Exercise 2: Quantify deforestation in the Amazon

How can I print an exercise to PDF format?

Software requirements

- ArcGIS Online
- ArcGIS Pro 3.1
- ArcGIS Image Analyst extension
- ArcGIS Spatial Analyst extension

Introduction

Spatial analysis allows you to solve complex location-based problems. Using ArcGIS Pro for spatial analysis, you can query data, explore and understand data from a geographic perspective, determine relationships, detect and quantify patterns, and make predictions and decisions. Spatial analysis goes beyond visualizing data on a map by allowing you to study the attributes of places and their relationships.

For this exercise, two layers have already been created that use the same definition query workflow that you learned in the previous exercise to create layers for 1992 and 2020. Each layer has been projected to the South America Albers Equal Area Conic projected coordinate system, and the area of interest has been clipped to the boundary of Rondônia, Brazil, to create an area of interest for the project. To more accurately quantify land area that has been converted from forest to cropland or urban areas in Rondônia, Brazil, it is best practice to project the data to an equal area projection. If you were using a larger dataset, such as the Global Land Cover layer, you could clip your data to create an area of interest that would allow faster calculation times.

Scenario

Imagine that you are continuing your work for the nonprofit organization that is mapping deforestation in the Amazon. While visualizing deforestation for your area of interest, it was clear that the land cover in Rondônia, Brazil, changed a lot. This caused you to question whether your GIS data could help you answer other questions, in particular, how much land area was affected by deforestation in Rondônia, Brazil. In this exercise, you will use spatial analysis in ArcGIS Pro to help answer this question. You will calculate how much land cover change occurred in the past two decades, specifically land that changed from forested to cropland and urban areas in Rondônia, Brazil. You will use the result to validate the patterns that are being visualized on your map.

Note: The exercises in this course include View Result links. Click these links to confirm that your results match what is expected.

Estimated completion time in minutes: 30

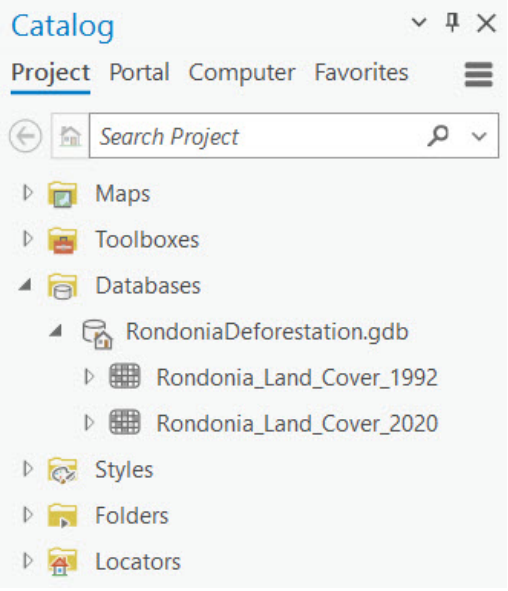
Expand all steps | Collapse all steps

- Step 1: Add data from a geodatabase

In this step, you will add two layers from the project's geodatabase that have been projected to an equal area projection for your area of interest, Rondônia, Brazil.

a If necessary, sign in to ArcGIS Pro with your course ArcGIS account username and password, and then open the RondoniaDeforestation project.

b On the right, in the Catalog pane, expand Databases, and then expand RondoniaDeforestation.gdb.



*Step 1b***: Add data from a geodatabase.*

- Hint

  Click View Result links to confirm that your results match what is expected.

The two layers that you will use for your analysis are stored in the project's geodatabase. An ArcGIS geodatabase is a collection of geographic datasets of various types held in a common file system folder. You will add the layers to the map.

c Right-click the Rondonia_Land_Cover_1992 layer and select Add To Current Map.

d Using the same method, add the Rondonia_Land_Cover_2020 layer to the map.

You added two layers from the project's geodatabase that focus on your area of interest, Rondônia, Brazil.

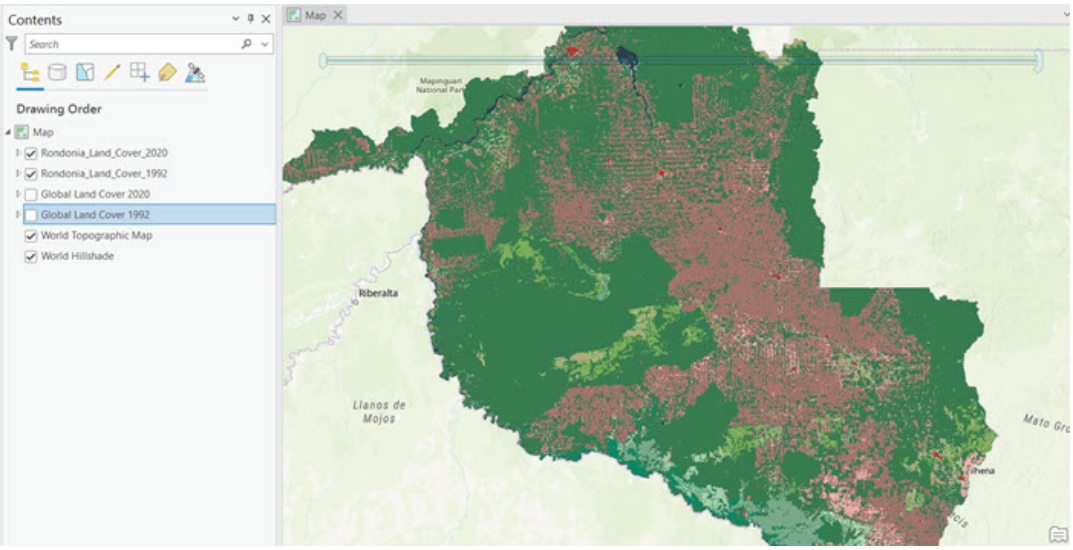
e Hide the legend for both layers.

- Hint

  To the left of the layer name, click the arrow.

f On the left, in the Contents pane, uncheck the box for the Global Land Cover 2020 layer to turn it off.

g Using the same method, turn off the Global Land Cover 1992 layer.



*Step 1g***: Add data from a geodatabase.*

To calculate area for your analysis, you need to know the cell size for the layer. You can find this information in the layer properties and in the metadata of the source layer. Metadata is important for GIS analyses because it provides important details about a layer or item.

You will review the metadata for the source layer, Global Land Cover 1992-2020.

h Go to https://www.arcgis.com/home/item.html?id=1453082255024699af55c960bc3dc1fe to view the source layer's metadata.

? According to the metadata, what is the cell size for the Global Land Cover 1992-2020 imagery layer?

- Answer
The cell size is 300 meters.

i Close the web browser tab for the source layer and save your ArcGIS Pro project.

You have added the layers that you need to calculate how much land was converted to cropland and urban areas between 1992 and 2020.

- Step 2: Calculate land cover change

In this step, you will calculate a new field in your data to compare how much land in Rondônia, Brazil, changed from forested in 1992 to cropland and urban areas in 2020.

a In the Contents pane, right-lick Rondonia_Land_Cover_2020 and choose Attribute Table.

Rondonia_Land_Cover_2020

Field: Add Calculate Selection: Select By Attributes Zoom To Switch Clear Delete Copy

	OBJECTID *	Value	Count	ClassName	Red	Green	Blue	Alpha	ESA Class	Popup Text	Opacity
1	1	10	10967	Rainfed Cropland	247	198	196	255	Cropland, rainfed	rainfed cropland	1
2	2	11	30341	Herbaceous Cropland	244	176	171	255	Herbaceous cover	herbaceous cropland	1
3	3	30	629055	Mostly Cropland in a M...	163	116	108	255	Mosaic cropland (>50%...	mostly cropland in a m...	1
4	4	40	56018	Mostly Natural Vegetati...	175	141	137	255	Mosaic natural vegetati...	mostly natural vegetati...	1

*Step 2a***: Calculate land cover change.*

The attribute table opens below the map. The attribute table stores the tabular data for the layer. The ClassName field identifies the type of land cover classification and the Count field shows the number of cells in the layer that are classified as each ClassName type. You can use the information from the attribute table and the cell size information from the layer's metadata to calculate the amount of land, or area, covered by each of the land cover classification types.

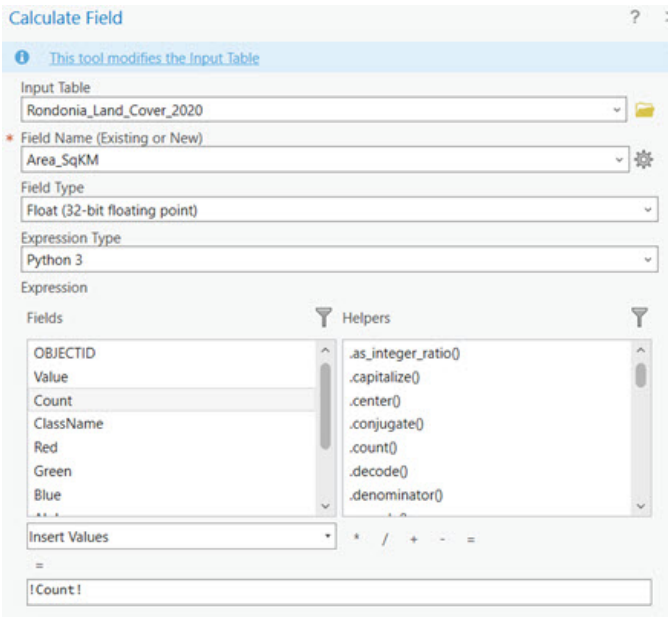
b At the top of the attribute table, click Calculate.

c In the Calculate Field dialog box, for Field Name, type **Area_SqKM**.

d For Field Type, click the down arrow and choose Float (32-bit Floating Point).

The Field Type refers to the data type that will be stored in the field that you are creating in the attribute table. You are working with numeric data for your analysis and can choose one of four numeric data types. Short and Long Integer are for numeric data types that only require whole numbers, whereas Float and Double numeric data types can store fractional numbers with decimal places. Your calculation will generate fractional numbers.

e Under Fields, double-click Count.



*Step 2e***: Calculate land cover change.*

You are using the Calculate Field tool to create a new field called Area_SqKM as a numeric field type. The Area_SqKM field will be calculated from the count, or number of cells, multiplied by 90,000, because the area of each 300-meter cell equals 90,000 square meters. It will then be multiplied by 0.000001 to convert the area from square meters to square kilometers.

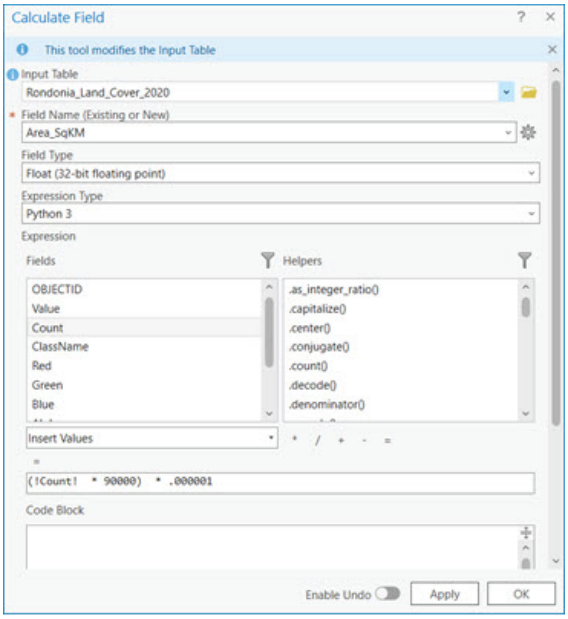
f To the right of Insert Values, click the multiply symbol *.

g In the equation field, after the multiply symbol, type **90000**

h Add parentheses around !Count! * 90000.

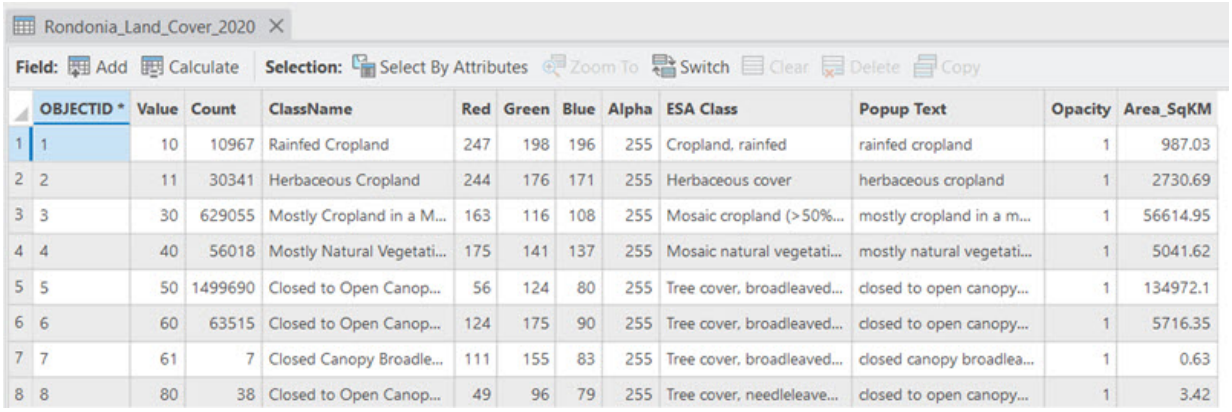
i Click the multiply symbol * again, and then type **.000001**

j Confirm that your final equation reads as follows: `(!Count!  * 90000)  * .000001`



*Step 2j***: Calculate land cover change.*

k Click Apply, and then click OK.



	OBJECTID *	Value	Count	ClassName	Red	Green	Blue	Alpha	ESA Class	Popup Text	Opacity	Area_SqKM
1	1	10	10967	Rainfed Cropland	247	198	196	255	Cropland, rainfed	rainfed cropland	1	987.03
2	2	11	30341	Herbaceous Cropland	244	176	171	255	Herbaceous cover	herbaceous cropland	1	2730.69
3	3	30	629055	Mostly Cropland in a M...	163	116	108	255	Mosaic cropland (>50%...	mostly cropland in a m...	1	56614.95
4	4	40	56018	Mostly Natural Vegetati...	175	141	137	255	Mosaic natural vegetati...	mostly natural vegetati...	1	5041.62
5	5	50	1499690	Closed to Open Canop...	56	124	80	255	Tree cover, broadleaved...	closed to open canopy...	1	134972.1
6	6	60	63515	Closed to Open Canop...	124	175	90	255	Tree cover, broadleaved...	closed to open canopy...	1	5716.35
7	7	61	7	Closed Canopy Broadle...	111	155	83	255	Tree cover, broadleaved...	closed canopy broadlea...	1	0.63
8	8	80	38	Closed to Open Canop...	49	96	79	255	Tree cover, needleleave...	closed to open canopy...	1	3.42

*Step 2k***: Calculate land cover change.*

A new field is added to your attribute table that displays the total number of square kilometers for each land cover classification in Rondônia, Brazil.

l Open the attribute table for the Rondonia_Land_Cover_1992 layer.

m Complete the same workflow for the 1992 layer to calculate the area in square kilometers.

	OBJECTID *	Value	Count	ClassName	Red	Green	Blue	Alpha	ESA Class	Popup Text	Opacity	Area_SqKM
1	1	10	6524	Rainfed Cropland	247	198	196	255	Cropland, rainfed	rainfed cropland	1	587.16
2	2	11	9667	Herbaceous Cropland	244	176	171	255	Herbaceous cover	herbaceous cropland	1	870.03
3	3	30	201730	Mostly Cropland in a M...	163	116	108	255	Mosaic cropland (>50%...	mostly cropland in a m...	1	18155.7
4	4	40	13956	Mostly Natural Vegetati...	175	141	137	255	Mosaic natural vegetati...	mostly natural vegetati...	1	1256.04
5	5	50	2038599	Closed to Open Canop...	56	124	80	255	Tree cover, broadleaved...	closed to open canopy...	1	183473.9
6	6	60	67423	Closed to Open Canop...	124	175	90	255	Tree cover, broadleaved...	closed to open canopy...	1	6068.07
7	7	61	42	Closed Canopy Broadle...	111	155	83	255	Tree cover, broadleaved...	closed canopy broadlea...	1	3.78
8	8	80	27	Closed to Open Canop...	49	96	79	255	Tree cover, needleleave...	closed to open canopy...	1	2.43

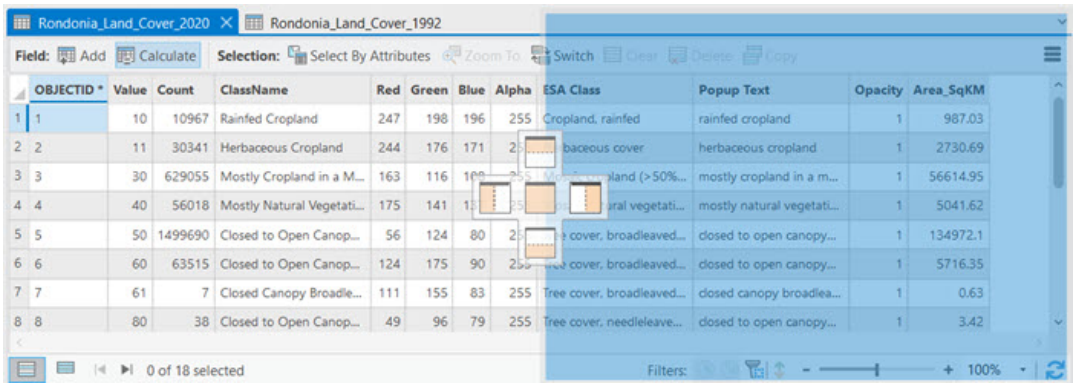
*Step 2m***: Calculate land cover change.*

You calculated the total area for each land cover classification in Rondônia, Brazil, for both 1992 and 2020. These calculations allow you to identify the total area of forest that was converted to cropland and urban areas between 1992 and 2020.

n Click and hold the Rondonia_Land_Cover_2020 attribute table tab.

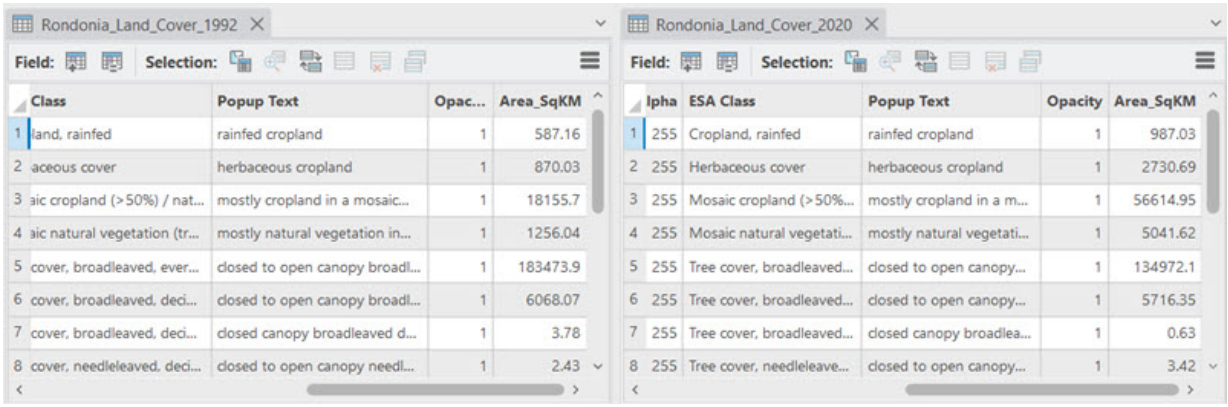
As you begin to drag the table tab, a docking target appears. Each target represents an area where the tab can be positioned: left, top, right, or bottom.

o Drag the tab to the right of the Rondonia_Land_Cover_1992, as shown in the following graphic:



p Release your mouse to dock the tables side by side.

q In both tables, scroll to the right until you can see the Area_SqKM field.



	Class	Popup Text	Opac...	Area_SqKM
1	land, rainfed	rainfed cropland	1	587.16
2	aceous cover	herbaceous cropland	1	870.03
3	aic cropland (>50%) / nat...	mostly cropland in a mosaic...	1	18155.7
4	aic natural vegetation (tr...	mostly natural vegetation in...	1	1256.04
5	cover, broadleaved, ever...	closed to open canopy broadl...	1	183473.9
6	cover, broadleaved, deci...	closed to open canopy broadl...	1	6068.07
7	cover, broadleaved, deci...	closed canopy broadleaved d...	1	3.78
8	cover, needleleaved, deci...	closed to open canopy needl...	1	2.43

	lpha	ESA Class	Popup Text	Opacity	Area_SqKM
1	255	Cropland, rainfed	rainfed cropland	1	987.03
2	255	Herbaceous cover	herbaceous cropland	1	2730.69
3	255	Mosaic cropland (>50%...	mostly cropland in a m...	1	56614.95
4	255	Mosaic natural vegetati...	mostly natural vegetati...	1	5041.62
5	255	Tree cover, broadleaved...	closed to open canopy...	1	134972.1
6	255	Tree cover, broadleaved...	closed to open canopy...	1	5716.35
7	255	Tree cover, broadleaved...	closed canopy broadlea...	1	0.63
8	255	Tree cover, needleleave...	closed to open canopy...	1	3.42

*Step 2q***: Calculate land cover change.*

You have calculated the amount in square kilometers of each land cover type for 1992 and for 2020. When you compare the attribute tables and your calculations, it shows that, between the years of 1992 and 2020, the area in square kilometers of cropland and urban areas increased while the area of forested land decreased.

r Close both attribute tables and save your project.

As you begin to answer questions in your analysis, even more questions are likely to arise. In this case, your next question might be: If an area changed to a different land cover type, or category, which land cover type did it change to?

You will use change detection to help answer this question next.

- Step 3: Compute change raster

ArcGIS Pro offers many different extensions. For this MOOC, you have access to the Spatial Analyst, Image Analyst, and 3D Analyst extensions. The Image Analyst extension provides change-detection tools for raster, or imagery, data.

The Compute Change Raster tool compares two rasters and generates a new raster containing the difference between the two. In this step, you will use the Compute Change Raster tool to identify areas that changed to a different land cover type between 1992 and 2020.

a On the ribbon, click the Analysis tab and, in the Geoprocessing group, click Tools.

The Geoprocessing pane open on the right. The Geoprocessing pane is where you can find and run geoprocessing tools. In ArcGIS Pro, you can use geoprocessing tools to perform spatial analysis or manage your GIS data.

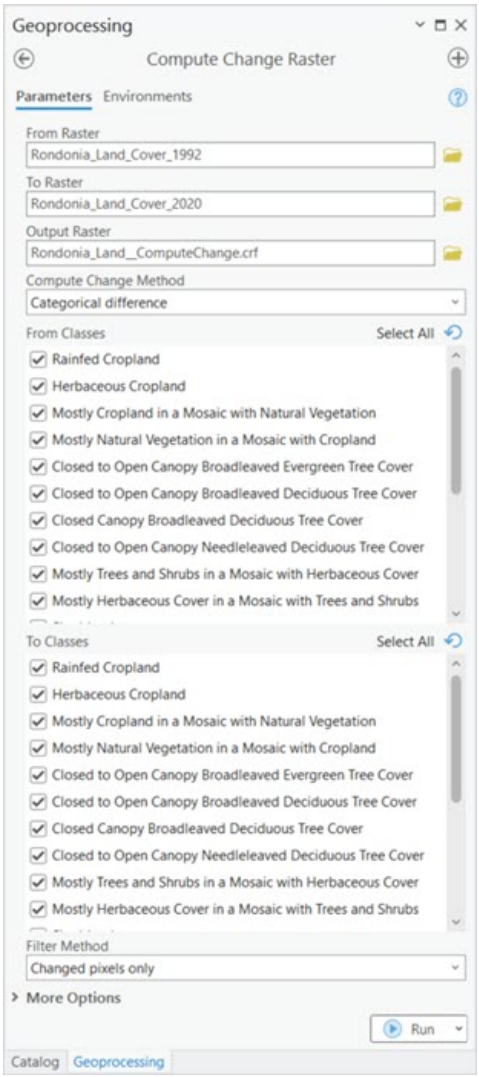
b In the Geoprocessing pane, in the Find Tools field, type **compute change**, and then press Enter.

c From the list of tools, click Compute Change Raster (Image Analyst Tools) to open the tool in the geoprocessing pane.

d In the Geoprocessing pane, set the following parameters:

- For From Raster, select Rondonia_Land_Cover_1992.
- For To Raster, select Rondonia_Land_Cover_2020.
- For Output Raster, leave the default value.
- For Compute Change Method, select Categorical Difference.
- For Filter Method, select Changed Pixels Only.

e Leave all other parameters as the default.



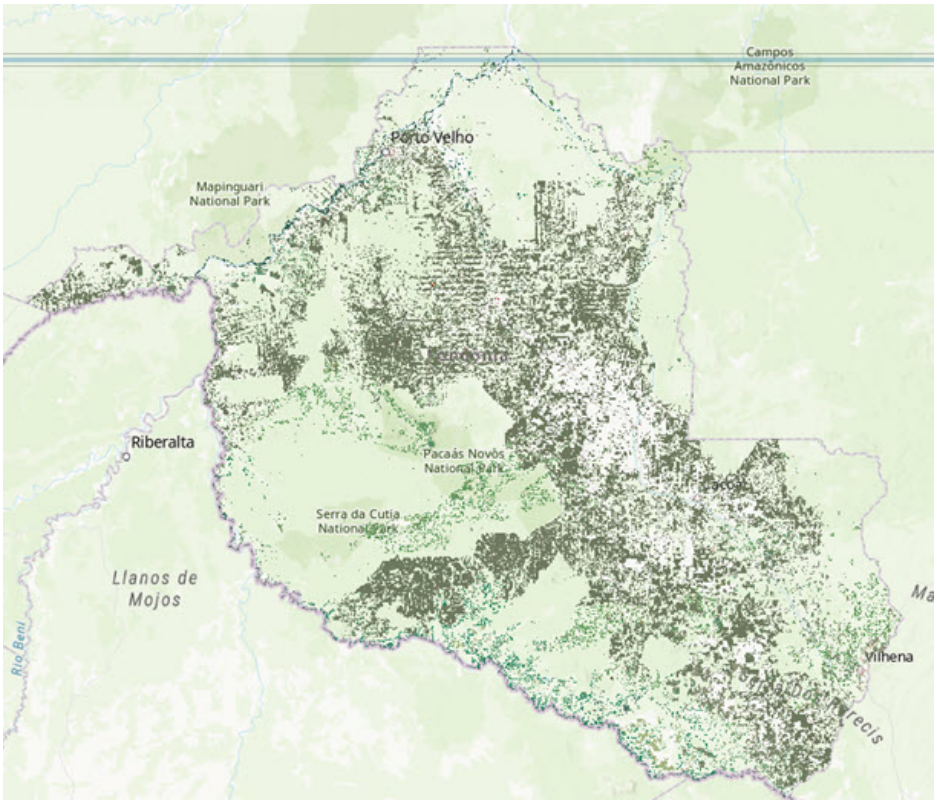
*Step 3e***: Compute change raster.*

The Output Raster parameter is the name of the new raster layer that will be created as a result of the tool being run. The Compute Change Method parameter is the calculation type that the tool will use for the analysis. In this case, the Categorical Difference option shows the difference between two categorical or thematic rasters in which the output shows every class transition that occurred between the two rasters; for example, the number of pixels that changed from Closed To Open Canopy Broadleaved Evergreen Tree Cover to Rainfed Cropland. For the Filter Method parameter, you selected Changed Pixels Only so that only those pixels that changed categories will be categorized in the output. Pixels that did not change categories will be grouped in a class called Other.

f At the bottom of the Geoprocessing pane, click Run.

g In the Contents pane, turn off the Rondonia_Land_Cover_1992 and the Rondonia_Land_Cover_2020 layers.

h For the Rondonia_Land_ComputeChange layer, expand the legend.



*Step 3h***: Compute change raster.*

The new Rondonia_Land_ComputeChange layer shows the change in land cover categories between 1992 and 2020 because you selected the Categorical Difference option in the tool's parameters.

For more information on the Compute Change Raster tool, see ArcGIS Pro Help: Compute Change Raster (Image Analyst).

i Right-click the Rondonia_Land_ComputeChange layer and choose Attribute Table.

Rondonia_Land_ComputeChange.crf

Field: Add Calculate Selection: Select By Attributes Zoom To Switch Clear Delete Copy

	OID	Value	Classvalue	Class_name	Class_From	Class_To	Red	Green	Blue	Alpha	Count	Area
1	0	0	211	Rainfed Cropland->Her...	Rainfed Cropland	Herbaceous Cropland	245	187	183	255	4	385943.144716
2	1	1	212	Rainfed Cropland->Mo...	Rainfed Cropland	Mostly Cropland in a M...	205	157	152	255	10	964857.861791
3	2	3	214	Rainfed Cropland->Clo...	Rainfed Cropland	Closed to Open Canop...	151	161	138	255	1244	120028318.007
4	3	4	215	Rainfed Cropland->Clo...	Rainfed Cropland	Closed to Open Canop...	185	186	143	255	79	7622377.10815
5	4	7	218	Rainfed Cropland->Mo...	Rainfed Cropland	Mostly Trees and Shrub...	205	205	186	255	127	12253694.8447
6	5	8	219	Rainfed Cropland->Mo...	Rainfed Cropland	Mostly Herbaceous Cov...	215	215	195	255	17	1640258.36504
7	6	9	220	Rainfed Cropland->Shr...	Rainfed Cropland	Shrubland	210	185	158	255	6	578914.717075
8	7	10	221	Rainfed Cropland->Gra...	Rainfed Cropland	Grassland	229	196	160	255	2	192971.572358

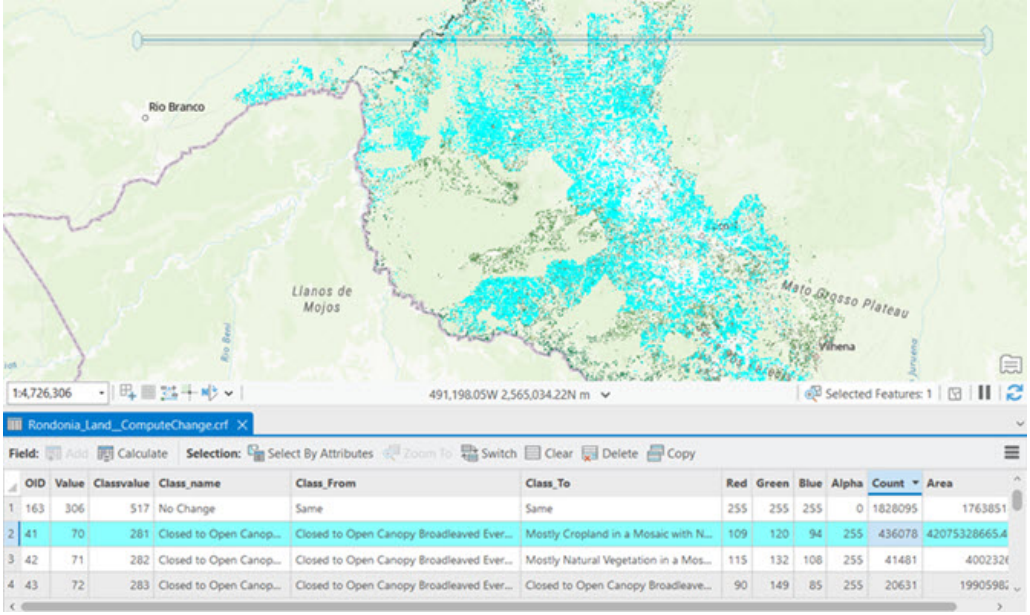
*Step 3i***: Compute change raster.*

The attribute table lists the land cover category, or class, that each cell changed from in 1992 to 2020. Each cell for this raster layer is equal to 300 meters x 300 meters, or 90,000 square meters. The attribute table provides a count of how many cells changed and then calculates the area in square meters using the method that you learned in the previous step. The larger the cell count, the larger the land area that changed category.

j In the attribute table, right-click the Count field and choose Sort Descending.

By sorting the table starting with largest cell count and area, you can see which land cover category changed the most. Most cells show no change; however, the category Closed To Open Canopy Broadleaved Evergreen Tree Cover, or forest, had the largest number of cells change to Mostly Cropland between 1992 and 2020. By using change detection, you quantified and identified that forested lands in Rondônia showed the largest decline in land area.

k On the left side of the attribute table, click the number 2 to select the second row.



*Step 3k***: Compute change raster.*

When you select a row in the attribute table, the same selection is highlighted in the map. By highlighting the second row, you can visualize how large the change was from forested land in 1992 to cropland in 2020.

l Continue to examine the attribute table and, when you are done, close the table.

m On the ribbon, if necessary, click the Map tab.

n In the Selection group, click Clear to clear the selection in the map.

o Save your project.

You have identified which land cover types replaced forests in Rondônia, Brazil. This analysis of deforestation is just one example of how GIS can be used to recognize climate change factors. Your findings could support future analyses of related climate change indicators, like greenhouse gas emissions.

Next, you will share your map to ArcGIS Online as a web map.

- Step 4: Create a web map

You can share maps from ArcGIS Pro to ArcGIS Online as web maps. You can then use these web maps to create web applications, such as dashboards or stories.

In this step, you will share your map to ArcGIS Online as a web map. However, before sharing the map, you will remove the layers that you do not need in your web map.

a In the Contents pane, right-click the Global Land Cover 2020 layer and choose Remove.

b Using the same method, remove the Global Land Cover 1992 layer.

c On the ribbon, click the Share tab.

d In the Share As group, click Web Map.

The Share As A Web Map pane opens on the right.

e In the Share As A Web Map pane, enter the following details:

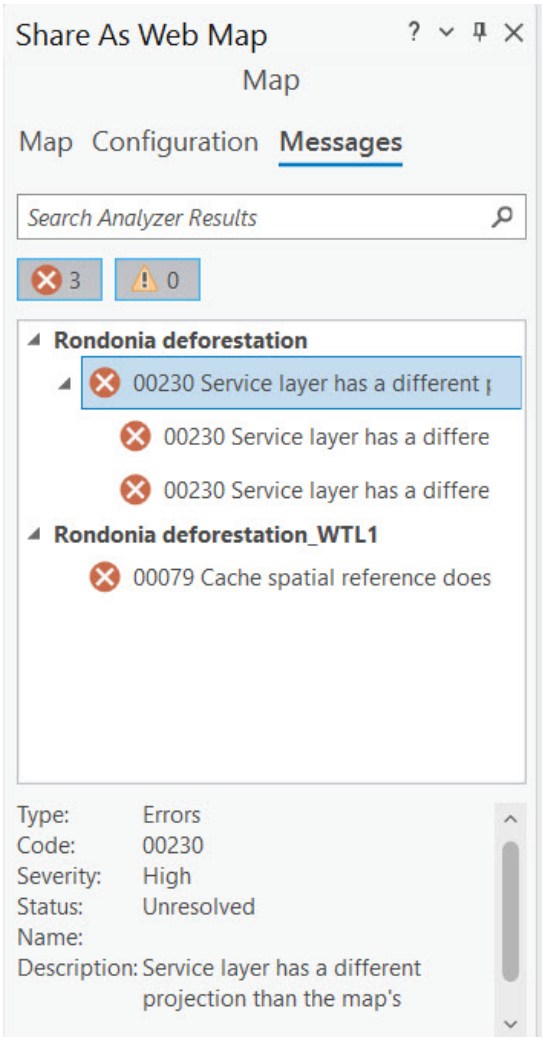
- Name: **Rondonia deforestation_<your first name and last name>**
- Summary: **Map of deforestation in Rondonia, Brazil, between 1992 and 2020.**
- Tags: **Brazil, Deforestation, Climate change**

Note: MOOC participants will be sharing their maps to the same ArcGIS Online organization. Therefore, you must give your web map a unique name by adding your full name to the web map name, for example, **Rondonia deforestation_StudentName**.

f Under Finish Sharing, click Analyze.

Analyzing your map before sharing allows you to view any errors or warnings. In this case, you receive two error messages about the spatial reference. You will fix these errors before publishing.

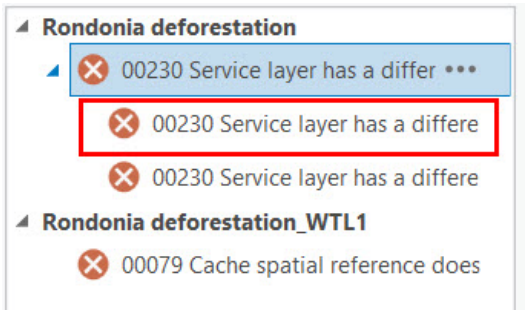
g Double-click the the 00230 error message to expand the message.



*Step 4g***: Create a web map.*

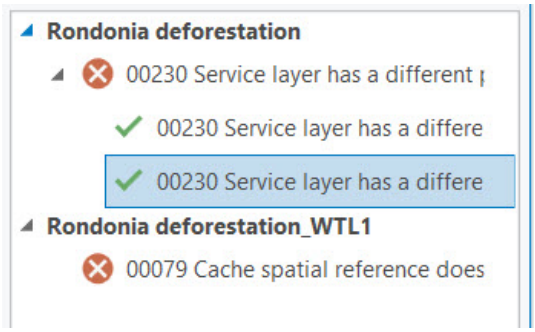
Near the bottom of the window is a description of the error message. Web maps require the WGS 1984 Geographic Coordinate System to be set before sharing. You will now resolve this error.

h Under the expanded 00230 error message, double-click the first error listed, as shown in the following graphic:



Double-clicking the error message instructs ArcGIS Pro to resolve the error by updating the coordinate system to WGS 1984.

i Double-click the second 00230 error message.



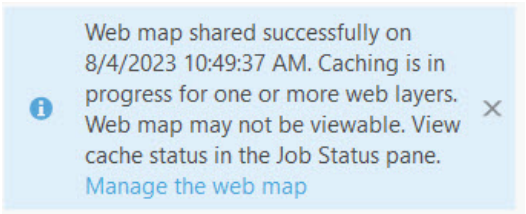
*Step 4i***: Create a web map.*

j Click Analyze again.

You have resolved the error messages. You are now ready to share your map as a web map.

k Click Share.

Note: It might take a couple of minutes to share your map because of the size of the imagery layers.



*Step 4k***: Create a web map.*

You have successfully shared your map as a web map that you can later share with others or embed in a web application.

l Save your project and close ArcGIS Pro.

In this exercise, you calculated how much land cover change occurred in Rondônia, Brazil, between 1992 and 2020. While working through your analysis, you used change detection to identify which land cover types replaced forests during this time period. Finally, you created a web map by sharing your map from ArcGIS Pro to ArcGIS Online.