

Exercise

Responding to Tornado Damage with
ArcGIS Online

Section 6 Exercise 1

08/2017



Responding to Tornado Damage with ArcGIS Online

Instructions

Use this guide and ArcGIS Online to reproduce the results of the exercise on your own.

Note: ArcGIS Online is a dynamic mapping platform. The version of ArcGIS Online that you will be using for this course may be slightly different from the screenshots you see in the course materials.

Time to complete

Approximately 35 minutes.

Technical note

To take advantage of the web-based technologies available in ArcGIS Online, you need to use a fairly new version of a standard web browser, such as Google Chrome, Firefox, Safari, or Internet Explorer. Older web browsers may not display your maps correctly.

Note: For information on supported browsers for ArcGIS Online, visit <http://doc.arcgis.com/en/arcgis-online/reference/browsers.htm>.

Introduction

This exercise uses ArcGIS Online maps to provide context to answer specific questions that an insurance company would have after a natural disaster occurred. The specific natural disaster is the tornado that touched down in Joplin, Missouri in 2011. You will see how an insurance adjustor would use imagery to determine damage percentage in covered areas.

The purpose of this exercise is to show how you can edit features in an existing feature service, and use publicly available imagery in ArcGIS Online for an analysis of damaged areas.

The speed of disaster recovery for affected areas is directly related to assessing the damage and providing assistance where it is needed to those individuals who will rebuild and replace lost property. Aerial imagery of the affected areas provided by satellite, aircraft, or unmanned aerial vehicles (UAV) can be displayed quickly on ArcGIS Online to help coordinate efforts. Having a common set of imagery for insurance adjustors and contractors makes the recovery effort more efficient.

Exercise scenario

On May 22, 2011, a tornado with a rating of EF5 touched down in Joplin, Missouri, with wind speeds of more than 200 miles an hour. The tornado was active on the ground for 38 minutes,

and in that time, it generated more than 2.8 billion dollars in damage to the overall area. The insurance payout was expected to be 2.2 billion dollars, which made it the highest insurance payout in Missouri history. The event generated 16,656 insurance claims in the affected area.

In this scenario, you are a member of a team of insurance adjustors who have been tasked with **evaluating the degree of damage for buildings in the affected areas**. Through imagery available on ArcGIS Online, you will analyze the damaged area, and estimate the percentage of damage for the city of Joplin. **Rather than identify every damaged building by yourself, this exercise has been set up so that everyone in the MOOC can participate and, by crowdsourcing**, we aim to identify all of the damaged buildings in Joplin. This estimate will allow the insurance company to determine how many field agents need to be sent to service the area.

Note: Because this is only an exercise, if the dataset gets filled up, we will reset it periodically so that everyone has a chance to do meaningful damage assessment. If you notice that all of the damaged buildings have been assessed, let us know in the Q&A, and we will reset the entries.



Area in Joplin, Missouri impacted by a tornado in May, 2011. The red polygon shows the path of the tornado.

Earth Imagery at Work

Using ArcGIS Online and Imagery for Damage Assessment

ArcGIS Online has a wealth of basemaps available for use in your maps, but the **publicly available data from other users and organizations allows for more thorough analysis**. In this case, the data that was made available originally from the National Oceanic and Atmospheric Administration (**NOAA**) has been published as a service. You can add this data to your map for your analysis.

In this exercise, you will use the data available to determine the percentage of damage to homes and outbuildings in the city.

Step 1: Sign in to an ArcGIS Online organization

In this step, you will sign in to the ArcGIS Online organization for the *Earth Imagery at Work MOOC* and create a new map.

- a Open a new Internet browser tab or window.
- b Go to www.arcgis.com and sign in to ArcGIS Online using the credentials provided at the start of this course.

Note: The Section 1 Exercise 1 PDF explains how to determine your ArcGIS Online credentials (username and password) for this course. If you have trouble signing in, email gistraining@esri.com for assistance.

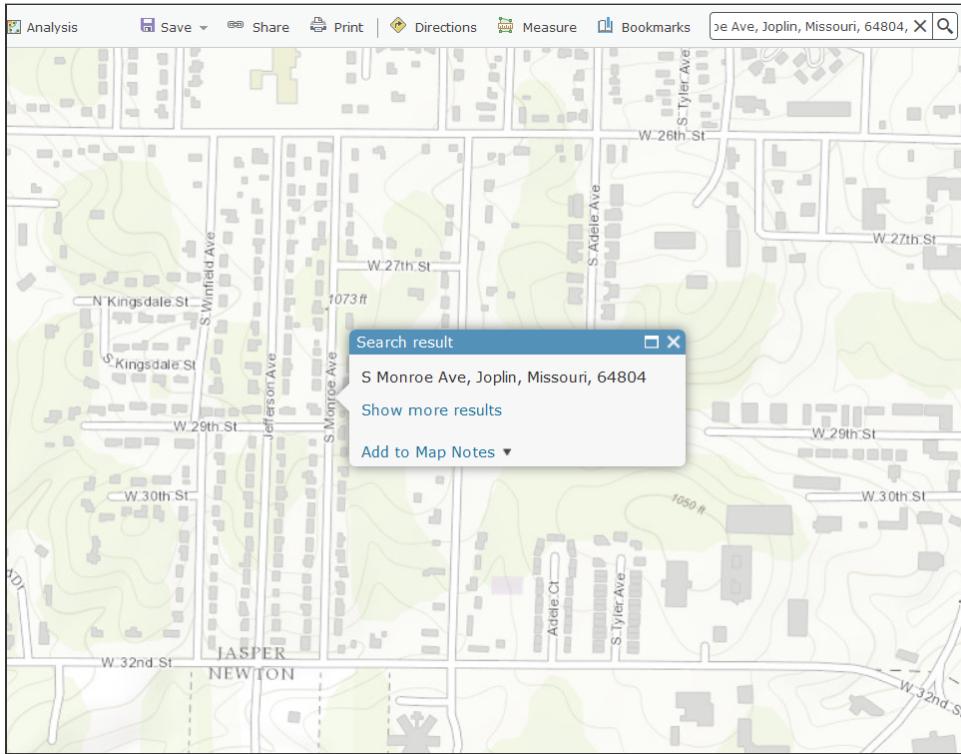
Now you are ready to create a map to help with your damage assessment.

- c At the top of the ArcGIS Online window, click **Map**.

Step 2: Add a layer to the map

Next, you will customize the map to highlight some of the capabilities for accessing Landsat image services using ArcGIS for Server.

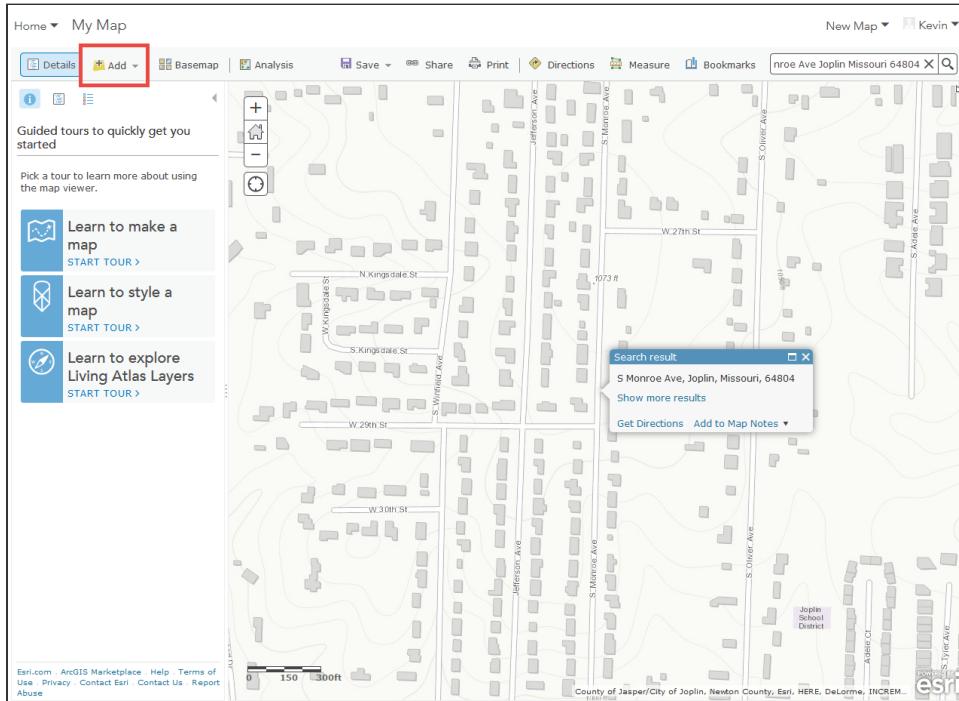
- a In the **Find Address** search bar, type **S Monroe Ave, Joplin, Missouri, 64804** and click the magnifying glass icon or press Enter.



- b) If necessary, change the basemap to Topographic.

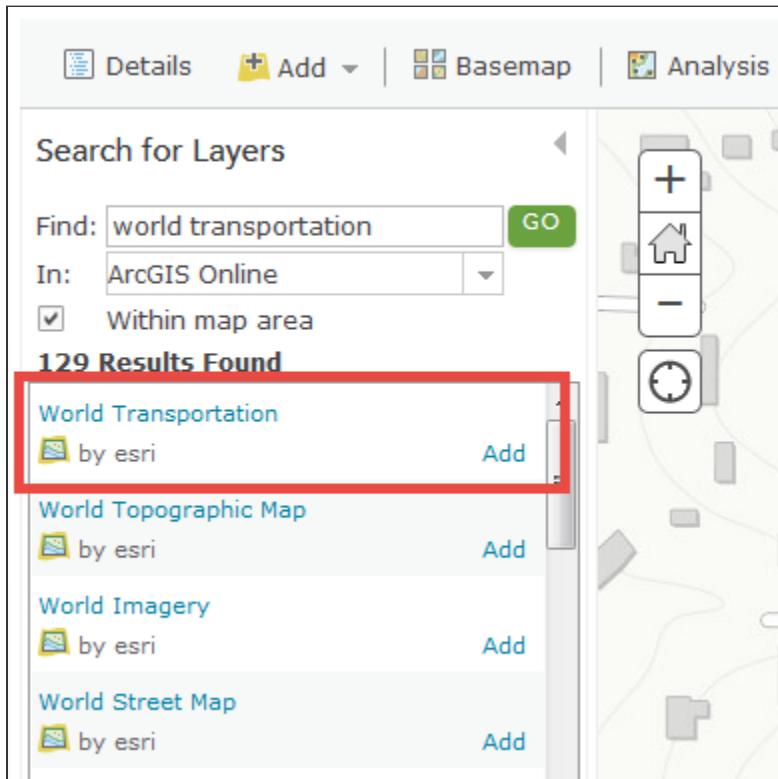
Hint: To change the basemap, at the top of the map window, click Basemap and choose the Topographic basemap.

Earth Imagery at Work MOOC



- c At the top of the map window, click the **Add Content To Map** button, select Search For Layers, and, in the Find field, type **world transportation**.
- d For In, select ArcGIS Online.
- e Ensure that the Within Map Area **check box is selected** to be sure that you are searching within the map area, and then click Go.

Note: The map area is the area that is visible in the map window.



- f To the right of the World Transportation layer by Esri, click Add to add the layer to your map, and then click Done Adding Layers.

You will see street labels added to the map.

Now that you have started adding online layers to your map, you can use the data to begin the analysis.

Step 3: Use basemap imagery to evaluate an area

Layers added to your map contribute to your understanding of the study area and can also be used to interpret aspects of the study area. Before you assess the damaged area, it is important to understand what property was there before the disaster occurred. You will begin your analysis of a four-block area bounded by W 27th Street, W 29th Street, S Oliver Avenue, and S Monroe Avenue.

- a Zoom in and pan the map to see the entire block area.



- b** Examine the locations of buildings represented by the gray building footprint polygons.
 - c** Based on what you see in the map, answer the following questions about the buildings in the study area block.

Note: The questions in this exercise are to help you assess your own understanding of what you are learning and **do not need to be submitted**. This is an **editable PDF**. You can type your answers in the Answer fields and save the document for your own reference if you would like. Answers are included at the end of this exercise.

1. How many houses are located in the four-block area? **15**

2. How many have detached garages or other buildings? **1**

The basemap layer typically shows basic features of the landscape. To better understand the area's geography, you can use imagery from the area as a basemap to provide context for your analysis and understanding of the area and the impact of the tornado.

- d Change the basemap to Imagery, and use what you see to answer the following questions.



3. How many homes are now visible in the four-block area? **16**

4. On which street are the new homes visible in the imagery located?

5. How many of the homes have detached garages or other buildings?

6. On which street do the homes not have large trees in their yard?

Notice that there have been significant changes between the topographic map and the imagery basemaps. For example, the building located at 2810 S Monroe Avenue, is much larger than the building indicated in the topographic map.

Now that you have evaluated the imagery before the disaster, you will add in information from ArcGIS Online, examine imagery from after the disaster, and evaluate the damage percentage.

Step 4: Add layers to the map

Federal agencies, non-government organizations, and other groups publish geographic data on ArcGIS Online to aid understanding, and facilitate analysis. In this case, imagery showing the area that the Joplin tornado damaged has been published to ArcGIS Online. You will use these layers to assess the damage on the area.

- a Click the **Add Content To Map** button, select Search For Layers, and, in the Find field, type **joplin imagery**.
- b Ensure that you are searching in ArcGIS Online within the map area, and then click Go.

The screenshot shows the ArcGIS Online interface with the title "My Map". At the top, there are tabs for "Details", "Add", "Basemap", and "Analy". Below the tabs is a search bar with "Find: joplin imagery" and a "GO" button. A checkbox "Within map area" is checked. The search results section shows "5 Results Found" with the following items:

- After Imagery for Joplin, MO tornado - Even by aaddison Add
- Joplin, MO Post Tornado Imagery .25ft** by rlanclos Add
- Joplin, MO Before Imagery (2008) by aaddison Add
- Joplin, MO Post Tornado Imagery 1foot by rlanclos Add
- Joplin Imagery - May 24, 2014 (Post Tornad by vhurtovenko Add

On the right side of the interface, there is a map view showing a street labeled "Jefferson Ave".

- c Next to the **Joplin, MO Post Tornado Imagery .25 ft** layer, click Add to add the layer to your map.



- d Click Done Adding Layers.

Next, you will rearrange the layers of the map to more clearly view on which streets the damage occurred.

- e In the Contents pane, move the Joplin, MO Post Tornado Imagery .25ft layer below the World Transportation layer so that the street labels will appear.

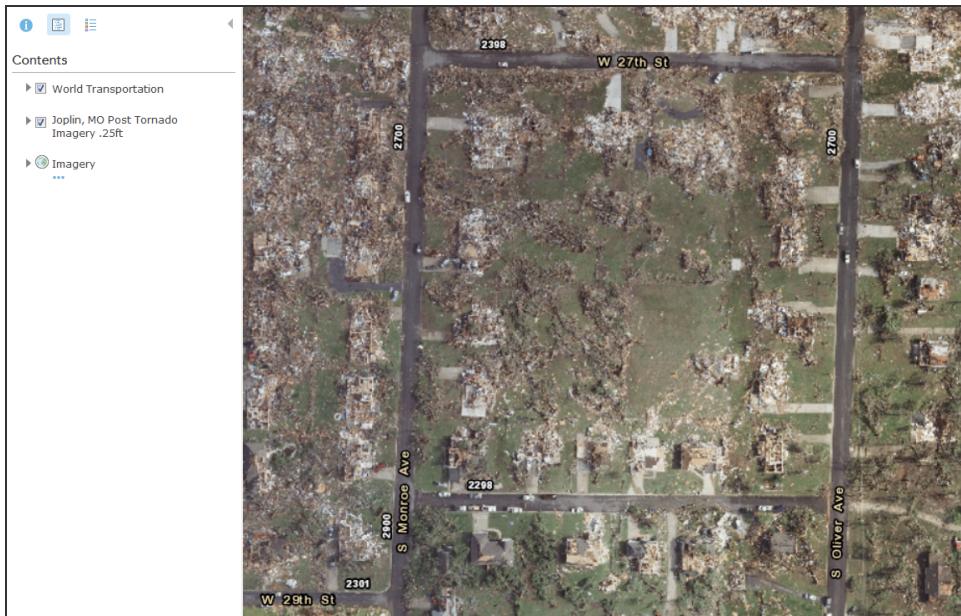
Hint: To re-order map layers, pause your pointer to the left of the Joplin, MO Post Tornado Imagery .25 ft layer in the Contents pane until your pointer changes to a four-arrow plus sign and the layer name is highlighted with a blue box. You can then click and drag the layer to the bottom of the list. A blue dashed line will indicate the location where the layer will be dropped. When you see the blue dashed line, release your mouse button to drop the layer into place.

Contents

- ▶ Joplin, MO Post Tornado Imagery .25ft
...
▶ World Transportation
- ▶  Imagery



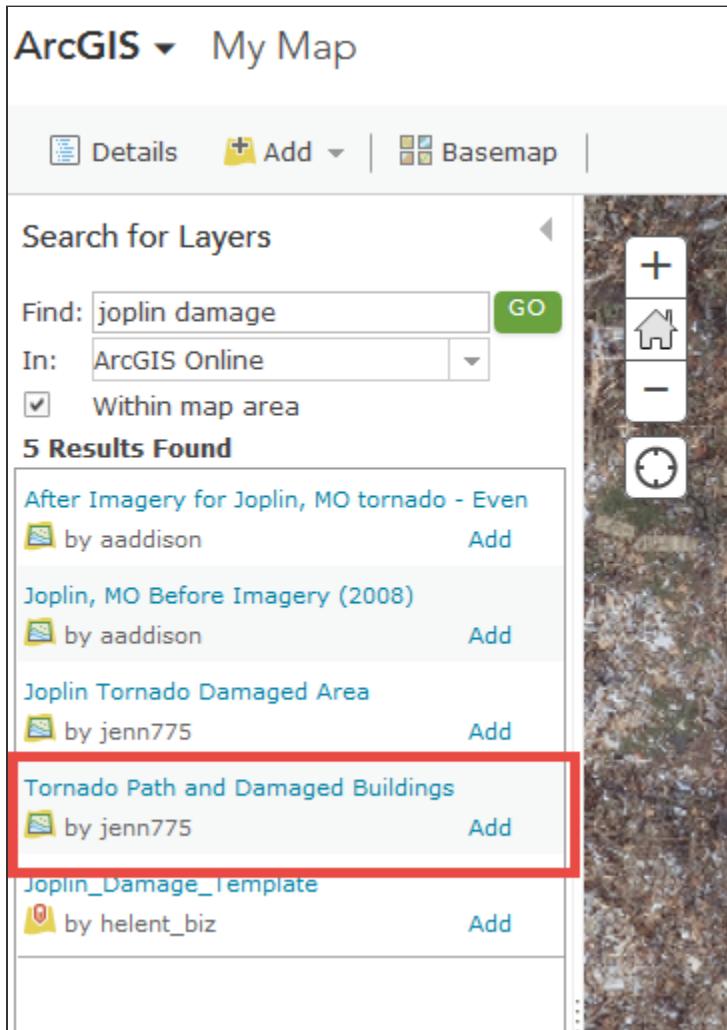
Examine the image and notice the damage inflicted by the tornado; nearly all of the buildings in the block area have been destroyed.



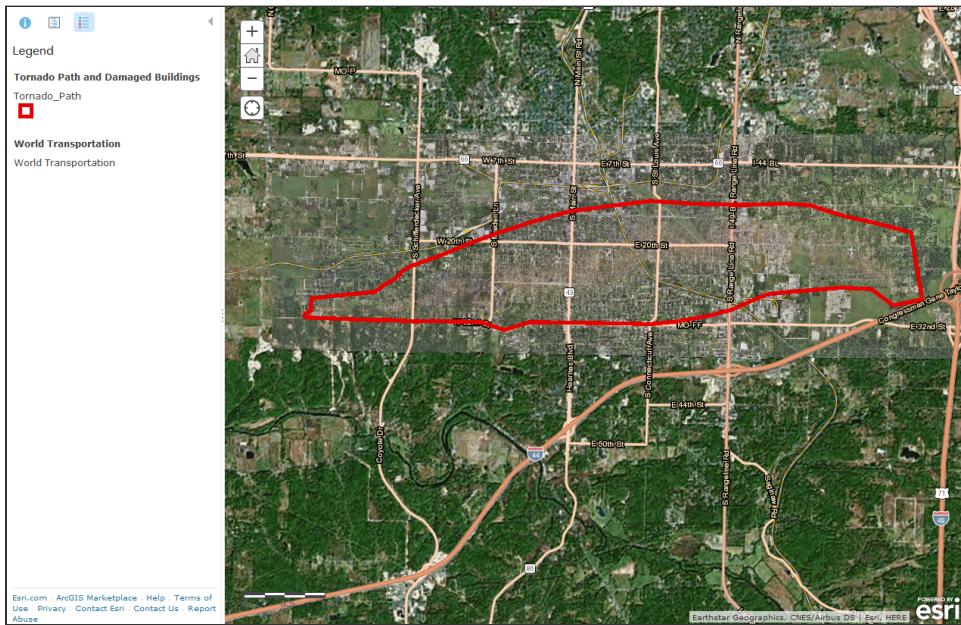
You can observe the direction that the trees have fallen by examining the direction the tornado passed over the area. In this case, **the wind from the storm came from the northwest**.

To understand the specific damage to property, you will also add a feature service that shows the building locations to determine the damage percentage for each building.

- f Click the **Add Content To Map** button, select Search For Layers, and, in the Find field, type **joplin damage**.
- g Ensure that you are searching in ArcGIS Online and within the map area, and then click Go.



- h Select the **Tornado Path And Damaged Buildings** layer, and click Add.
- i Click Done Adding Layers.
- j Zoom out to see the tornado path.



- k Use the Find Address search bar and Zoom button to return to the close-up view of the block study area.



Notice that the building outlines overlay on the damaged area. This overlay gives you an idea of what previously stood in the location prior to the tornado. These features will be used to help assess the degree of damage for each structure.

Step 5: Use a feature service to edit and share data

Feature services allow you to serve features over the Internet and provide the symbology to use when displaying the features. They are a great way to convey discreet data like building outlines, and they let you add more information to complete your analysis.

- a Click the **Add Content To Map** button, select Search For Layers, and, in the Find field, type **joplin damage assessment**.
- b Ensure that you are searching in ArcGIS Online and within the map area, and then click Go.

Home ▾ My Map

Details Add Basemap Analysis

Search for Layers

Find: GO

In: ArcGIS Online

Within map area

1 Result Found

Joplin_Damage_Assessment by kevin.eiaw [Add](#)

- c Next to the Joplin_Damage_Assessment feature layer, click Add.

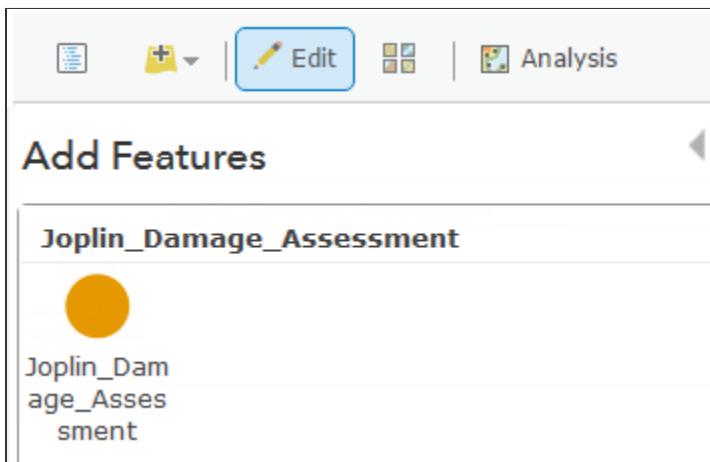


- d Click Done Adding Layers.

The building footprints are displayed with an orange polygon that identifies those buildings determined to be damaged by the tornado. The feature service allows you to edit the data and share your data with other users of the service.

Now you will determine the damage degree, and then update the feature service accordingly. You will add point features for several buildings in Joplin. Before beginning your assessment, you will save your map.

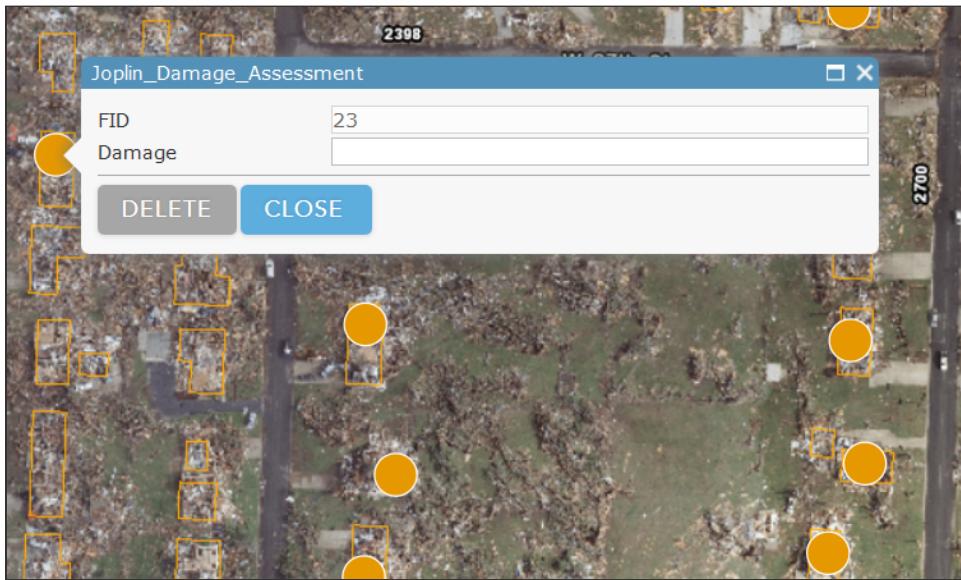
- e From the ribbon, click Save and choose Save As.
- f In the Save Map dialog box, in the Title field, type **Joplin_Damage_yourfirstandlastname**. Add an underscore and your first and last names so the map has a unique name. Add your own tags and summary, then click Save Map.
Note: Because there are many other students creating a similar map, adding your first and last name will ensure that you can later find your map.
- g At the top of the map window, click Edit.
- h In the Add Features pane, under Joplin_Damage_Assessment, click the listed feature.



- i Visually assess and evaluate a building within the study block to determine the damage degree.

You will add a point on the location of the building to indicate your damage assessment. Notice that when you move your pointer over the map now, you are prompted to click to add a point.

- j Click one of the buildings, and, in the Damage field of the pop-up, type the degree or percentage of damage based on your assessment. Use a whole number between 0 and 100 and no percentage sign.



The size of the orange circles will be similar.

- k** After typing a damage degree value, click Close.
- l** Add more features to evaluate the damage degree for several buildings in the area impacted by the tornado.
- m** Click the Edit button again to close the Editing pane.

Now that you have assessed the damage degree, you will interpret the results of the analysis.

Step 6: Use statistical analysis

With the damaged buildings in the city assessed, you will analyze the points to determine where the greatest areas of need for your field agents will be. You will use the ArcGIS Online **Summarize Within** tool to summarize the amount of damage to buildings in Joplin.

- a** At the top of the map window, click the **Analysis** button.

Note: If you don't see the Analysis button, ensure that you are signed in to [ArcGIS Online](#) using the credentials for access to the content associated with this course.

- b** In the Perform Analysis pane, expand **Summarize Data**, and click **Summarize Within**.

- c In the Summarize Within pane, set the following options:
- For Choose Area Layer, select Tornado Path And Damaged Buildings - Tornado Path.
 - For Choose Layer To Summarize, select Joplin_Damage_Assessment.
 - For Add Statistics From The Layer To Summarize, select the following fields and statistics:
 - Damage - Minimum
 - Damage - Maximum
 - Damage - Average
 - For Result Layer Name, type **Summary of Joplin Building**
Damage_yourfirstandlastname.

Note: Add your first and last name to the result layer name to make it unique. If you run the analysis multiple times, you will need to provide a unique result layer name each time to avoid encountering an error message.

The Save Result In field defaults to your account name; you do not need to change this value for this exercise.

- d **Uncheck** the Use Current Map Extent check box, which is checked on by default. This will allow the results **to encompass the entire study area** that you have been examining.

 **Summarize Within** i ◀

1 Choose area layer to summarize other features within its boundaries i

Tornado Path and Damaged Buil... ▼

2 Choose layer to summarize i

Joplin_Damage_Assessment ▼

3 Add statistics from the layer to summarize i

Count of points

Damage ▼ Minimum ▼ ✖

Damage ▼ Maximum ▼ ✖

Damage ▼ Average ▼ ✖

Field ▼ Statistic ▼

4 Choose field to group by (optional) i

Field ▼

Add minority, majority i

Add percentages i

5 Result layer name i

Summary of Joplin Building Damage Kevin ▼

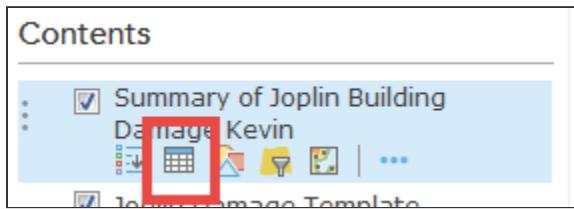
Save result in ▼

Use current map extent Show credits

- e Click Run Analysis.

A new summary layer is added to the map.

- f In the Contents pane, pause your pointer over the new Summary of Joplin Building Damage layer, and then click the Show Table button to open the layer table.



The table provides the minimum, maximum, and average damage percentage assessments from the feature layer.



In the image above, proportional symbols were used. If you have time, feel free to change the symbols in your map to match.

Your results will vary depending upon the number of damage assessments.

- g Use the information in the table to answer the following questions:

7. **How many houses had been assessed for damage when you ran your analysis?**

8. What are the statistics (Max, Min, and Average) for the houses that you assessed in the study area?

9. How many of these houses had a damage degree assessment of 100%?

10. Based on this analysis, what percentage of the number of houses are a complete loss (100% degree of damage)?

Hint: Sort the Maximum Damage column in descending order.

- (h) Close the layer table by clicking the X in the upper-right corner.

Summary of Joplin Building Damage Kevin (1 feature, 0 selected)					Table Options ▾
Count of Points	Minimum Damage	Maximum Damage	Average Damage	Name	X
18	75	100	87.9412		

The results can be explored using tables to see specific attributes, but symbolizing the points will also yield information about where to send the field agents.

In the next step, you will evaluate the regional impact of the tornado.

Step 7: Filter the view of features in a layer

By editing the feature service, you were able to assume the role of an insurance adjustor using imagery from ArcGIS Online to evaluate damage to homes caused by a natural disaster.

In this step, you will evaluate the data published to ArcGIS Online regarding damage to buildings in the regional area.

- (a) In the Contents pane, click the arrow to the left of the Tornado Path And Damaged Buildings map service to expand it.

Contents

- Summary of Joplin Building Damage
Kevin
- Joplin Damage Assessment
 - ◀ Tornado Path and Damaged Buildings
 - Building footprints clip
 - Tornado Path
 - ▶ World Transportation
 - ▶ Joplin, MO Post Tornado Imagery .25ft
 - ▶  Imagery
 - ...

- b Open the table view of the **Building Footprints Clip** layer.



- c Use the information in the layer table to answer the following questions.

11. According to the table, how many damaged buildings are there?

You can glean more information by filtering the records in the layer table.

- d At the top right of the layer table, click **Table Options**.
e From the drop-down list, choose **Filter**.

You will filter your view of the layer's features to better understand the impact of the damage on the region. **Most residential buildings are under 35 feet high and under 3,000 square feet**, so you will create a filter expression to locate buildings that meet these criteria.

- f In the Filter dialog box, choose HEIGHT as the field to filter on.
- g In the second field, select Is Less Than.
- h For the third field, ensure that the Value option is selected, and type **35** into the field.

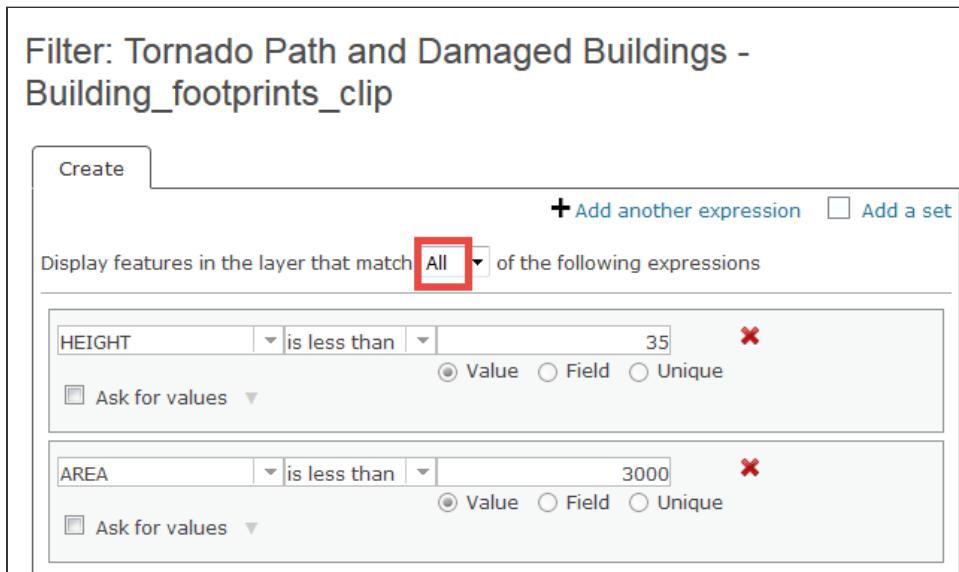
This expression addresses the criterion for building height. You can combine expressions to more efficiently filter records in the table, so now you will create a second expression to address the criterion for square footage.

- i At the top of the Filter dialog box, click Add Another Expression.
- j Choose Area as the field to filter on.

In this dataset, the Area field contains information about building square footage.

- k In the second field, select Is Less Than.
- l For the third field, ensure that the Value option is selected, and type **3000** into the field.

Because you want to find features (buildings) that meet both the square foot and height criteria, be sure that the statement at the top of the dialog box is set to "All."



- m Click **Apply Filter**.

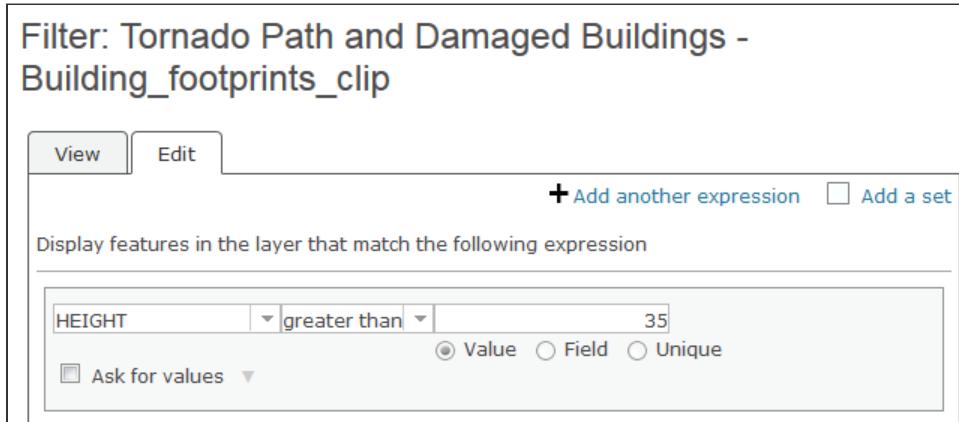
The number of features in the table changes, and only those that meet the identified criteria are listed.

Use the filter on the Building Footprints Clip layer table to answer the following questions.

12. How many damaged buildings are under 35 feet high, and under 3,000 square feet?

Edit the filter to answer additional questions.

- (n) Click Table Options, and then select Filter.
- (o) In the Filter dialog box, click Edit.
- (p) Delete the second expression related to building area by clicking the red X.
- (q) For the building height expression, in the second field, change the value to Is Greater Than.



- (r) Click **Apply Filter**.

13. How many buildings are over 35 feet tall?

As you consider damage and loss assessments, you are interested in **what the average square footage of the buildings over 35 feet tall is**. You can use table statistics to examine this information.

- (s) In the table, click the name of the **Area column**, and from the pop-up, choose **Statistics**.

Statistics

Field: AREA

Number of Values	494
Sum of Values	2,507,209.06182
Minimum	47.37878
Maximum	225,380.47452
Average	5,075
Standard Deviation	18,165

Use the information in the Statistics pop-up to answer the following questions:

- 14. What is the average size of these buildings over 35 feet tall?**

- 15. If the analysis that you performed for the damaged area in Joplin is representative of the total damage of the 8,820 buildings, how many of the total damaged buildings would be considered a complete loss?**

-
- t Click Close to close the Statistics pop-up, and then close the table.

Conclusion

In this exercise, you learned how imagery can be used to assist in the analysis of damage and loss due to a disaster. Through an examination of the damage displayed on imagery, you were able to assess the degree of damage to buildings that the tornado caused.

Answers to Exercise Questions

1. How many houses are located in the four-block area?

Fifteen. The larger buildings are houses, and the smaller buildings are likely garages or other small buildings.

2. How many have detached garages or other buildings?

2

3. How many homes are now visible in the four-block area?

17

4. On which street are the new homes visible in the imagery located?

W 27th Street

5. How many of the homes have detached garages or other buildings?

6

6. On which street do the homes not have large trees in their yard?

W 29th Street

7. How many houses had been assessed for damage when you ran your analysis?

Answers will vary, depending upon the number of houses that you assessed

8. What are the statistics (Max, Min, and Average) for the houses that you assessed in the study area?

Answers will vary, depending upon the number of houses that you assessed

9. How many of these houses had a damage degree assessment of 100%?

Four appear to be damaged at 100% based on the available imagery, but results may vary

10. Based on this analysis, what percentage of the number of houses are a complete loss (100% degree of damage)?

4/15, or 26.6%

11. According to the table, how many damaged buildings are there?

10,570

12. How many damaged buildings are under 35 feet high, and under 3,000 square feet?

8,820

13. How many buildings are over 35 feet tall?

494

14. What is the average size of these buildings over 35 feet tall?

5,075

15. If the analysis that you performed for the damaged area in Joplin is representative of the total damage of the 8,820 buildings, how many of the total damaged buildings would be considered a complete loss?

At 26%, the answer is 2,352, but results will vary.