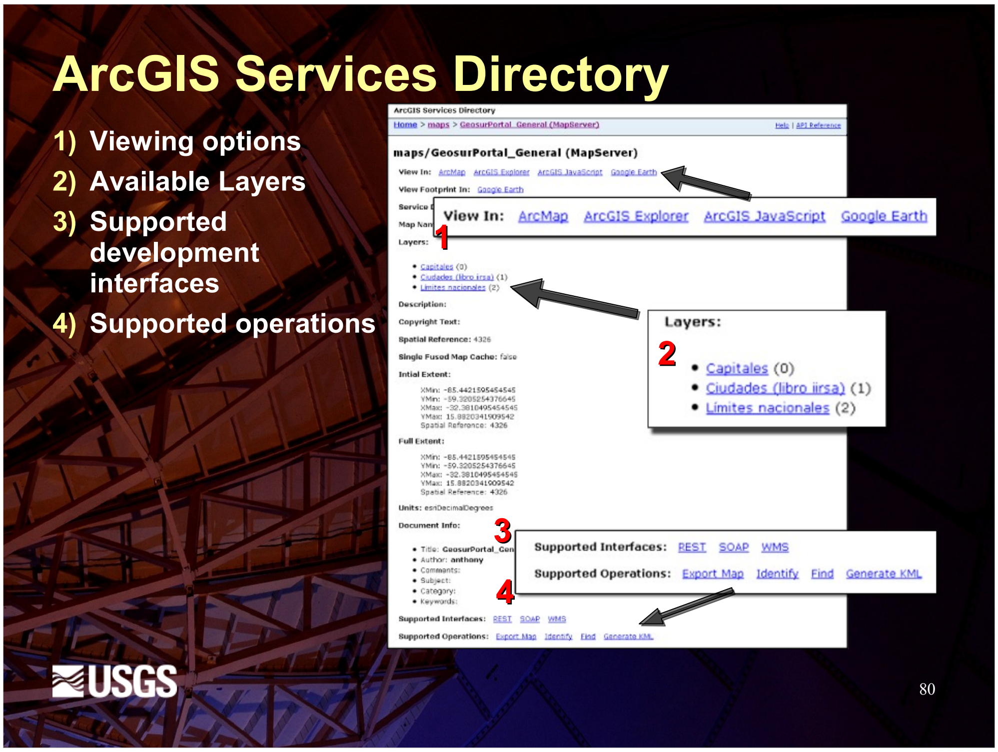
GeoSUR preliminary geoprocessing services web browser interface.



Accessing GeoSUR Web Services

- Web Interface
- ArcGIS Explorer
- ArcGIS – ArcMap
- Google Earth
- Javascript APIs (Google, ESRI, OpenLayer)

- Services Directory helps you do these things:
  - **Browse the contents of the GIS server and get service level metadata**
  - You can navigate a series of links to view information about the services on your GIS server. The links also allow you to preview how your service looks in ArcMap, in a Web browser, in Google Earth, and so on.
  - Get information to help you develop applications
  - When you develop applications with the JavaScript APIs you must provide URLs to services and the layers and functionality they expose. Services Directory provides an interactive way for you to construct those URLs.



When you publish a map service, you can get the contents in several different formats using Services Directory. When you navigate to a map service's page, you see the option to "View In" different applications. These include:

ArcMap (*.lyr), ArcGIS Explorer (.nmf), ArcGIS JavaScript -(simple preview of the map in a Web browser), Google Earth (URL provides the contents of the map as KML network link (.kmz)), Virtual Earth (Web Mercator projection (102113)), Google maps (Web Mercator projection (102113)).

Supported Interfaces:

Supported Operations:

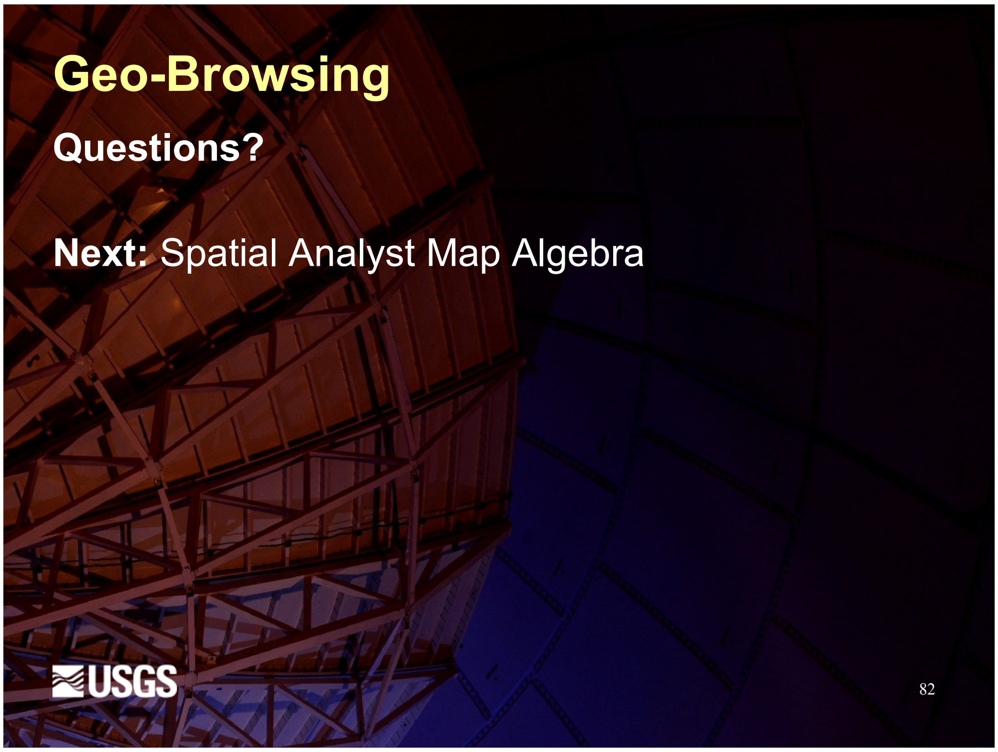
So example of accessing GeoSUR maps through several interfaces.
ArcMap

ArcGIS Explorer

Google Earth

Maybe:

ESRI API or Google Maps



Request any insight that other may have on Geo-browsing.

No expert on this.

Analyzing Spatial Data Exercises

- Map Algebra
- Topographic surface models
- Viewshed Analysis
- Viewshed ModelBuilder
- Vulnerability ModelBuilder
- Hydrological Derivatives
- Drainage Basin Delineation using ModelBuilder

USGS

Spatial Analyst Map Algebra

Map Algebra

A language that defines a syntax for combining map themes by applying mathematical operations and analytical functions to create new map themes. In a map algebra expression, the operators are a combination of mathematical, logical, or Boolean operators (+, >, AND, tan, and so on), and spatial analysis functions (slope, shortest path, spline, and so on) and the operands are spatial data and numbers (ESRI, 2009a).

Example:

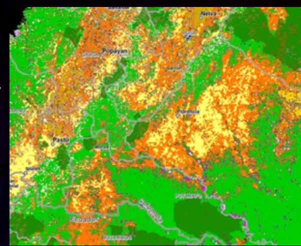
output_raster = con([elevation] > 2000, 0, [elevation])

USGS

Spatial Analyst Map Algebra

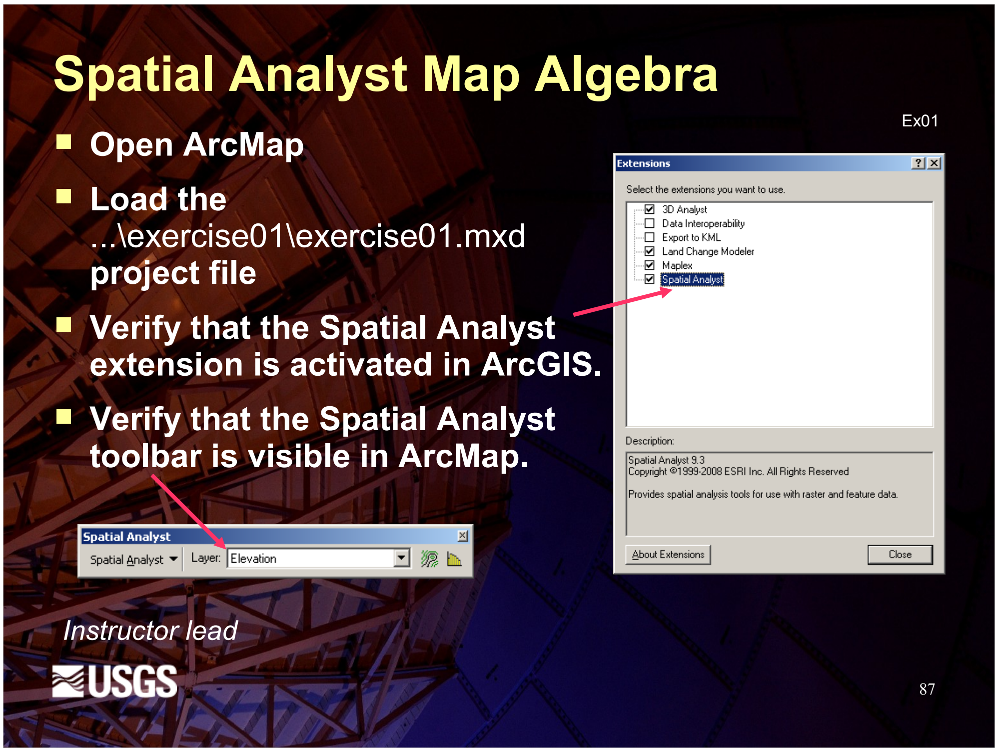
Ex01

- **Protected Area Vulnerability Exercise**
- **Question:** Recent activity in the region covering Colombia and Ecuador's border suggests an expansion of intensive agriculture into the closed tropical evergreen forest. Areas of highest vulnerability are southern facing slopes with a slope of between 0 and 15 degrees between the elevation of 1000 m and 2000 m. Your task is to identify these vulnerable areas within the protected areas of this region.



Instructor lead

USGS



Open ArcMap

Load the ...\exercises\exercise01\exercise01.mxd

Verify that spatial Analyst is loaded

Set spatial analyst options

Working directory = ...\exercises\exercise01

Analysis Mask = NONE

Analysis extent = “Elevation”

Cell Size = “Elevation”

Create elevation derivative

Reclass elevation Tool: Reclass by ASCII File, (elevation_reclass.rmp)

Select Elevation zone = [sel_elev] = setnull([elev_reclass] ne 4, 1)

Create Slope = scaler factor 0.000016 (four zeros)

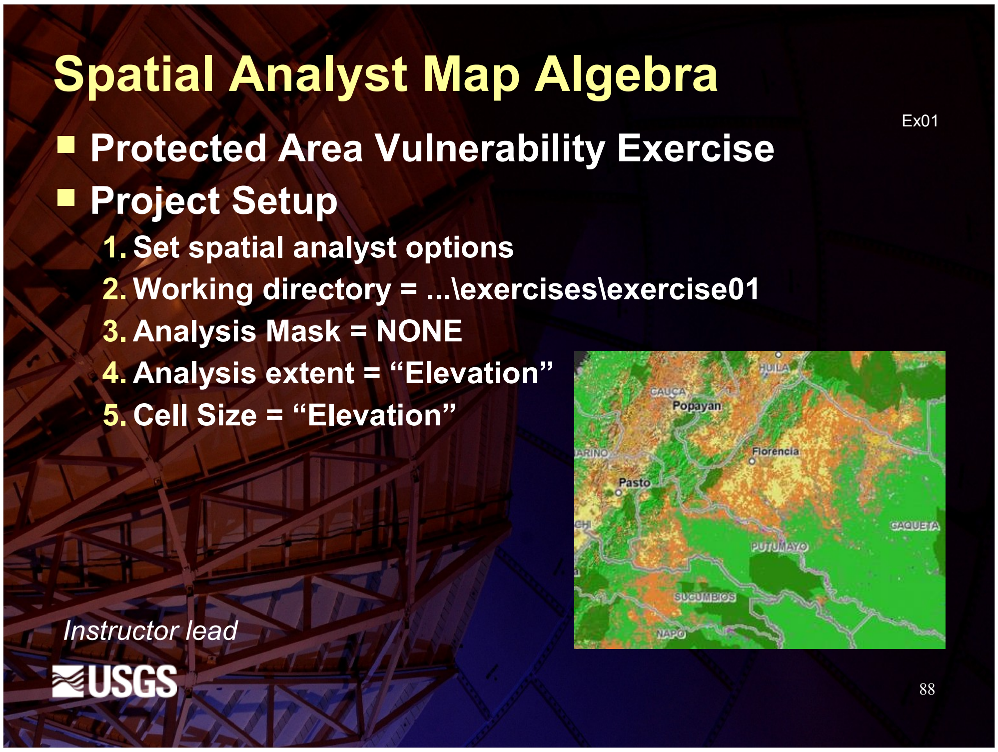
Select Slope Zone = [sel_slope] = setnull([slope] gt 15, 1)

Create Aspect

Select Aspect Zone = [sel_aspect] = setnull([aspect] lt 112.5 or [aspect] gt 247.5, 1)

Create Land-Cover derivative:

Select land-cover Zone = [VulArea] = con([sel_elev] eq 3 & [Protected] eq 1 & [sel_aspect] eq 1 & [sel_slope] eq 1 & [Landcover] eq 10, 1, 0)



Open ArcMap

Load the ...\exercises\exercise01\exercise01.mxd

Verify that spatial Analyst is loaded

Set spatial analyst options

Working directory = ...\exercises\exercise01

Analysis Mask = NONE

Analysis extent = “Elevation”

Cell Size = “Elevation”

Create elevation derivative

Reclass elevation Tool: Reclass by ASCII File, (elevation_reclass.rmp)

Select Elevation zone = [sel_elev] = setnull([elev_reclass] ne 4, 1)

Create Slope = scaler factor 0.000016 (four zeros)

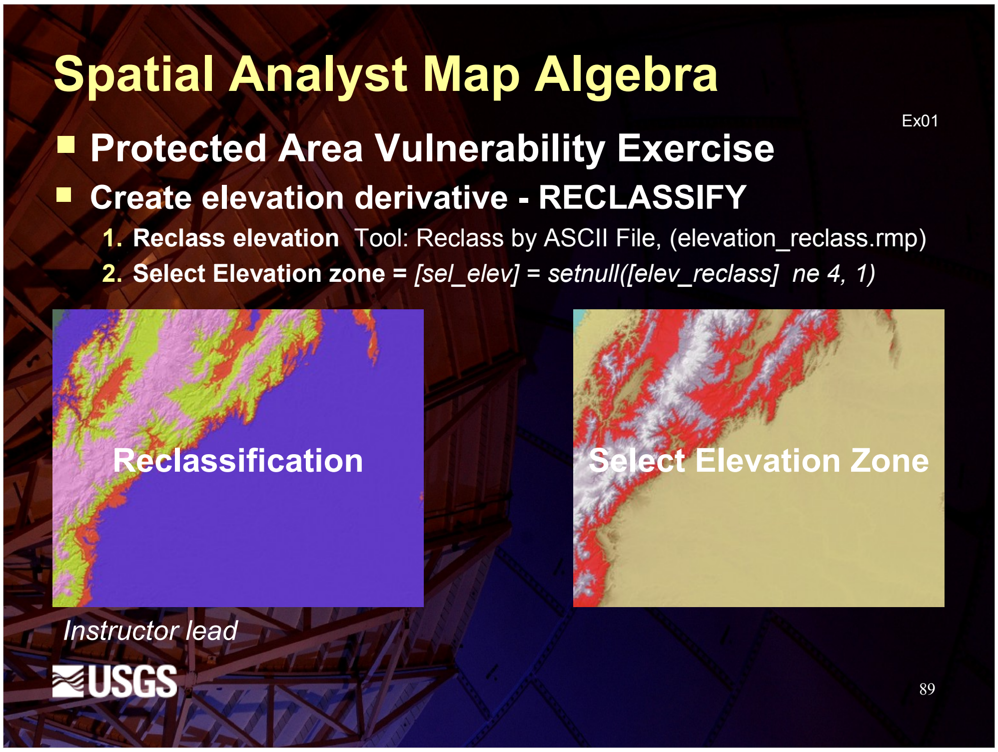
Select Slope Zone = [sel_slope] = setnull([slope] gt 15, 1)

Create Aspect

Select Aspect Zone = [sel_aspect] = setnull([aspect] lt 112.5 or [aspect] gt 247.5, 1)

Create Land-Cover derivative:

Select land-cover Zone = [VulArea] = con([sel_elev] eq 3 & [Protected] eq 1 & [sel_aspect] eq 1 & [sel_slope] eq 1 & [Landcover] eq 10, 1, 0)



Open ArcMap

Load the ...\exercises\exercise01\exercise01.mxd

Verify that spatial Analyst is loaded

Set spatial analyst options

Working directory = ...\exercises\exercise01

Analysis Mask = NONE

Analysis extent = "Elevation"

Cell Size = "Elevation"

Create elevation derivative

Reclass elevation Tool: Reclass by ASCII File, (elevation_reclass.rmp)

Select Elevation zone = [sel_elev] = setnull([elev_reclass] ne 4, 1)

Create Slope = scaler factor 0.000016 (four zeros)

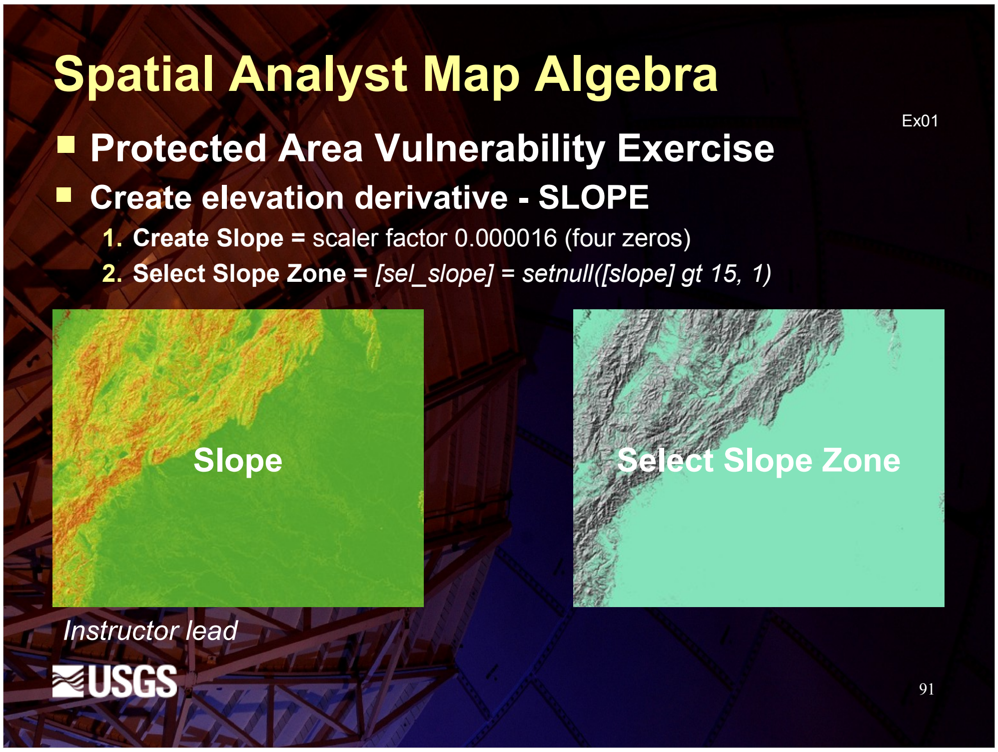
Select Slope Zone = [sel_slope] = setnull([slope] gt 15, 1)

Create Aspect

Select Aspect Zone = [sel_aspect] = setnull([aspect] lt 112.5 or [aspect] gt 247.5, 1)

Create Land-Cover derivative:

Select land-cover Zone = [VulArea] = con([sel_elev] eq 3 & [Protected] eq 1 & [sel_aspect] eq 1 & [sel_slope] eq 1 & [Landcover] eq 10, 1, 0)



Open ArcMap

Load the ...\exercises\exercise01\exercise01.mxd

Verify that spatial Analyst is loaded

Set spatial analyst options

Working directory = ...\exercises\exercise01

Analysis Mask = NONE

Analysis extent = "Elevation"

Cell Size = "Elevation"

Create elevation derivative

Reclass elevation Tool: Reclass by ASCII File, (elevation_reclass.rmp)

Select Elevation zone = [sel_elev] = setnull([elev_reclass] ne 4, 1)

Create Slope = scaler factor 0.000016 (four zeros)

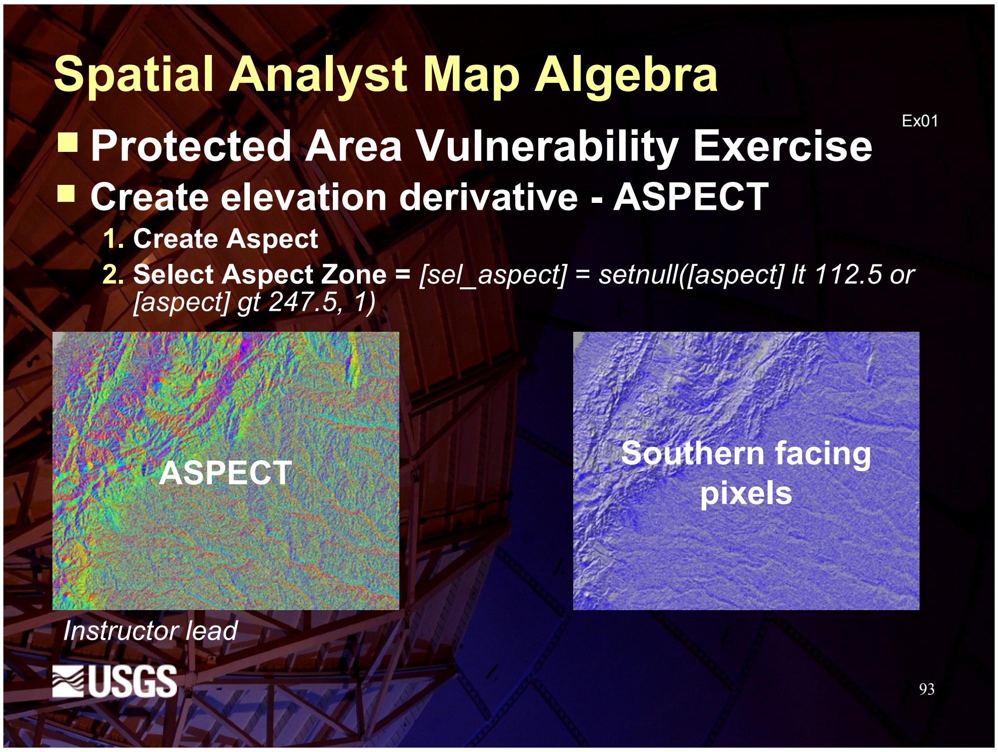
Select Slope Zone = [sel_slope] = setnull([slope] gt 15, 1)

Create Aspect

Select Aspect Zone = [sel_aspect] = setnull([aspect] lt 112.5 or [aspect] gt 247.5, 1)

Create Land-Cover derivative:

Select land-cover Zone = [VulArea] = con([sel_elev] eq 3 & [Protected] eq 1 & [sel_aspect] eq 1 & [sel_slope] eq 1 & [Landcover] eq 10, 1, 0)



Open ArcMap

Load the ...\exercises\exercise01\exercise01.mxd

Verify that spatial Analyst is loaded

Set spatial analyst options

Working directory = ...\exercises\exercise01

Analysis Mask = NONE

Analysis extent = "Elevation"

Cell Size = "Elevation"

Create elevation derivative

Reclass elevation Tool: Reclass by ASCII File, (elevation_reclass.rmp)

Select Elevation zone = [sel_elev] = setnull([elev_reclass] ne 4, 1)

Create Slope = scaler factor 0.000016 (four zeros)

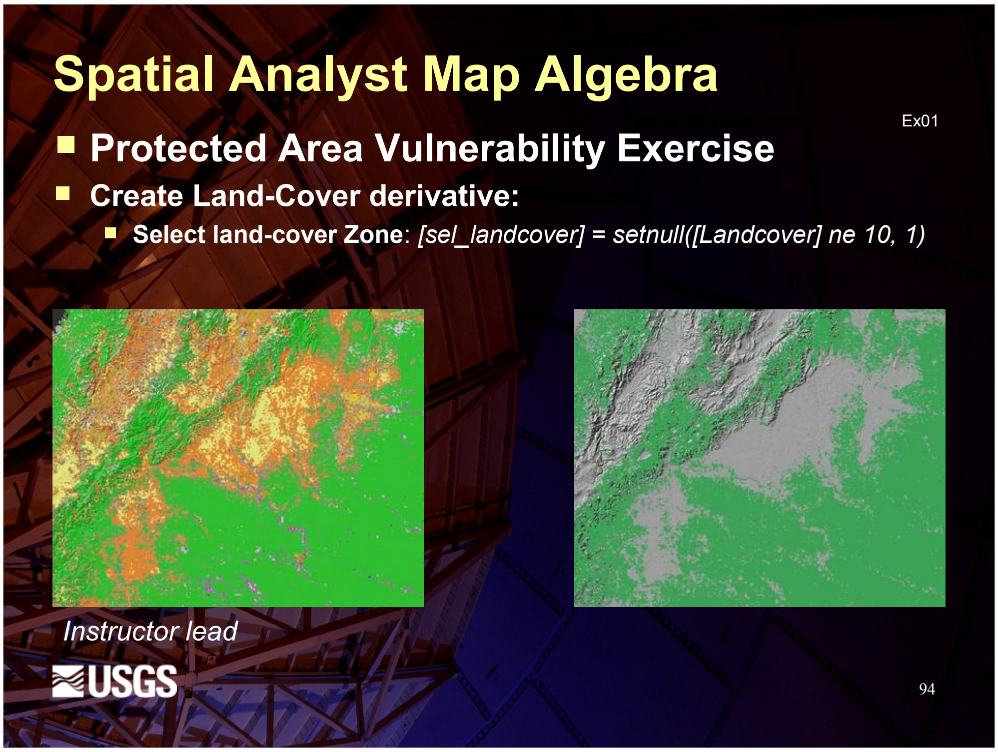
Select Slope Zone = [sel_slope] = setnull([slope] gt 15, 1)

Create Aspect

Select Aspect Zone = [sel_aspect] = setnull([aspect] lt 112.5 or [aspect] gt 247.5, 1)

Create Land-Cover derivative:

Select land-cover Zone = [VulArea] = con([sel_elev] eq 3 & [Protected] eq 1 & [sel_aspect] eq 1 & [sel_slope] eq 1 & [Landcover] eq 10, 1, 0)



Open ArcMap

Load the ...\exercises\exercise01\exercise01.mxd

Verify that spatial Analyst is loaded

Set spatial analyst options

Working directory = ...\exercises\exercise01

Analysis Mask = NONE

Analysis extent = “Elevation”

Cell Size = “Elevation”

Create elevation derivative

Reclass elevation Tool: Reclass by ASCII File, (elevation_reclass.rmp)

Select Elevation zone = [sel_elev] = setnull([elev_reclass] ne 4, 1)

Create Slope = scaler factor 0.000016 (four zeros)

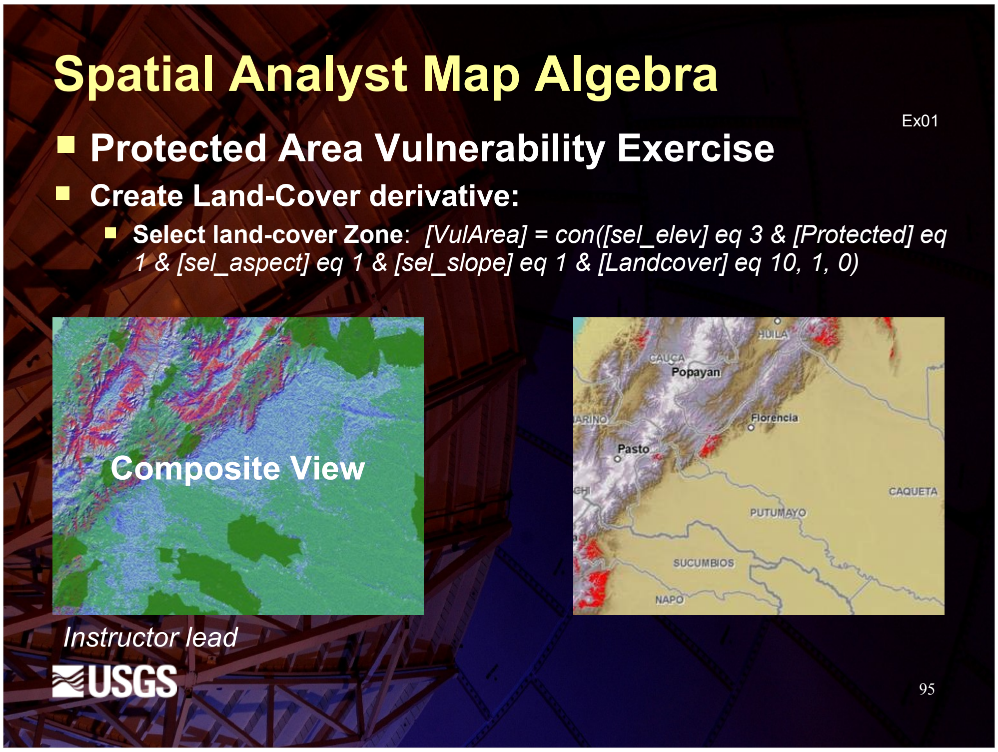
Select Slope Zone = [sel_slope] = setnull([slope] gt 15, 1)

Create Aspect

Select Aspect Zone = [sel_aspect] = setnull([aspect] lt 112.5 or [aspect] gt 247.5, 1)

Create Land-Cover derivative:

Select land-cover Zone = [VulArea] = con([sel_elev] eq 3 & [Protected] eq 1 & [sel_aspect] eq 1 & [sel_slope] eq 1 & [Landcover] eq 10, 1, 0)



Open ArcMap

Load the ...\exercises\exercise01\exercise01.mxd

Verify that spatial Analyst is loaded

Set spatial analyst options

Working directory = ...\exercises\exercise01

Analysis Mask = NONE

Analysis extent = “Elevation”

Cell Size = “Elevation”

Create elevation derivative

Reclass elevation Tool: Reclass by ASCII File, (elevation_reclass.rmp)

Select Elevation zone = [sel_elev] = setnull([elev_reclass] ne 4, 1)

Create Slope = scaler factor 0.000016 (four zeros)

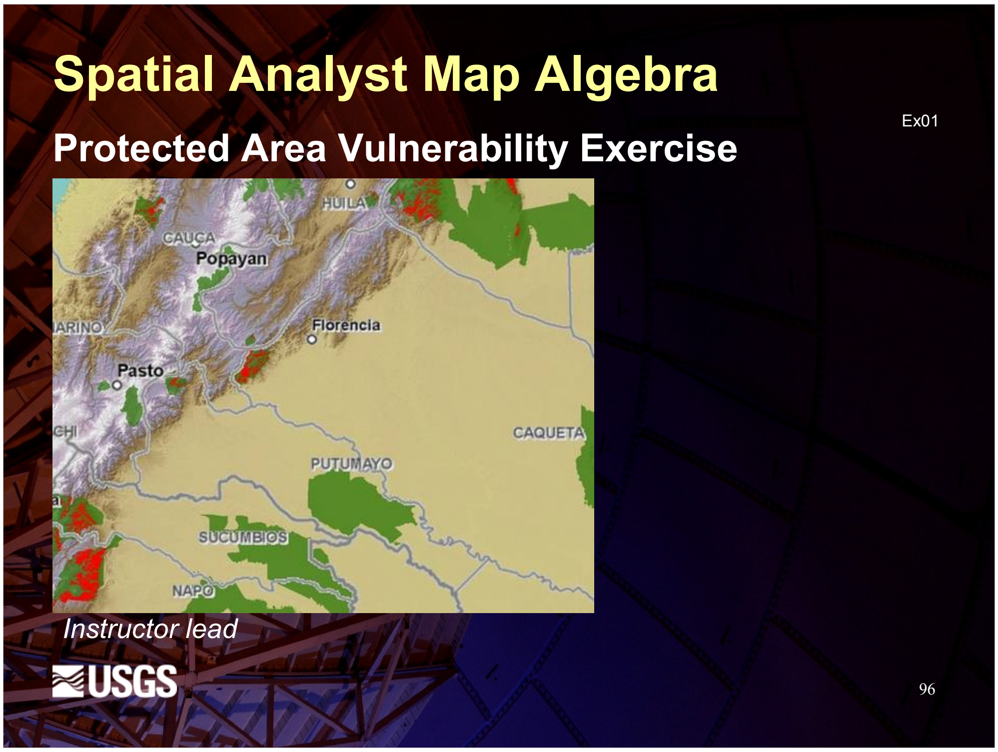
Select Slope Zone = [sel_slope] = setnull([slope] gt 15, 1)

Create Aspect

Select Aspect Zone = [sel_aspect] = setnull([aspect] lt 112.5 or [aspect] gt 247.5, 1)

Create Land-Cover derivative:

Select land-cover Zone = [VulArea] = con([sel_elev] eq 3 & [Protected] eq 1 & [sel_aspect] eq 1 & [sel_slope] eq 1 & [Landcover] eq 10, 1, 0)



Open ArcMap

Load the ...\exercises\exercise01\exercise01.mxd

Verify that spatial Analyst is loaded

Set spatial analyst options

Working directory = ...\exercises\exercise01

Analysis Mask = NONE

Analysis extent = “Elevation”

Cell Size = “Elevation”

Create elevation derivative

Reclass elevation Tool: Reclass by ASCII File, (elevation_reclass.rmp)

Select Elevation zone = [sel_elev] = setnull([elev_reclass] ne 4, 1)

Create Slope = scaler factor 0.000016 (four zeros)

Select Slope Zone = [sel_slope] = setnull([slope] gt 15, 1)

Create Aspect

Select Aspect Zone = [sel_aspect] = setnull([aspect] lt 112.5 or [aspect] gt 247.5, 1)

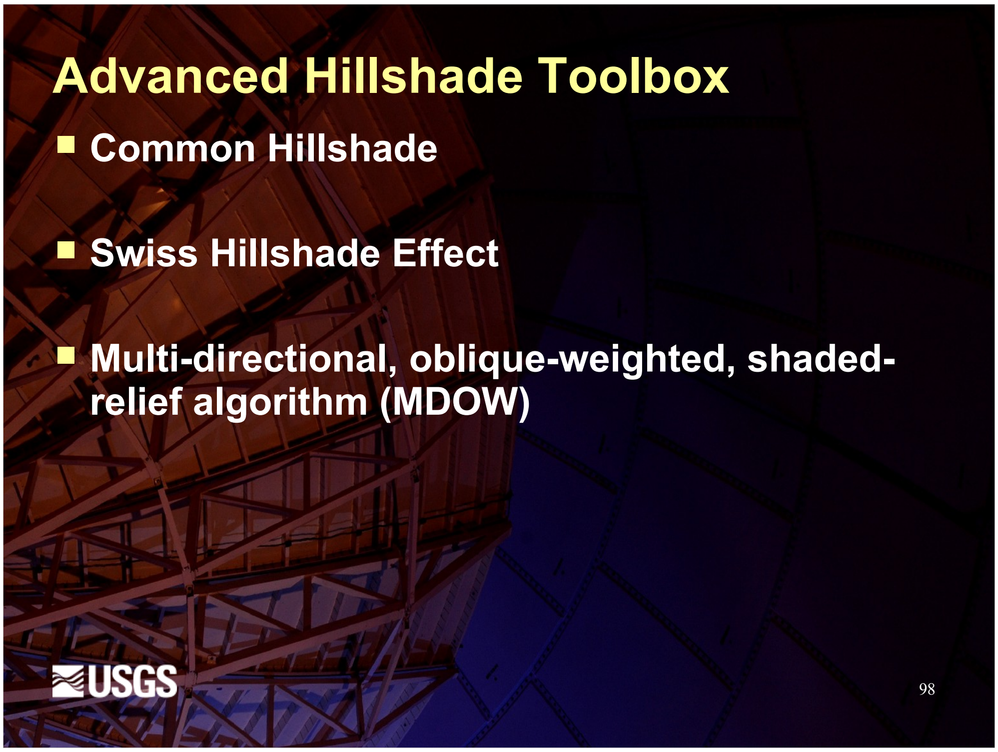
Create Land-Cover derivative:

Select land-cover Zone = [VulArea] = con([sel_elev] eq 3 & [Protected] eq 1 & [sel_aspect] eq 1 & [sel_slope] eq 1 & [Landcover] eq 10, 1, 0)

Spatial Analyst Map Algebra

Questions?

Next Exercise: Advanced Hillshade Toolbox

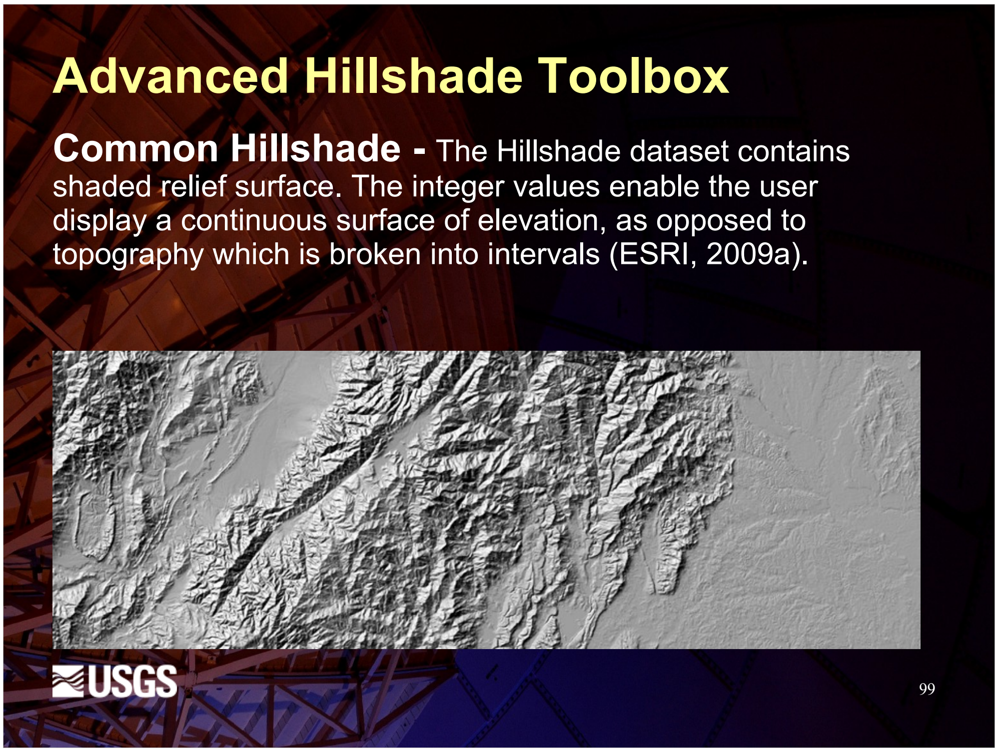


Swiss Hillshade

The Swiss hillshade effect is created using two modified hillshades that are displayed together with a layer tinted DEM. The first modified hillshade is a generalized hillshade produced by using a median filter on the default hillshade - this creates a smoothing effect and generalizes the terrain to emphasize the major geographic features, minimize the minor features, and smooth irregularities on the slopes; however, it still maintains the rugged characteristics of ridge tops and canyon bottoms. The second modified hillshade is created from both the original DEM and the default hillshade in such a way as to simulate an aerial perspective that makes the higher elevations lighter and the lower elevations darker. These two modified hillshade and a layer tinted DEM are displayed with transparencies to produce an effect similar to the Swiss-style hillshade

MDOW:

As Dr. Mark of the USGS, who originally developed the model as an Arc Workstation AML, stated: "Traditional computer-generated shaded-relief maps emphasize structures that happen to be obliquely illuminated, but wash out structures that are illuminated along the structural grain. This method produces a surface that emphasizes oblique illumination on all surfaces, ... providing more detail in areas of an image that would otherwise be illuminated by direct light or left in darkness by a single source illumination..." In essence, the hillshade is created by combining four hillshades generated from 225 degree, 270 degree, 315 degree and 360 degree azimuths, all at 30 degrees altitude.

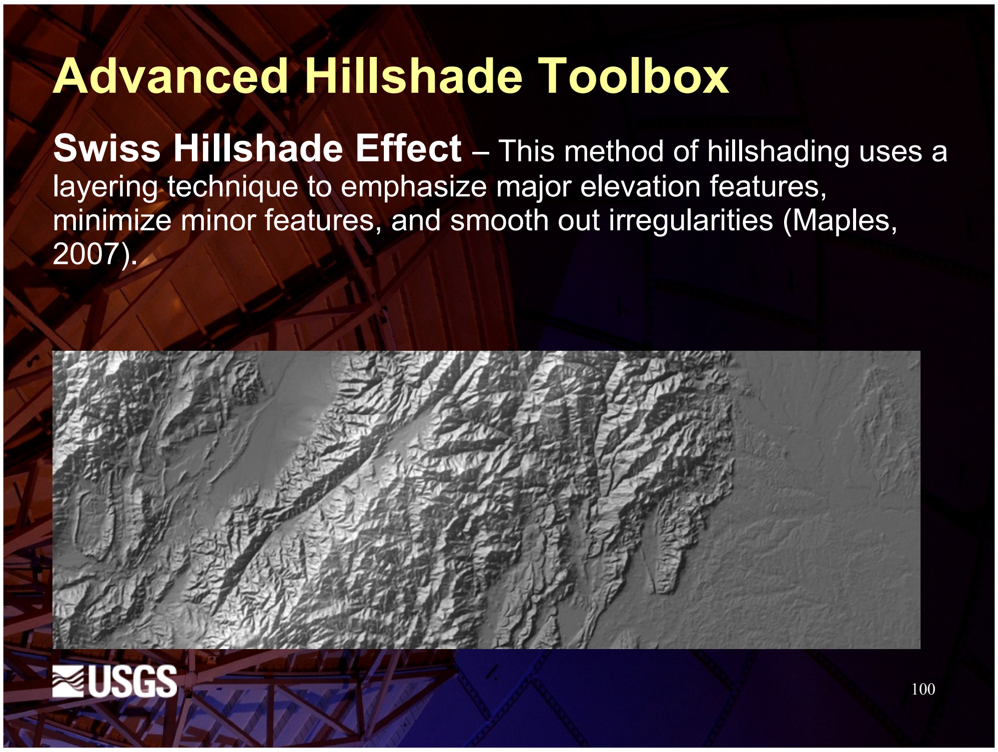


Swiss Hillshade

The Swiss hillshade effect is created using two modified hillshades that are displayed together with a layer tinted DEM. The first modified hillshade is a generalized hillshade produced by using a median filter on the default hillshade - this creates a smoothing effect and generalizes the terrain to emphasize the major geographic features, minimize the minor features, and smooth irregularities on the slopes; however, it still maintains the rugged characteristics of ridge tops and canyon bottoms. The second modified hillshade is created from both the original DEM and the default hillshade in such a way as to simulate an aerial perspective that makes the higher elevations lighter and the lower elevations darker. These two modified hillshade and a layer tinted DEM are displayed with transparencies to produce an effect similar to the Swiss-style hillshade

MDOW:

As Dr. Mark of the USGS, who originally developed the model as an Arc Workstation AML, stated: "Traditional computer-generated shaded-relief maps emphasize structures that happen to be obliquely illuminated, but wash out structures that are illuminated along the structural grain. This method produces a surface that emphasizes oblique illumination on all surfaces, ... providing more detail in areas of an image that would otherwise be illuminated by direct light or left in darkness by a single source illumination..." In essence, the hillshade is created by combining four hillshades generated from 225 degree, 270 degree, 315 degree and 360 degree azimuths, all at 30 degrees altitude.

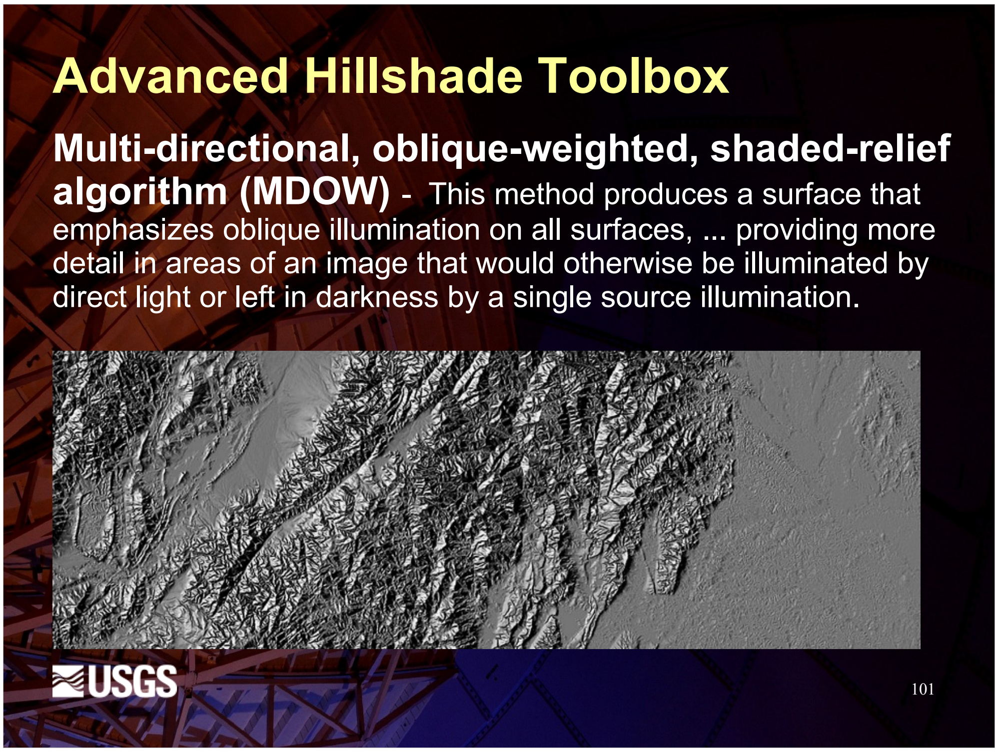


Swiss Hillshade

The Swiss hillshade effect is created using two modified hillshades that are displayed together with a layer tinted DEM. The first modified hillshade is a generalized hillshade produced by using a median filter on the default hillshade - this creates a smoothing effect and generalizes the terrain to emphasize the major geographic features, minimize the minor features, and smooth irregularities on the slopes; however, it still maintains the rugged characteristics of ridge tops and canyon bottoms. The second modified hillshade is created from both the original DEM and the default hillshade in such a way as to simulate an aerial perspective that makes the higher elevations lighter and the lower elevations darker. These two modified hillshade and a layer tinted DEM are displayed with transparencies to produce an effect similar to the Swiss-style hillshade

MDOW:

As Dr. Mark of the USGS, who originally developed the model as an Arc Workstation AML, stated: "Traditional computer-generated shaded-relief maps emphasize structures that happen to be obliquely illuminated, but wash out structures that are illuminated along the structural grain. This method produces a surface that emphasizes oblique illumination on all surfaces, ... providing more detail in areas of an image that would otherwise be illuminated by direct light or left in darkness by a single source illumination..." In essence, the hillshade is created by combining four hillshades generated from 225 degree, 270 degree, 315 degree and 360 degree azimuths, all at 30 degrees altitude.



Swiss Hillshade

The Swiss hillshade effect is created using two modified hillshades that are displayed together with a layer tinted DEM. The first modified hillshade is a generalized hillshade produced by using a median filter on the default hillshade - this creates a smoothing effect and generalizes the terrain to emphasize the major geographic features, minimize the minor features, and smooth irregularities on the slopes; however, it still maintains the rugged characteristics of ridge tops and canyon bottoms. The second modified hillshade is created from both the original DEM and the default hillshade in such a way as to simulate an aerial perspective that makes the higher elevations lighter and the lower elevations darker. These two modified hillshade and a layer tinted DEM are displayed with transparencies to produce an effect similar to the Swiss-style hillshade

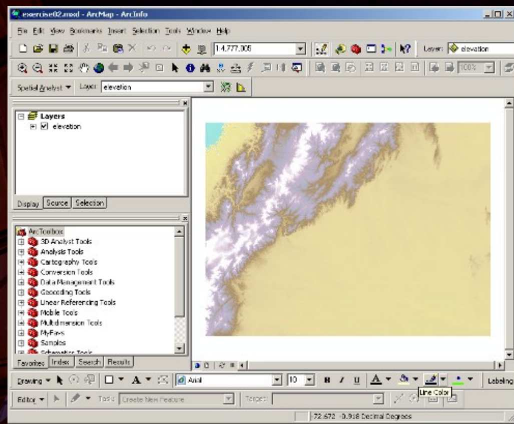
MDOW:

As Dr. Mark of the USGS, who originally developed the model as an Arc Workstation AML, stated: "Traditional computer-generated shaded-relief maps emphasize structures that happen to be obliquely illuminated, but wash out structures that are illuminated along the structural grain. This method produces a surface that emphasizes oblique illumination on all surfaces, ... providing more detail in areas of an image that would otherwise be illuminated by direct light or left in darkness by a single source illumination..." In essence, the hillshade is created by combining four hillshades generated from 225 degree, 270 degree, 315 degree and 360 degree azimuths, all at 30 degrees altitude.

Basic Hillshade Dataset

Ex02

- Open ArcMap
- Load ...\exercise02\exercise02.mxd project file



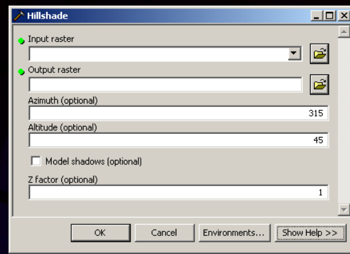
Instructor lead

USGS

Basic Hillshade Dataset

Ex02

- Open ArcToolbox in ArcMap
- Locate the Spatial Analyst Toolset
- Open the Hillshade tool with the Surface toolset.



- Input Parameters:
- Input Raster: ...\exercises\exercise02\data\elevation
- Output raster: ...\exercises\exercise02\hillshade
- Azimuth (Angle of the light source in degrees)
- Altitude (Altitude of the light source on the horizon)
- Z-factor (number of ground x, y units in one surface z unit)

Instructor lead

USGS

Z-factor

- **A conversion factor used to adjust vertical and horizontal measurements into the same unit of measure. Specifically, the number of vertical units (z-units) in each horizontal unit (ESRI, 2009e)**
- **For a detailed explanation of the Z-factor visit the ESRI's Mapping Center Blog.**

Ex02

Latitude	Z-factor in meters
	0.00000898
10	0.00000912
20	0.00000956
30	0.00001036
40	0.00001171
50	0.00001395
60	0.00001792
70	0.0000[illegible]19
80	0.00005156

Note: *Z-factor Calculation*

1 degree = 0.0174532925 radians

Z-factor = 1.0 / (113200 * cos(<input latitude in radians>))

USGS

Swiss Hillshade Effect

Ex02

- **Load Toolbox:**
  ...\exercises\exercise02\Hillshade_Tools_9.3
- **Open Swiss Hillshade Model**
  - Input DEM: ...\exercises\exercise02\data\elevation
  - Z-factor: 0.00000898
  - Filtered Hillshade (output): ...\exercises\exercise02\fltrhlshd
  - Aerial Perspective (output): ...\exercises\exercise02\arlprsp
- **Create Layer Group**
  - Set Filtered Hillshade transparency to 35%
  - Verify Aerial Perspective transparency is at 0%

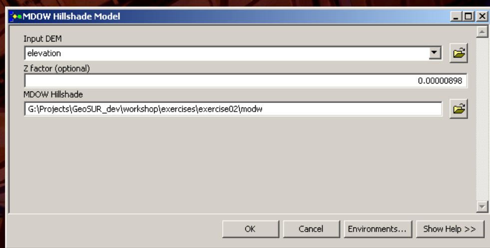
Instructor lead

USGS

MDOW Hillshade

Ex02

- Open MDOW Hillshade Model
  - Input DEM: ...\exercises\exercise02\data\elevation
  - Z factor: 0.00000898
  - MDOW Hillshade (output): ...\exercises\exercise02\modw
- Overlay elevation dataset with 30% transparency



Instructor lead

Advanced Hillshade Toolbox

Questions?

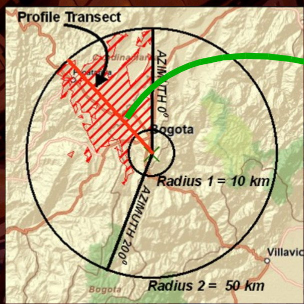
Next Exercise: Viewshed Analysis

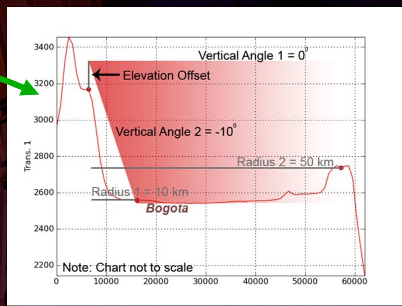
USGS

Viewshed Analysis

Ex03

A Viewshed analysis identifies the surface area visible from a given location based on its elevation.



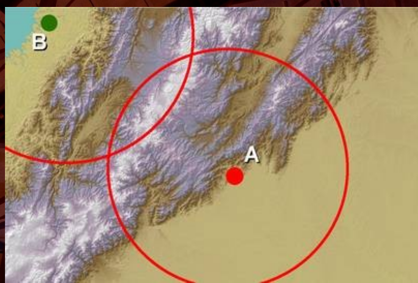


Instructor lead

Viewshed Analysis

Ex03

- **Viewshed analysis task.**
- Identify potential sites for a relay transmission tower between site A and B with a slope no greater than 10 degrees.



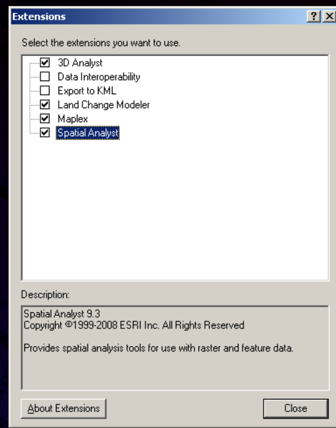
Instructor lead

USGS

Viewshed Analysis

Ex03

- **Open ArcMap**
- **Load the** ...\exercise03\exercise03.mxd **project file**
- **Verify that the Spatial Analyst extension is activated in ArcGIS.**
- **Verify that the Spatial Analyst toolbar is visible in ArcMap.**



Instructor lead

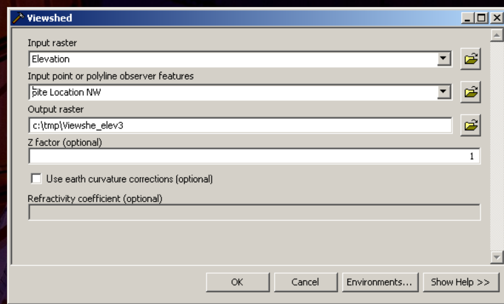
USGS

Viewshed Analysis

Ex03

- **Viewshed Analysis parameters:**
  - **Input raster: Elevation (DEM)**
  - **Input point or polyline observation features**
    - *Observation feature parameters defined in attribute table*
  - **Output raster dataset**
  - **Z-factor**

Note: Z-factor will be **1** in this exercise because the elevation dataset is in an equal-area projection.



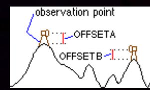
Instructor lead

Viewshed Analysis

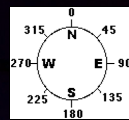
- **Viewshed observation feature input parameters**
  - *Site location SE (A):*
    - **OFFSETA = 300 m**
    - **OFFSETB = 30 m**
    - **AZIMUTH1 = 285°**
    - **AZIMUTH2 = 330°**
    - **VERT1 = 90°**
    - **VERT2 = -90°**
    - **RADIUS1 = 50 km (50 000 m)**
    - **RADIUS2 = 150 km (150 000 m)**

Instructor lead

Ex03

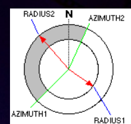


OFF SETS



AZIMUTH

VERTICAL ANGLE



RADIUS
(ESRI, 2009a)

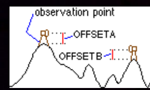
USGS

Viewshed Analysis

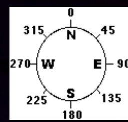
Ex03

- **Viewshed observation feature input parameters**
  - *Site location NW (B):*
    - **OFFSETA = 300 m**
    - **OFFSETB = 30 m**
    - **AZIMUTH1 = 120°**
    - **AZIMUTH2 = 150°**
    - **VERT1 = 90°**
    - **VERT2 = -90°**
    - **RADIUS1 = 50 km (50 000 m)**
    - **RADIUS2 = 150 km (150 000 m)**

Instructor lead

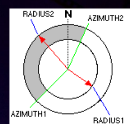


OFF SETS



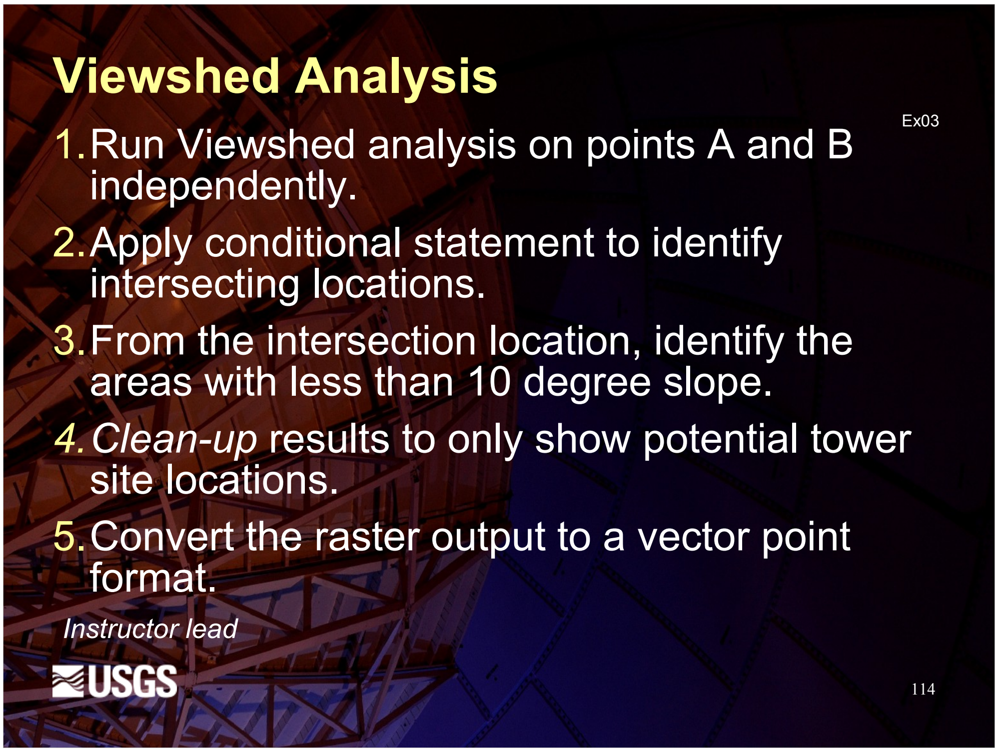
AZIMUTH

VERTICAL ANGLE



RADIUS
(ESRI, 2009a)

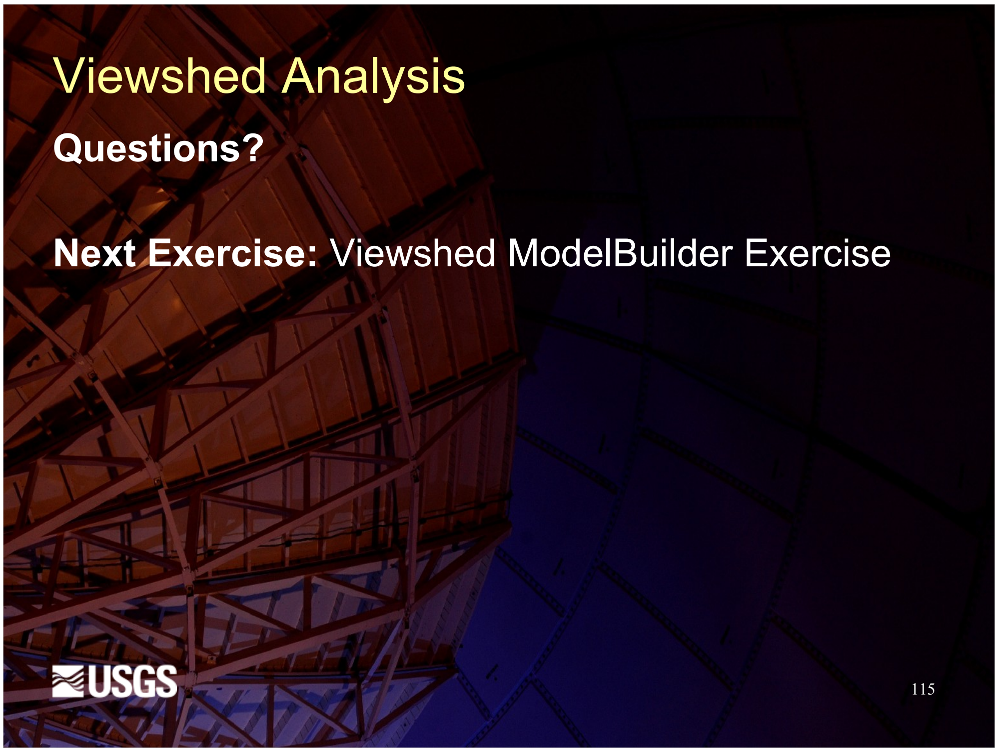
USGS



Step 2 conditional statement: [sites01] = con([Viewshed1] eq 1 and [Viewshed2] eq 1, 1,0)

Step 3 conditional statement: [sites02] = con([sites01] eq 1 and [slope] lt 10, 1, 0)

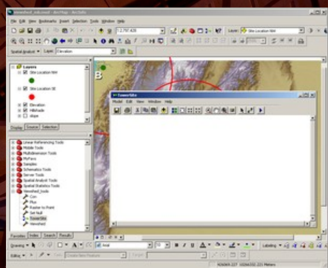
Step 4 Setnull statement (Clean-up): [site03] = setnull([sites02] eq 0, 1)


Viewshed Analysis
Questions?
Next Exercise: Viewshed ModelBuilder Exercise
USGS
115

Viewshed ModelBuilder Exercise

Ex04

- **Open** .../exercise04/exercise04.mxd project **file.**
- **Open Toolbox in ArcMap.**
- **Expand the <u>Viewshed_tools</u> toolset.**
- **Open the <u>TowerSite</u> model in edit mode.**



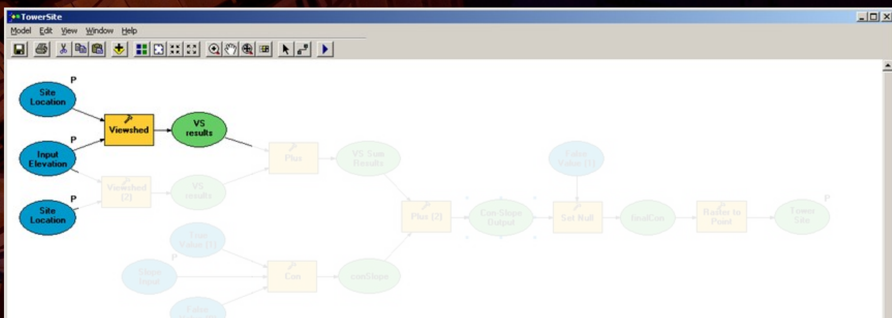
Instructor lead

USGS

Viewshed ModelBuilder Exercise

Ex04

Add <u>Viewshed</u> tool (*hint: drag and drop tool from the toolbox*)**.**



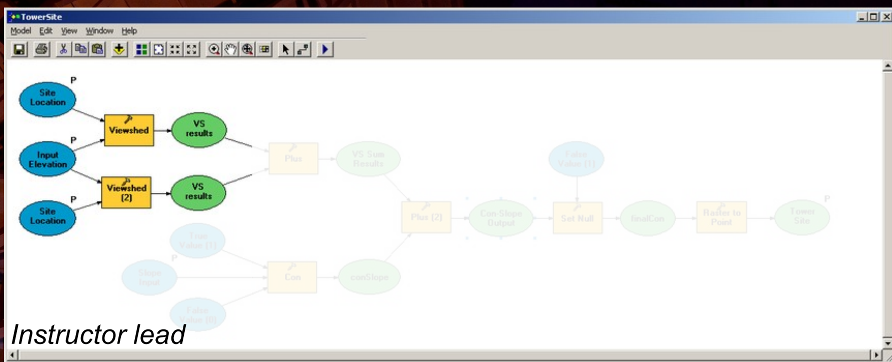
Instructor lead

USGS

Viewshed ModelBuilder Exercise

Ex04

Add a second Viewshed tool.

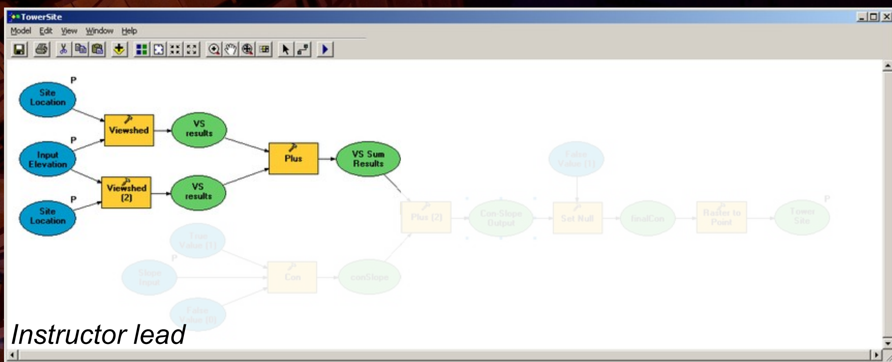


Instructor lead

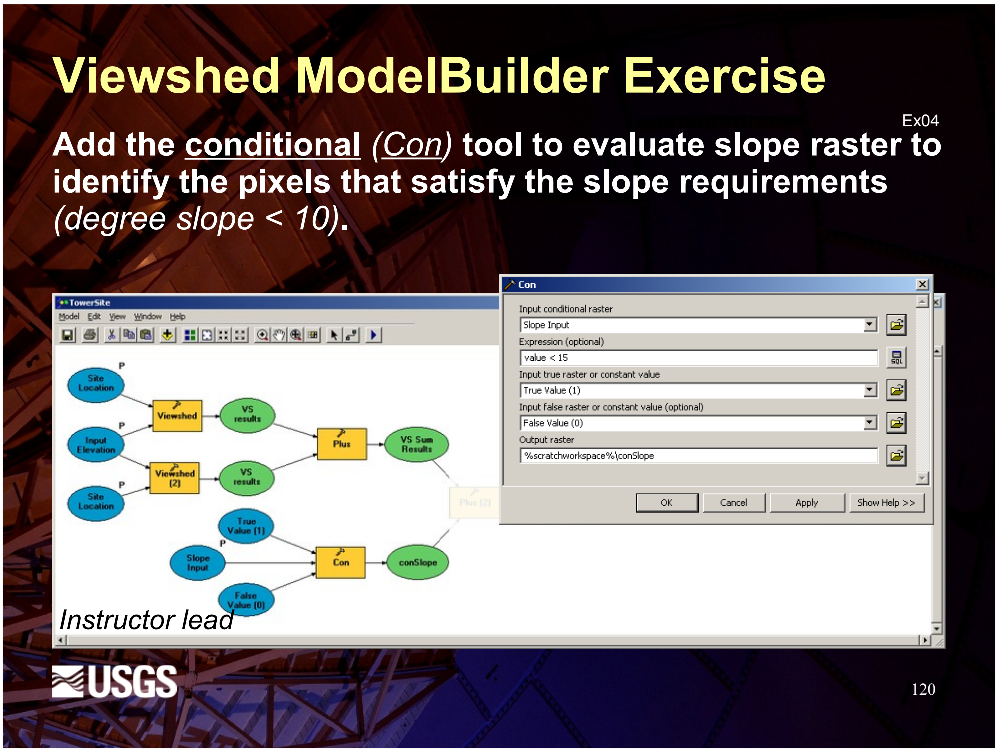
Viewshed ModelBuilder Exercise

Ex04

Add the Plus tool to identify potential tower locations. The resulting raster with pixel values equal to 2 that represents intersecting locations between both Viewshed analyses.



Instructor lead



Input Conditional Raster: Slope

Expresstion: value < 15

Input TRUE constant value: 1

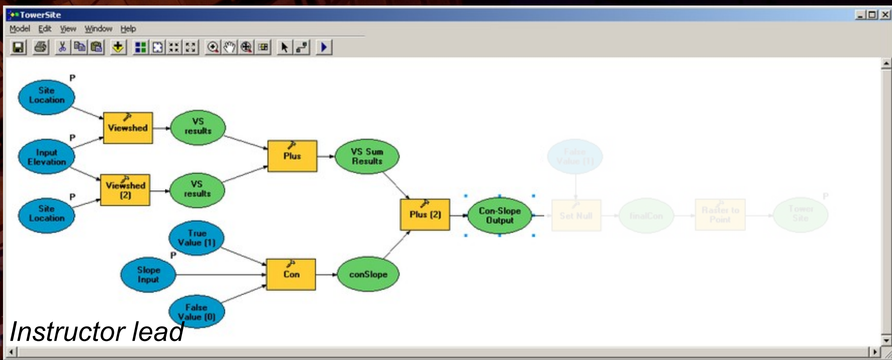
Input FALSE constant: 0

Output Raster: conSlope

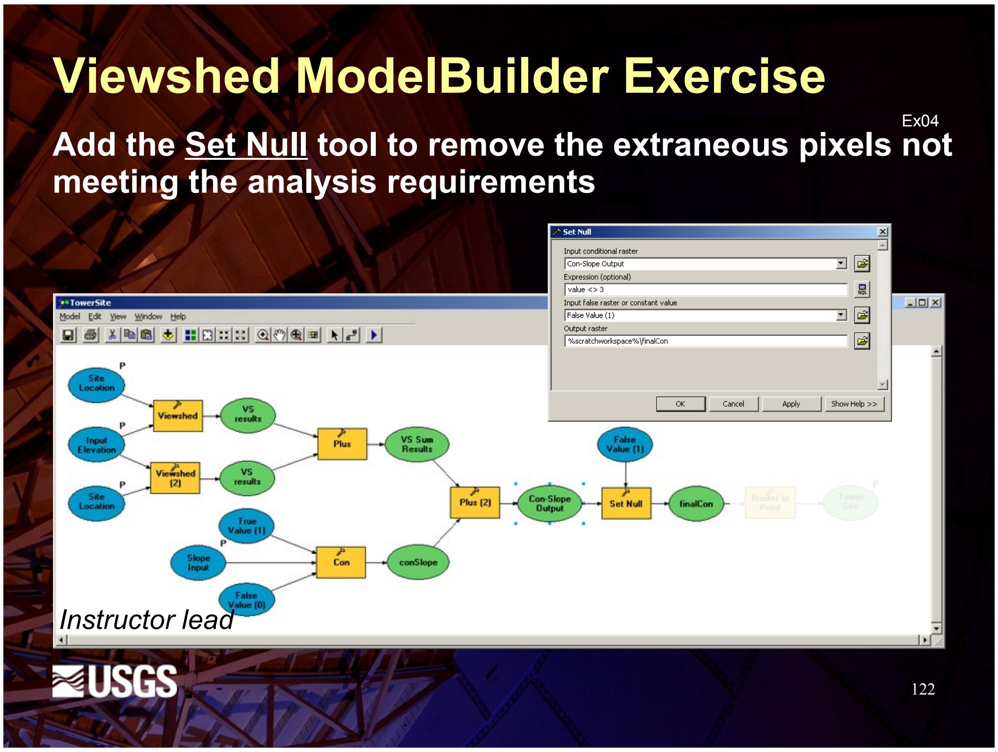
Viewshed ModelBuilder Exercise

Ex04

Add another Plus tool to sum the results from the Viewshed analyses and the slope conditional statement.



Instructor lead

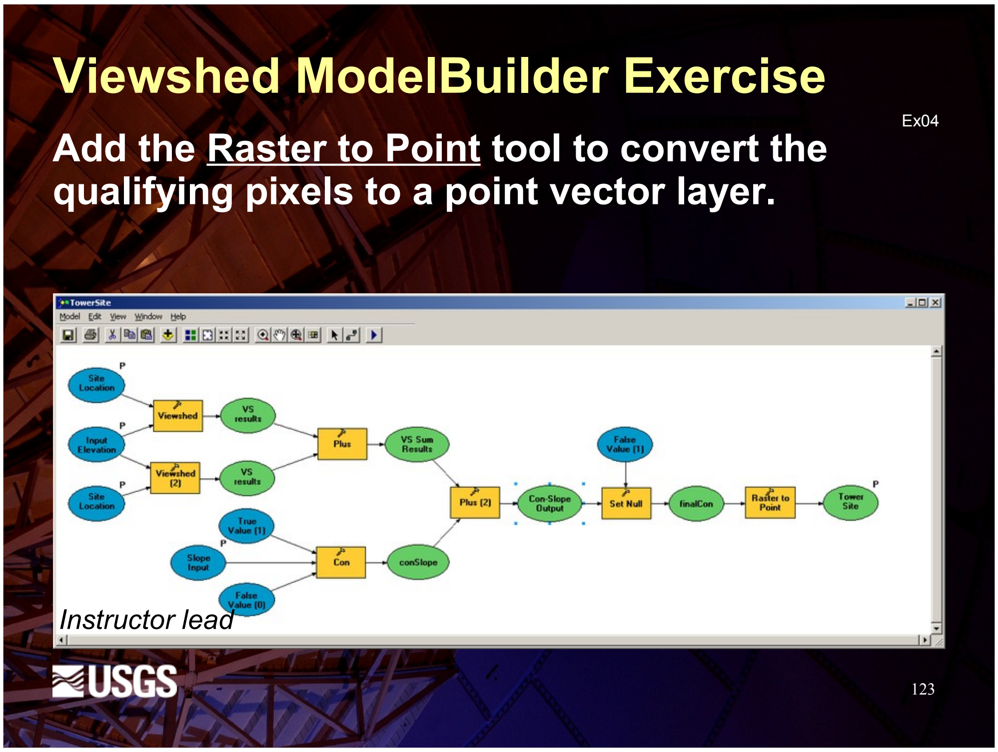


Input: Con-Slope Output

Expression: value <> 3

Input false constant value = 1

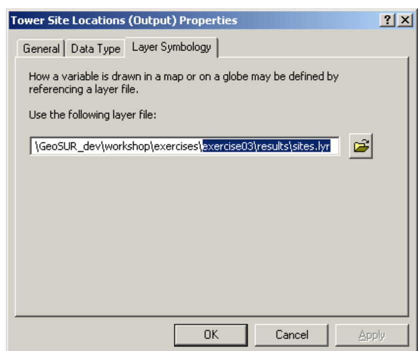
Output: %scratchworkspace%/finalCon

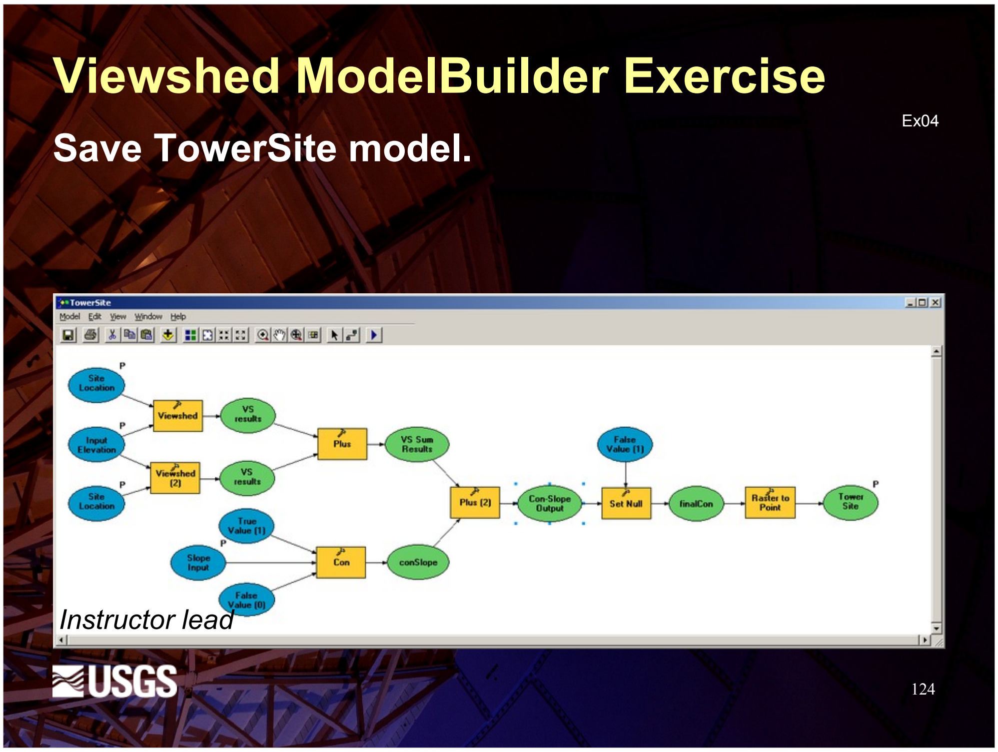


Once the model is built walk through SETTING the input and output parameter definitions!

Discuss the concept of **Model Parameters**, **Managed**, **Intermediate** data types

Show the option to set the output layer symbology
...\exercise03\results\sites.lyr

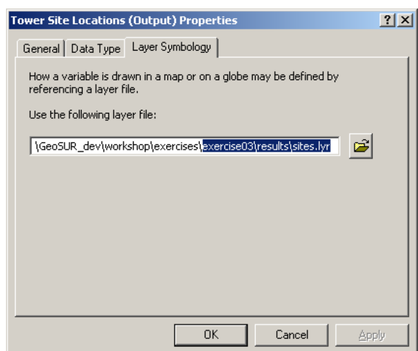




Once the model is built walk through SETTING the input and output parameter definitions!

Discuss the concept of **Model Parameters**, **Managed**, **Intermediate** data types

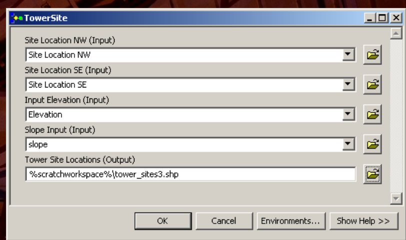
Show the option to set the output layer symbology
...\exercise03\results\sites.lyr



Viewshed ModelBuilder Exercise

Ex04

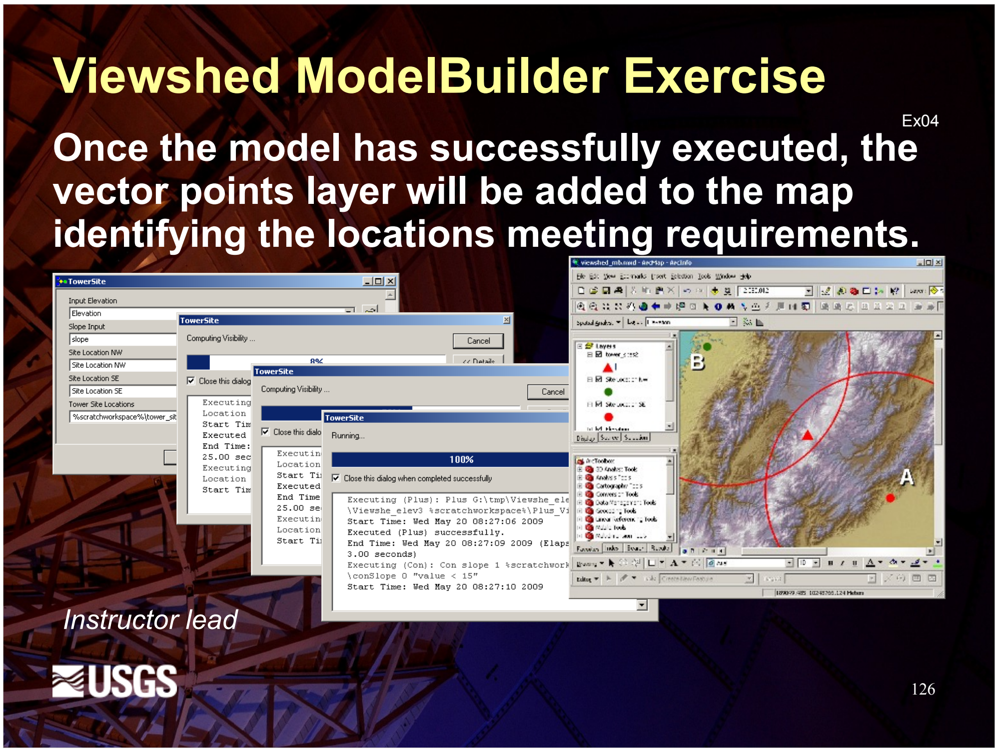
- Open the TowerSite model in the Run mode by double clicking the model icon in toolbox or right click on the icon and select the "Open" option.
- Confirm that the input and output information is accurate.
- Click the OK button to execute the model.



Instructor lead

USGS

Discuss the concept of using deferent datasets or changing output locations.



Discuss the LOF between the two procedures.

The Raster calculator is better for one-off analysis

ModelBuilder is a better environment for a repeated process or an application that may require detailed documentation.

Viewshed ModelBuilder Exercise

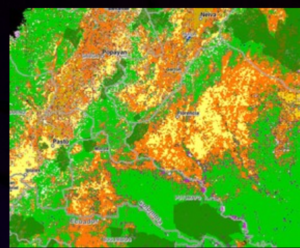
Questions?

Next Exercise: Vulnerability ModelBuilder Exercise

Vulnerability ModelBuilder Exercise

Ex05

- **Protected Area Vulnerability Exercise**
- **Question:** Recent activity in the region covering Colombia and Ecuador's border suggests an expansion of intensive agriculture into the closed tropical evergreen forest. The areas of highest vulnerability are southern facing slopes with a slope of between 0 and 10 degrees between the elevation of 1000 m and 2000 m. Your task is to identify these vulnerable areas within the protected areas of this region.

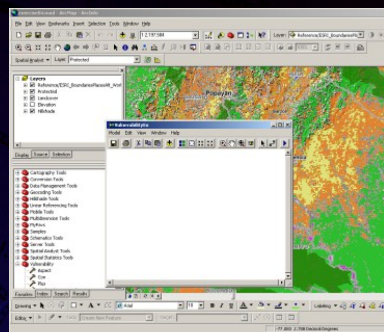


Instructor lead

Vulnerability ModelBuilder Exercise

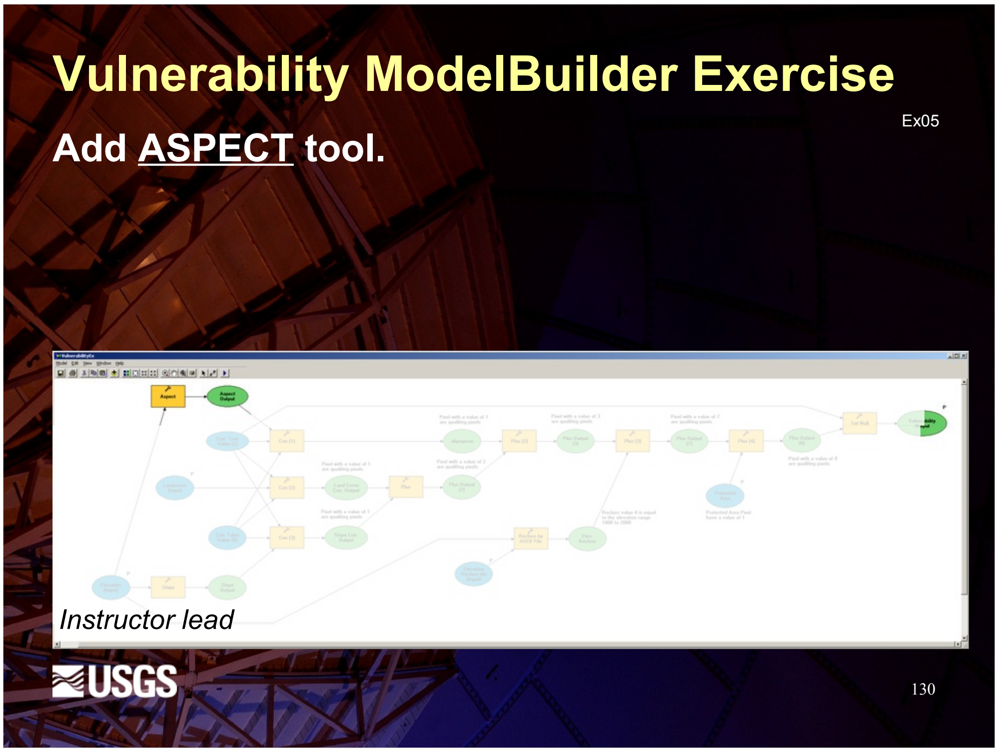
Ex05

- **Open** .../exercise04/exerise04.mxd.
- **Open Toolbox in ArcMap.**
- **Expand the Vulnerability toolset.**
- **Open the VulnerabilityEx model in edit mode.**



Instructor lead

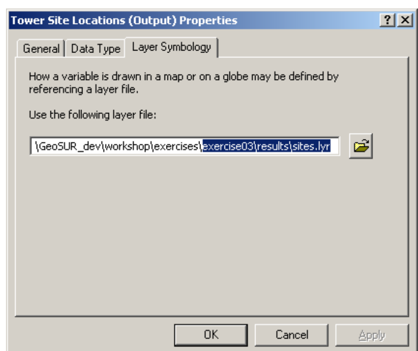
USGS

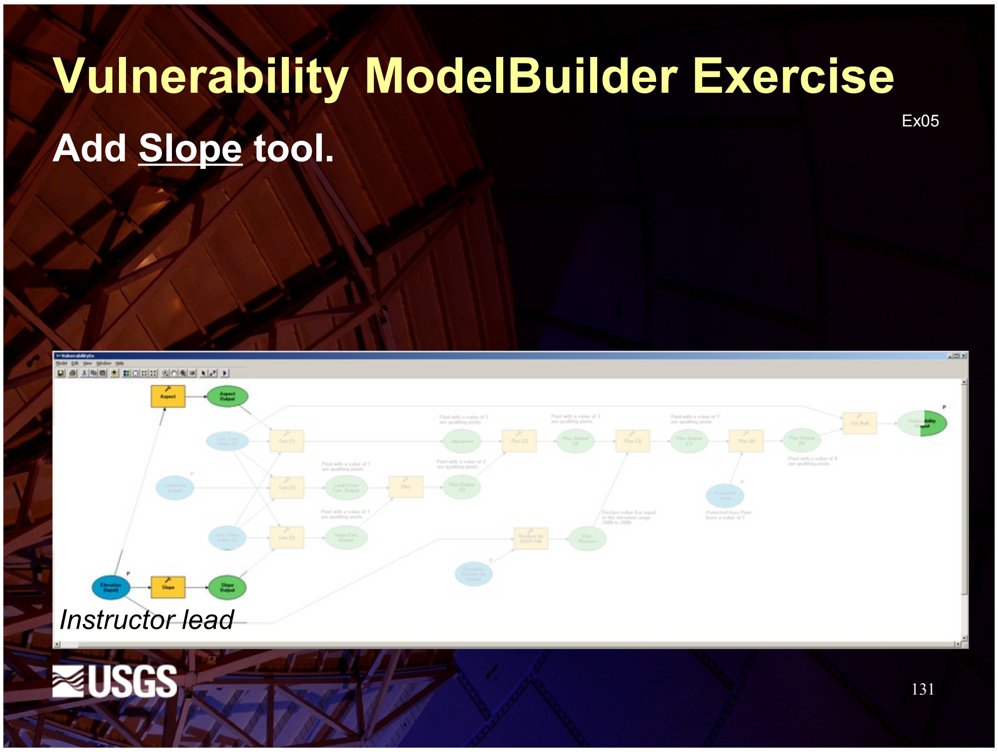


Once the model is built walk through SETTING the input and output parameter definitions!

Discuss the concept of **Model Parameters**, **Managed**, **Intermediate** data types

Show the option to set the output layer symbology
...\exercise03\results\sites.lyr



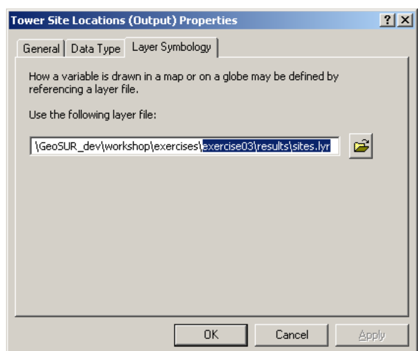


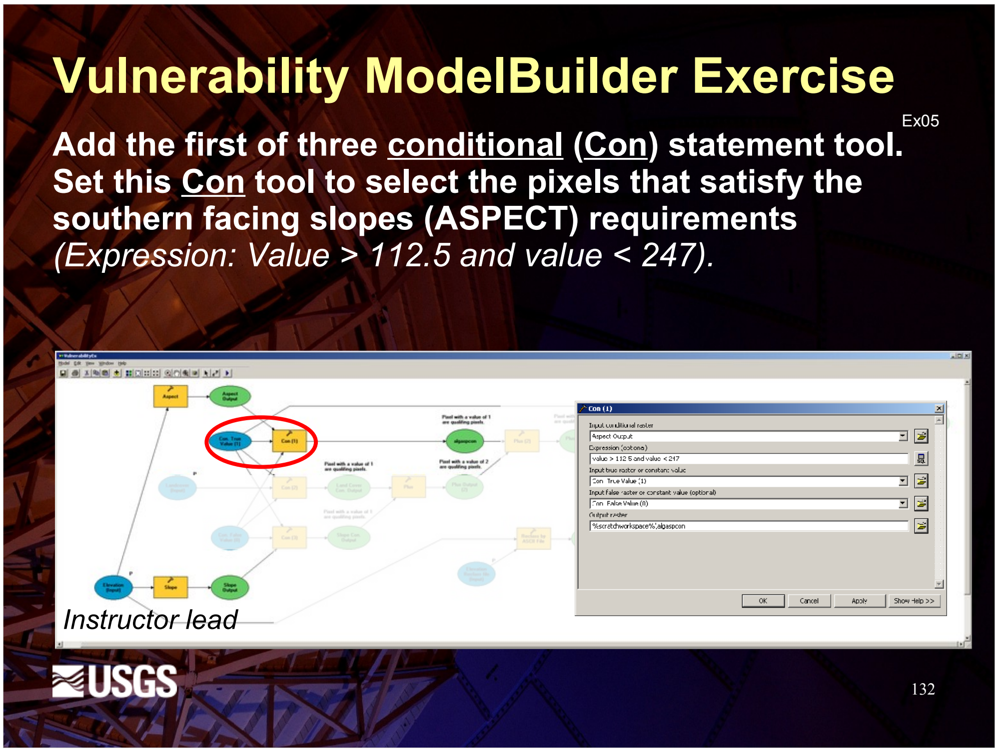
Once the model is built walk through SETTING the input and output parameter definitions!

Discuss the concept of **Model Parameters**, **Managed**, **Intermediate** data types

Show the option to set the output layer symbology

...\exercise03\results\sites.lyr

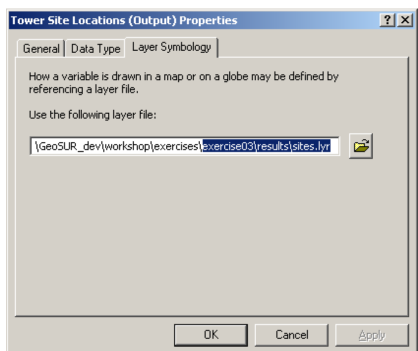


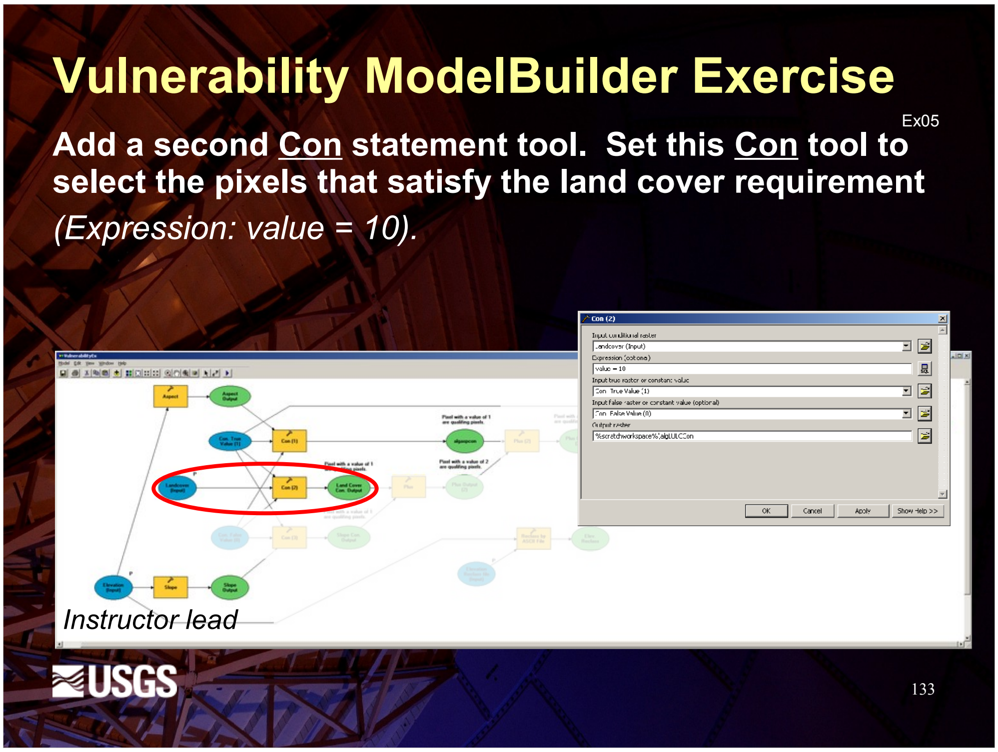


Once the model is built walk through SETTING the input and output parameter definitions!

Discuss the concept of **Model Parameters**, **Managed**, **Intermediate** data types

Show the option to set the output layer symbology ...\exercise03\results\sites.lyr

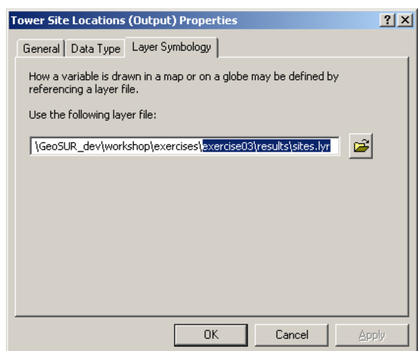


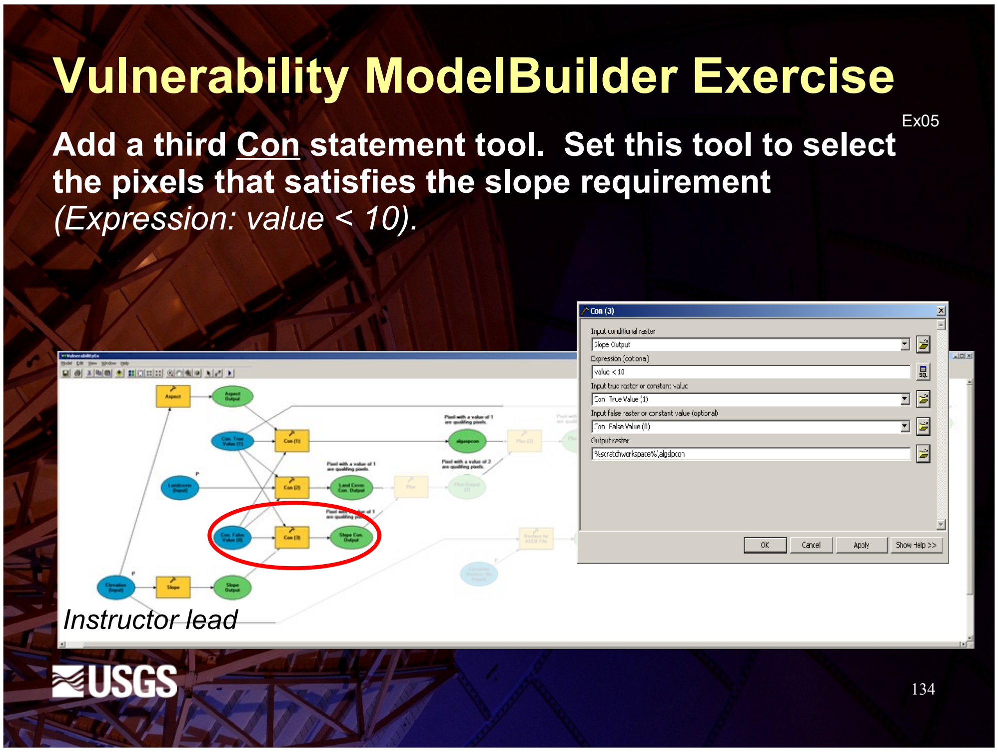


Once the model is built walk through SETTING the input and output parameter definitions!

Discuss the concept of **Model Parameters**, **Managed**, **Intermediate** data types

Show the option to set the output layer symbology
...\exercise03\results\sites.lyr



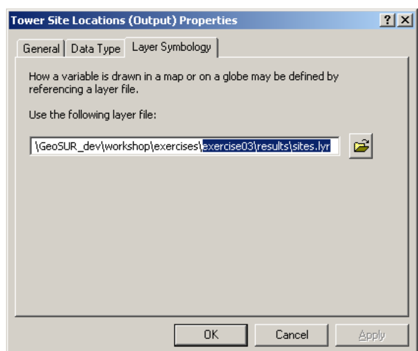


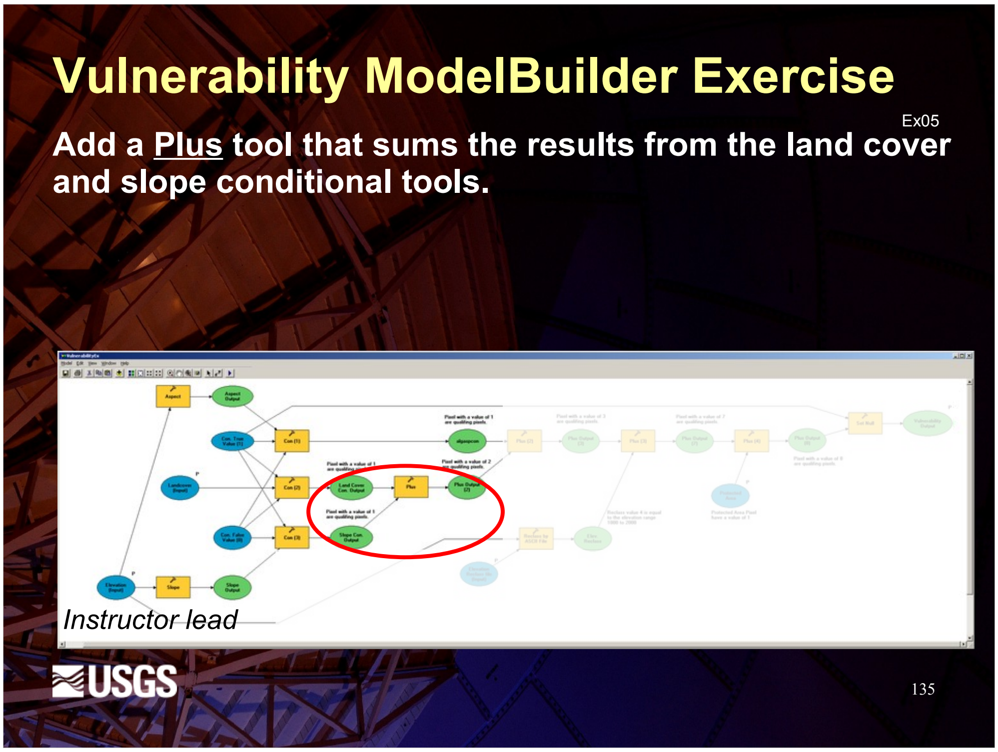
Once the model is built walk through SETTING the input and output parameter definitions!

Discuss the concept of **Model Parameters**, **Managed**, **Intermediate** data types

Show the option to set the output layer symbology

...\exercise03\results\sites.lyr

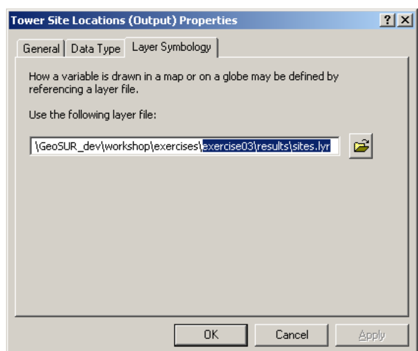


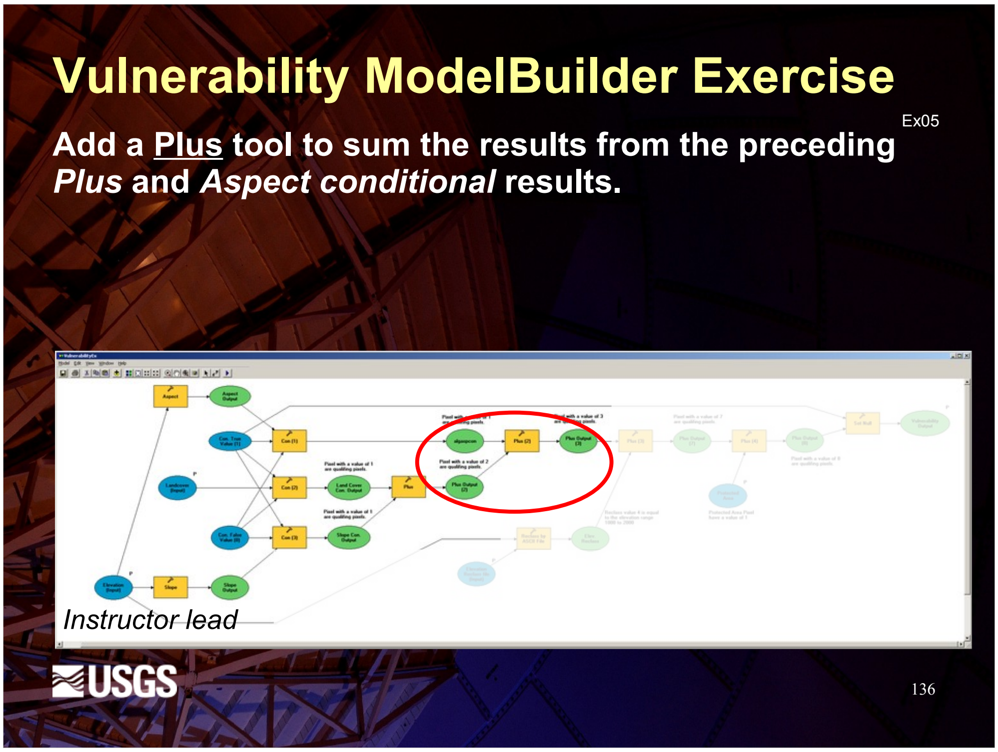


Once the model is built walk through SETTING the input and output parameter definitions!

Discuss the concept of **Model Parameters**, **Managed**, **Intermediate** data types

Show the option to set the output layer symbology ...\exercise03\results\sites.lyr



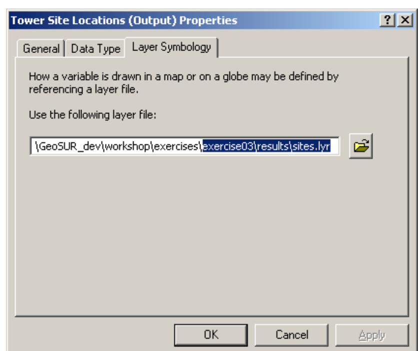


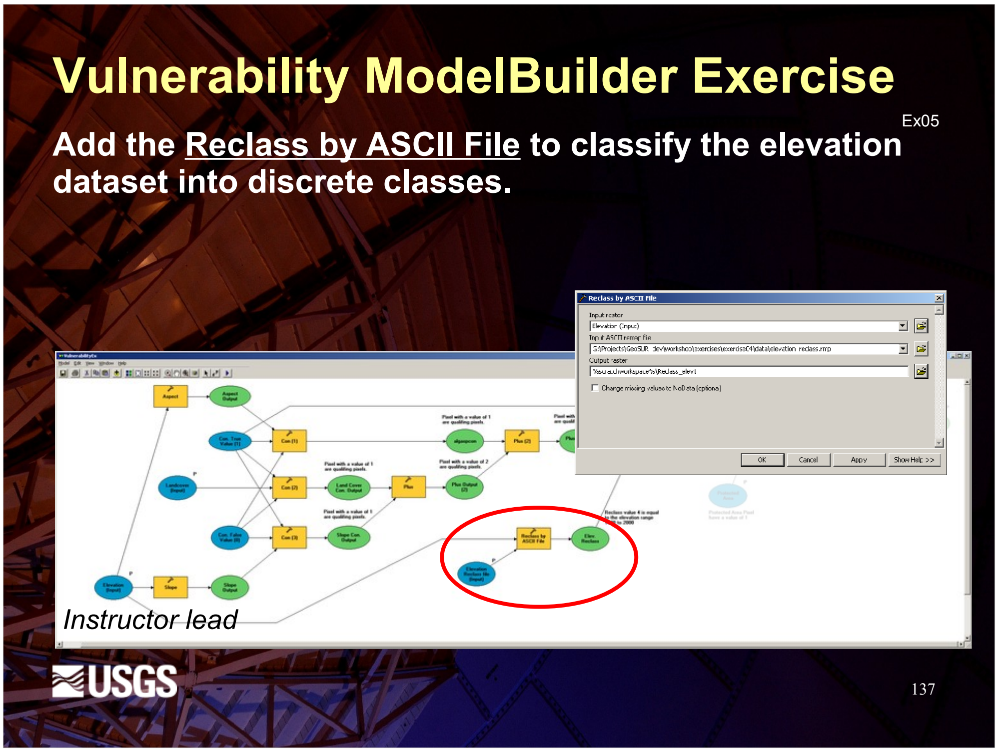
Once the model is built walk through SETTING the input and output parameter definitions!

Discuss the concept of **Model Parameters**, **Managed**, **Intermediate** data types

Show the option to set the output layer symbology

...\exercise03\results\sites.lyr



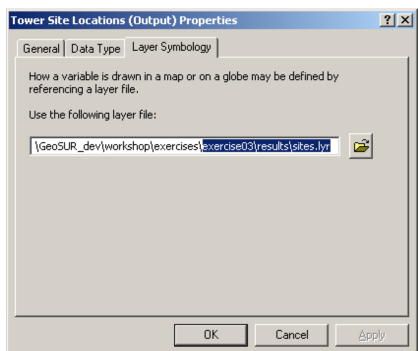


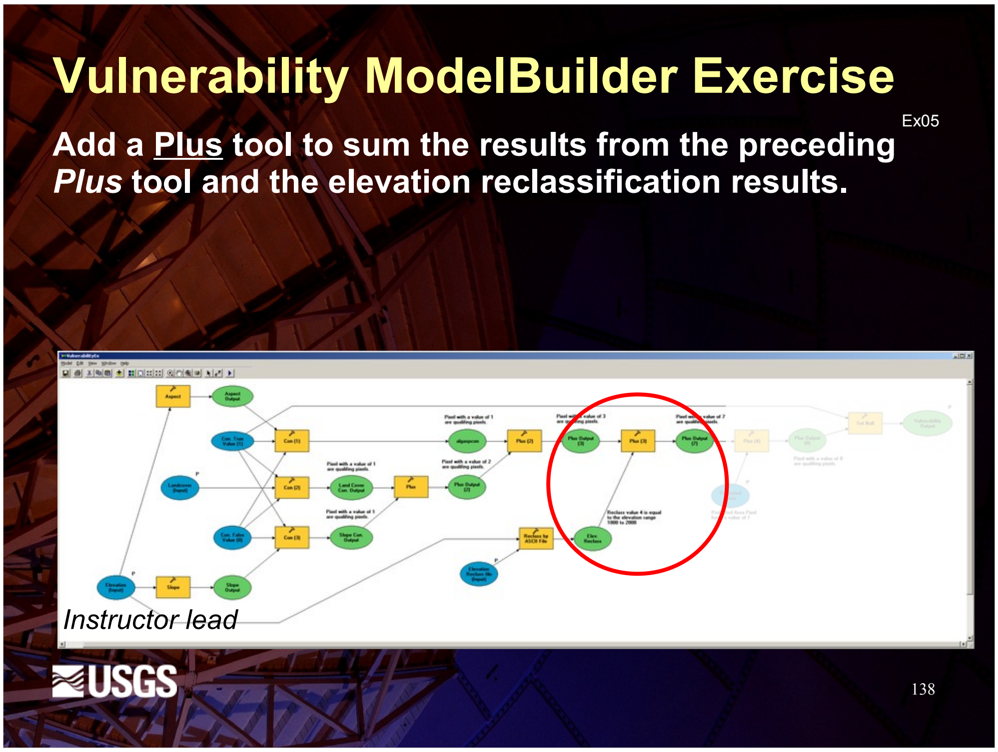
Once the model is built walk through SETTING the input and output parameter definitions!

Discuss the concept of **Model Parameters**, **Managed**, **Intermediate** data types

Show the option to set the output layer symbology

...\exercise03\results\sites.lyr

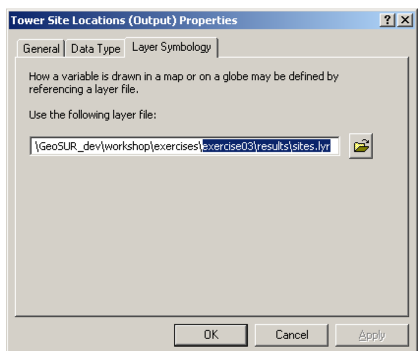


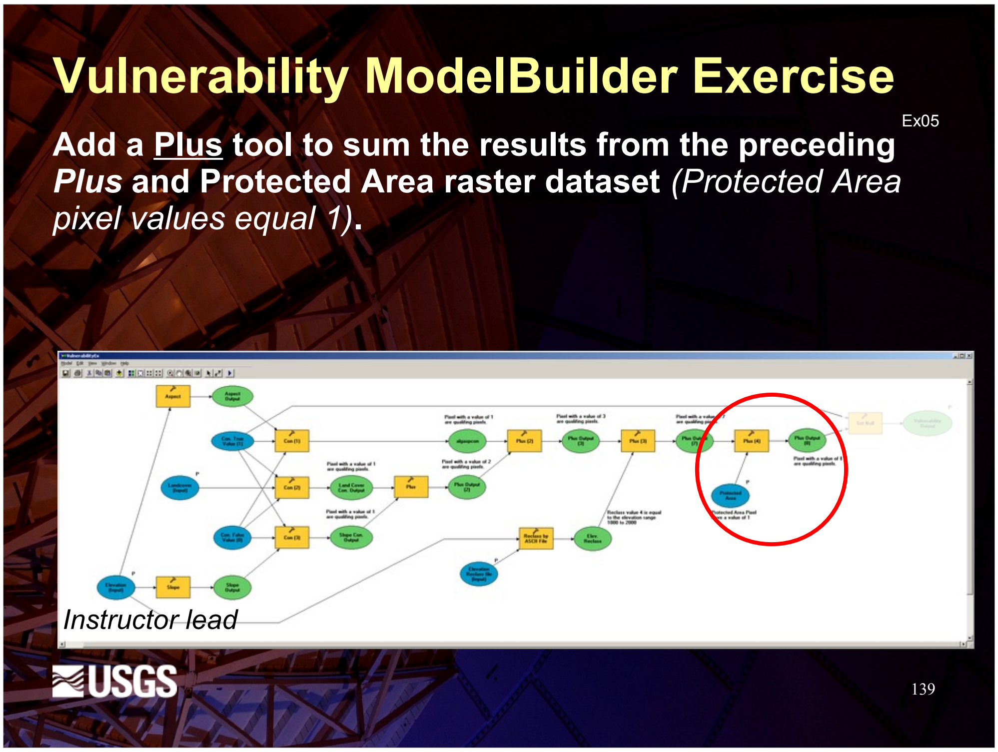


Once the model is built walk through SETTING the input and output parameter definitions!

Discuss the concept of **Model Parameters**, **Managed**, **Intermediate** data types

Show the option to set the output layer symbology ...\exercise03\results\sites.lyr



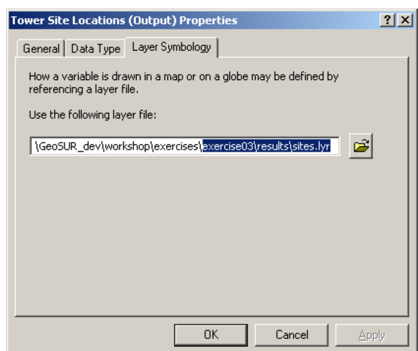


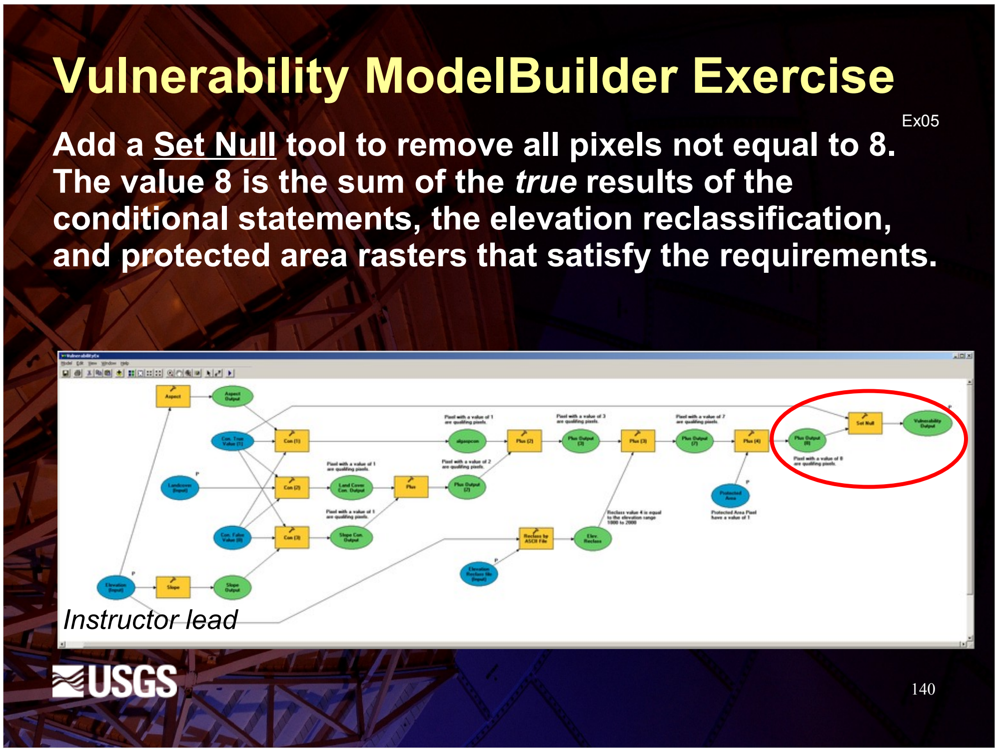
Once the model is built walk through SETTING the input and output parameter definitions!

Discuss the concept of **Model Parameters**, **Managed**, **Intermediate** data types

Show the option to set the output layer symbology

...\exercise03\results\sites.lyr

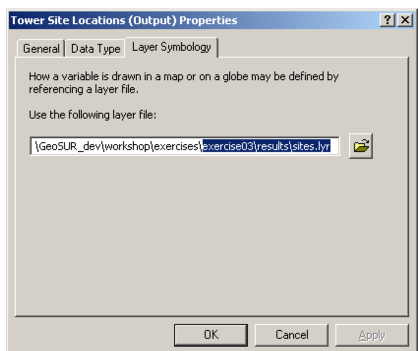


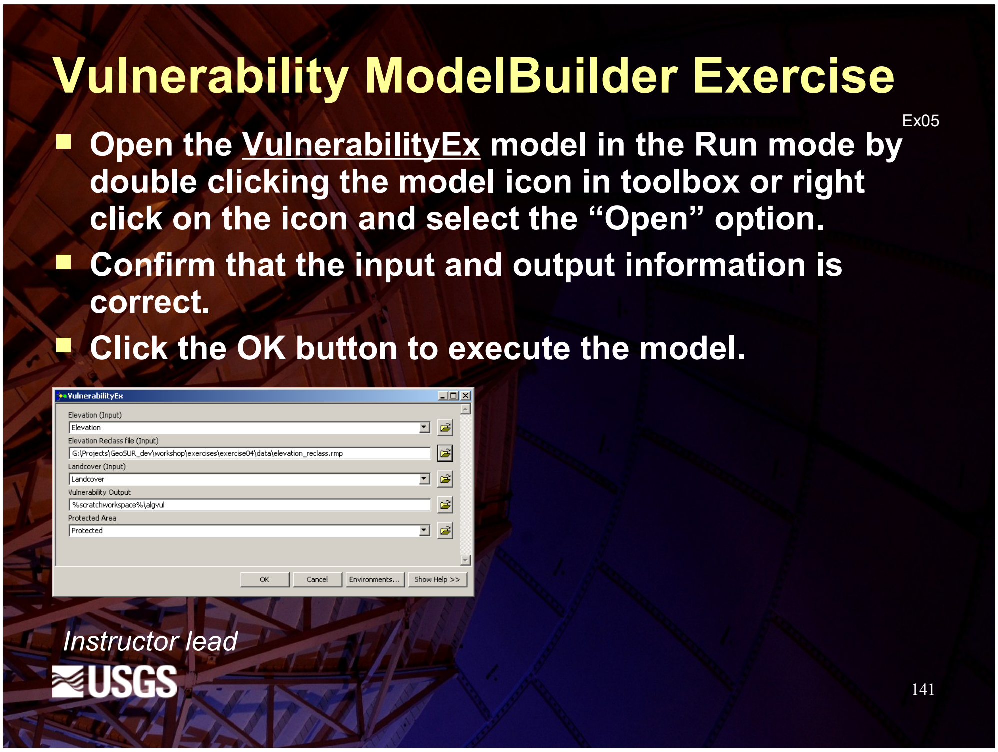


Once the model is built walk through SETTING the input and output parameter definitions!

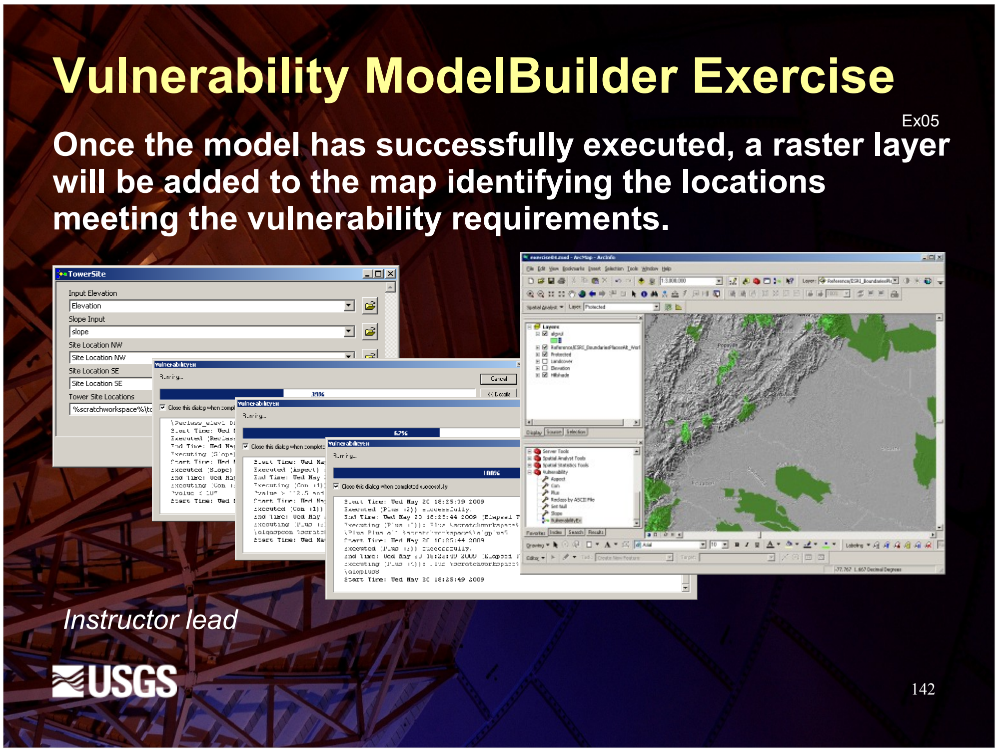
Discuss the concept of **Model Parameters**, **Managed**, **Intermediate** data types

Show the option to set the output layer symbology ...\exercise03\results\sites.lyr





Discuss the concept of using deferent datasets or changing output locations.



Discuss the LOF between the two procedures.

The Raster calculator is better for one-off analysis

ModelBuilder is a better environment for a repeated process or an application that may require detailed documentation.

Vulnerability ModelBuilder Exercise

Questions?

Next Exercise: Generating hydrological derivatives from the SRTM Level-1 (90 m) Dataset

USGS

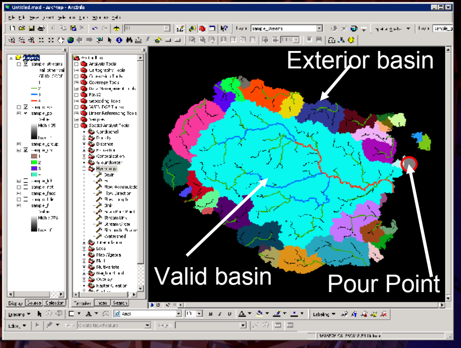
Hydrological Derivative Development

- **After completing this exercise, participants should:**
  - Understand how hydrological derivative products can be developed for GeoSUR project.
  - Be familiar with ESRI’s ArcGIS Toolsets and Models.
  - Have a general understanding of simple hydrology modeling.

Hydrological Derivative Development

Ex06

- **Review Results**
- Review valid basins and exterior basins
- Pour point location



USGS

Hydrological Derivative Development

Questions?

Next Exercise: Drainage Basin delineation from SRTM Level-2 Derivatives

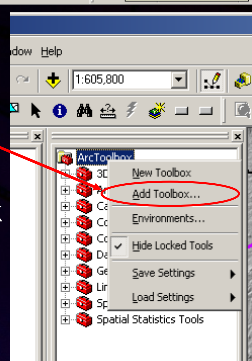
Drainage Basin Delineation

Ex07

Adding a Toolset to ArcGIS Toolbox.

- In ArcMap click on the Show/Hide ArcToolbox Window button.
- Select the ArcToolbox item at the top of the list. Right click the mouse and select the "Add Toolbox…" option.
- In the Add Toolbox browse dialog, navigate to "…\exercise07\srtm_derivative_exercise_gdb.mdb" and select "SRTM_Derivative_Toolset" then click "Open".
- This will add the selected toolset into the ArcToolbox catalog.

Instructor lead



USGS

Drainage Basin Delineation

Questions?

Next Exercise: Access and use GeoSUR GP Web Services

USGS

Accessing GeoSUR Web Services

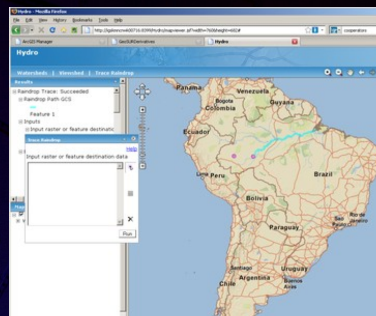
- Access GeoSUR Geoprocessing (GP) Web Service
  - Web browser interface
    - www.geosur.info
  - Google Earth
  - ArcGIS Explorer
    - Loading Map Layer
    - Access GP tool
  - ArcGIS Desktop application
    - ArcCatalog
    - ArcMap
    - Python

USGS

Accessing GeoSUR Web Services

GeoSUR Web Browser Exercise

1. Open a web browser and navigate to the GeoSUR GP services page (www.geosur.info/).
2. Click the Rain Drop tool
3. Provide the appropriate input
4. Execute the tool
5. Review Results



USGS

Need web address from Michelle!!!!!!
www.geosur.info/?????????????????????????????????????

Accessing GeoSUR Web Services

Load Map Service into Google Earth (GE)

1. Determine available **KML** services from GeoSUR's ArcGIS Services Directory
2. (http://www.geosur.info/ArcGIS/rest/services)
3. Choose a Google Earth (KML) service from the directory and load it into GE.

USGS

Accessing GeoSUR Web Services

Loading Map Services into ArcGIS Explorer

1. Determine available **map** services from GeoSUR's ArcGIS Services Directory
2. (http://www.geosur.info/ArcGIS/rest/services)
3. Choose a service from the directory and load that service into ArcGIS Explorer's Toolbox.

USGS

Accessing GeoSUR Web Services

ArcGIS Explorer GP Services Exercise

1. Determine available GP services from GeoSUR's ArcGIS Services Directory in a Web browser.
2. (http://www.geosur.info/ArcGIS/rest/services)
3. Choose a service from the directory and load that service into ArcGIS Explorer's Toolbox.
4. Execute that service in ArcGIS Explorer.

USGS

Accessing GeoSUR Web Services

Loading Map Service into ArcMap

1. Open ArcCatalog and connect to GeoSUR ArcGIS Server (www.geosur.info/arcgis/services).
2. Connect to the service as a <u>user</u>, not as a <u>manager</u>.
3. Close ArcCatalog
4. Open ArcMap and load both the maps/iirsa and maps/iirsa_cache layers into a data-frame.
5. Determine the difference between the two layers.
6. ***NOTE***: *DON'T close ArcMap when you are finished*

Accessing GeoSUR Web Services

Loading GP Service into ArcMap

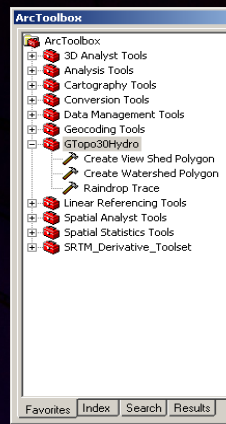
1. In the current ArcMap session, open the ArcToolbox.
2. In ArcToolbox, open the “Add Toolbox...” dialog.
3. Within the dialog, navigate to the GIS Servers folder and open the “www.geosur.info” connection.
4. Once connected, open the Models folder and add the Gtopo30Hydro toolset.

USGS

Accessing GeoSUR Web Services

Loading GP Service into ArcMap

1. With ArcToolbox, locate the newly add “GTopo30Hydro” toolset and open the Raindrop Trace tool.
2. Provide the appropriate inputs and execute.
3. Open the Create Watershed Polygon tool.
4. Provide the appropriate inputs and execute.
5. Examine the result from both tools.



Accessing GeoSUR Web Services

Advanced Web Service Demonstrations

1. Exploring the GP Web service Viewshed tool.
2. Exploring tools available in the **GeoSUR_Derivatives** Web service.
3. Incorporating GP Web services into local GP Models using ModelBuilder.
4. Accessing GP Web services in Python.
5. Basic image format conversion.
6. Requests from the audience.

USGS

References

ESRI, 2009a: ArcGIS 9.3 Desktop Help: An overview of Spatial Analyst Toolsets and Tools, http://webhelp.esri.com/arcgisdesktop/9.3/index.cfm TopicName=An_overview_of_Spatial_Analyst_Toolsets_and_Tools (version 22 May 2009)

ESRI, 2009b: ArcGIS Server 9.3 Help: Components of an ArcGIS Server system http://webhelp.esri.com/arcgisserver/9.3/dotNet/index.htm#components_of_server.htm (version 22 May 2009)

ESRI, 2009c: ArcGIS Desktop: Which GIS Software Is Right For You http://www.esri.com/software/arcgis/about/gis_for_me.html (version 22 May 2009)

ESRI, 2009d: ArcGIS Server REST API - Overview: http://resources.esri.com/help/9.3/arcgisserver/apis/rest/index.html (version 22 May 2009)

ESRI, 2009e: GIS Dictionary: http://support.esri.com/index.cfm?fa=knowledgebase.gisDictionary.search&searchTerm=z-factor (version 22 May 2009)

ESRI, 2009f: An overview of geoprocessing with ArcGIS Server http://webhelp.esri.com/arcgisdesktop/9.3/body.cfm?tocVisable=1&ID=1120&TopicName=An%20ove # (version 22 May 2009)

ESRI, 2009g: Image services http://webhelp.esri.com/arcgisserver/9.3/dotNet/index.htm#image_service.htm (version 22 May 2009)

USGS

References

ESRI, 2009h: Map services http://webhelp.esri.com/arcgisserver/9.3/Java/index.htm#map_service.htm (version 22 May 2009)

ESRI, 2009i: An overview of the geodatabase http://webhelp.esri.com/arcgisdesktop/9.3/index.cfm?TopicName=An_overview_of_the_geodatabase (version 2 June 2009)

Farr, T. G., et al. (2007), The Shuttle Radar Topography Mission, Rev. Geophys., 45, RG2004, doi:10.1029/2005RG000183. P 21- 22.

Grohman, Greg, Kroenung, George and Strebeck, John, (2006): Filling SRTM Voids: The Delta Surface Fill Method: Photogrammertric Engineering & Remote Sensing, v. 72, no. 3, p 213 – 217.

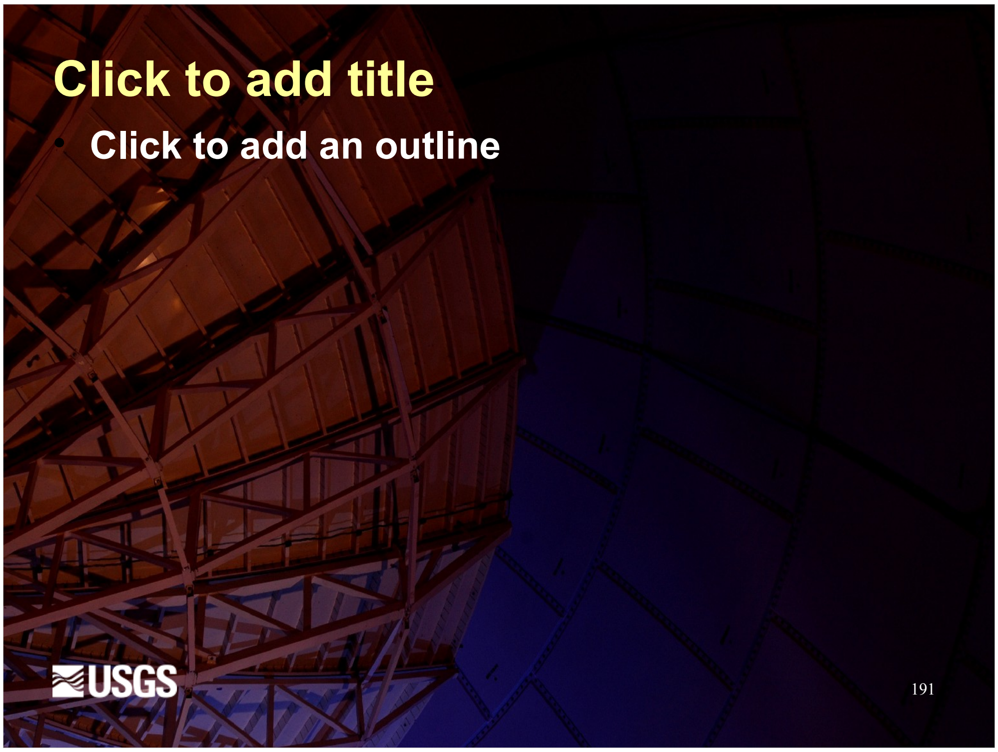
Maples, S. 2007, Classic Cartographic Techniques in ArcMap, Yale University Library Available on-line: (version 14 May 2009)

Pierce, L., Kellndorf, J., Walker, W., and Barros, O., Evaluation of the Horizontal Resolution of SRTM Elevation Data: Photogrammetric Engineering and Remote Sensing, v. 72, no. 11, p 1235 - 1244

Valeriano, M. M., Kuplich, T. M., Storino, M, Amaral, B. D., Medes Jr., J. N, and Lima, D. J., 2005, Modeling small watersheds in Brazilian Amazoia with shuttle radar topographic mission-90 m data: Computers and Geosciences, v. 32, p. 1169 – 1181.

Guth, P. L. 2006, Geomorphometry from SRTM: Comparison to NED: Photogrammetric Engineering and Remote Sensing, v. 72, no. 3, p 269 – 277.

W3C, 2009: Web Services Glossary: http://www.w3.org/TR/ws-gloss/ (version 22 May 2009)


Click to add title
• Click to add an outline
191