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# EXERCISE 2

# Reviewing and exporting results from the Cover Mapper application

## Introduction

In this exercise, you will learn how to review and export Landsat composites, change detection layers, and land cover layers from the Cover Mapper application.

## Objectives

- Inspect the composites, change detection layers, and land cover layers
- Review the output accuracy information
- Export data and download to local machine

## Prerequisites

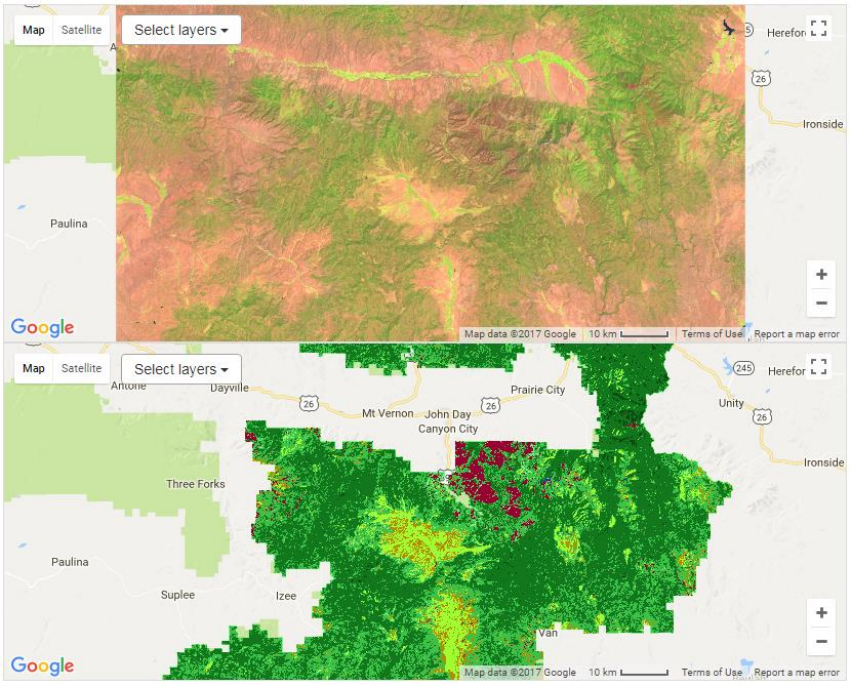
- **You have completed Exercise 1 on setting up the application.**
- **You are using the Google Chrome web browser (preferably wide-screen)**
- **You have a strong internet connection (preferably wired)**

## Table of Contents

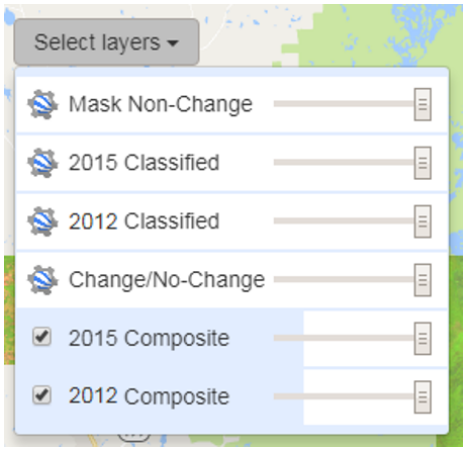
# Part 1: Inspecting map layers

## A. Navigating the map layers

1. The first thing to note is that there are now two maps! These maps are linked, meaning that if you pan or zoom one map, the other will automatically mirror the first. The maps will be arranged either left-right, or top-bottom, depending on your selection for Map Arrangement in the Visualization subpanel. Remember that you can change the map arrangement at any time. Here is an example of a top-bottom map arrangement:




2. If you still see training data points and/or a study area boundary on the left (or top) map, remember that you can show/hide those at any time by clicking the Show/Hide buttons in the Training Data and Composites inputs subpanels, respectively.
3. At the top of the map panels should be three buttons: **Map**, **Satellite**, and **Select layers**. The first two are the standard Google Maps road map and satellite background layers. If you hover your mouse over Map you will see a button for Terrain, which displays a background layer with a hillshade so as to emphasize terrain features. The third button, Select layers, is where you will be able to change which new map layers are visible. Hover your mouse over the button to reveal the dropdown, or click on the button to fix the dropdown. Click again to allow the dropdown to hide.



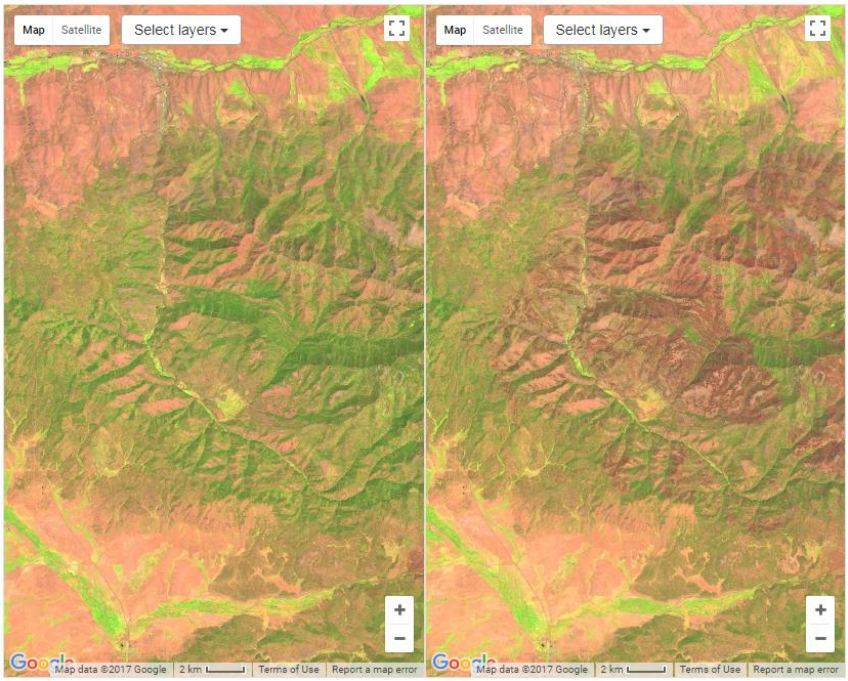

4. Each row in the layers dropdown corresponds to a map layer. Like in ArcMap and similar GIS software, the layers are arranged in a "stack", meaning that the layers are on top of one another, with the top-most layer in the dropdown also the top-most layer in the stack. The checkboxes turn individual layers on and off, while the small sliders change the transparency or opacity of each individual layer, revealing the layers beneath. As the map tiles load, a shaded blue bar will fill in each row from left to right, showing the loading progress. Notice that if you pan or zoom the map, the bars may reset, indicating that new map tiles are being loaded.

*Note: If you turn layers on/off with the checkboxes, they will need to reload/redraw, but using the sliders will prevent visualization delays due to drawing.*

5. By default, the left (or top) map has two composites displayed, while the right (or bottom) map has two land cover layers displayed. However, all of the layers are available to both maps, meaning that you can configure any combination you choose by turning on or off various layers. As we explore the various layers, we will suggest various combinations, but feel free to use any combinations you prefer.

## B. Composites

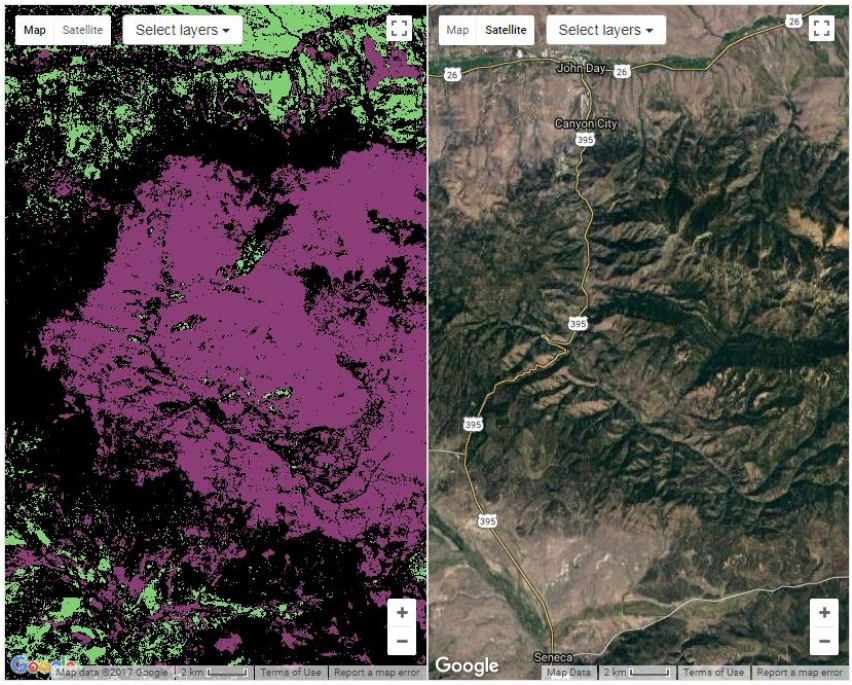
1. By default, the left (or top) map displays the cloud-free Landsat composites for 2012 and 2015, with the later year on top of the stack.
2. Click the checkbox by the 2015 composite to hide it, which reveals the 2012 composite beneath. Click the checkbox to turn it back on, and now use the slider by the 2015 composite to change the transparency to quickly go back and forth between years.
3. You can also use the layers dropdown on the right (or bottom) map to compare the composites simultaneously. Turn off the 2015 composite on the left map, and turn on the 2015 composite on the right map. Zoom in to the stretch of Highway 395 between Seneca and John Day, Oregon. You should be able to see the burn areas from the 2015 Canyon Creek fire.




*Note: If you would like to change the composite visualization bands, return to the Visualization subpanel on the inputs tab, and change the options there. Then click* ***Update Layers****.*

## C. Change maps

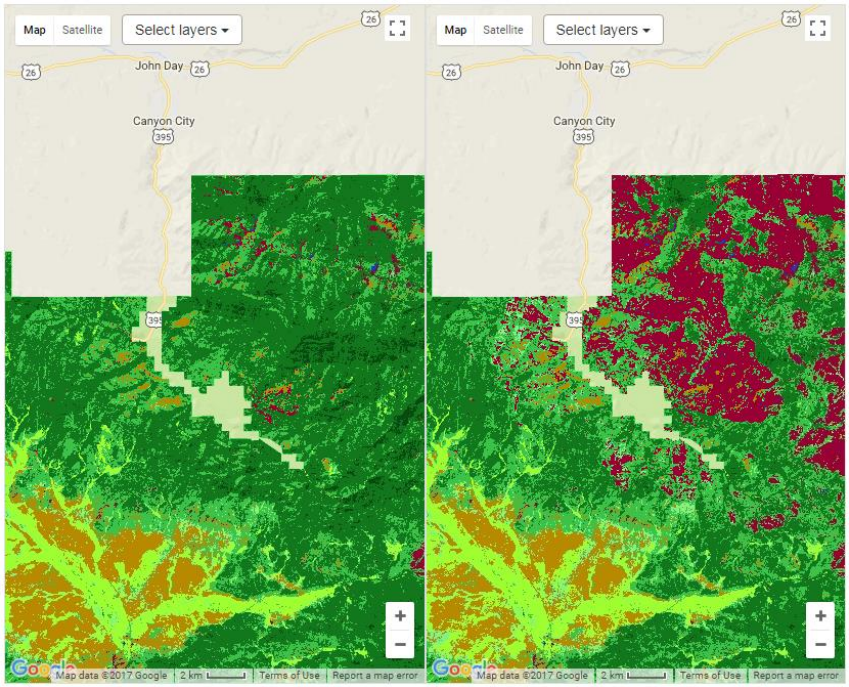
1. By default, the change/no-change map is not displayed. To turn it on, simply click the checkbox by the layer "Change/No-Change".
2. Areas of no-change are in black, while areas of change are either in purple (loss) or green (gain). The decision as to whether a pixel is change or no-change is determined by the pixel's difference index values (e.g., RdNBR). For more information, see the Change Detection Histogram described in Part 2, Section A.




## D. Land cover maps

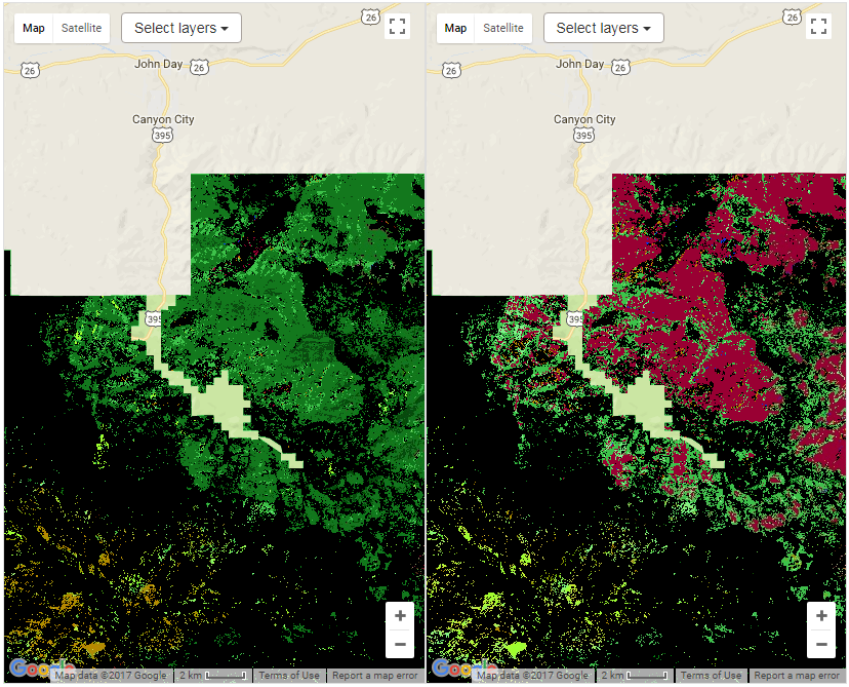
1. By default, the right (or bottom) map displays the land cover classifications for 2012 and 2015, with the later year on top of the stack. You can hide and show these layers in the same way we explored the composites. You will notice that the land cover layers have been clipped to the study area you defined, so as to reduce processing time and memory.
2. Turn on the 2012 classification on the left map, and the 2015 classification on the right map. If you are still zoomed in to the Canyon Creek fire area, you should see some differences in the two maps. Where the fire occurred, the canopy cover has decreased from dark green to lighter green. Some dark, burned areas have now been classified as Barren.

*Note: Recall that in the Visualizations subpanel on the inputs tab is the legend for the land cover maps. You can also change class colors there, and update the map by clicking the **Update Layers** button.*




## E. Emphasizing change

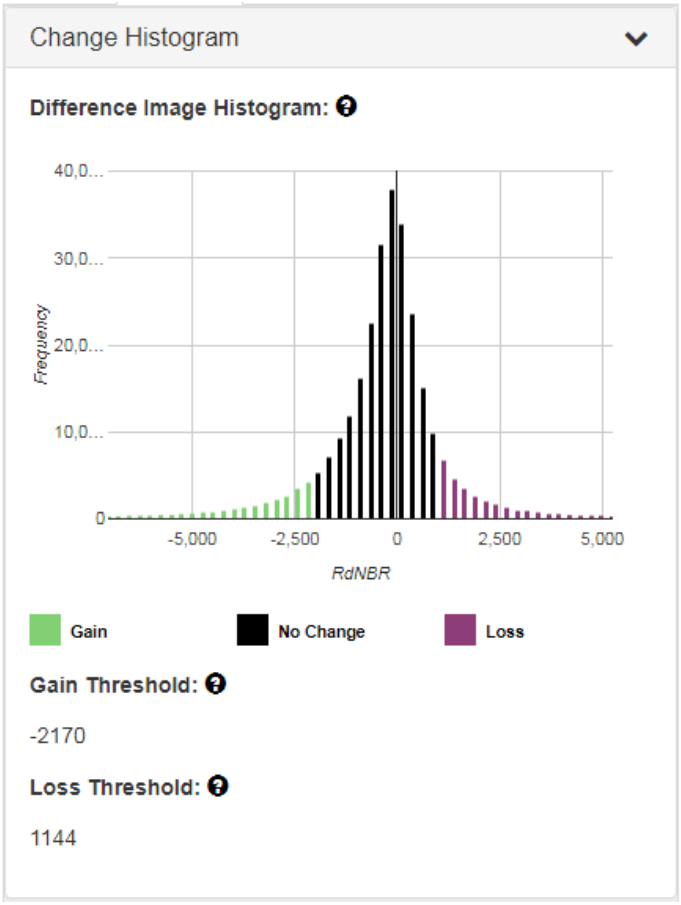
1. It is possible to emphasize the changes on the map by turning on the "Mask Non-Change" layers on either map. Do this now for both maps. Now you can see the exact changes.




# Part 2: Reviewing accuracy outputs

## A. Change Detection Histogram

1. Navigate to the Outputs panel, and expand the **Change Histogram** subpanel. You should see a display similar to this:

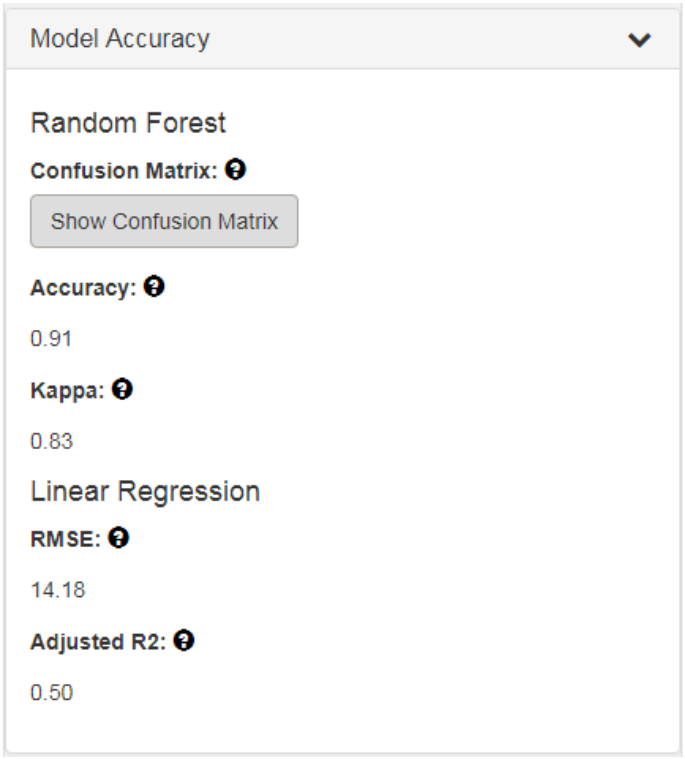



2. At the top of this subpanel is a **Difference Image Histogram**, displaying the frequency of binned difference index (RdNBR) values across the composite area. Bars in green are below the gain percentile, and represent change (gain). Similarly, bars in purple are above the loss percentile, and also represent change (loss). The remaining black bars represent no-change. You can hover your mouse cursor over the bars to get specific values. You can also click on the chart to expand it.
3. Below the histogram are two numbers, the **Gain Threshold** and the **Loss Threshold**. These are the difference index (RdNBR) values corresponding to the gain and loss percentiles, respectively.

*Note: You can use this information to check whether more or fewer pixels should be classified as change. If you feel that the green and purple bars are too large (i.e., too many pixels are classified as change), you can separate the gain/loss percentile sliders and re-run the application. Conversely, you can bring the sliders closer together if you feel that more pixels should be classified as change.*

## B. Model Accuracy

1. Remain on the Outputs panel, and expand the **Model Accuracy** subpanel. You should see a display similar to this:




2. This subpanel reports several accuracy measures for the classification and regression models used to produce the land cover classifications. If you are not interested in these, simply skip the remainder of this section.
3. The first accuracy measure is the **Confusion Matrix** for the Random Forest model. Click the **Show Confusion Matrix** button. You should see a table similar to the following:

| | | Predicted | | | | | Producer's Accuracy |
|---|---|---|---|---|---|---|---|
| | | BARREN | FOREST | GRASSLAND | SHRUB | WATER | |
| Actual | BARREN | 10 | 1 | 0 | 1 | 0 | 0.83 |
| | FOREST | 0 | 122 | 2 | 6 | 0 | 0.94 |
| | GRASSLAND | 0 | 4 | 23 | 0 | 0 | 0.85 |
| | SHRUB | 0 | 3 | 0 | 10 | 0 | 0.77 |
| | WATER | 0 | 0 | 0 | 0 | 10 | 1.00 |
| Consumer's Accuracy | | 1.00 | 0.94 | 0.92 | 0.59 | 1.00 | 0.91 |

This table represents the out-of-bag (OOB) estimate for the Random Forest regression model. It shows the actual and predicted class values of training data sample observations that were kept out of individual bootstrap samples. Also shown are the producer's and consumer's accuracies. For instance, out of the 122+2+6 = 130 actual forest observations, 122 (or 94%) of them were correctly predicted as forest (producer's accuracy). Conversely, out of 1+122+4+3

= 130 observations predicted as forest, 122 (or 94%) were actually forest (consumer's accuracy). The producer's accuracies are reported in the right-most column, while the consumer's accuracies are reported in the bottom-most row. Lastly, in the lower right corner is the overall accuracy of 0.91 (or 91%).

4. Below the Confusion Matrix button, the **Overall Accuracy** is reported again.
5. Next, the **Kappa** statistic is reported. Kappa partially represents the agreement between actual and predicted values that is due to random chance. A kappa value greater than zero suggests that the agreement is better than would be expected by chance.
6. Below this are accuracy values corresponding to the Linear Regression model used to predict percent forest cover. The first value is **RMSE** (root mean squared error). It is the square root of the average of the squared errors. A smaller value indicates greater accuracy (lower prediction error).
7. The last reported accuracy is the **Adjusted R2**. This is the Coefficient of Determination (r-squared) which provides a measure of the goodness of fit of the linear regression model. It has been adjusted to account for the many different explanatory variables used in the model.

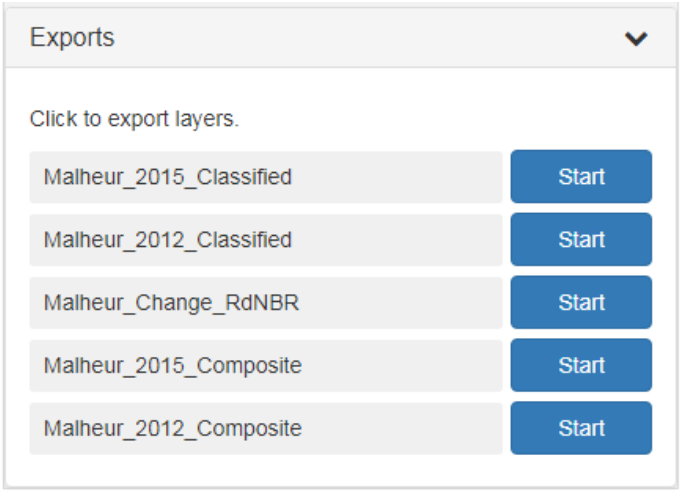
*Note: A model with no error would have producer's, consumer's, overall accuracy, and a kappa of 1.0 (100%), an RMSE of 0, and an adjusted R2 of 1.0. Such a model would be extremely overfit to the training data, modeling the random noise in the data, and would likely have a higher error rate on new training data. So, do not expect to obtain such high accuracies.*

*If your accuracies are lower than desired, consider adding additional training data (particularly for rare classes). Also consider combining similar classes, or classes that are difficult to separate spectrally.*

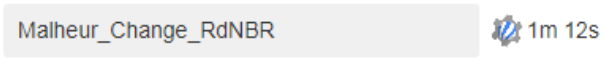
# Part 3: Exporting results

## A. Starting Exports

1. Remain on the Outputs panel, and expand the **Exports** subpanel. You should see a display similar to this:



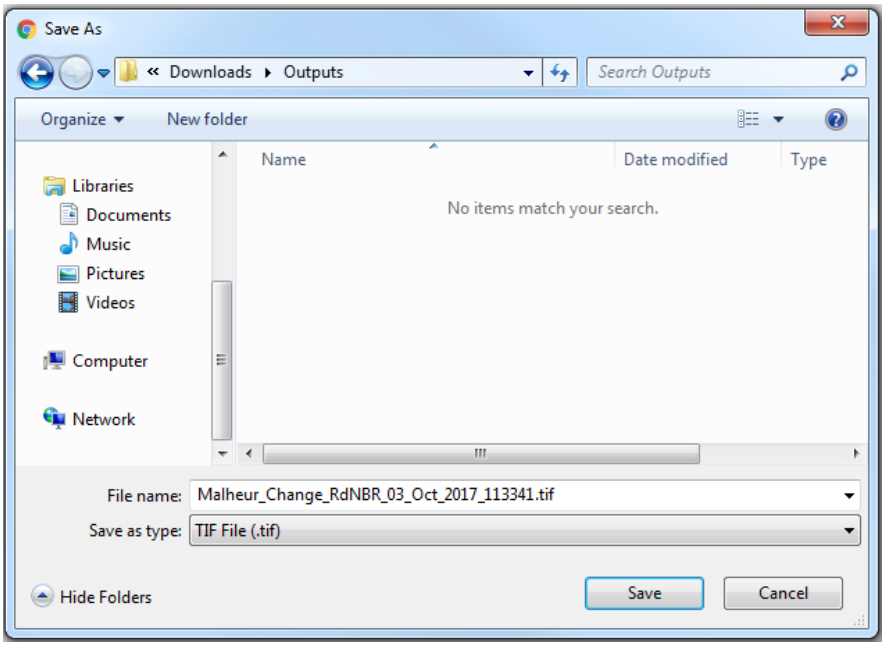
2. Each row in the exports manager contains a map layer you can export. The names mostly match the layers, with an added study area name prefix. The change/no-change map layer has been renamed with the difference index added.
3. To start an export task, click the **Start** button by one row. Let's export the **Malheur_Change_RdNBR** layer.
4. The start button should be replaced with a new spinning gear and a stopwatch that updates every 10 seconds or so.




5. If you hover your mouse cursor over the spinner or stopwatch, a cancel button will appear. If you click this button, the task will be canceled. To reduce the demand on Cloud Storage and Earth Engine, we encourage you to cancel any task that you no longer wish to download.
6. Each export may take between 5-15 minutes to run, so please be patient. How long the export takes depends on several factors, including: the size of the study area, the amount of training data, the number of days between the start and end dates, and most of the advanced inputs. If your application failed to load, the exports may take even longer to run.
7. If the export task is successful, the spinner will disappear, the task will turn blue, and a **Download** button will appear.


## B. Downloading Imagery

1. A successfully completed export task means that somewhere in Cloud Storage, your map layer has been stored as a GeoTiff image. To download this image to your local computer, click the **Download** button.
2. A new tab will open in your browser and a **Save As** popup will display.




3. Choose the location on your computer where you would like to save the image. You can also decide to change the image name. By default, the name matches the export task name, with the date and time of export appended to the name. Finally, click **Save**!

## C. Export Properties

1. When you export the map layers, you will need to know what each image band corresponds to, and what the pixel values mean.
2. The composites each have 11 bands. Unless otherwise specified below, bands are the 50$^{th}$, or median, percentile. Divide by the scale factor to get the original value:

| Band | Description | Scale Factor |
|---|---|---|
| 1 | Blue | 10000 |
| 2 | Green | 10000 |
| 3 | Red | 10000 |
| 4 | Near Infrared | 10000 |
| 5 | Shortwave Infrared 1 | 10000 |
| 6 | Shortwave Infrared 2 | 10000 |
| 7 | NDVI (10$^{th}$ percentile) | 10000 |
| 8 | NDVI (50$^{th}$ percentile) | 10000 |
| 9 | NDVI (90$^{th}$ percentile) | 10000 |
| 10 | NBR | 10000 |
| 11 | SAVI (L = 0.5) | 10000 |

3. The Change/No-Change map has one band, and three possible pixel values:

| Value | Description |
|---|---|
| 0 | Change (gain) |
| 1 | No-Change |
| 2 | Change (loss) |

4. The land cover classifications have one band and *n* possible pixel values, where *n* is the number of land cover classes (from the Visualization legend). The land cover values start at 1, and go to *n* through the classes in the Visualization legend order (alphabetical). Pixels with a value of 0 are masked, meaning they are not in the study area. Here are the values for the example we covered in this exercise:

| Value | Description |
|---|---|
| 0 | Masked (not in study area) |
| 1 | Barren |
| 2 | Forest 0-15% CC |
| 3 | Forest 15-40% CC |
| 4 | Forest 40-80% CC |
| 5 | Forest 80-100% CC |
| 6 | Grassland |
| 7 | Shrub |
| 8 | Water |

**Congratulations!** You've completed this exercise on using the Cover Mapper application. You now have all the information you need to review and export cloud-free Landsat composites, change detection maps, and land cover classifications. In the next exercise you will learn how to troubleshoot common issues encountered when running the application.