

How Can and Should Modern Geospatial Technologies be Taught and Learned?

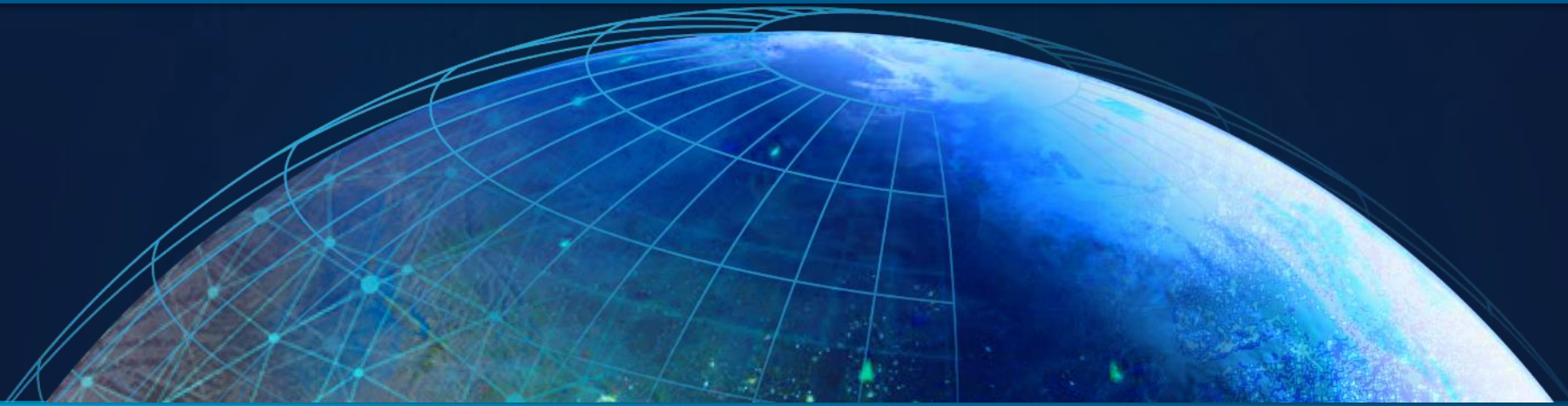
Joseph Kerski, PhD GISP
Esri and University of Denver

M [303 625 3925](tel:3036253925) | jkerski@esri.com | esri.com/education
<https://www.josephkerski.com> | Our Earth Video Channel: <https://esriurl.com/ourearth>



Objectives

1. What are “modern geospatial technologies”?
2. Why and how can you use modern geospatial technologies across the curriculum ?
3. Approaches, skills, and benefits to teaching with modern geospatial technologies.

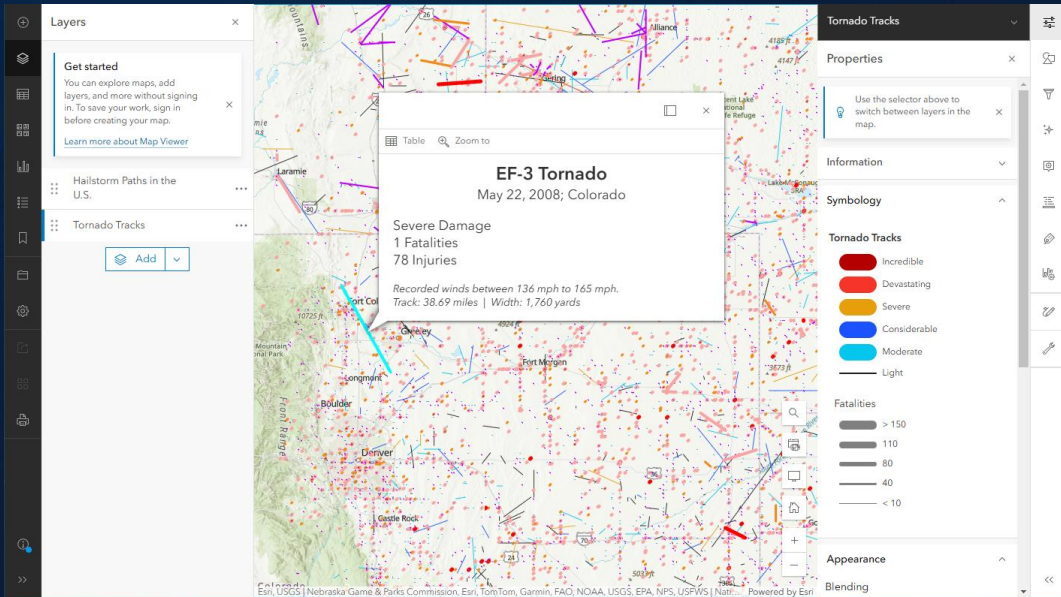


Threading throughout the session ...

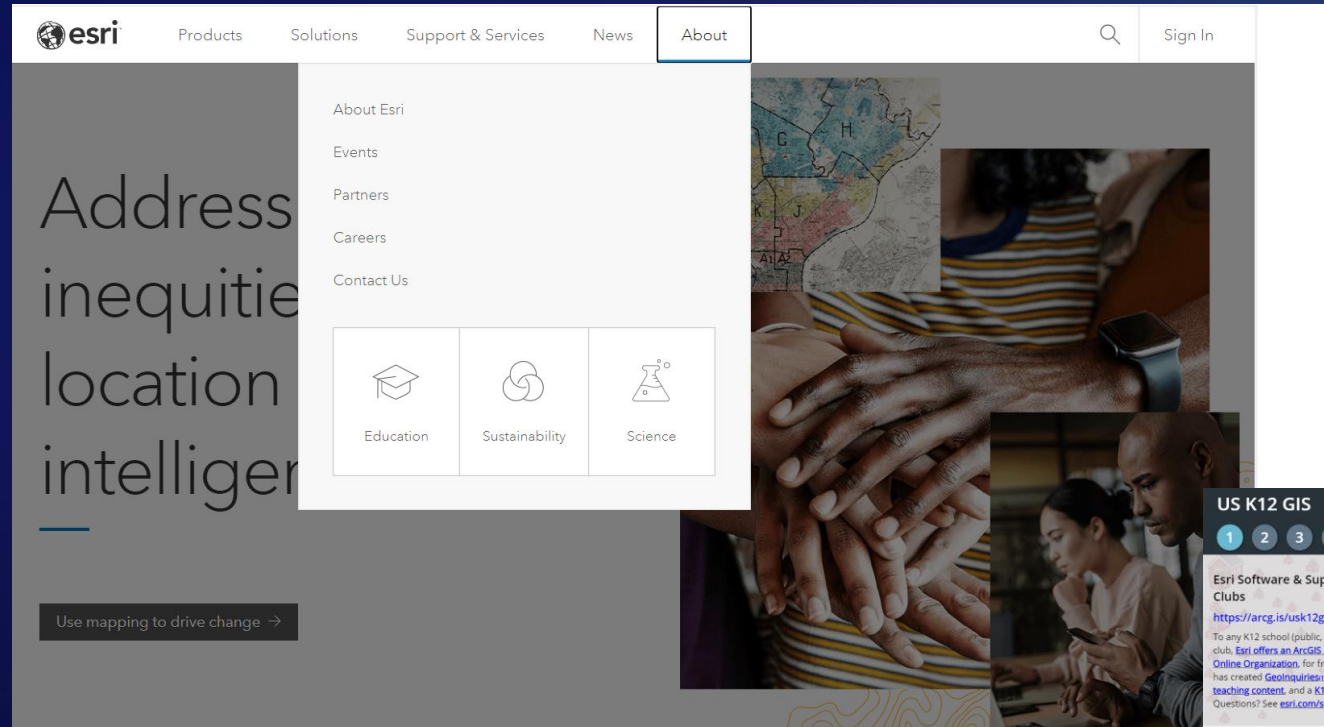


Why and how to teach and do research with modern geotechnologies?

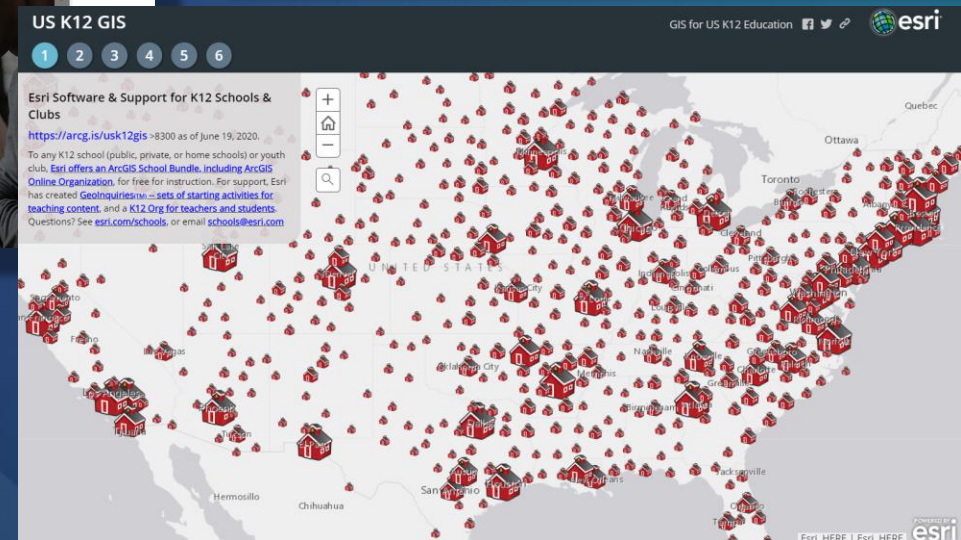
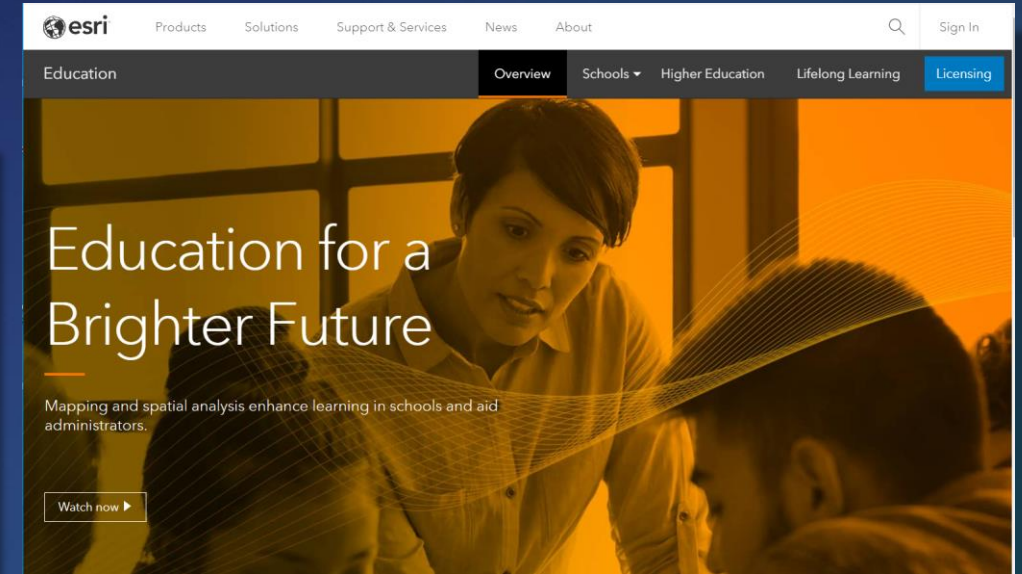
The higher, nobler goal: Not mapping, but understanding, and taking action.



Esri and the Education Program



Esri



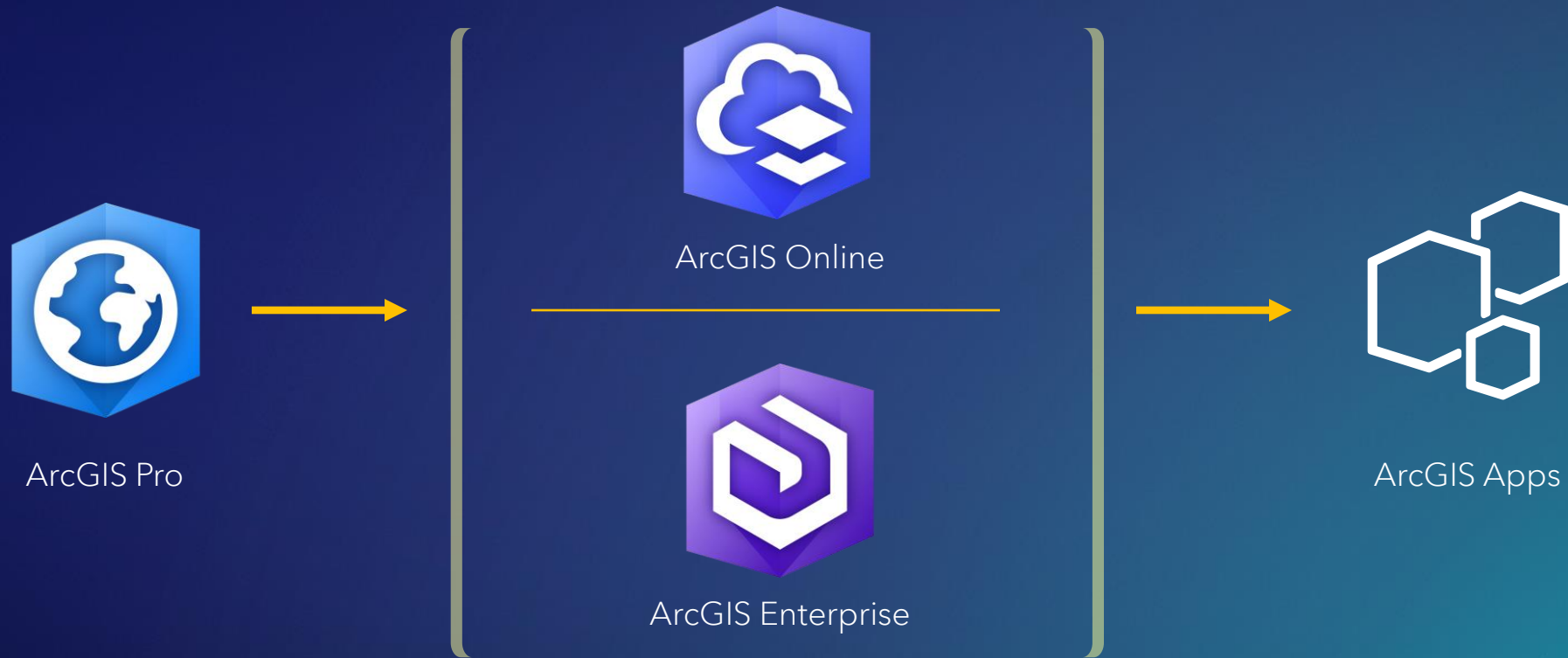
The Education Program



Software products	→	Platforms and APIs
2D	→	2D/3D/4D AR/VR
Client/server	→	Web Services and apps
Standalone desktop	→	Connected devices
Printed maps	→	Web maps, dashboards, other apps
Static data	→	Data services, live streams, big data
Custom applications	→	Interoperable packages, libraries
Single, all-purpose application	→	Focused apps
Proprietary data	→	Open Data & Shared Services
Using data created by others	→	Combining others' data with our own
Limited sharing	→	Many ways to share
Niche technology	→	Ties to larger IT community: GitHub
Some attention to societal concerns	→	Much attention to societal concerns
Mapping department	→	Integrated across the business

...GIS has changed.

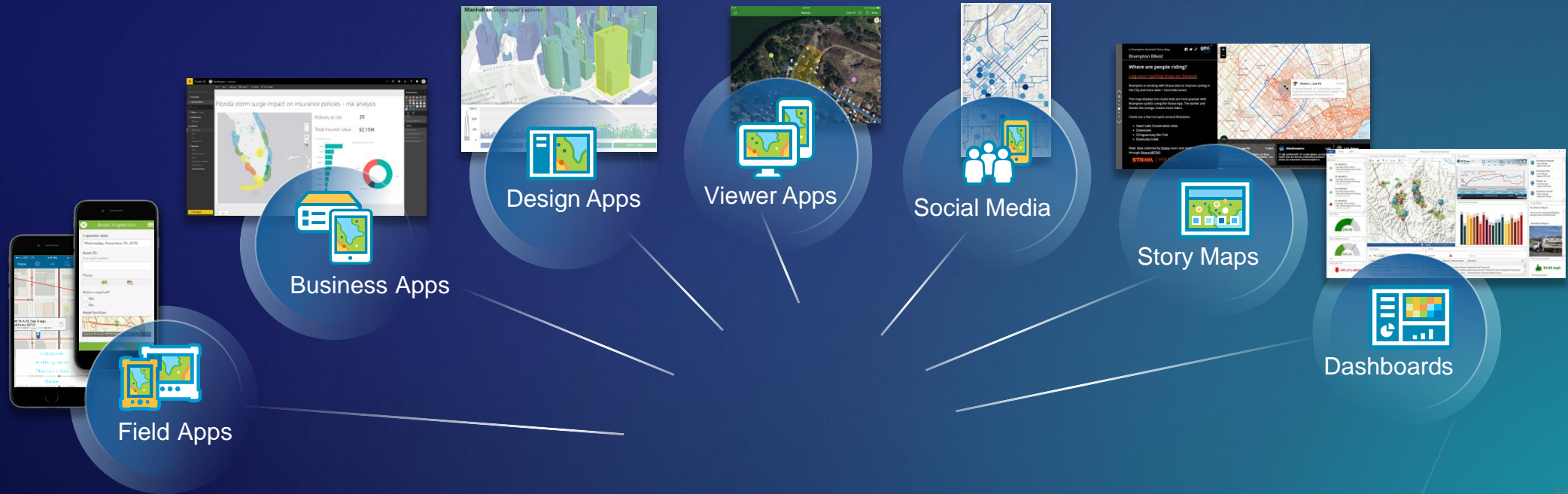
Modern GIS is web enabled: The Web GIS Paradigm



ArcGIS for Developers

ArcGIS Apps Bring the Power of Location to Everyone

Extending the Reach of GIS



Across Organizations and Beyond

Apps by theme

Focused, powerful, ready to use



Office



ArcGIS
Earth



Esri
CityEngine



Maps for
Office



Maps for
SharePoint



Insights
for ArcGIS



Esri Business
Analyst



GeoPlanner
for ArcGIS



ArcGIS Maps
for Adobe
Creative
Cloud



Operations
Dashboard
for ArcGIS



Field



Workforce
for ArcGIS



Navigator
for ArcGIS



Tracker
for ArcGIS



Survey123
for ArcGIS



Collector
for ArcGIS



Drone2Map
for ArcGIS



ArcGIS
Explorer



ArcGIS
QuickCapture

Why teach with GIS?

Learning objectives: critical thinking, spatial thinking, scale, systems thinking, permissions, communications, problem-based learning ...

Content objectives: population, crime, weather, hazards, watersheds, ecoregions, ocean currents ...

Geospatial objectives: Spatial analysis, databases, field methods, expressions, media fluency, classification, measurement ...



Ways to use GIS in education

1. As a teaching tool to teach content, concepts, and/or skills.

1a) Teach about GIS.



1b) Teach with GIS.

2. As a research tool for you and your students.



3. As a presentation and assessment tool.



My research: The implementation and effectiveness of GIS in education

Progress and challenges



The deeper goal



The wider goal

Taylor & Francis Online

Home ▶ All Journals ▶ The Geography Teac... ▶ List of Issues ▶ Volume 19, Issue 3 ▶ Online, Engaged Ins...

The Geography Teacher >
Volume 19, 2022 - Issue 3

1,002	8	3
Views	CrossRef citations to date	Altmetric

Articles

Online, Engaged Instruction in Geography and GIS Using IoT Feeds, Web Mapping Services, and Field Tools within a Spatial Thinking Framework

Joseph J. Kerski

Pages 93-101 | Received 15 Apr 2021, Accepted 12 Jul 2021, Published online: 25 Jul 2022

Cite this article <https://doi.org/10.1080/19338341.2022.2070520> Check for updates

Spatial Thinking | Spatial Analysis

Spatial Thinking:

“Identifying, analyzing, and understanding the location, scale, patterns, and trends of the geographic and temporal relationships among data, phenomena, and issues.” (Kerski)

Spatial Analysis:

“The process of examining the locations, attributes, and relationships of features in spatial data through overlay and other analytical techniques in order to address a question or gain useful knowledge. (Esri)

Spatial analysis extracts or creates new information from spatial data.

Spatial analysis is how we understand our world —mapping where things are, understanding how they relate, what it all means, and what actions to take.



Vocabulary

making PREDICTIONS



26. Predicting what-if.
25. Predicting where phenomena will move, flow, or spread.
24. Predicting how and where objects affect wave propagation.
23. Predicting how and where objects spatially interact (attraction and decay).
22. Interpolating a continuous surface and trends from discrete sample observations.
21. Finding the factors that explain observed spatial patterns and making predictions.
20. Given a success case, identifying, ranking, and predicting similar locations.

detecting and quantifying PATTERNS



19. Are spatial patterns changing over time?
18. Which features/pixels are similar, and how can they be grouped together?
17. What are the local, regional, and global spatial trends?
16. Where are the significant hot spots, anomalies, and outliers?

finding THE BEST LOCATIONS AND PATHS



15. Finding the best supply locations given known demand and a travel network.
14. Finding the best route, path, or corridor across open terrain.
13. Finding the best route, path, or flow along a network.
12. Finding the best allocation of resources to geographic areas.
11. Finding the best locations that satisfy a set of criteria.

determining HOW PLACES ARE RELATED



10. Determining overlapping relationships in space and time.
9. Determining what is visible from a given location(s).
8. Determining what is closest.
7. Determining and summarizing what is within an area(s).
6. Determining what is nearby or coincident.

measuring SIZE, SHAPE, AND DISTRIBUTION



5. Calculating geometries and distributions of feature collections.
4. Calculating individual feature geometries.

understanding WHERE



3. Understanding where and when things change.
2. Understanding where the variations and patterns in values are (comparative maps).
1. Understanding where things are (location maps).

The Language of

spatial ANALYSIS

how we understand our world—
mapping where things are,
how they relate, what it all means,
and what actions to take

- Ask questions
- Explore the data
- Analyze and model
- Interpret the results
- Repeat as necessary
- Present the results
- Make a decision

process

- Achieve objectives
- Improve program outcomes
- Reduce costs
- Avoid costs
- Increase efficiency and productivity
- Increase revenue
- Assure revenue
- Protect staff and citizens
- Support regulatory compliance
- Improve customer service
- Enhance customer satisfaction
- Enhance competitive advantage

benefits



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The Geographic Inquiry Process

1. Ask Geographic Questions

Repeat?



5. Act on Geographic Knowledge



4. Analyze Geographic Information



3. Explore Geographic Data



2. Acquire Geographic Resources



10 Essential GIS *skills*

Working with maps and layers | Creating and Sharing Map Content
Map Navigation | Symbology, classification, and filtering
Working with Attributes | Field Data
Drawing and Sketching | Creating Expressions
Creating web mapping applications | Performing Analysis

For more, see my [essay](#).



10 *Benefits* from teaching with GIS

Geographic and Scientific Inquiry

Spatial Thinking | Critical Thinking | PBL

Data Fluency | Community Connections

Field Work | Career Pathways

Content Knowledge | Students as Change Agents

For more, see my [essay](#).

Transactions in GIS



REVIEW ARTICLE | Open Access |

“GIS works!”—But why, how, and for whom? Findings from a systematic review

Uwe Schulze

First published: 24 November 2020 | <https://doi.org/10.1111/tgis.12704> | Citations: 6

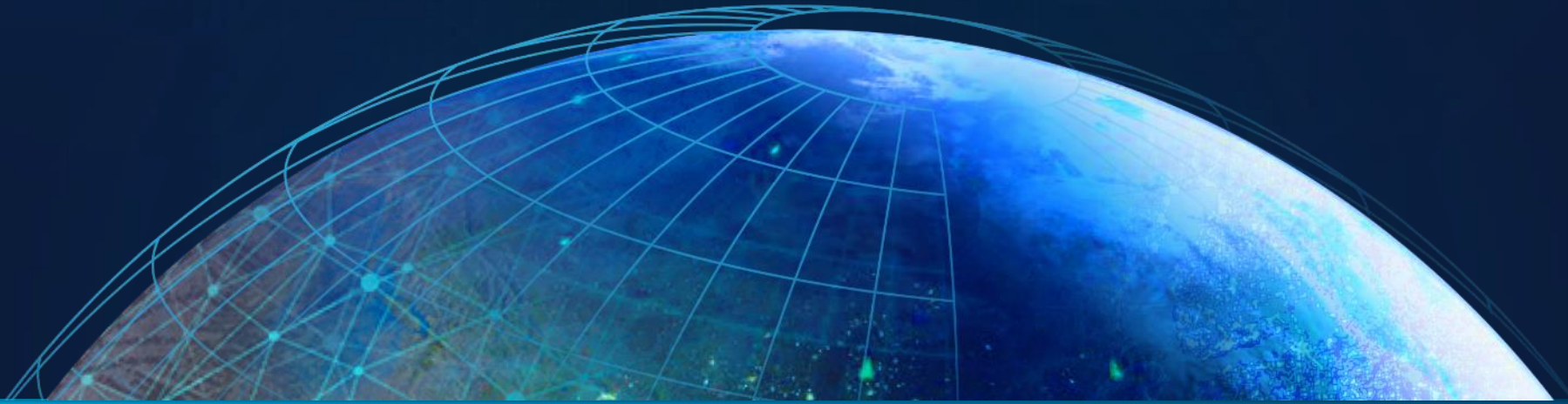
10 Strategies for teaching with GIS

Anchored | Holistic | Focused | Multiscale | Interesting

Relevant | Field-based | Multi-level | Visionary

> So that students can shine, explore, and grow.

For more, see my [essay](#).



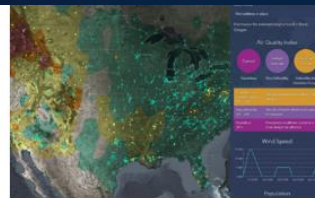
Selected Instructional Methods and Tools

1. ArcGIS Living Atlas of the World Apps.

Water Balance, Wayback Imagery, Sentinel-2 Land Cover, Ecological Marine Units, Wildfire Aware, Landsat Explorer, and more.



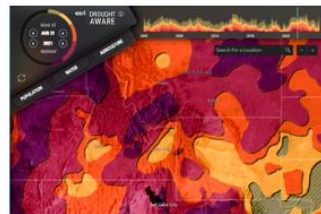
Wildfire Aware



Air Quality Aware



Hurricane Aware



Drought Aware



Sentinel-2 Land Cover Explorer



Landsat Explorer



Sentinel-1 Explorer



World Imagery Wayback App



Historical Topo Map Explorer

2. Story Maps:

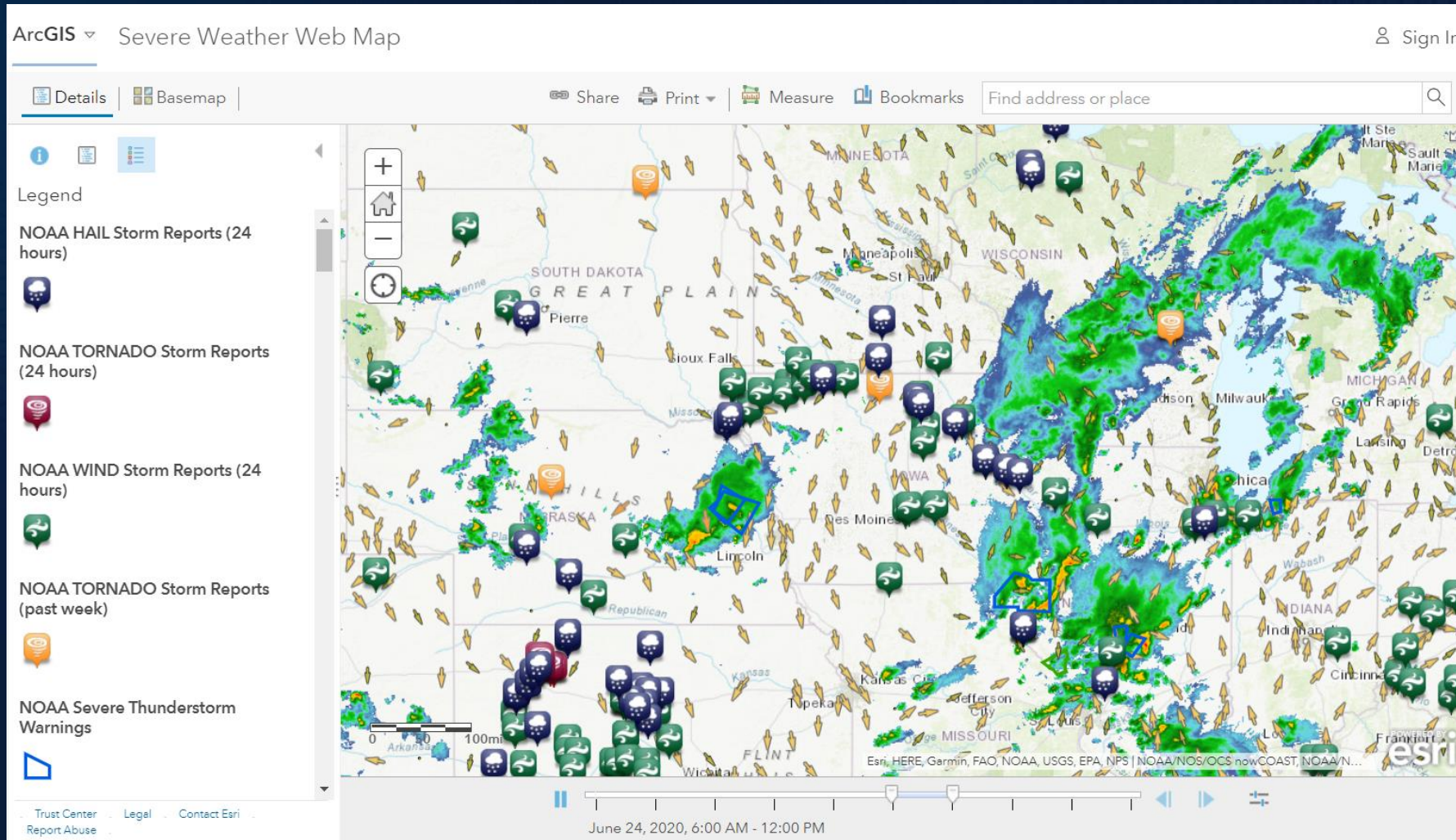
The 10 most damaging hurricanes in the USA.

<https://story.maps.arcgis.com/apps/MapSeries/index.html?appid=50aea84a9853491f994f775cb989ea92>



3. Real time data feeds.

<https://www.arcgis.com/home/webmap/viewer.html?webmap=d16d53126f1243a3a7a7f1d0dff39662>



4. Field Tools: ArcGIS Field Maps, Survey123, QuickCapture, iNaturalist, others.

ArcGIS Survey123 | My surveys | Organization | Help | Joseph

South Dakota State University Campus Litter... | Overview | Design | Collaborate | Analyze | Data | Settings

3 What does the litter look like?
Submit a photograph

Drop image here or select image

4 Tick all the types of litter found here

- Glass
- Plastic
- Paper
- Cans
- Bottles

Choices | Batch edit

Show choices in random order (exclude "Other")

- Glass
- Plastic
- Paper
- Cans
- Bottles
- Allow "Other"

Other

Save | Preview | Publish



Instructional Approaches



Photo by Joseph Kerski

Taken in an actual high school!



Your role as instructor is critical



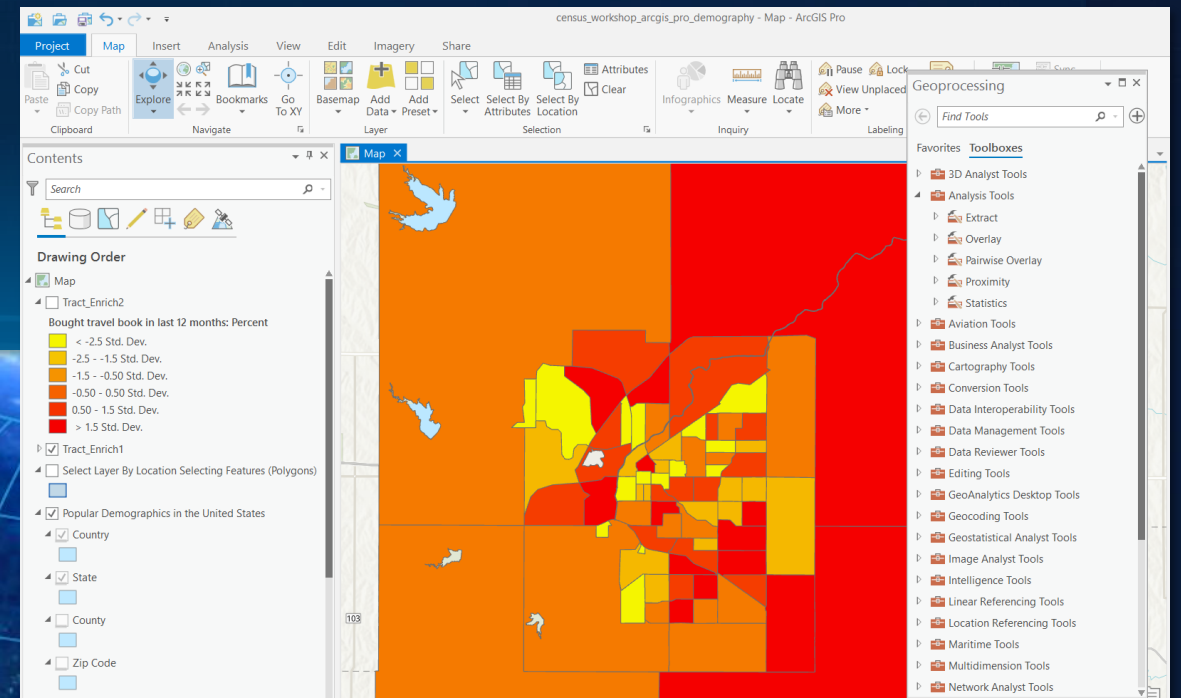
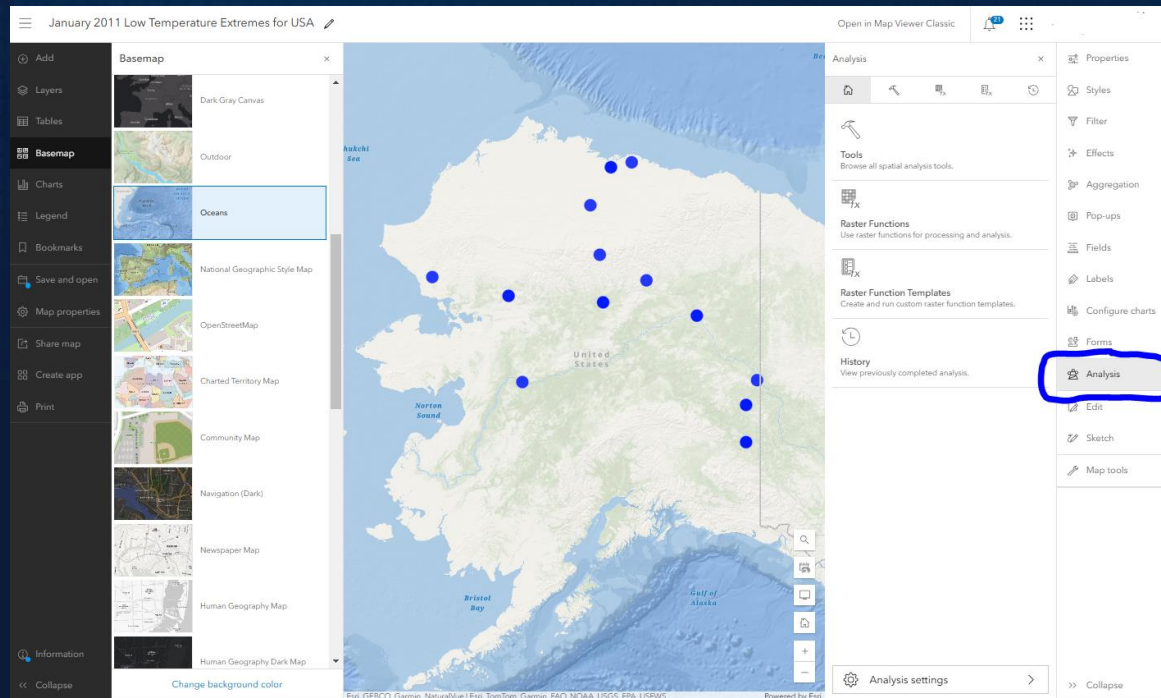
This mobile home was destroyed by a relatively weak EF0 tornado.

What is the most important tool of all?

Advice for Instructors

1. Don't overscript your lessons.
2. Use the most appropriate toolset for the job.

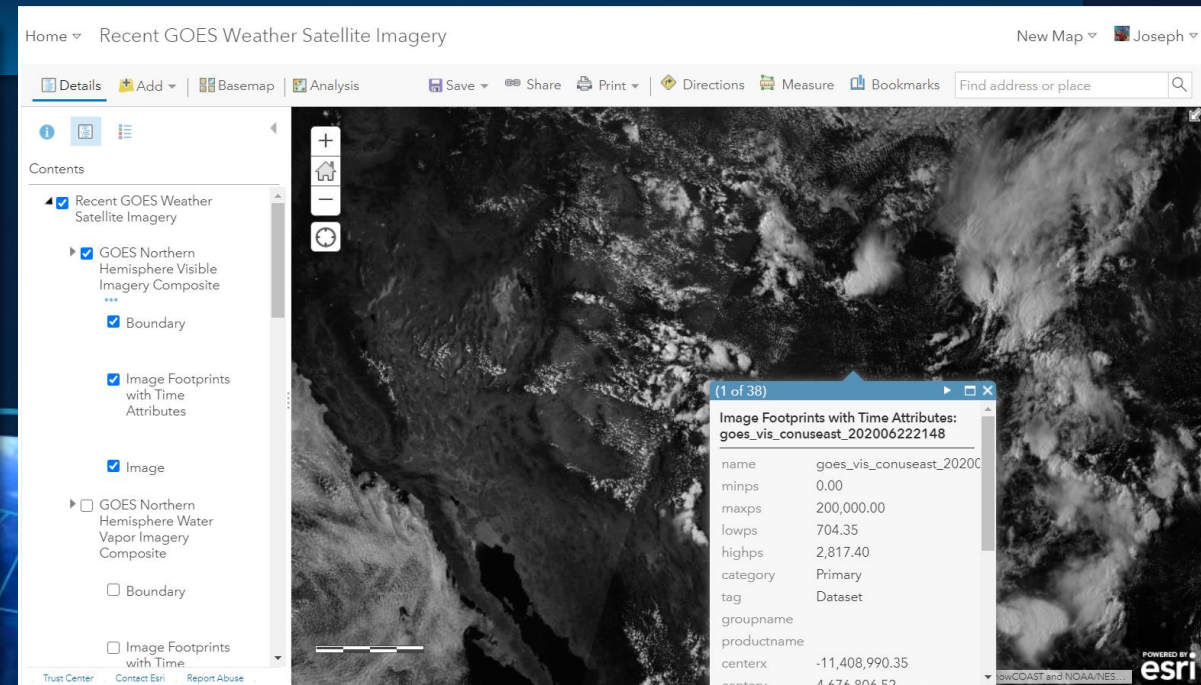
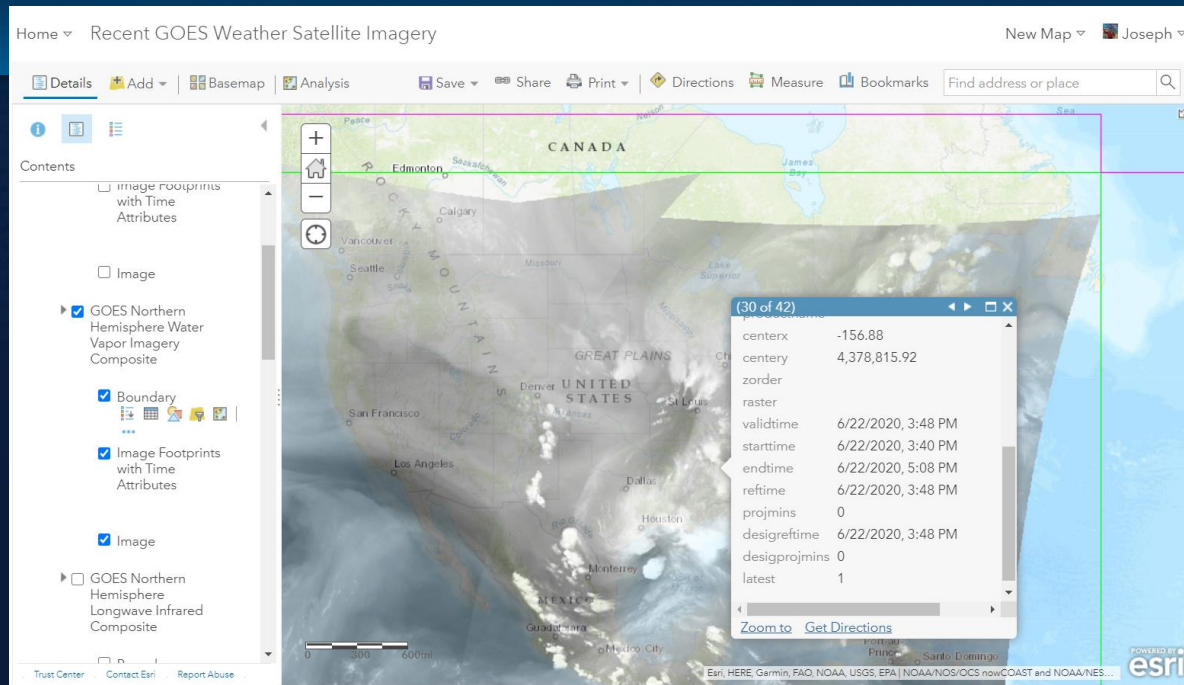
ArcGIS Pro: 2,000 tools. ArcGIS Online: 100 tools.



Where can you get the geospatial data?

Best starting point: The ArcGIS Living Atlas of the World

<https://livingatlas.arcgis.com/en/browse/#q=weather>



Methods of obtaining geospatial data

Old school but still viable: Download data > Process Data > Analyze.

New paradigm: Stream data > Analyze.

Example: Local government GIS portal:

<https://opendata-bouldercounty.hub.arcgis.com/datasets/floodplain-fema-regulated>

The screenshot shows the Boulder County Geospatial Open Data portal. The main map displays the FEMA DFIRM floodplain for Boulder County, with various municipalities labeled. The interface includes a navigation menu, search bar, and user profile. Below the map, there are options for 'Overview', 'Data', and 'API Explorer'. A 'Download' button and 'APIs' link are visible. The 'About' section provides details about the data source and metadata.

Boulder County Geospatial Open Data

Overview Data API Explorer

12/13/2019 Feature Layer Download APIs

FEMA DFIRM (Digital Flood Insurance Rate Map) floodplain effective December 18, 2012, created for Boulder County and all municipalities within under the direction of the FEMA Map Modernization project. This data supercedes all other flood data.

About

Boulder County Open Data 2.0
Content
Shared By: BoulderCountyAdmin
Data Source: maps.bouldercounty.org
View Metadata
Create Webmap
Create a Story Map

Attributes

AR_REVERT	AR_SUBTRV	BFE_REVERT	DEP_REVERT	DEPTH	DFIRM_ID
-----------	-----------	------------	------------	-------	----------

The screenshot shows the ArcGIS map interface. The map displays the floodplain data overlaid on a topographic map of Boulder County. The legend on the left identifies the data layers: 'BOCO.HAZARD.FLOOD2013 PostFloodStreamChannel' and 'BOCO.HAZARD.FIRE WILDFIRE HISTORY'. The map includes various geographical features, roads, and municipalities. The interface includes a legend, search bar, and navigation tools.

Legend

- BOCO.HAZARD.FLOOD2013 PostFloodStreamChannel
- BOCO.HAZARD.FIRE WILDFIRE HISTORY

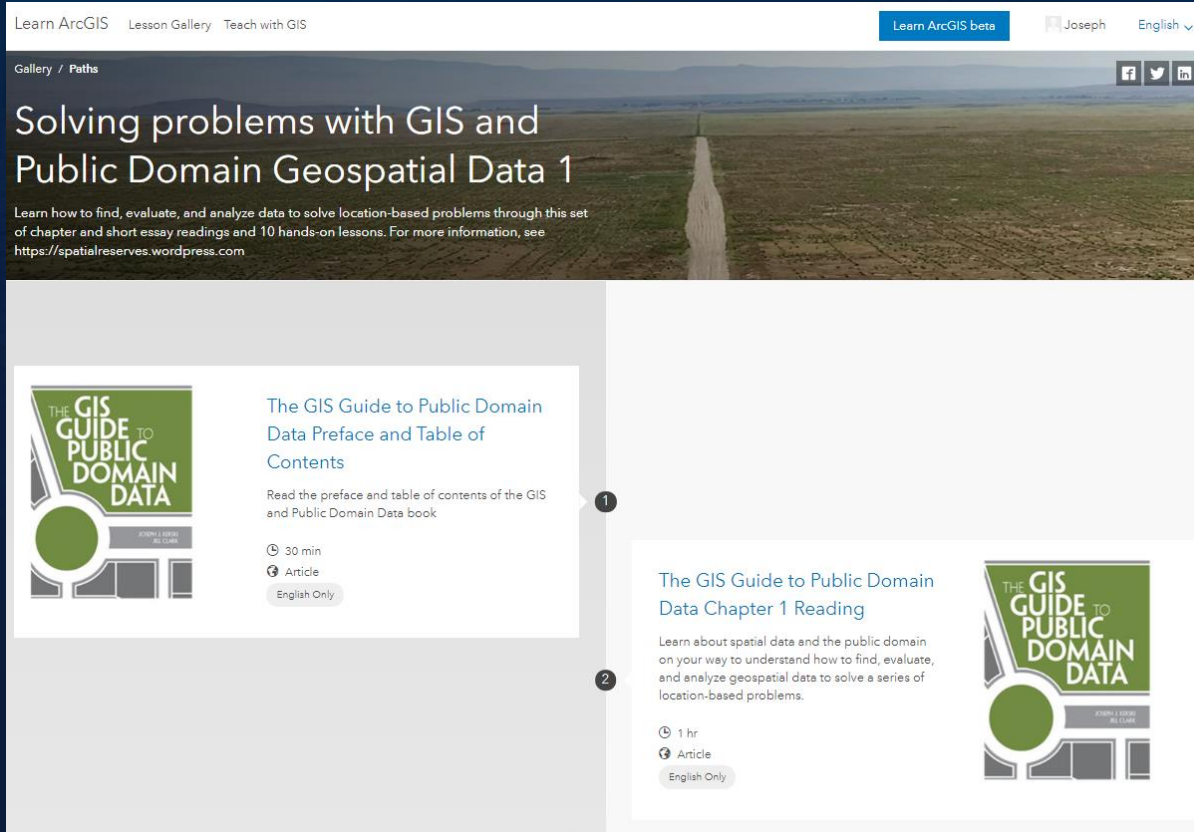
Esri, NASA, NGA, USGS | City of Boulder, Boulder County, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA, USFWS

Powered by Esri

Societal Issues Surrounding Data

Sources, trustworthiness, location privacy, ethics, copyright:

The Spatial Reserves book and blog: <https://spatialreserves.wordpress.com>




Learn ArcGIS Lesson Gallery Teach with GIS Learn ArcGIS beta Joseph English

Gallery / Paths

Solving problems with GIS and Public Domain Geospatial Data 1

Learn how to find, evaluate, and analyze data to solve location-based problems through this set of chapter and short essay readings and 10 hands-on lessons. For more information, see <https://spatialreserves.wordpress.com>

- 


The GIS Guide to Public Domain Data Preface and Table of Contents

Read the preface and table of contents of the GIS and Public Domain Data book

30 min
Article
English Only
- The GIS Guide to Public Domain Data Chapter 1 Reading**

Learn about spatial data and the public domain on your way to understand how to find, evaluate, and analyze geospatial data to solve a series of location-based problems.

1 hr
Article
English Only

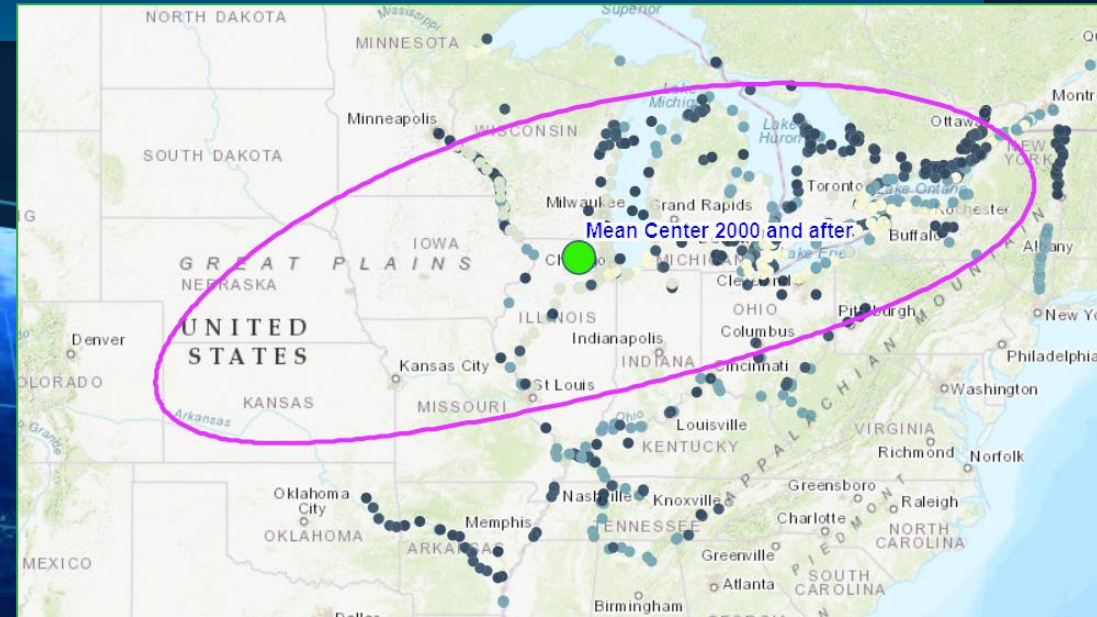
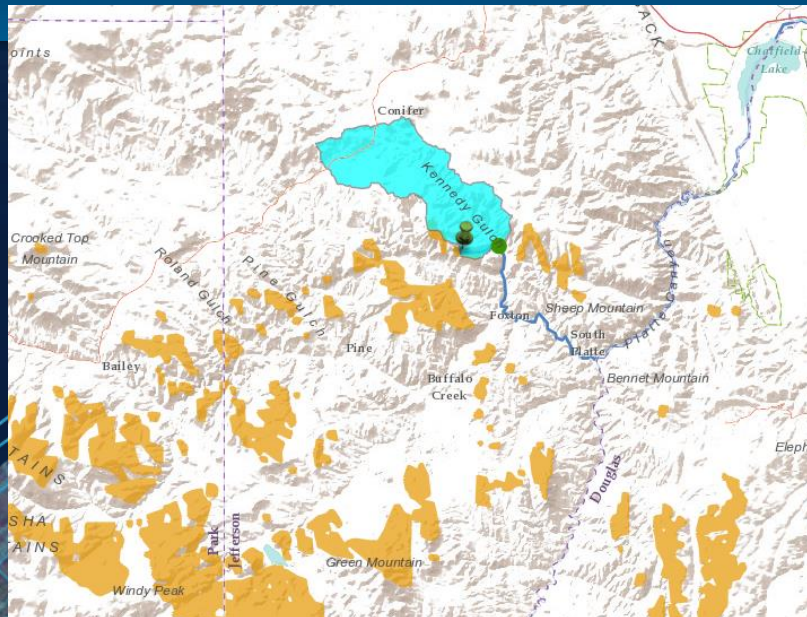
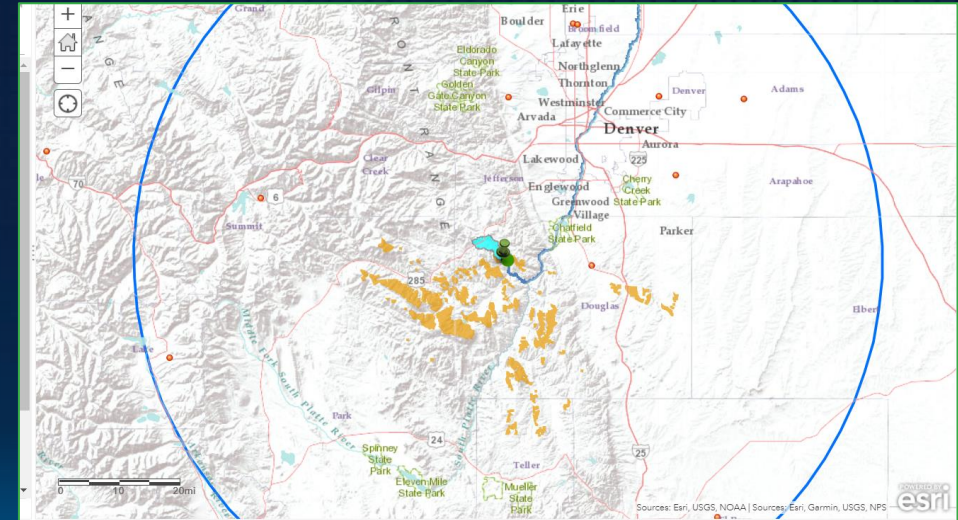




Selected lessons

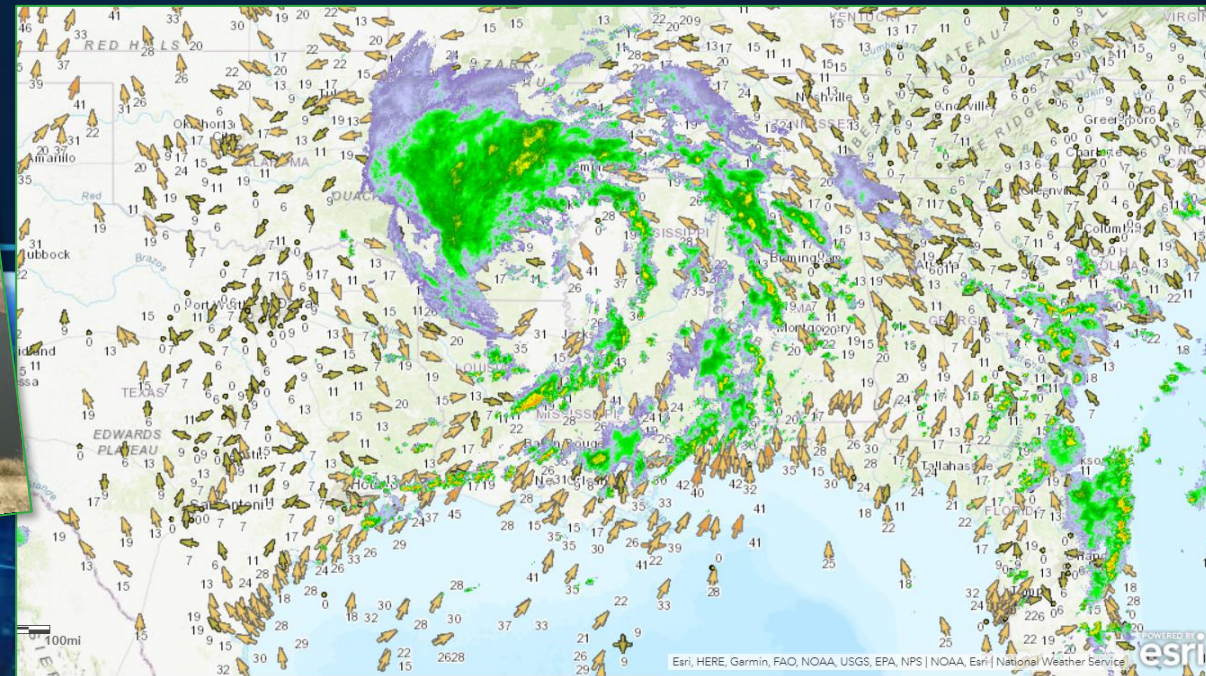
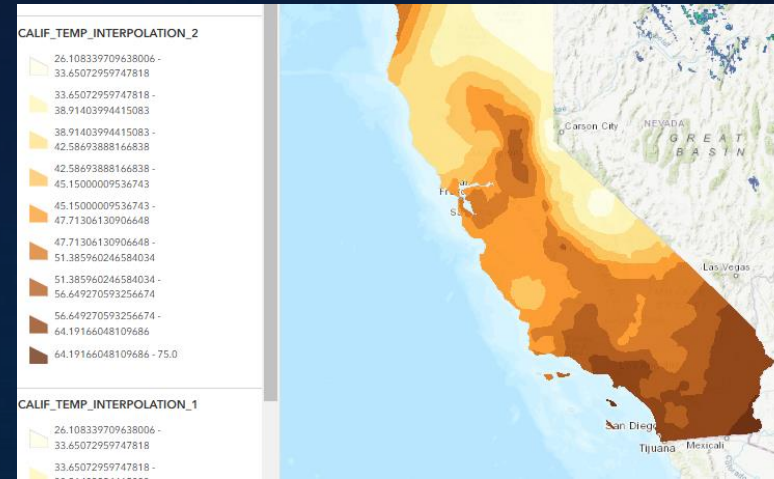
Viewsheds, trace downstream, watersheds.

Spread of zebra mussels.



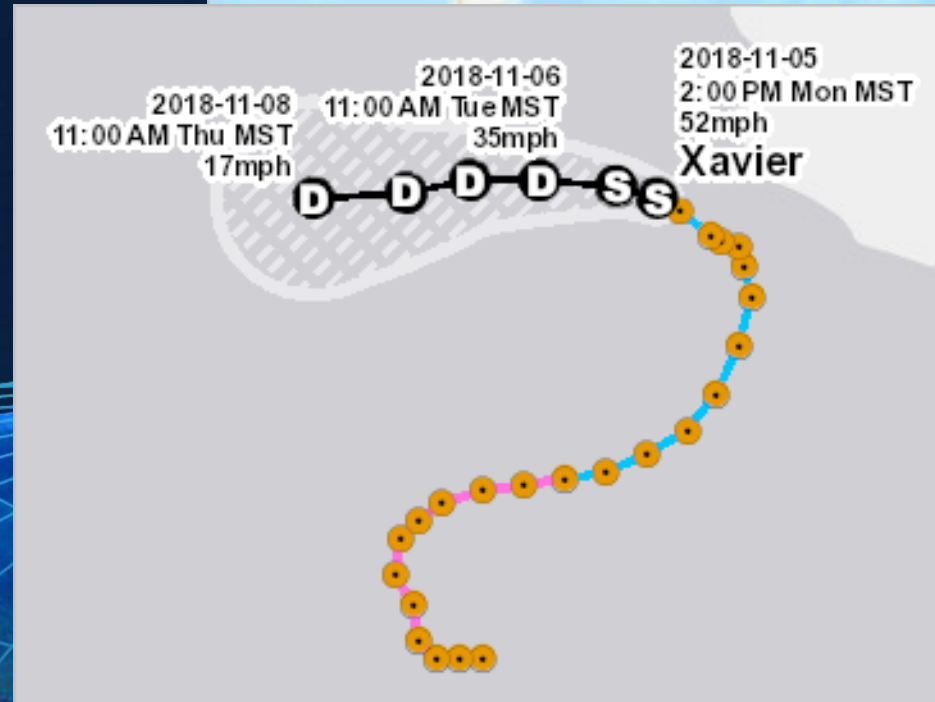
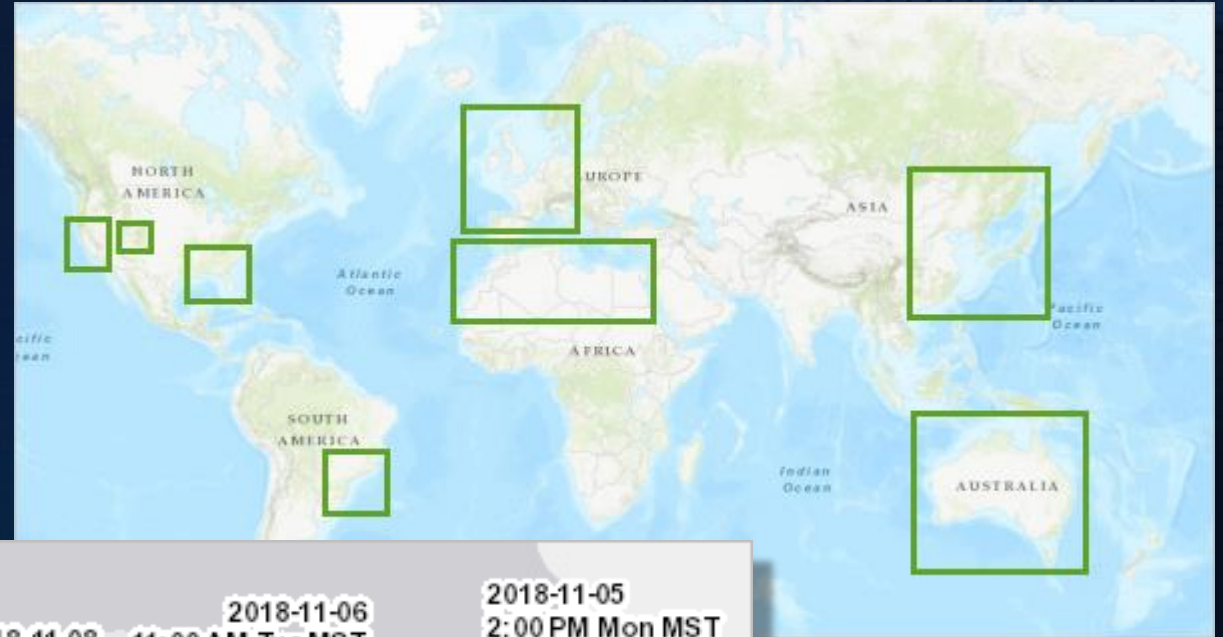
Interpolating Surfaces: Weather

Analysis results.

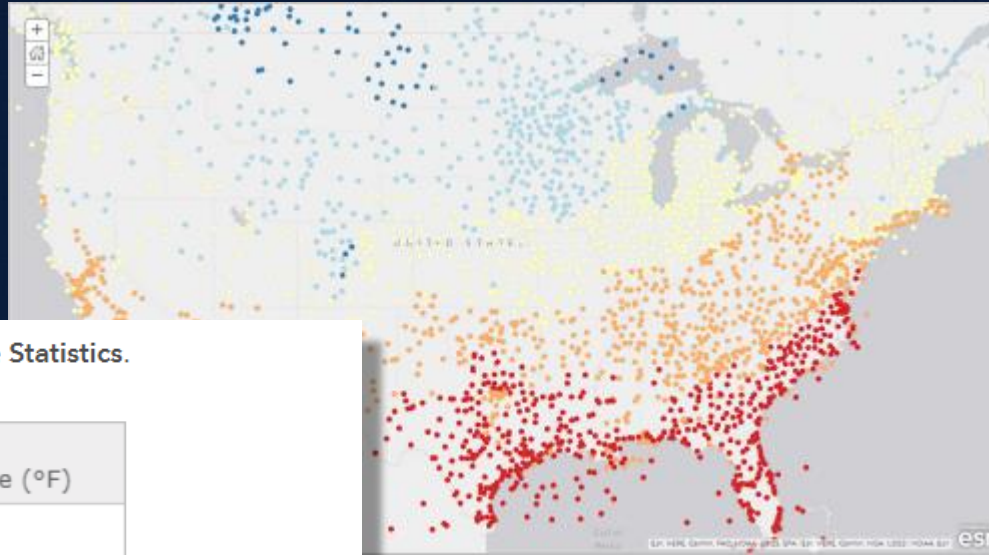


Add data

Set bookmarks



Change style Analyze



Legend

NOAA_METAR_current_wind_speed_direction

Stations

- ◆ 0 km/h (Calm / No Reading)
- < 12 km/h (Light Breeze)
- < 39 km/h (Moderate Breeze)
- < 62 km/h (Strong Breeze)
- < 89 km/h (Gale Force)
- < 118 km/h (Storm Force)
- >= 118 km/h (Hurricane Force)

16 In the table, click the **Air Temperature** field and choose **Statistics**.

Station Elevation (Meters)	Air Temperature (°F)	Dew Point Temperature (°F)
3,807.00	<ul style="list-style-type: none">Sort AscendingSort DescendingStatistics	40

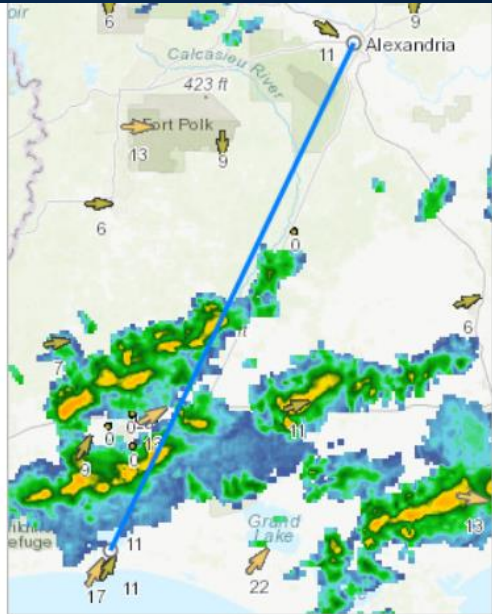
The **Statistics** window appears.

Field: Air Temperature (°F)

Number of Values	4,780
Sum of Values	240,394.7999959
Minimum	-18.4
Maximum	96.8
Average	50.6
Standard Deviation	19.96

Analyze extremes

Predict pressure

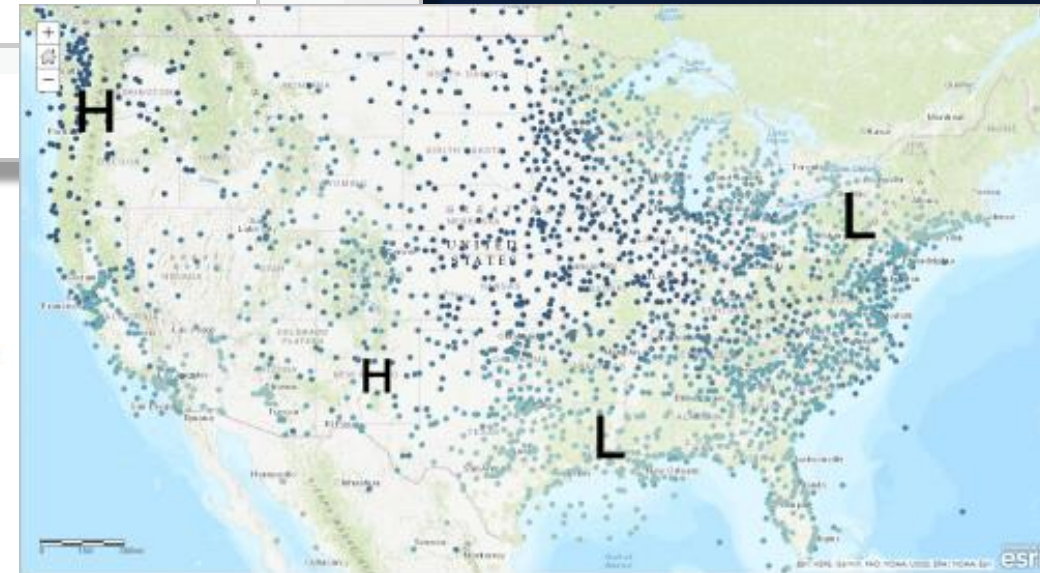


Center on Selection

360

In the example image, a northeastern arrow with a wind speed of 17 kilometers per hour is about 180 kilometers away from Alexandria. At this rate, it would take over 10 hours for rain to reach the city. Additionally, other stations in the area record either no wind, slower wind, or wind that is more easterly. It's possible the precipitation will pass south of the city altogether.

- How far away is rainfall from the city you found?
- How long would it take rainfall to reach the city given the wind speed and direction?
- Are there other winds that might cause the rainfall to avoid your city?
- Overall, how likely would you say it is that your city receives rain?



Label

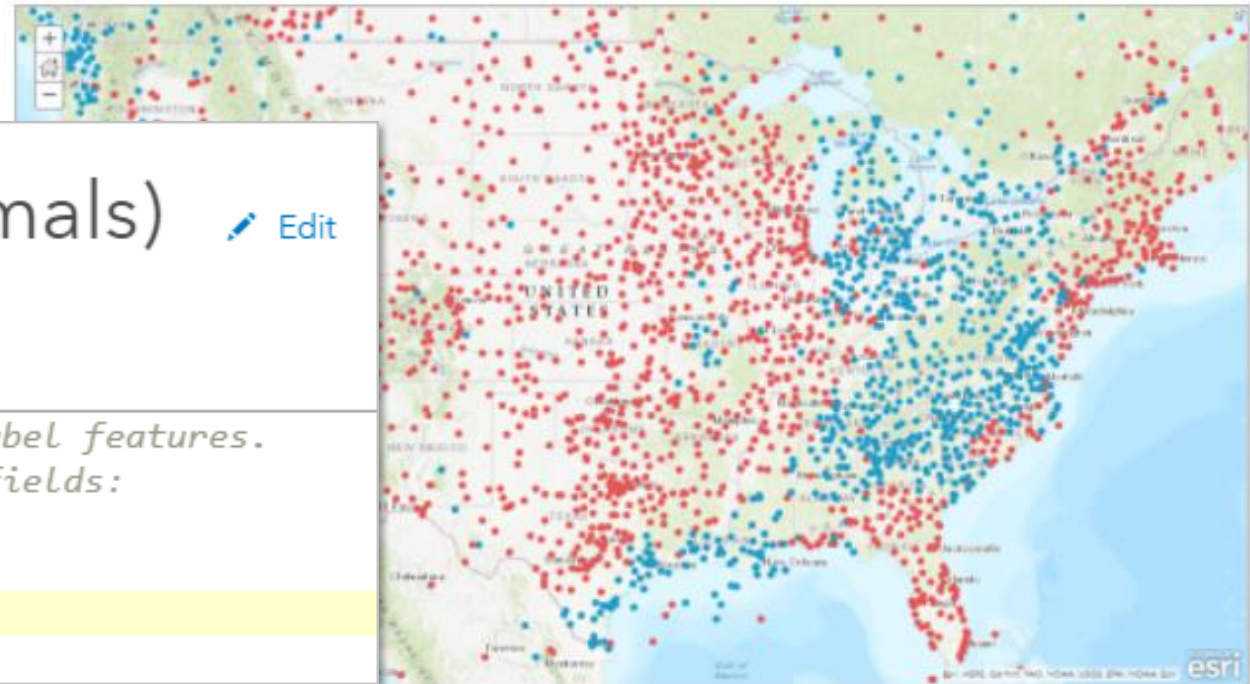
Predict weather

Build expressions

```
1 // Write a script that returns a value that will be used to
2 // For example, find the percentage of males:
3 // Round(($feature.MalePop / $feature.TotalPop) * 100, 2)
4
5 ($feature.TEMP - $feature["DEW_POINT"]) < 4
```

10 Click **OK**.

The expression is saved and the map is automatically styled based on it.








Air Temperature (No Decimals) [Edit](#)

Expression

```
1 // Write a script that will be used to label features.
2 // For example, append the value of two fields:
3 // $feature.name + " " + $feature.status
4
5 Round($feature.TEMP, 0)
```

Interpolating Surfaces



- ▶ Data Enrichment ?
- ▼ Analyze Patterns ?
 -  Calculate Density ?
 -  Find Hot Spots ?
 -  Find Outliers ?
 -  Find Point Clusters ?
 -  **Interpolate Points** ?
- ▶ Use Proximity ?

3 Optimize for ?

Speed Accuracy

Output prediction errors ?

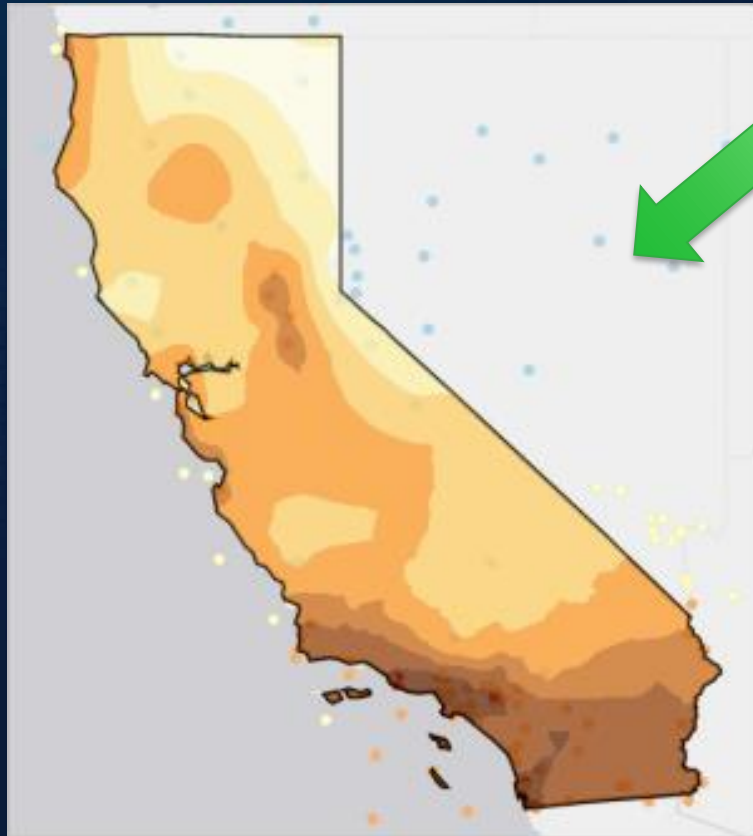
Options ?

Clip output to

States ?

Interpolating Surfaces: Considerations

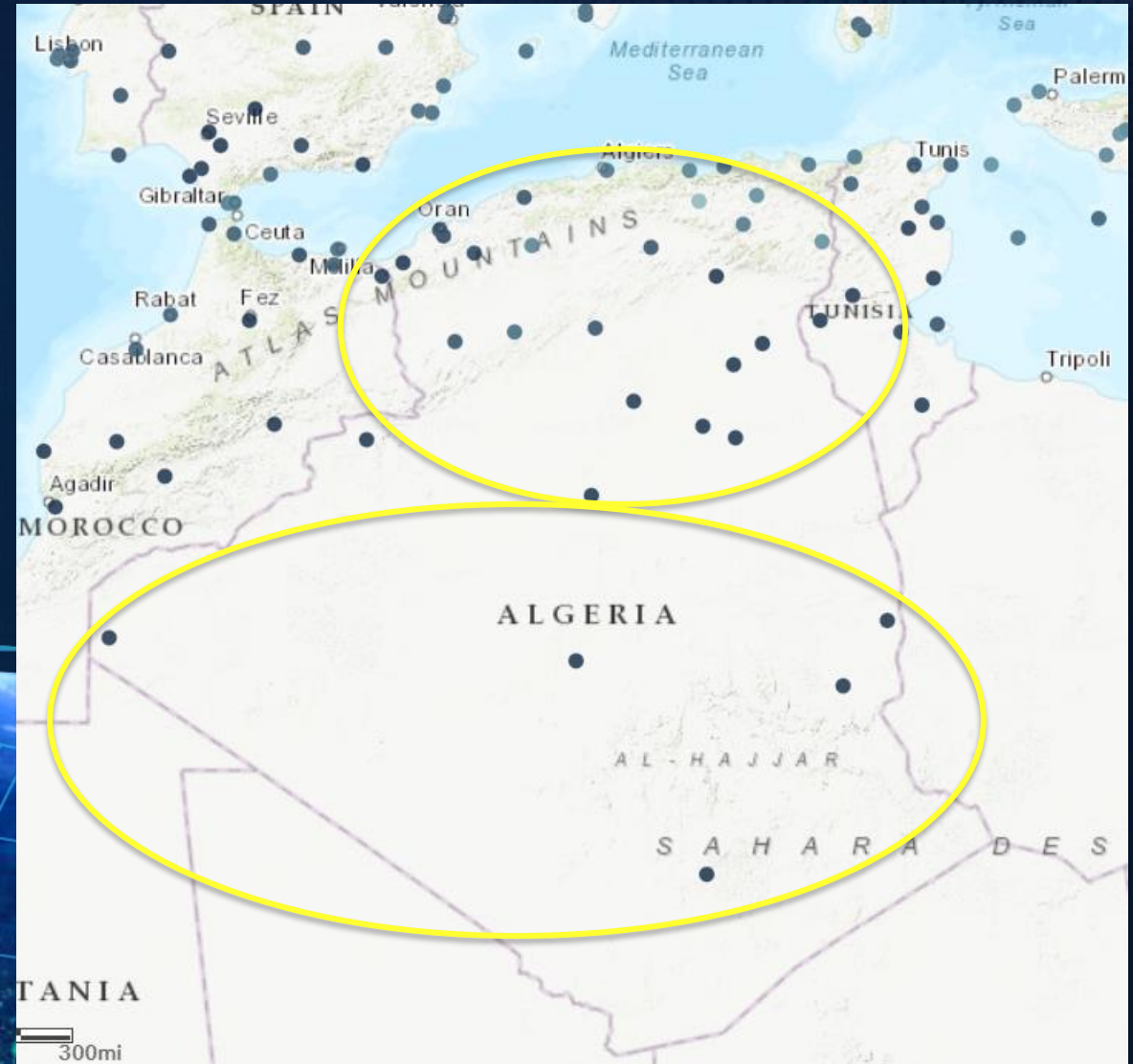
CA



CA + NV



Algeria

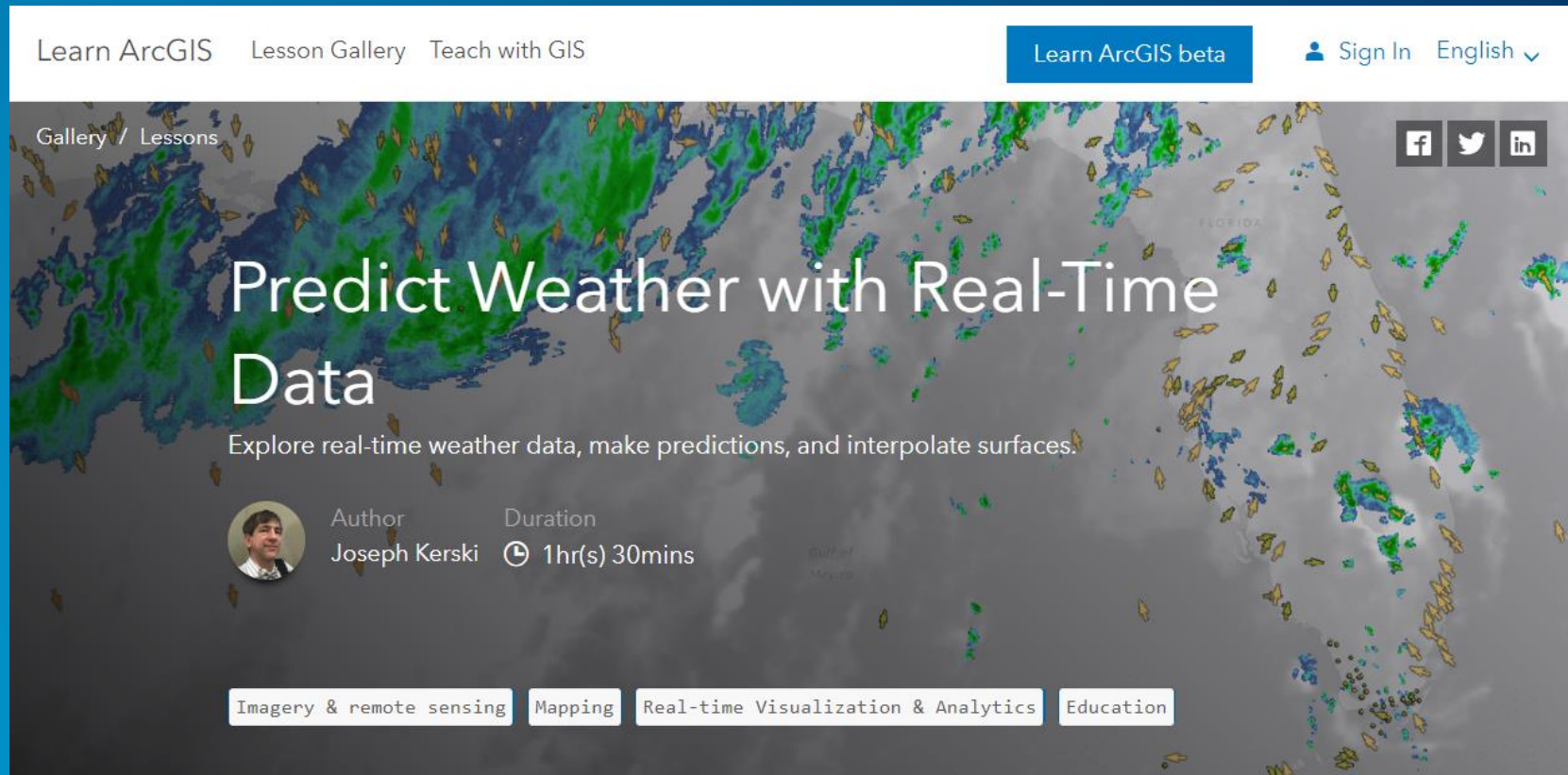


Dig Deeper

Lesson: Predicting the Weather

Search Learn ArcGIS Lesson library under

“Predicting the Weather” <https://learn.arcgis.com>



The screenshot shows the top navigation bar of the Learn ArcGIS website. It includes links for 'Learn ArcGIS', 'Lesson Gallery', and 'Teach with GIS'. On the right, there is a 'Learn ArcGIS beta' button, a 'Sign In' link with a user icon, and a language dropdown set to 'English'. Below the navigation is a breadcrumb trail 'Gallery / Lessons' and social media icons for Facebook, Twitter, and LinkedIn. The main content area features a weather map of Florida with the title 'Predict Weather with Real-Time Data' and a subtitle 'Explore real-time weather data, make predictions, and interpolate surfaces.' Below the title, there is a profile picture of the author, Joseph Kerski, and the duration '1hr(s) 30mins'. At the bottom, there are four category tags: 'Imagery & remote sensing', 'Mapping', 'Real-time Visualization & Analytics', and 'Education'.

Learn ArcGIS Lesson Gallery Teach with GIS [Learn ArcGIS beta](#) Sign In English

Gallery / Lessons

Predict Weather with Real-Time Data

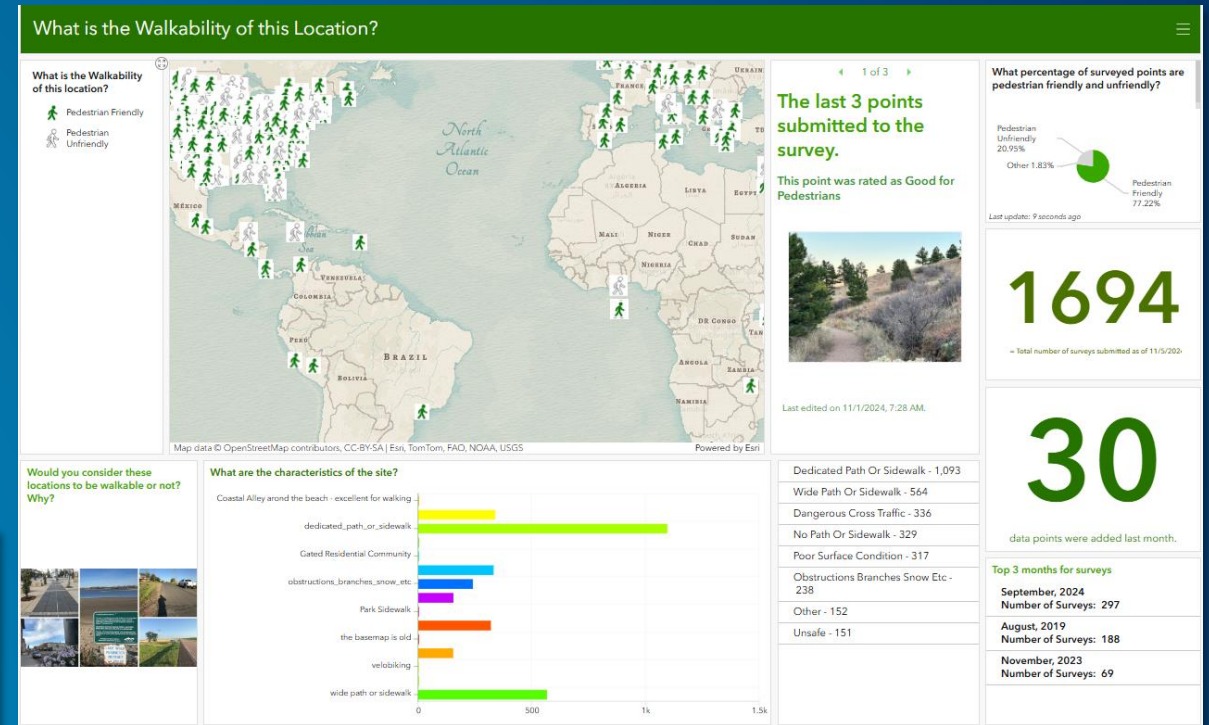
Explore real-time weather data, make predictions, and interpolate surfaces.

Author: Joseph Kerski Duration: 1hr(s) 30mins

Imagery & remote sensing Mapping Real-time Visualization & Analytics Education

Connecting components of the Web GIS platform is powerful

Connecting surveys, maps, dashboards, story maps: Walkability:

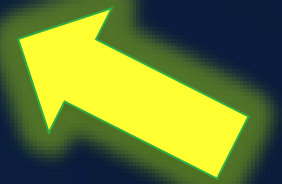


2 powerful instructional points:

1. You can create web mapping *applications* to communicate the results of your analysis: Story Maps, Instant Apps, Experience Builder, and Dashboards.

→ And your students can do the same!

2. You can bring the results of your analysis and your maps and layers into ArcGIS Pro, ArcGIS Insights, Business Analyst Web App, and other ArcGIS platform tools (and outside, for example, to the R statistics package) for further analysis.



Keep Learning!

1. Modern GIS Strategies and resources:

<https://www.esri.com/en-us/industries/higher-education/roles/educators/modern-gis>

2. Data sources, data quality, and societal issues:

<https://spatialreserves.wordpress.com>

3. Learn ArcGIS Library: <https://learn.arcgis.com>

4. GeoInquiries: <https://www.esri.com/geoinquiries>

5. Esri Monthly Higher Education Chats:

<https://gis-in-higher-education-chat-edresources.hub.arcgis.com/>

6. Esri Education Community blog:

<https://community.esri.com/community/education/pages/education-blog>



esri

**THE
SCIENCE
OF
WHERE**

