

ENV101 EARTH SYSTEMS

Practical Exercise 10 – Image Interpretation

1. OVERVIEW

Image interpretation is a fundamental skill employed by many practitioners within earth science related fields. It involves being able to identify different features within an image based on a set of interpretation cues, and being able to understand and infer the biophysical processes that can cause and affect different features. Image interpretation can be undertaken at a number of different spatial and temporal scales, however in this exercise we will focus on interpreting a small subset of high spatial resolution multispectral satellite imagery. It is important to understand the terminology used when identifying and describing features, patterns, and processes within image data, as this will help students to communicate other aspects of spatial information as they progress through this and subsequent units in their studies.

1.1. Learning Outcomes

After completing this practical, students will be able to:

1. Use image interpretation cues to identify and describe different land cover types in very high spatial resolution satellite imagery;
2. Become familiar with and be able to apply common terminology used to describe environmental features and patterns in spatial data;
3. Gain further confidence with using basic tools in ArcMap; and
4. Have a basic understanding of true colour vs. false colour imagery, including the additional information that non-visible spectral information may provide.

1.2. Preparation

External students:

- Ensure that you have installed and licensed the ArcGIS 10 software from the CD that you received in the mail.
- Create a folder (e.g. Prac8) on your C drive on your home computer where you can store all the files and folders for this class. Regardless of the location, note that it is not good practice to use spaces in file or folder names. Instead, use an underscore to give the effect of a space between words.
- Copy all the data required for this tutorial from the CD you received in the mail, or download from week 8 of the ENV101 companion site <http://learnline.cdu.edu.au/units/ses101/materials.htm>, into the folder that you have just created. Hereafter this folder will be referred to as your *working directory*.

Internal students:

- Create a folder (e.g. Prac10) for today's practical on the desktop, your personal student folder (G:\ENV101\sXXXXXX), or a personal memory stick/hard drive. Hereafter this folder will be referred to as your *working directory*.
- Copy all the data required for this into the folder you created above (e.g. Prac10).

- If you are working in the GIS/RS lab, you can either work from the student server (slow, but will be backed up), your personal hard drive or your desktop (faster, but will NOT be backed up and all data will be removed on logout). If you are working from the desktop, you should copy your work onto a memory stick or the student server at the end of the session BEFORE logging out.

1.3. **Required data**

ENV101-Prac10-Image_interp.mxd

This project file has been created for the use of this practical and contains the following dataset:

WV2_130610_pansharp

Pansharpened Worldview-2 image – Casuarina campus and surrounding area, very high spatial resolution (50cm pixel size) colour infrared image acquired 13th June 2010

2. **IMAGE INTERPRETATION**

Open the project file ENV101-Prac10-Image_interp.mxd in ArcMap

There is only one layer in this week's ArcMap project – a high spatial resolution satellite image that was acquired by the Worldview-2 satellite (© Digital Globe). The image shows the CDU Casuarina Campus, Rapid Creek, and parts of surrounding suburbs.

Use your zooming and panning tools to gain a closer look at different features within the image and get a feel for the amount of detail that you can see, and the minimum sized feature that you can identify.

Read through the following information and fill in the corresponding table with your interpretation of the image.

Image interpretation is a fairly well established science that includes a number of artistic and necessarily subjective tasks. These tasks have also provided the basis for interpretation of satellite images and have recently been the focus of automated image processing and pattern recognition software. There are several key elements or "cues" to interpretation and they are outlined below with reference to the aerial photographs used in this tutorial exercise.

Summary of Interpretation elements obtained from:

Remote Sensing Core Curriculum, Vol.1 Air Photo Interpretation and Photogrammetry, Lecture 2, Elements, Aids, Techniques and Methods of Photographic/Image Interpretation, by Prof. John E. Estes, Remote Sensing Research Unit, Department of Geography, University of California, Santa Barbara, California 93106, U.S.A. Copyright reserved.

2.1. *Interpretation Cues*

Tone / colour

Tone can be defined as each distinguishable variation from white to black. Colour may be defined as each distinguishable variation on an image produced by a multitude of combinations of hue, value and chroma. Many factors influence the tone or colour of objects or features recorded on photographic emulsions. But, if there is not sufficient contrast between an object and its background to permit at least detection, there can be no identification. While a human interpreter may only be able to distinguish between ten and twenty shades of grey, computers can distinguish many more colours.

Texture

The frequency of change and arrangement of tones. This is a micro image characteristic. The visual impression of smoothness or roughness of an area can often be a valuable clue in image interpretation. Water bodies are typically fine textured or smooth, while grass is medium, and forest is rough, although there are always exceptions.

Size

The size of objects can be important in discrimination of objects and features (cars vs. trucks or buses; single family vs. multi-family residences, shrubs vs. trees, etc.). In the use of size as a diagnostic characteristic both the relative and absolute sizes of objects can be important. Size can also be used in judging the significance of objects and features (size of trees related to board feet which may be cut; size of agricultural fields related to water use in arid areas, or amount of fertilisers used; size of runways gives an indication of the types of aircraft that can be accommodated)

Shape

The shape of objects/features can provide diagnostic clues that aid identification. The Pentagon building in Washington is a diagnostic shape. Man-made features have straight edges that natural features tend not to. Roads can have right angle turns, railroads do not.

Shadow

Geologists like low sun angle photography because shadow patterns can help identify objects.

Steeple and smoke stacks can cast shadows that can facilitate interpretations. Tree identification can be aided by an examination of the shadows thrown. Shadows can also inhibit interpretation.

Pattern

Pattern is the spatial arrangement of objects. Pattern can be either man-made or natural. Pattern is a macro image characteristic. It is the regular arrangement of objects that can be diagnostic of features on the landscape. An orchard has a particular pattern. Likewise, the network or grid of streets in a subdivision or urban area can aid identification and aid in problem solving such as the growth patterns of a city. Pattern can also be very important in geologic or geomorphologic analysis. Drainage pattern can tell the trained observer a great deal about the lithology and structural patterns in an area. Dendritic drainage patterns develop on flat bedded sediments; radial on/over domes; linear or trellis in areas with faults or other structural controls.

Context

Site

How objects are arranged with respect to one another; or with respect to various terrain features, can be an aid in interpretation. Aspect, topography, geology, soil, vegetation and cultural features on the landscape are distinctive factors that the interpreter should use when examining a site. The relative importance of each of these factors will vary with local conditions, but all are important. Just as some vegetation grows in swamps others grow on sandy ridges. Agricultural crops may like certain conditions. Man made features may also be found on rivers (e.g. power plant) or on a hill top (observatory or radar facility).

Association

Some objects are so commonly associated with one another that identification of one tends to indicate or confirm the existence of another. Smoke stacks, step buildings, cooling ponds, transformer yards, coal piles, railroad tracks = coal fired power plant. Arid terrain, basin bottom location, highly reflective surface, sparse vegetation = beach. Association is one of the most helpful clues in identifying man made installations. Aluminium manufacture requires large amounts of electrical energy. Absence of a power supply may rule out this industry. Cement plants have rotary kilns. Schools at different levels typically have characteristic playing fields, parking lots, and clusters of buildings in urban areas. Large farm silos typically indicate the presence of livestock.

Shadow

The presence of shadows may be used to aid in estimation of the size or height of an object (if the elevation of the sun above the horizon is known). Shadow is also a hindrance in aerial photography as it masks the surface. Digital images obtained from airborne or satellite platforms can be processed to remove shadow effects.

2.2. Terminology to use when applying interpretation cues

Tone

When describing the tone of an object within a photo it is common practice to specify its *colour* (hue, e.g., red, green, blue) and *relative brightness* (e.g. bright, dark). For example, on a true colour aerial photograph golf courses will appear bright green, deep clear water will appear dark blue and silty/turbid river water appears light brown.

Texture

Texture is defined as the frequency of tonal or brightness changes on an image or a photograph. When describing a feature's texture the terminology applied is a combination of the two texture extremes, *rough* or *coarse* and *smooth*. The former implies a high frequency of changes in tone, pattern and shadow within a feature, while smooth features are uniform in appearance with limited spatial variation. For example, residential areas in aerial photographs and satellite images have a rough or coarse texture due their heterogeneous composition (concrete, wood, grass, trees etc). Whereas closed canopy forest and grasslands exhibit smooth textures. Modifying terms, such as moderately smooth or extremely smooth may also be used.

Shape/Form

Shape represents one of the elements of texture and features are described in terms of the *shape of their boundaries* (e.g. rectangular football fields) and *the shape of their internal elements* (e.g. the orchard contained rectangular rows made up of trees

with circular canopies). In each case then feature is referenced to a standard shape (circle, square, rectangle, ellipse...) and its approximation to the shape also defined. For example, the aquaculture ponds used for prawn farming appear in 1:25000CIR photos as 1cm x 1cm squares with rounded corners.

Pattern

Pattern is used to define the features produced by the repetition of shape and tonal features in a photograph or image. At the most basic level patterns are described as *regular* or *irregular*. For example, the grid network of streets characteristic of North American towns is a regular pattern, as is the arrangement of trees in rows in an orchard. Arrangements of drainage channels or streams when viewed from small scale aerial photographs or satellite images are irregular patterns, indicative of the climatic regime or structural geology of an area.

Size

Size may be used to refer to two dimensions of features in photographs or images, the actual *extent of the feature* and the *size of individual elements* characteristic of that feature. For example, mangroves can be defined in terms of the size or width of the zone they occupy and in terms of the width of individual tree canopies.

Context

Site

Site is used as an interpretation cue to tie geographic location constraints to identification of specific ground cover features. This applies to specific human activities or "land-use" zones and specific vegetation assemblages or ecosystems that only occur in specific environments. For example, vegetation types requiring cool, moist and shaded conditions will only be found on the south facing sides of steep slopes (in the southern hemisphere).

Association

Association is similar to site, but encompasses positional associations between both natural and artificial features. For example, port facilities located on a harbour or river; aircraft, terminals and hangers associated with runways; irrigation systems associated with farms and dams.

Shadow

Presence or absence of shadow is noted, as with the length and direction as these indicate heights of objects and solar position.

Q1. Use the above information about basic photo interpretation cues to define an interpretation key for three major land-cover or land-use types of your choice present in the Worldview-2 satellite image of the CDU campus and surrounds. As you fill in the table, you should be considering how you would describe each landcover / landuse type to another person so that they could easily identify it not only in the same image that you are using, but in another similar image. This means that your key and terminology should be transferrable between data sets.

Interpretation Cue	Landcover/use #1	Landcover/use #2	Landcover/use #3
Tone – Colour			
Texture			
Size			
Shape			
Pattern			
Shadow			
Context (site and association)			

3. MULTISPECTRAL SATELLITE IMAGERY

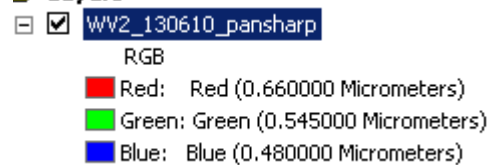
When you opened the project file, the Worldview-2 image had been pre-loaded to be displayed as a *true colour image* i.e. it looks true to the colours that our eyes would normally see.

The Worldview-2 image is an example of a multispectral satellite image. This means that instead of just displaying in an image containing information with respect to visible reflected light (i.e. the same as our own vision system), we can begin to look at other wavelengths of light that we cannot see with our eyes. The image provided also contains near infra red (NIR) reflected light, which is particularly useful for monitoring vegetation.

This Worldview-2 image subset is comprised of 4 layers, representing blue, green, red, and NIR (the full image actually contains 8 layers, but only 4 are used here). However, computers are only able to display 3 layers at a time, and with these three layers, it is possible to mix all colours to make every colour of the rainbow. With a true colour image such as that shown above:

- The Red computer channel represents the amount of red light reflected from the ground
- The Green computer channel represents the amount of green light reflected from the ground
- The Blue computer channel represents the amount of blue light reflected from the ground
- There is no channel to display NIR

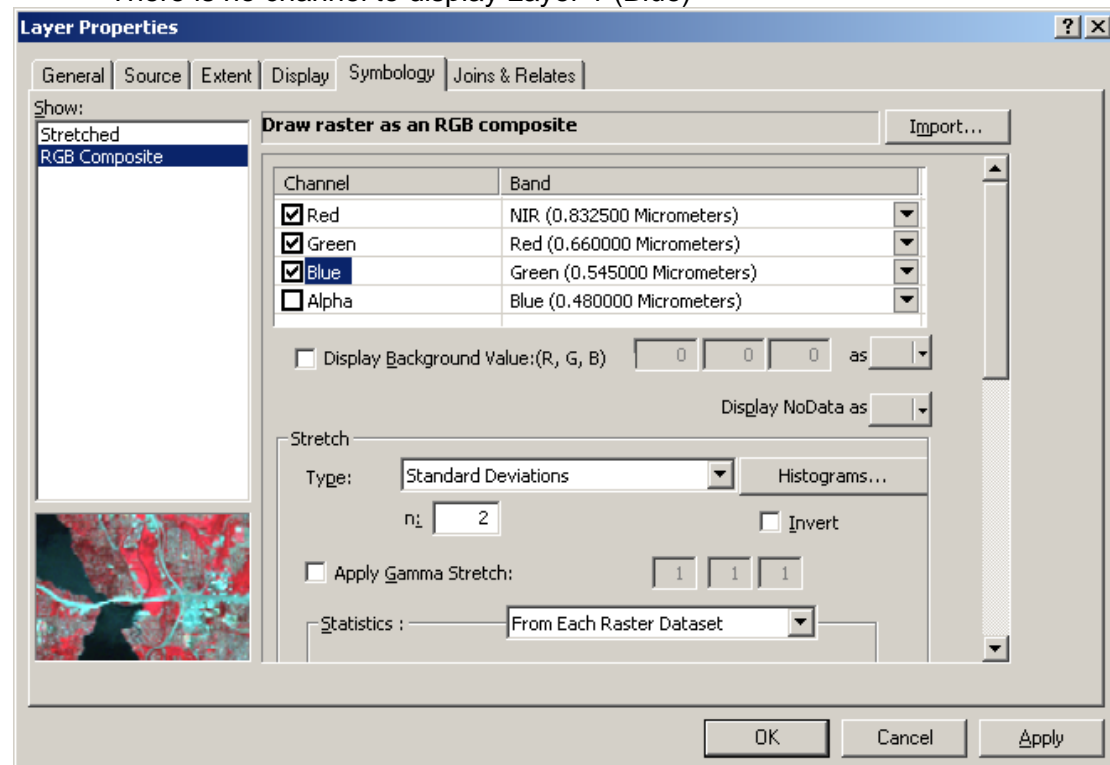
You should be able to see the band assignment in the TOC as well



In the TOC, **right click** on the WV2 layer → **Properties** → **Symbology** tab

Next, change the association to reflect the following:

- The red channel is displaying NIR
- The green channel is displaying Red
- The blue channel is displaying Green
- There is no channel to display Layer 1 (Blue)



Click OK.

Your display should now look like that shown below, and this is called a *standard false colour composite*.



Q2. What colour does vegetation appear in the false colour composite? What does this mean in terms of the amount of light it is reflecting in different wavelengths?

Q3. Compare the true colour and false colour composite images. Think about the contrast between different features within each display, and comment on the types of features that are more apparent in one display compared with the other.