Using ArcGIS as a Scientific Data Platform

- Feroz Kadar
- Sudhir Raj Shrestha
Topics

- Introduction
- Ingesting and managing
- Visualizing and analyzing
- Disseminating and consuming
- The road ahead
Scientific Data

Oceanographic
- Salinity
- Sea Temperature
- Ocean current

Meteorological
- Temperature
- Humidity
- Wind speed/direction

Terrestrial
- Soil moisture
- NDVI
- Land cover
Challenges

Manage

variety of formats
volume & velocity
redundancy

Analyze

portability
scalability
reproducibility

Share

integration
standards
accessibility
Multidimensional Rasters

- Gridded
- Multidimensional
- Multivariate
Demo

Using data & information products in a WebGIS
Ingesting and Managing Data
Multidimensional Mosaic Dataset

Representing multivariate collection of multidimensional rasters in ArcGIS
### Tabular View

<table>
<thead>
<tr>
<th>Raster</th>
<th>Shape</th>
<th>Variable</th>
<th>StdTime</th>
<th>StdZ</th>
</tr>
</thead>
<tbody>
<tr>
<td>...</td>
<td>...</td>
<td>Temperature</td>
<td>3/22/2016</td>
<td>-10</td>
</tr>
<tr>
<td>...</td>
<td>...</td>
<td>Temperature</td>
<td>3/23/2016</td>
<td>-10</td>
</tr>
<tr>
<td>...</td>
<td>...</td>
<td>Temperature</td>
<td>3/24/2016</td>
<td>-10</td>
</tr>
<tr>
<td>...</td>
<td>...</td>
<td>Salinity</td>
<td>3/22/2016</td>
<td>-10</td>
</tr>
<tr>
<td>...</td>
<td>...</td>
<td>Salinity</td>
<td>3/23/2016</td>
<td>-10</td>
</tr>
<tr>
<td>...</td>
<td>...</td>
<td>Salinity</td>
<td>3/24/2016</td>
<td>-10</td>
</tr>
<tr>
<td>...</td>
<td>...</td>
<td>Temperature</td>
<td>3/22/2016</td>
<td>-20</td>
</tr>
<tr>
<td>...</td>
<td>...</td>
<td>Temperature</td>
<td>3/23/2016</td>
<td>-20</td>
</tr>
<tr>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
</tbody>
</table>

*Tabular view of items in a multivariate multidimensional mosaic dataset*
Metadata

- Variables
- Dimensions
- Values
- Statistics

Describing the structure of a multivariate multidimensional mosaic dataset
Raster Types

Format-agnostic direct ingestion of rasters into a mosaic dataset

data on disk → raster type → mosaic dataset

- netCDF
- HDF
- GRIB
- d-aware rasters

- crawls disk
- identifies rasters
- extracts metadata
- attaches processing

- stores no pixels
- references rasters
- stores processing & metadata
Geoprocessing

· Tools—building blocks for managing data

· Data Management > Raster > Mosaic Dataset

· Intuitive UI for interactive workflows

· ModelBuilder: composite operations

· Python: automate or extend

Managing a mosaic dataset
Demo

Make a netCDF raster layer
Demo

- Make a netCDF raster layer
- Populate a mosaic dataset using a raster type
- Properties of a multidimensional mosaic dataset
- Attribute table of a mosaic layer
Make your mosaic dataset accessible to other users as a web-enabled dynamic image service
Visualizing and Analyzing
Filtering

variables
value range(s) per dimension
SQL WHERE clause
dimension-orthogonal cutting & chopping

slicing & dicing a multivariate multidimensional mosaic dataset
Filtering in ArcMap

- netCDF raster layer properties
- Select by Dimension GP tool
- Multidimensional mosaic layer properties
Rendering
Rendering

- Choose and customize
- Scalar or vector field
- Export and reuse

Control how original or transformed data is presented on a map
Demo

Vector-field mosaic dataset
Multidimensional mosaic layer on map
Dimensional slicing & animation
Demo

Vector-field mosaic dataset
Multidimensional mosaic layer on map
Dimensional slicing & animation
Tool-based Analytic Models

Dengue - Aedes aegypti Exposure Model

... using Geoprocessing
Transforming Raster Data

- Using raster functions for on-the-fly processing
- Raster-valued transformation
  - Piecewise, scale-aware
  - Local / focal
  - On-demand processing
- Arity: unary, binary, ..., n-ary, polyadic

... using raster functions for on-the-fly processing
Chaining Raster Functions

... to compose a complex analytic model
Demo

Applying a simple transformation
Dimensional Aggregation

Multidimensional filtering followed by aggregation using a raster function

- Dimensional filtering
- Aggregating function
Extending Analytic Capabilities

Learn more at: github.com/Esri/raster-functions

Choose from dozens of built-in functions or implement your own algorithm using Python
Raster Models

A portable & reusable chain of raster functions
Raster Model: Grouping

Manage Processing Templates

Default Template

Windchill
A raster function template that computes windchill on the Fahrenheit scale given rasters representing wind-speed and temperature.

Edit Properties

Type: Item Group
Group Items By:
Group Field Name: Variable
Tag Field Name: StdTime
Definition Query:

Thumbnail:
Thumbnail not available
Demo

Combining variables using a raster model
Demo

Raster models on a mosaic dataset
Aggregating temporal slices
Difference of means
Applying a Raster Model

- Choose & customize a raster model
  - Mosaic dataset
  - Mosaic dataset item(s)

- Define & transmit a raster model
  - Image service

- Image layer on a desktop map

- Image service layer on a web map
Disseminating and Consuming
Disseminating professional geospatial analysts

multivariate multidimensional mosaic dataset

Server

Desktop  Web  Device

Online Content and Services

Apps

Access / Identity

Services
Dissemination Strategies

- Tiled map service
- Dynamic map service
- Dynamic image service
Sharing your data as an image

- Mosaic Dataset > Generate Tile Cache
- Avoid copying source image to ArcGIS Online
- Cache tiles generated using ArcGIS for Desktop
- Accessed via tiled map service

Enable access to a static representation of your data as a map service
Sharing your map

- File > Share As > Service
- Features overlaid on rasters
- Static vs Dynamic map service
- Multidimensional WMS
Sharing data & information products

- Mosaic Dataset > **Share As Image Service**
- Pixels & item metadata
- On-demand server-side processing
- Raster models: predefined or client-specified
- Multidimensional info, filtering, vector fields

*Enable access to a dynamic representation of your information product as an image service*
Demo

Publishing a multidimensional mosaic dataset
Consuming your services

- In any ArcGIS application or any WMS client

- In a web map
  - Identify web services driven by maps or datasets
  - Bring service layers into a web map

- In a map-based application
  - Configurable apps
  - Story Maps
  - Web AppBuilder
  - Custom web apps using ArcGIS API for JavaScript
Maps & Apps

Sea Level Rise and Storm Surge Effects on Energy Assets: New Orleans

Surge. Using the NCA Intermediate-High scenario in conjunction with NGAA data, the New Orleans area is projected to experience 2 feet of SLR by around 2050, and 6 feet of SLR by around 2100.

The following layers were created to show projected inundations. Click to view.

No Storm Surge
- 2 Feet of Sea Level Rise
- 6 Feet of Sea Level Rise

Category 1 Storm Surge
- 2 Feet of Sea Level Rise
- 6 Feet of Sea Level Rise

Category 5 Storm Surge
- 2 Feet of Sea Level Rise
- 6 Feet of Sea Level Rise

Assets

The New Orleans MSA includes more than 112 energy assets, which consist of electricity, petroleum and natural gas assets. For the purposes of this analysis, additional focus is placed on banker-energized assets.
What's going on in Oklahoma?

The Problem

According to the Oklahoma Geological Survey's earthquake catalog, there have been over 17,000 earthquakes in Oklahoma since 1842. Over 15,000 of these earthquakes were recorded after the beginning of 2008. The highest recorded earthquake magnitude was 5.6 on November 6, 2011 in Lincoln County near Prague, which destroyed 14 homes and injured two people (Nicks 2014). Today, roughly 15% of Oklahoma residents have earthquake insurance (Werts 2014). From 1978 through 2006, there were between zero and three earthquakes per year with a magnitude of three or greater (ESGS, 2013). Between 2008 and 2012, there was an average of one earthquake per week with a magnitude of at least three. From 2013 to 2014, this average increased from two earthquakes per week to two and a half earthquakes per day.
Maps & Apps

Chesapeake Bay Program and Region 3 of the U.S. Environmental Protection Agency

http://gis.chesapeakebay.net/air
https://www.govloop.com/resources/story-mapping-chesapeake
Demo

Using image service layers in ArcGIS Online map viewer
The Road Ahead

- **Python Raster Types**: extensible data ingestion
- **Raster processing models**: on GitHub and out-of-the-box
- **NetCDF, HDF, GRIB**: as raster products, raster layer, image service
- **Collection Processing**: scalable transformation of large sets of rasters
- **Raster Analytics**: distributed analysis and processing of imagery or rasters in a Web GIS

... with ArcGIS 10.5
Raster Analytics can power systems that need to execute spatial analysis and image processing models in a distributed and scalable environment. It is designed for users, developers, and system integrators.
GIS workflows that scale

... built for the characteristics of multidimensional scientific data
Please take our Survey
Your feedback allows us to help maintain high standards and to help presenters

Find your event in the Esri Events App

Find the session you want to review

Scroll down to the bottom of the session

Answer survey questions and submit