American Museum of Natural History
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Justification for using photo interpretation methods to interpret satellite imagery

Ned Horning

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Center for Biodiversity and Conservation
American Museum of Natural History
Central Park West at 79th street
New York, New York, 10024 USA

Justification for using photo interpretation methods to interpret satellite imagery

Introduction

An often-overlooked method for analyzing satellite imagery is visual interpretation. The launch of the first Landsat satellite in 1972 and the subsequent increase in analysis and interpretation of digital imagery caused a paradigm shift away from the time-tested methods of visual interpretation. The move was toward automated classification as the search for the Holy Grail of accurate automated image classification began.

This guide focuses on comparing digital image photos to classified images. For information about using visual and automated methods to create land cover maps, please read the Land Cover Classification guide.

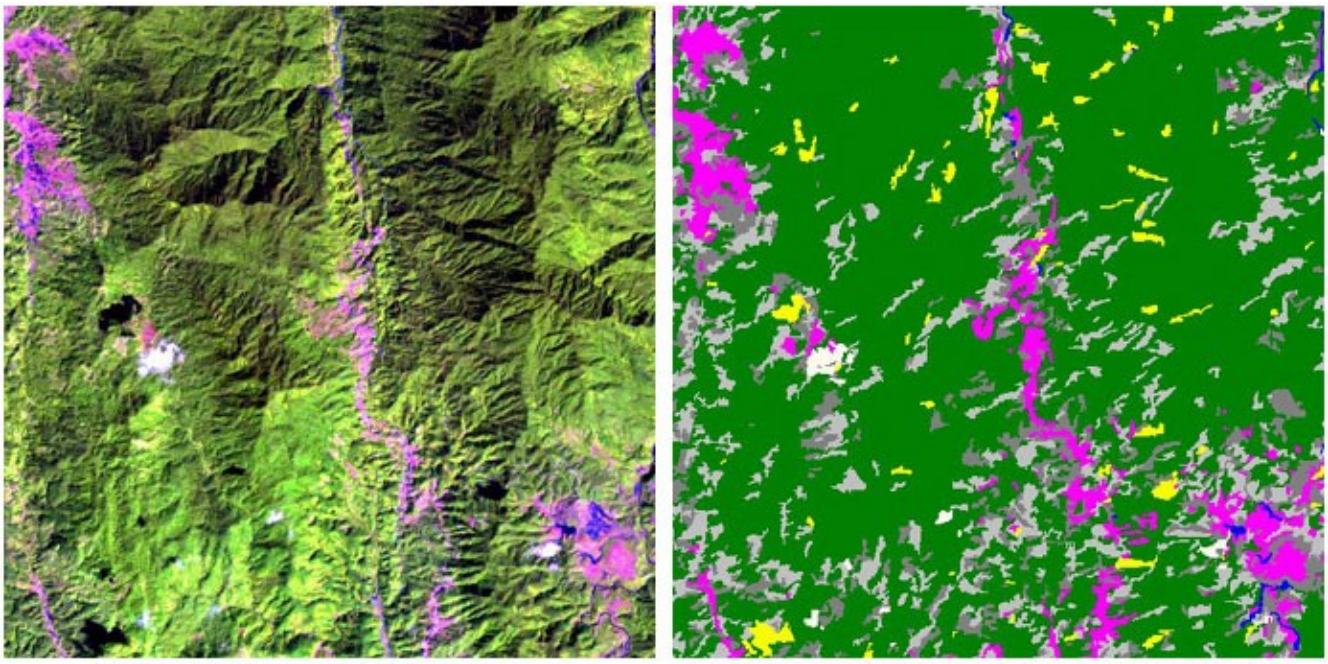
Visual interpretation was the backbone of remote sensing when aerial photographs were the only remotely sensed images available. Advances in technology have made a tremendous contribution to remote sensing through the introduction of new digital sensors and improved algorithms to process imagery.The classified map products, however, have not significantly increased in quality.

Using visual cues, such as tone, texture, shape, pattern, and relationship to other objects, an observer can identify many features in an image. Methods to visually interpret satellite images are very similar to methods developed to interpret aerial photographs over 100 years ago. With the advent of fast computers and sophisticated algorithms for image classification, many users of satellite imagery are convinced that the only way to benefit from satellite imagery is to classify the image. Although there are certainly appropriate times to use classified images, in many cases the image classification process reduces the information content and can introduce misleading errors .

These criticisms of classified image products are not meant to discredit land cover products based on remote sensing or to suggest that since these products have errors they are not useful. On the contrary, classified image products have been, and will continue to be, of tremendous importance. In some cases, however, working directly with visual products will provide more useful information. An unfortunate emphasis has been placed on automated classification methods, when, in many cases, visual interpretation methods are often more valuable and more appropriate.

The Value of Using Satellite Image Photoproducts

When a satellite image is classified, a thematic class replaces the visual cues that exist in the original image. In other words, the subtle changes throughout a forest that can be seen in an image photo are replaced by a single color representing a particular feature such as forest. (Figure 1)



Landsat TM Path = 125 Row = 49 January 9, 2001

Land cover map corresponding to the image on the left Green = dense forest, Light gray = degraded forest, Pink = grass, Dark gray = shrubland, Blue = water, Yellow = shadow, White = cloud

Figure 1: Subset region in Vietnam. This comparison illustrates the difference in quantity and quality of information between an enhanced satellite image and a corresponding land cover classification. The satellite image is full of visual cues to help aid the viewer in identifying subtle features whereas the classified image only portrays the class information.

Another issue is that a land cover map derived from a satellite image, while it might look impressive, will contain errors. The errors in a classified image can range dramatically, depending on:

- The qualities of the area being classified (season, terrain, land cover patterns, etc.),
- The ancillary data available to assist in the classification, and
- The resources available to conduct the classification.

As a general rule, if there are just a few major classes of land cover, accuracy estimates on the order of 80% are common, and as the number of classes increases the accuracy per class can easily degrade to under 50%.

Of course a visual interpreter also risks misinterpreting a satellite image. However, the person examining a satellite image has an inherent sense for the degree of confidence they have in their interpretation. In other words, there will be cover types they can identify with a high level of confidence and others they will be less sure about. In a classified map, this information is usually missing (some classified maps contain information about the confidence for each pixel; however, this is difficult to visualize in a single image product). The accuracy assessment guide has a more thorough overview of theoretical and practical issues related to evaluating the accuracy of a land cover map.

A misleading quality with most classified maps is that they display classes as discrete entities

with well-defined boundaries. In many cases, however, the change from one land cover class to another is continuous, and this is easily visualized on an image photo product (Figure 1). Defining a discrete boundary between land cover types that transition from one cover type to another in a continuous fashion often results in a somewhat arbitrary line drawn between those classes. This effect is illustrated in the map/image comparison interactive.

Another quality of classified maps is that they tend to look impressive even if the classification results are less than suitable for the intended application. The author has witnessed on several occasions that the results of satellite image classifications were initially greeted with great enthusiasm simply because they looked great but over time, as people began to use them in the field, many of these products were viewed as inaccurate and sometimes even unusable. In most of these cases, the users of the classified image were delighted to use the image photo product instead of the classified image. Since they were familiar with the area, these users were quickly able to obtain more information about the landscape they were interested in from the image photo products.

Advantages of Visual Interpretation

Five significant advantages of visual interpretation of photo products over classified images are:

- Less time required to create a usable product,
- Little, if any, expense incurred beyond the acquisition of the image,
- Image illumination "problems" (such as shadows and brightly illuminated surfaces) can be used as an interpretation aid,
- Minimal expertise required to interpret the image, and
- Uses the power of the brain.

Less time - A reliable land cover classification project can take months or years to complete. With photo interpretation methods, visualization can start immediately once the satellite data are in hand. All that is needed is a photograph of the image or a computer and some visualization software to view the image on a screen.

Less expense - Land cover classification projects can be very costly. Costs include the analysts' time for the classification and error analysis. This usually includes fieldwork for collecting validation data and can easily run into tens of thousands of dollars. Usually, the cost of the data is a small fraction of the total cost of a land cover classification project.

Image illumination - The uneven illumination of a satellite image is a source of problems for automated classification. A significant and sometimes futile effort can go into accounting for these effects. In visual interpretation, however, these "defects" can be used to aid in the interpretation of an image. The variations in illumination across an image are largely responsible for the appearance of relief on a satellite image which is a useful aid in identifying features on the image.

Less expertise - The level of expertise required to carry out a robust land cover classification is substantial, and selecting appropriate methods is not always intuitive. Using photo interpretation methods to classify an image requires training, but less is required to adequately interpret an image than is needed for conducting a land cover classification.

More brain power - The capability of the brain to interpret land cover features in a satellite image is still significantly more effective than that of a computer. A computer is very good at consistently applying a specific set of rules to classify an image, but unfortunately in the "real world" these rules are not clear-cut or necessarily static.

Visual Interpretation VS. Automated Methods - Which one to Use?

Clearly, both classified products and photo products have their value, but when would you choose one over the other? In many quantitative studies, the preferred data product would be a classified image. One clear case for using classified data is in modeling. When modeling, the algorithm needs to know the value of a particular parameter at a particular location, and that information is only available in a classified image.

For more qualitative studies, however, photo products are often the product of choice. Examples of qualitative applications include:

- Planning protected area limits,
- Planning field work,
- Getting a broad-picture view of an area to understand land cover types and patterns,
- Visualizing where land cover change is occurring over time, and
- Planning development projects.

The following examples demonstrate some of the ways that satellite image photo products can be used.

Planning protected area limits or planning development projects

Planning protected area boundaries or development projects requires a good overview of the region being considered or protection. This type of view can often best be provided with satellite images. In a Geographic Information System (GIS) environment, one can use a satellite image as a base layer over which ancillary data, such as towns, roads, and political boundaries, can be placed. It can also be helpful to drape the satellite image over a Digital Elevation Model (DEM) to better visualize the terrain features.

Even in cases where computer models are used to plan development projects, it is always a good idea to overlay the results on a satellite image to see if they appear to make sense. If the suitability model produces results that don't make sense when overlaid on a satellite image, there is a good chance there is a problem with the model results. These problems could be due to a faulty model or the use of low-quality data layers as input into the model.

Planning field work

When planning a fieldwork mission, it can be very helpful to view the landscape to determine

appropriate places to set up camps. Using a satellite image that has been draped over a DEM can provide a good overview of a landscape. This can be enhanced by overlaying ancillary data such as information about access, roads, political boundaries, and the location of specific areas to be visited.

Reconnaissance-level understanding of cover types and patterns

Satellite imagery is ideal for providing an overview of the environment for an area of interest. Information on land cover type, land use, fragmentation, burning (from fires and burn scars), and environmental events, such as floods and hurricanes, can be derived from imagery. Georeferenced satellite images can effectively be used as a map. In this capacity they are a very powerful communication tool.

Land cover change over time

By overlaying two different dates of satellite imagery and "flickering" (changing which image is on top and bottom) between them or by displaying satellite imagery taken on two separate dates next to one another, one can easily locate areas of land cover change.

Using Visual Interpretation Techniques to classify an Image

When a decision is made to classify an image, one can use visual methods, automated methods, or a combination of the two.