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Overview of accuracy assessment of land cover products

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Overview of accuracy assessment of land cover products

The purpose of this document is to provide a basic understanding of the importance of accuracy assessment and how to interpret accuracy statistics. Details on how to design and implement an effective accuracy assessment will not be covered. For this sort of detail you can look at some of the remote sensing tutorials listed on the tutorial links page or pick up a remote sensing text-book.

Importance of accuracy assessment

When looking at a land cover map it is important to remember that it is not a perfect representation of reality. There are always errors in maps and before we can evaluate the utility of a particular map we need to have an idea of how accurate it really is and how accurate it should be to sufficiently meet the requirements for the intended application. The only way to reliably check the accuracy of a map is to design and implement an accuracy assessment. Without such an objective measure of the map's quality we might be limited to using qualitative statements from people who have used the map. These comments may provide a rough indication as to the quality of a map but they tend to be very subjective and can be misleading.

The result of an accuracy assessment typically provides us with an overall accuracy of the map and the accuracy for each class in the map. For example in a land cover map the water class could be very accurate but some of the vegetation classes might be less accurate. This can have a significant effect on the utility of the map and in some cases may indicate that some classes should be merged. For example if two forest types, say deciduous and coniferous are relatively inaccurate it might make sense to combine them into a single forest class with much higher accuracy.

Conducting a proper accuracy assessment of a product created using remotely sensed data can be time consuming and costly. This is the primary reason why this important step is often not carried out in a mapping project. Time and again, accuracy assessment is in the project design but is regularly dropped or greatly modified in the interest of saving time or money. In these cases one can try to take an educated guess of what the accuracy is, based on the methods, experience, and data used but in the end it is only a guess.

Understanding image classification accuracy

There are two primary components of error in thematic maps such as land cover maps; position error and thematic error. In a map with poor position error the shape and size of a particular feature, such as a lake, might be correct but the placement on the map is incorrect. Thematic error occurs when a feature is misidentified. For example, if an area labeled shrub on the map was actually grassland then the thematic error of the map would increase. In most cases both of these error components work together. For example, when trying to delineate the boundary between two cover types that gradually change from the one cover type to the other it is difficult to accurately draw that line that divides these two cover types.

When we look at the accuracy of a land cover map we typically do not differentiate between position and thematic errors. The accuracy assessment sampling design usually has a built-in mechanism that allows for reasonable position errors based on the input data being used and on the scale of the final map. In the end, however, the accuracy figures do not indicate if the error is due to a positional error or a thematic error.

Basic concepts of understanding image accuracy statistics

Looking at accuracy statistics can be misleading if you don't understand what they represent. In this section we will describe and compare some of the ways that accuracy is represented. We will start with a simple hypothetical example detailed in figure 1.

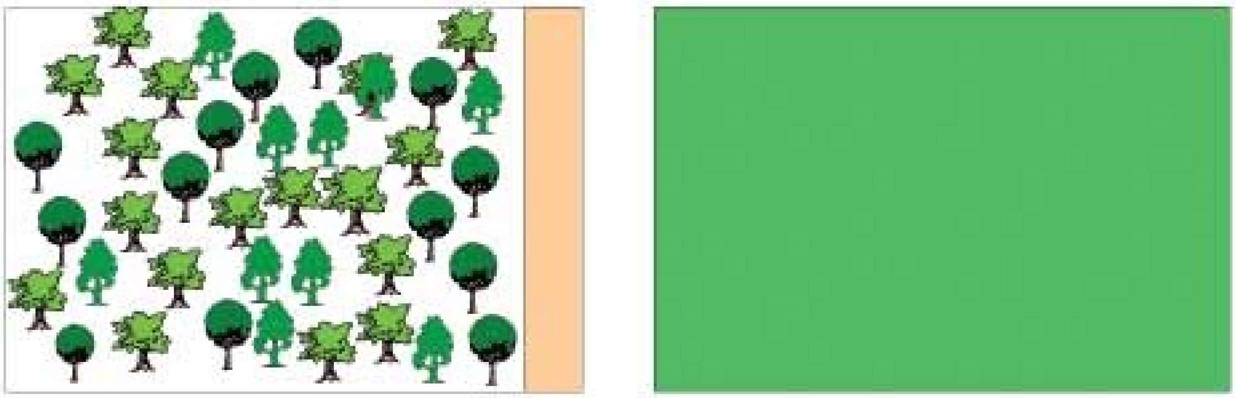

Figure 1: A landscape (left) and the classified map of the landscape (right)

The picture on the left represents the landscape (forest and soil). On the right is a land cover map of this area with green representing forest. The entire area was mapped as forest.

In this figure you can see that the map did not accurately represent the actual landscape since it classified the entire area as forest whereas 10% is actually non-forest. Lets see how this is reflected in the accuracy statistics. Clearly the overall map accuracy is 90% but one could say that the accuracy of the forest class is 100% since all of the entire area of the forest class was accurately classified as forest. As you can see, there are different ways to represent accuracy. Two types of accuracy are producer's accuracy and consumer's accuracy.

Producer's accuracy is a reference-based accuracy that is computed by looking at the predictions produced for a class and determining the percentage of correct predictions. In other words, if I know that a particular area is hardwood (I've been out the on the ground to check), what is the probability that the digital map will correctly identify that pixel as hardwood?

Consumer's accuracy is a map-based accuracy that is computed by looking at the reference data for a class and determining the percentage of correct predictions for these samples. For example, if I select any hardwood pixel on the classified map, what is the probability that I'll be standing in a hardwood stand when I visit that pixel location in the field?

A tool that is used to present accuracy statistics is called a contingency table. Table 1 is a contingency table for a map that delineates conifer, hardwood, grass, and barren land. This table will be used to illustrate how to calculate producer's and consumer's accuracy as well as some other common accuracy indicators.

Table 1: Example of a contingency table

Contingency Table: A pixel by pixel comparison of ground reference class to satellite-based map class.

		Satellite Map Class (pixel counts)					
	Cover Type	Conifer	Hardwood	Grass	Barren	Total	Producers Accuracy, Percent Correct (1-omission error)
ground reference	Conifer	911	20	1	0	932	97.7
	Hardwood	40	343	72	2	457	75.1
	Grass	0	62	176	14	252	69.8
	Barren	0	0	19	27	46	58.7
	Total	951	425	268	43	1687	
Users Accuracy, Percent Correct (1-commission error)		95.8	80.7	65.7	62.8		86.4

Overall accuracy = (# pixels correctly classified) / (total # of pixels)

= (911+343+176+27) / 1687 = 0.864 = 86.4%

Producers accuracy: Producer accuracy (hardwood) = (# of pixels correctly classified as hardwood) / (# ground reference pixels in hardwood) = 343/457 = 0.751 = 75.1%

Omission Error: Excluding a pixel that should have been included in the class (i.e., omission error = 1 - producers accuracy = 1 - 0.751)

Consumer's Accuracy: Consumer's accuracy (hardwood) = # of pixels correctly classified as hardwood) / (total # of pixels classified as hardwood) = 343/425 = 0.807 = 80.7%

Commission Error: Including a pixel in a class when it should have been excluded (i.e., commission error = 1 - consumer's accuracy = 1 - 0.807).

Here are some other terms associated with accuracy assessments.

Average (Class) Accuracy: The average of the individual class accuracy.

Average Accuracy = (sum of producer class accuracies) / number of classes) = (97.7 + 75.1 + 69.8 + 58.7) / 4 = 0.754 = 75.3%

Minimum Class Accuracy: The lowest class accuracy noted in the classification. In this case Barren: 58.7%

Training Accuracy: The ground reference pixels used to assess accuracy are the same pixels used to train the classifier. Their accuracy figures tend to be inflated and present a "best-case" scenario. It also gives an indication of the effectiveness of the training pixels. If this number is not high then it might be worth reevaluating the reference data used to train the classification.

Test Accuracy: The ground reference pixels used to assess accuracy were not used to train the classifier, rather, they're an independent set of field/photo observations. Test accuracy represents the nominal or "real-life" accuracy of a map. This is typically how accuracy assessments are carried out.

Kappa: An accuracy statistic that permits two or more contingency matrices to be compared. The statistic adjusts overall accuracy to account for chance agreement. Use kappa to statistically test for agreement between two contingency matrices.