White Paper

Medium Resolution Images and Clutter From Landsat 7 Sources

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Introduction

Space technologies have long been available for Earth observation. They produce a wide array of products in terms of resolution and type. Radio planning requires a good knowledge of the clutter environment and a good representation of the areas of interest. The Landsat7 satellite project provides the source information that allows the creation of a good 30m medium resolution clutter and image.

The Landsat Project is a joint initiative of the U.S. Geological Survey (USGS) and the National Aeronautics and Space Administration (NASA) to gather Earth resource data using a series of satellites. The primary objective of the Landsat Project is to ensure a collection of consistently calibrated Earth imagery. Landsat's Global Survey Mission is to establish and execute a data acquisition strategy that ensures repetitive acquisition of observations over the Earth's land mass, coastal boundaries, and coral reefs

The Enhanced Thematic Mapper Plus (ETM+) is a multispectral scanning radiometer that is carried on board the Landsat 7 satellite. The sensor has provided continuous coverage since July 1999, with a 16-day repeat cycle. The ETM+ instrument provides image data from eight spectral bands. The spatial resolution is 30 meters for the visible and near-infrared (bands 1-5 and 7). Resolution for the panchromatic (band 8) is 15 meters, and the thermal infrared (band 6) is 60 meters. The approximate scene size is 170 x 183 kilometers.

This article describes the process for preparing SOL clutter layers and IMG image layers from Landsat 7 sources using ICS Map Server.

Source and Import

There are a number of sources for Landsat 7 images. The main source is through the USGS paid service that allows the selection of an area among a very large number of scenes. The free source that I recommend is run by the ESDI at http://glcfapp.umiacs.umd.edu:8080/esdi/index.jsp.

The site provides a very good interface for selecting, previewing and downloading the scenes. The ETM+ images should be preferred, but TM images will also work. Select orthorectified images only. After selecting the scene, the eight spectral bands are available for download. The .met file contains all the information we need and should be downloaded along with the layers 3, 4 and 5 for a minimum dataset. The layer 1 (visible blue) is rarely used, the other layers are only useful for specific purposes. The layers are greyscale TIFF 8 bits and can be batch imported to IC1s under the Landsat menu.

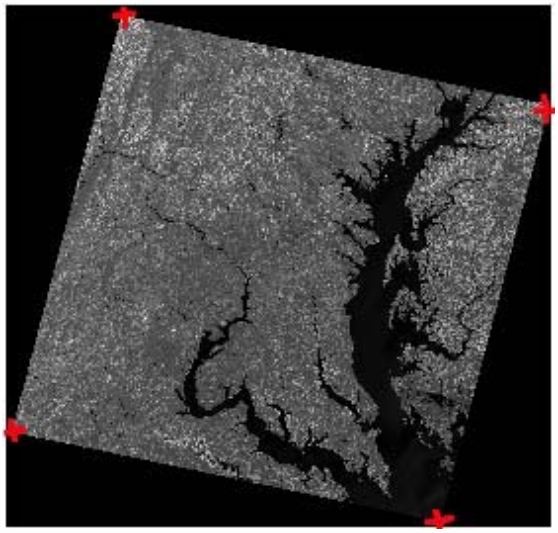
Color Imagery

Three layers are combined in order to produce a color image. The classic combinations, in the order Blue Green Red are 2-3-4, 3-4-5, 3-4-7. These days, our favorite combnation is 3-4-5.

Landsat 7 image using channels 3-4-5

Select the channels in the channel selector box and assign them to the Red Green and Blue components. A convolution function with pre-defined filters (sharpen and edge enhance) is available in the right toolbar in order to produce a crisper image. Once satisfied with the appearance, the image is converted to an 8bit IC1 with an adaptive palette.

The imported channels are already orthorectified. However, ICS Map Server does not read the geographic parameters at import time and the user needs to assign them using the 'reference point' tool in the 'open channel' window. The ASCII .met file contains the resolution (usually 28.5m), the projection zone (UTM is the default), and the coordinates of the corners of the scene in decimal degrees (4DEC) and usually UTM. The corners coordinates correspond to the corners of the image itself as shown in red in the following image:



Channel Geocoding

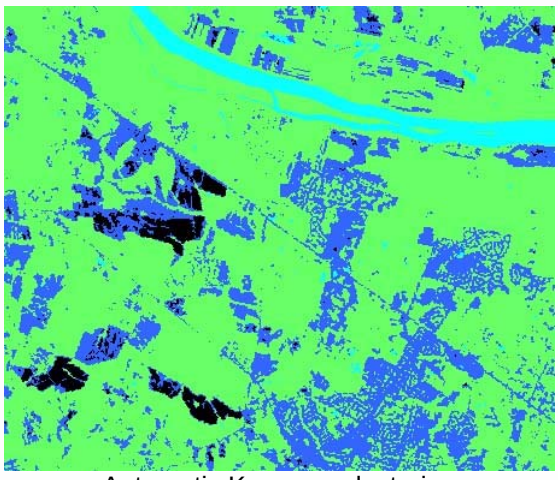
Just click on one corner and fill the X, Y and Step fields. As a sanity check, verify that the other three corners match the .met coordinates by just moving the cursor around.

The specific part is complete. The generic geoconversion processes used in order to get a set resolution and projections, palette standardizing, cutting and tiling are classic functions of ICS Map Server.

Clutter Extraction

Clutter extraction from Landsat images in ICS Map Server is still a work-in-progress. However, the main components are already implemented.

The K-means clustering method consists of classifying the pixels of a multispectral image closest to a set of manually set reference points. In order to get a good result, more layers need to be downloaded (2 and 7 at least). The operator uses the reference point to click on areas of known clutter classes, like vegetation, open, water, urban. The number of points is not limited but using only a few points per class is preferred. The classify function does the rest. We do not have an official recipe for success at this time, but a few iterations provide decent results. Some classes like water extract very well, while the urban areas, because they have a complex spectral identity, extract with more difficulties.

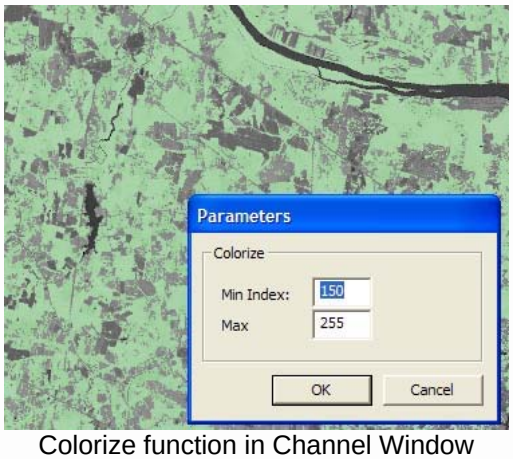


Automatic K-means clustering

Our preference is for a step by step, class-per-class approach:

Vegetation: A very classic and well documented method for extracting vegetation is the calculation of the Normalized Difference Vegetation Index (NDVI). This index basically calculates the difference in reflection from the red and the near infrared channels (NDVI = (L4-L3) / (L4+L3)). The result is directly proportional to the density of the vegetation. ICS Map Server calculates the NDVI index from the Combine Channels Box, and applies the 100x(NDVI+1) transformation in order to be readable as an IC1 layer. The user has to decide the threshold from which the vegetation class is applied. By opening the layer in an Open

Channel window, it is possible to colorize the values between 2 presets and validate the threshold. Usually, this value is between 120 and 150.



Colorize function in Channel Window

The result is classified easily in a disc 8-bit window with a transform function: All<150 to 0, All>149 to 5.

Water: the water layer is even easier at it does not reflect infrared. Again, a threshold is sought on the layer 5 or 7, and all<threshold to 6, all>threshold to 0.

Urban Areas: At this stage, we are favoring manual extraction of the urban and suburban areas, as well as the main roads using a standard contour extraction process using the Landsat color image as the wallpaper and using line, fill and polygon functions.

Merging: The three or four layers are then merged into a complete clutter layer that is processed like the image with possible geoconversion.

Conclusion

The 30m resolution image and clutter generated from Landsat images match very well the 90m DTM from SRTM sources. The end product is very current and technological. The datasets created cover most medium resolution needs anywhere in the world consistently. The free access to large repositories of data allows access to RF Planning in places where no data was available and in the frame of projects where purchasing information is not possible.

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