ENV 202/502 INTRODUCTORY REMOTE SENSING

Practical Exercise 5 – Analysing Image Data

# Overview

When we visualise features in the world around us, as within imagery, our brain uses a number of different cues to bring together information that our eyes can see. It is a challenge to understand just how our brain pieces together this information. By understanding the fundamentals of manual interpretation, we are then eventually able to program computers to learn to recognise features in the same way. This then provides the foundation for developing autonomous mapping systems.

## Learning Outcomes

After completing this practical, students will be able to:

1. Define the meaning of commonly used image interpretation cues and be able to use them appropriately to analyse an image;
2. Make measurements of features within an image;
3. Understand colour mixing theory and how it applies to multi-band image display; and
4. Use multi-band colour combinations to assist with feature identification.

## Preparation

You will first need to ensure that you have all the data required for this tutorial (as listed below).

Copy today’s practical materials into your working directory from

G:\Resources\ENV202\

## Required data

All data for this practical is available for internal students under:

G:\Resources\ENV202\

External students should have received these data on a CD in the mail.

L8\_Darwin\_240713\_dps

L8\_Darwin\_240713\_dps.hdr

This is a radiometrically and atmospherically calibrated Landsat 8, eight band multispectral image of Darwin and surroundings that was acquired on 24th July 2013.

WV2\_05062010\_subsetdps

WV2\_05062010\_subsetdps.hdr

This is a radiometrically and atmospherically calibrated Worldview-2 eight band multispectral image subset of the downtown Darwin region that was acquired on 5th June 2010.

## Additional Software

NA

# Image Interpretation

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.

## 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; interpreters 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, brush 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.

Steeples 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

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).

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 = playa. 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.

## 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 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 facings sides of steep slopes (in the southern hemisphere).

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. Using the WV2 image of downtown Darwin and based on the labelling in the figure below, fill in the following table (28 points):



|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Colour and tone | Texture | Size | Shape | Pattern | Shadow | Context (site & association | Feature |
| A |  |  |  |  |  |  |  |  |
| B |  |  |  |  |  |  |  |  |
| C |  |  |  |  |  |  |  |  |
| D |  |  |  |  |  |  |  |  |
| E |  |  |  |  |  |  |  |  |
| F |  |  |  |  |  |  |  |  |
| G |  |  |  |  |  |  |  |  |

## Interpretation Keys

Interpretation cues are grouped together to create an interpretation key. This is usually done in a hierarchical structure where different features are identified using a number of cues in a step-wise manner.

Q2. Using your Worldview 2 image as a guide, indicate the cues that you would use to differentiate between the following (4 points):

Land and water

Urban residential and industrial

Grasses, mangroves, and savannah woodland

Cars and boats

# Understanding Colour

Throughout the semester we will be looking at multiband images through only three different colour display guns – red, green, and blue. It is really important to understand how all the colours of the rainbow can be created using just these three colours. Primary coloured light (red, green, and blue) is mixed in an *additive* process to provide secondary colours.

Primary coloured light is mixed to provide the following secondary colours:

|  |  |
| --- | --- |
|  | Red + Green = Yellow  Red + Blue = Magenta  Green + Blue = Cyan  Red + Green + Blue = White |

NB: The process of mixing light is different to the *subtractive* process of mixing paints or pigments, where the primary colours are red, yellow, and blue.

**Visit the following website** and have a practice at mixing the primary colours in equal proportions.

<http://lightpigment.com/labs.html>

**Visit the following websites** and experiment with their colour mixing tools

<http://www.colorpicker.com/>

Q3. Which of the primary colours mix together, and in what proportions, to make the following colours:

Orange

Grey

Black

Dark purple

# Colour and Multiband Image Interpretation

Exercise 3 demonstrated how to change the spectral band combinations for image display to be able to visualise non-visible light through different colour guns. Three common Landsat band combinations are:

|  |  |  |  |
| --- | --- | --- | --- |
| True Colour | Blue | Green | Red |
| Standard False Colour | Green | Red | NIR |
| False Natural Colour | Red | NIR | SWIR |

Pixels within an image are the colour of the colour gun used to create that composite. In a true colour image, healthy vegetation will appear green because it reflects more green light when compared to blue and red, as per the spectral profiles that you have looked at previously. However, in a standard false colour composite, the NIR reflectance is included, and displayed through the red colour gun. As healthy vegetation has a higher NIR reflectance relative to red and green, then the red colour gun will dominate the blue and green colour guns, and vegetation will appear red.

Note that all natural features will in fact reflect light over a mixture of wavelengths, so a pure red, green, or blue display is unlikely. More commonly and image will show both colour and tonal (i.e. bright to dark) variations or mixtures.

**Open** L8\_Darwin\_240713\_dps

**Create a true colour composite image display** using the Landsat 8 image (RGB = RGB).

Q4. Taking into account the input bands and the colour display, describe the tone and colour of the following features, and the reason why they appear this way. The first one has been done for you (6 points):

|  |  |  |  |
| --- | --- | --- | --- |
| **Feature** | **Tone** | **Colour** | **Justification** |
| Deep water | Dark | Blue | Moderate reflectance in blue, low to very low in green and red. Therefore the dominant colour is blue, with little contribution from the other bands. Tone is dark as reflectance levels are relatively low. |
| Healthy Vegetation |  |  |  |
| Bare dry ground |  |  |  |

**Create a standard false colour composite image display** using the Landsat 8 image (RGB = NIR, R, G).

Q5. Taking into account the input bands and the colour display, describe the tone and colour of the following features, and the reason why they appear this way (9 points).

|  |  |  |  |
| --- | --- | --- | --- |
| **Feature** | **Tone** | **Colour** | **Justification** |
| Deep water |  |  |  |
| Healthy Vegetation |  |  |  |
| Bare dry ground |  |  |  |

**Create a false natural colour composite image display** using the Landsat 8 image (RGB = SWIR, NIR, G).

Q6. Taking into account the input bands and the colour display, describe the tone and colour of the following features, and the reason why they appear this way (9 points).

|  |  |  |  |
| --- | --- | --- | --- |
| **Feature** | **Tone** | **Colour** | **Justification** |
| Deep water |  |  |  |
| Healthy Vegetation |  |  |  |
| Bare dry ground |  |  |  |

Q7. Complete the following table. The first one has been done for you (6 points)

|  |  |  |  |
| --- | --- | --- | --- |
| **Display Type** | **Display Tone and Colour** | **Input Contribution** | **Potential Feature & Justification** |
| RGB = NIR, R, G | Bright red | High NIR  Low red  Low green | Healthy vegetation – reflects high levels of NIR due to internal cellular structure and biomass; absorbs red for photosynthesis |
| RGB = NIR, R, G | Bright white |  |  |
| RGB = NIR, R, G | Bright cyan |  |  |
| RGB = SWIR, NIR, G | Moderate orange |  |  |

# Top Tips

1. Context is integral in image analysis;
2. Try to create keys based on cues that are specific enough to identify features, but generic enough to be applicable on different dates, in different areas;
3. Practice looking at different band combinations to see the range of colours that different features may be displayed as; and
4. Learn the most commonly used band combinations, and the appearance of common features within them (e.g. healthy vegetation appears as bright red in a standard false colour composite).