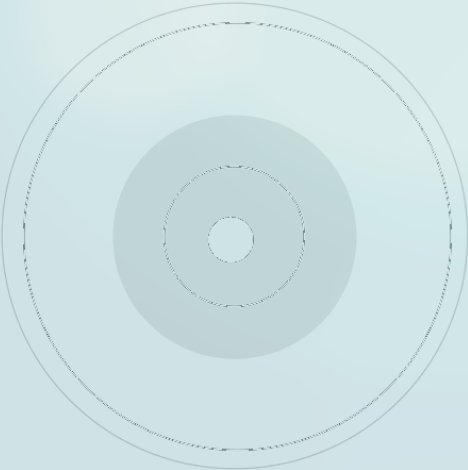# Thailand's Miracle Cave Rescue – A Race Against Time

Lesson Overview

On June 23, 2018, a teenage soccer team was exploring Thailand's extensive Tham Luang cave when rising rainwater unexpectedly trapped the 12 boys, as well as their coach, far below ground. Organizers have asked you to create maps assisting the rescue effort.

Build Skills in These Areas

➤ Selecting by attribute

➤ Creating bookmarks

➤ Searching for data

Software Requirements

➤ ArcGIS Online account (create a free ArcGIS Public Account or get a free ArcGIS trial)
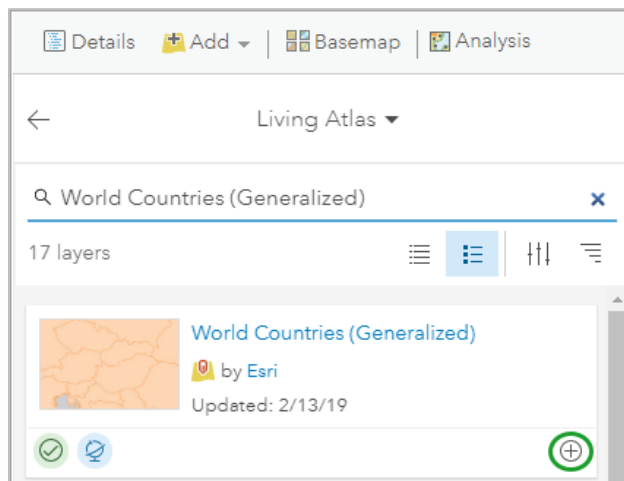
Estimated Time

➤ 30 – 1 hour

Teacher Resources

➤ YouTube video: Thailand Cave Rescue: ABC News (Australia)

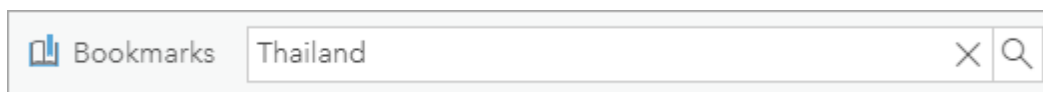➤ Hands-on lab: Sinkholes in a Cup

➤ National Speleological Society

Exercise

Step 1: Browse the Living Atlas
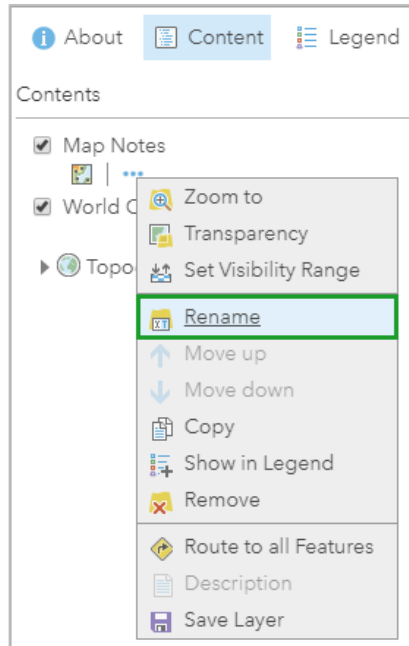
1. Go to ArcGIS Online and sign into your organizational account.

2. Click **Map** on the top ribbon.

3. Click **Content** under **Details**.

4. Go to **Add**, click **Browse Living Atlas Layers**, and in the search box, type World Countries (Generalized).

5. Click the **add** button in the lower right corner to add the layer to the map.

6. Click the **back arrow** to return to the **Content** pane.

7. Click **More Options** at the end of the **World Countries (Generalized)** layer and click **Zoom to**.

8. In the upper right corner of the map, in the search box, type Thailand and press *Enter*.

9. Click **Add to Map Notes**.

10. In the **Content** pane, point to the **Map Notes** layer, click the **More Options**, and click **Rename**.

11. Name the **Map Notes**: Thailand and click **OK**.

12. On the ribbon, click **Save** and click **Save As**.

13. Add the appropriate metadata to the **Save Map** window:

- **Title**: Type Thailand Rescue (and then type your initials)

- **Tags**: Type Thailand, cave, rescue (press *Enter* after each entry)

- **Summary**: Type A spatial presentation of the Thailand Cave Rescue.
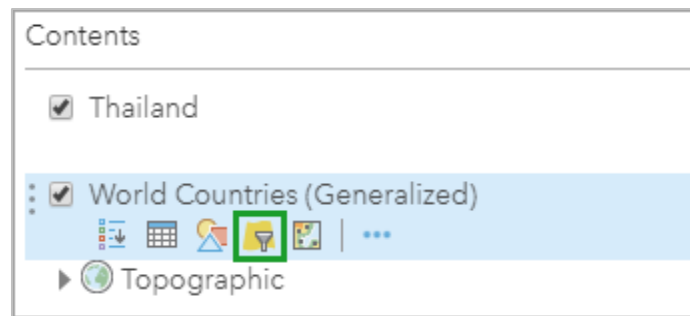
- **Save in folder**: Choose a folder.
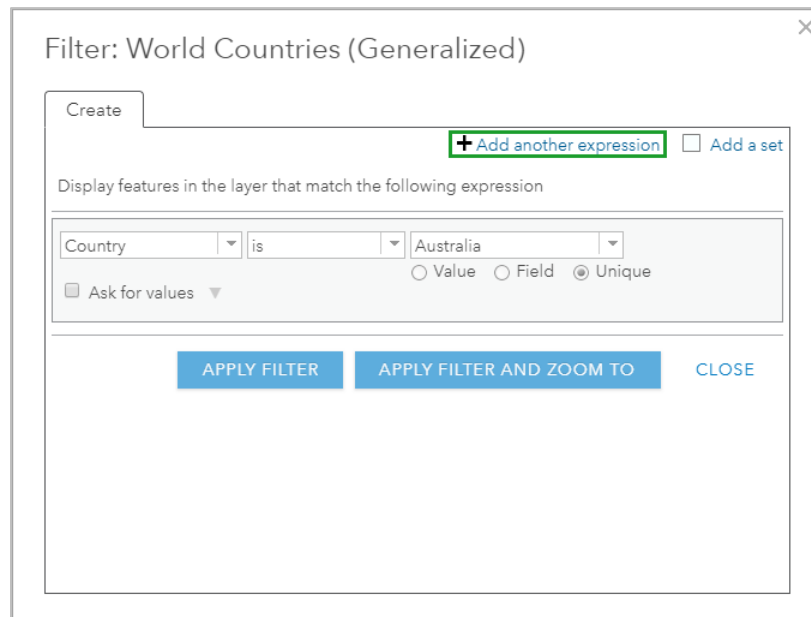
14. Click **Save Map**.

Step 2: Identify international help

The following countries are helping with the rescue: Australia, China, Japan, Laos, Myanmar, the United Kingdom, and the United States. Your job is to make a map showing the location of these countries.
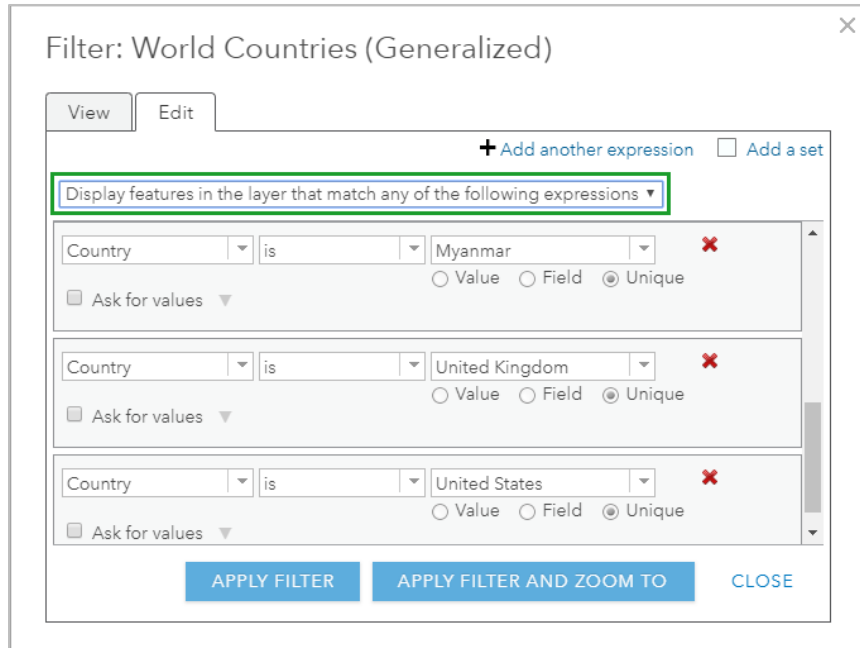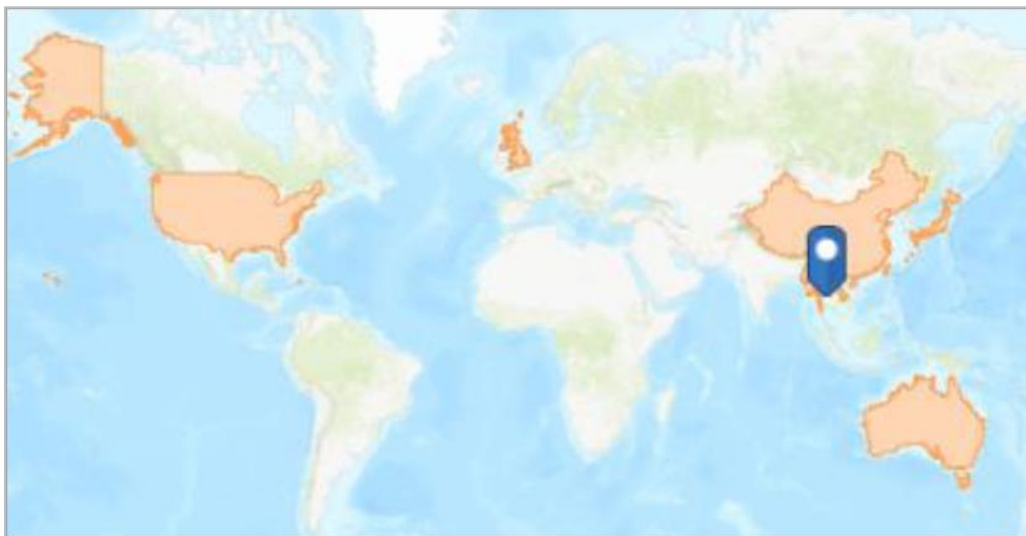
1. Click **Filter** under **World Countries**.

2. Create the expression: **Country is Australia**.

3. Click **Add another expression**.

4. Continue adding expressions for the remaining six countries.

5. Select the **Display features in the layer that match any of the following expressions** tab.

Filter: World Countries (Generalized)

View   Edit

+ Add another expression   ☐ Add a set

Display features in the layer that match any of the following expressions ▼

Country ▼ | is ▼ | Myanmar ▼ | ✖
○ Value ○ Field ◉ Unique
☐ Ask for values ▼

Country ▼ | is ▼ | United Kingdom ▼ | ✖
○ Value ○ Field ◉ Unique
☐ Ask for values ▼

Country ▼ | is ▼ | United States ▼ | ✖
○ Value ○ Field ◉ Unique
☐ Ask for values ▼

APPLY FILTER   APPLY FILTER AND ZOOM TO   CLOSE

6. Click **Apply Filter and Zoom to**.

7. Click **More Options** at the end of **World Countries** and rename the layer: <u>International Help</u>.

8. On the ribbon, click the **Bookmarks** tab.

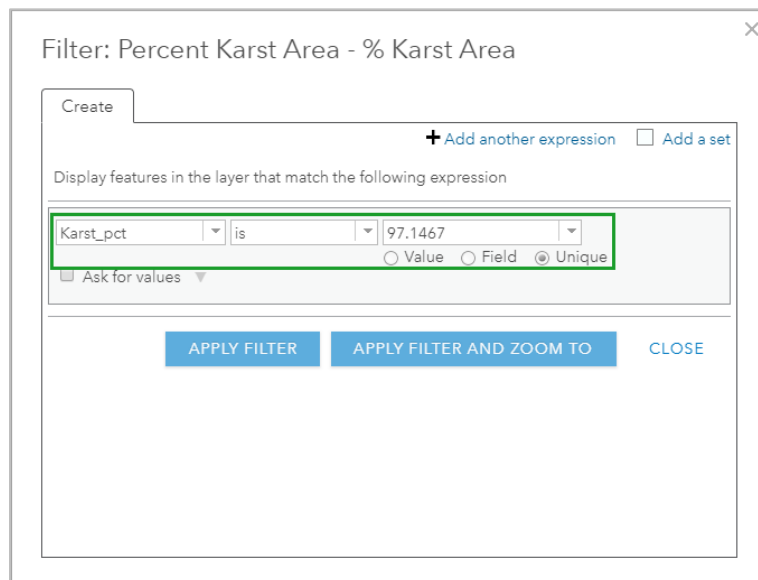9. Add a bookmark and name it <u>International Help</u>.

Step 3: Make a map: Identify Thailand

Significant portions of Thailand are karst, which is landscape that includes sinkholes, limestone cliffs, and underground streams. These features, made from soluble rock such as limestone and gypsum, took millions of years to form. This includes the Tham Luang caves, where the trapped boys were located two miles from the entrance.

1. Go to **Add** and search **Browse Living Atlas Layers**.

2. Search for a karst layer.

3. Add **Percent Karst Area**.

4. Click the back button.

5. Click the **Percent Karst Area** layer to expose the legend.

Notice that the layer uses colors, from lightest to darkest, to categorize karst percentages.

6. Click **Filter** under the **Percent Karst Area** layer.

7. Filter the karst layer for the highest percentage: 97.1467 percent.

8. Click **Apply Filter**.

9. Zoom to the area with the highest karst percentage in the world.

    (Hint: Uncheck the three layers and zoom in to the **Topographic** layer.)

    Q1: *What US state has the world's highest percentage of karst?*
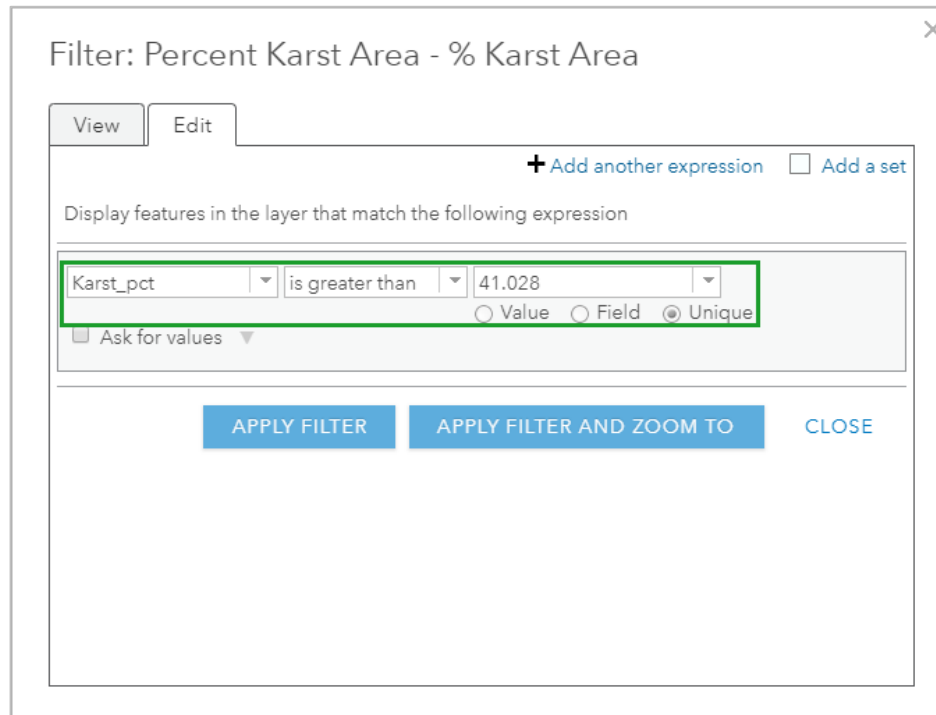
    A1: _____

10. Change the basemap from **Topographic** to **Imagery**.

   Q2: *What features in the imagery would be an indication of karst?*

   A2: _____

11. Change the basemap back to **Topographic** and check all three layers.

12. Filter the **Percent Karst Area** layer that is greater than 41.028. (You will need change the operator as well as click the **Edit** tab on the window.)
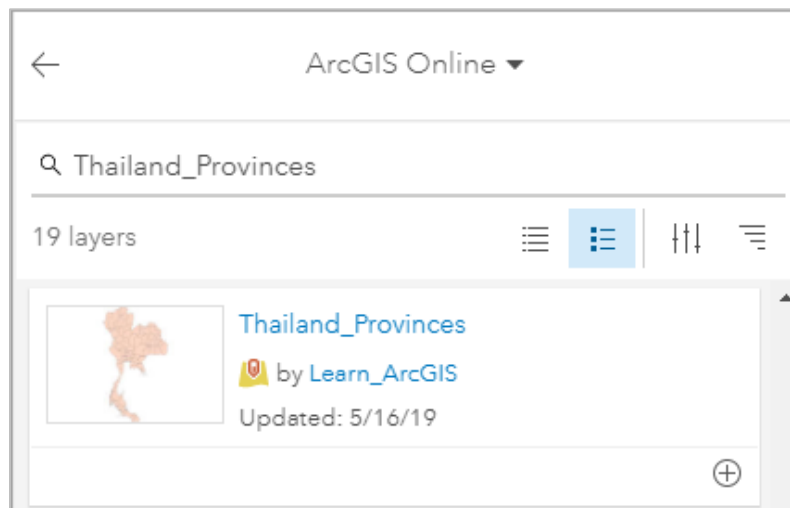

13. Click **Apply Filter and Zoom to**.

Now, the map shows areas having more than 41.028 percent karst.

In Thailand, a province is comparable with an American state. The Tham Luang cave is in the Chiang Rai province.

14. Go to **Add**, click **Search for Layers**, click **ArcGIS Online** and then search for:

Thailand_Provinces. In the results, add the layer from Learn_ArcGIS.

15. Click the back arrow to return to the **Content** pane.

16. Click **Filter** under the **Thailand Provinces** layer and create the expression: **Name is Chiang Rai**.

17. Click **Apply Filter and Zoom to**.

The Chiang Rai province is isolated in the center of your map.

18. Zoom out three levels so you can see Thailand's karst regions as well as the Map Note marker. (Hint: Click the **Percent Karst Area** layer.)

Q3: *What is the karst percentage in Chiang Rai Province?*

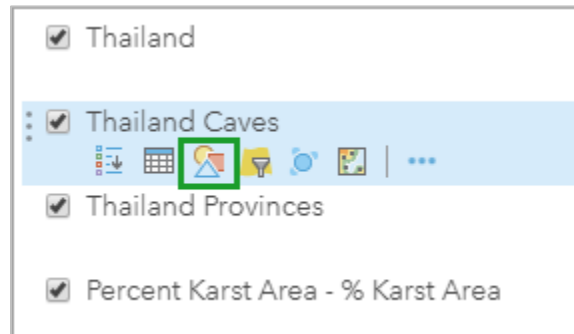A3: _____

19. Create a Chiang Rai Province bookmark.

Step 4: Identify the cave

1. Go to **Add**, click **Search for Layers**, click **ArcGIS Online**, search for Thailand_Caves and then add the layer from LearnArcGIS. (This layer contains nearly 40,000 points; optionally, you may want to publish your data as a hosted tile layer to accommodate such a large number.)
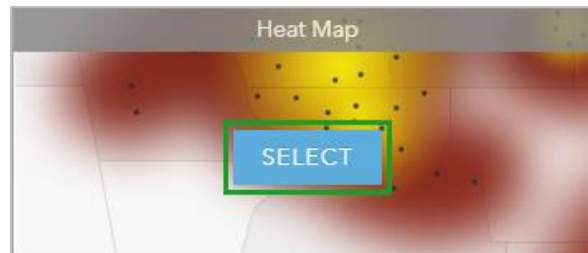
    Q4: *Is there any correlation between the karst and the number of caves?*

    A4: _____

2. Click **Change Style** under **Thailand_Caves**.

3. For **Heat Map**, click **Select**, and then click **Done**.

Heat maps show concentrations of point features. In ArcGIS Online, this heat map is scalable.
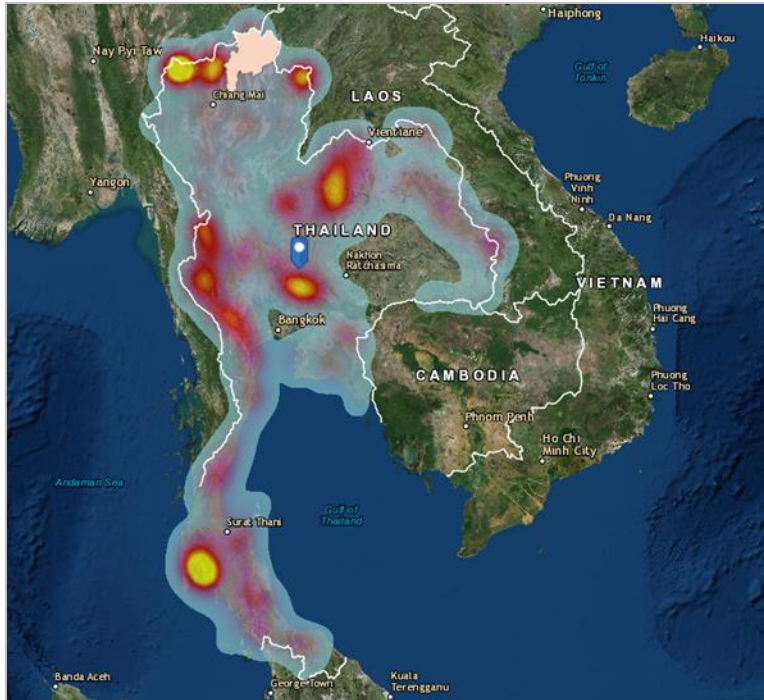
4. Uncheck the layers for **International Help** and **Percent Karst Area**.

5. Change the basemap to **Imagery with Labels**.

    Q5: *Name some locations in Thailand with high concentrations of caves. (Zoom in as necessary.)*
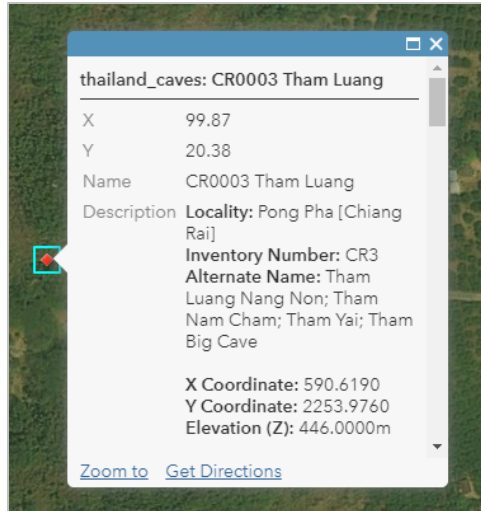
    A5: _____

    Q6: *What is a scalable map?*

    A6: _____

6. Change the **Thailand Caves** style back to **Location (Single Symbol)** and click **Done**.

7. Filter the Thailand Caves layer using the expression: <u>Name starts with CR0003</u>. (Hint: If you inadvertently use "is" as an operator, you will get an error message saying you have too many values to display.)

   The name of the cave is Tham Luang.

8. Click **Apply Filter and Zoom to**.

9. Click **Change Style** under **Thailand Caves**.

10. Click **Options**.

11. Click **Symbols** choose a symbol and make it 36 pixels.

12. Click **OK** twice and click **Done**.

13. Uncheck the layers for **International Help**, **Percent Karst Area**, and **Thailand Provinces.**

14. Zoom out until you can clearly see the trees.

15. Change the basemap to **Imagery** and click the symbol to see its pop-up.

16. Close the pop-up and create a bookmark called <u>Cave</u>.

> Q7: *Zoom out and describe the landscape around the cave.*
>
> A7: _____

Step 5: Symbolize Thailand's caves

1. Open the <u>Thailand Cave Symbolization</u> map.

So far, this lesson has created maps with four different types of symbolization.

A heat map is a scalable map reflecting concentrations of points.
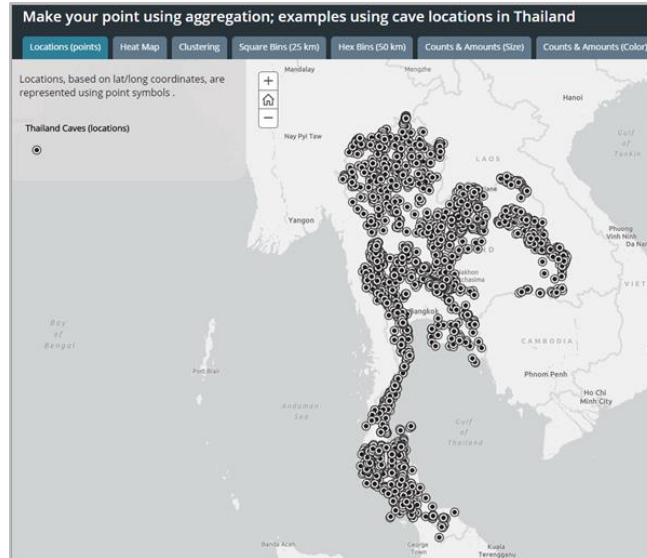
Clustering is used with many points to extract information from your data. It's applied at multiple scales, which means as you zoom out, more points are aggregated into fewer groups while zooming in creates more cluster groups.

Hex bins are used to summarize point data into equal sized connected hexagons. By using a hexagon, you can make the actual x, y location of the point private, which is good for sensitive material such as the cave locations.
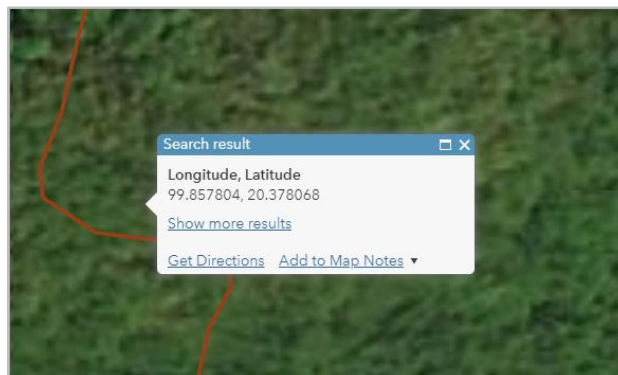
2. Click the tabs, read the legends, and answer the following question:

> Q8: *Which type of aggregation groups point features into one symbol?*
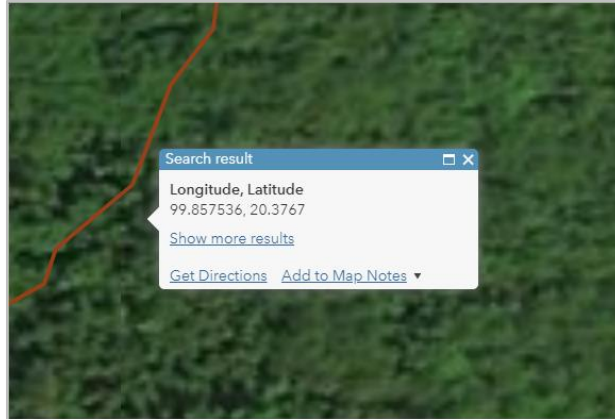>
> A8: _____

3. Return to the Thailand Rescue map and go to **Add**, click **Search for Layers**, and click **ArcGIS Online**.

4. Search for <u>learn_thailand</u>.

5. Add <u>cave_line</u> to the map.

6. Click the back arrow to return to the **Content** pane.

7. In the search box, type <u>99.8578044,20.3780681</u>.

8. Add a Map Note.

9. Name the Map Note: <u>Pattaya Beach</u> and change the symbol to one of your choice. (Hint: Click the symbol and click **Edit**.)

This is where the rescue crew hoped to find the boys.

10. In the search box, type <u>99.8575364,20.3767639</u>.

11. Add a map note named <u>Boys</u> and change the symbol.

This is the actual location where the boys and coach were found.

12. Make a bookmark named <u>Inside the Cave</u>.

13. Save the project.

Conclusion

Nine days after the boys went missing, and with the help of 100 international divers, the stranded team was located on July 2; another week would pass before the entire team was successfully extracted. More than 10,000 people joined the rescue. One Thai special forces diver was asphyxiated while delivering oxygen supplies. A second Thai Navy SEAL diver died in December 2019 after he was overcome by a blood infection contracted during the rescue.

In this lesson, you have created a series of local, regional, and world maps, to show the location of the Tham Luang cave.

Exercise Answers

Q1: *What US state has the world's highest percentage of karst?*

A1: *Florida*

Q2: *What features in the imagery would be an indication of karst?*

A2: *Sinkholes.*

Q3: *What is the karst percentage in Chiang Rai Province?*

A3: *5.1 – 15.0%*

Q4: *Is there any correlation between the karst and the number of caves?*

A4: *Yes. The number of caves appear to correspond with the percentage of karst, e.g. the higher the karst percentage, the higher the number of caves.*

Q5: *Name some locations within Thailand with high concentrations of caves.*

A5: *Krabi, Loei, Wang Saphung, Mae Hong Son, Chiang Mai, (Answers will vary)*

Q6: *What is a scalable map?*

A6: *A dynamically changing map reflecting the appropriate scale, detail, and appearance of the Earth's surface while panning or zooming.*

Q7: *Zoom out and describe the landscape around the cave.*

A7: *Cave entrance appears to be sandwiched between a forest valley to the west and farm fields and rural development to the east.*

Q8: *Which type of aggregation groups point features into one symbol?*

A9: *Clustering*

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About the Author

Kathryn Keranen is an award-winning teacher and author. She serves as an instructor in geographic science at James Madison University and is the co-founder of the award-winning Geospatial Semester. With Bob Kolvoord, she is the co-author of the Making Spatial Decisions series from Esri Press.

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