GRASS GIS image processing environment
Gearing towards GRASS GIS 7

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Abstract

GRASS GIS, commonly referred to as GRASS (Geographic Resources Analysis Support System), is a free Geographic Information System (GIS) software used for geospatial data management and analysis, image processing, graphics/maps production, spatial modeling, and visualization [1].

GRASS GIS 7 started its development by the branching out of GRASS GIS 6.x from the main trunk of code (rev 31142). This was done on 27th of April 2008, and a large amount of changes took place since that date, more are still underway.

- Raster library in GRASS 7 (ongoing)
- Vector library in GRASS 7 (ongoing)
- Raster3D (volume) library and modules in GRASS 7 (finished)
- Temporal extension for GRASS 7 (finished)

GRASS GIS' capacity in remote sensing has also been greatly improved with additions for version 7.

Linear features extraction

An edge is considered as a change in image digital values. Edge detection & extraction in i.canny is done by a Canny edge detector [2]. The Canny edge detector encompasses Gaussian smoothing, gradient computation & non-maximum suppression.

This creates thin edges and thresholding with hysteresis which preserves only important edges. Thus, no pre- or post-processing is required. The produced binary image shows boundaries of areas in the input image which is usually a gray scale image e.g., intensity channel or the result of PCA.

The i.edge module is suitable as a first step in building or road detection. The level of details of the output image is easily customizable.
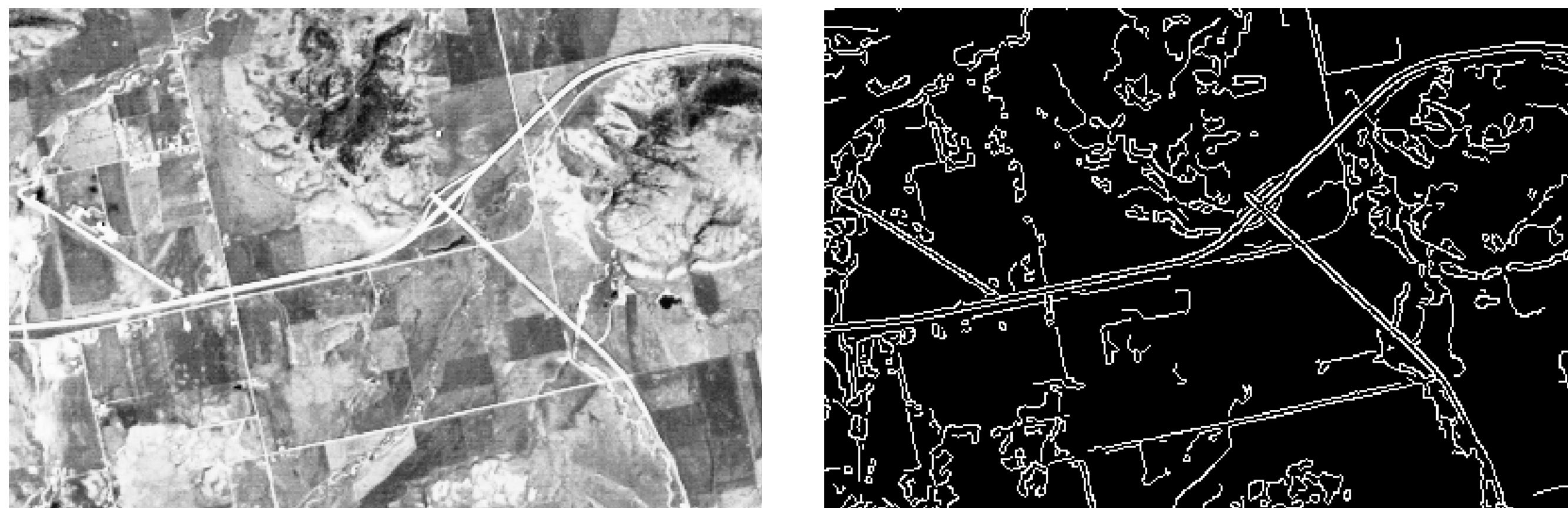

Figure 1: Canny edge detector on a road network [2]

Object recognition

The module i.segment [3] is using a region growing algorithm [4], some ideas have also been implemented from [5]. It produces a raster map with segments (objects), and optionally other maps with segments statistics (mean/variance/range/etc.).
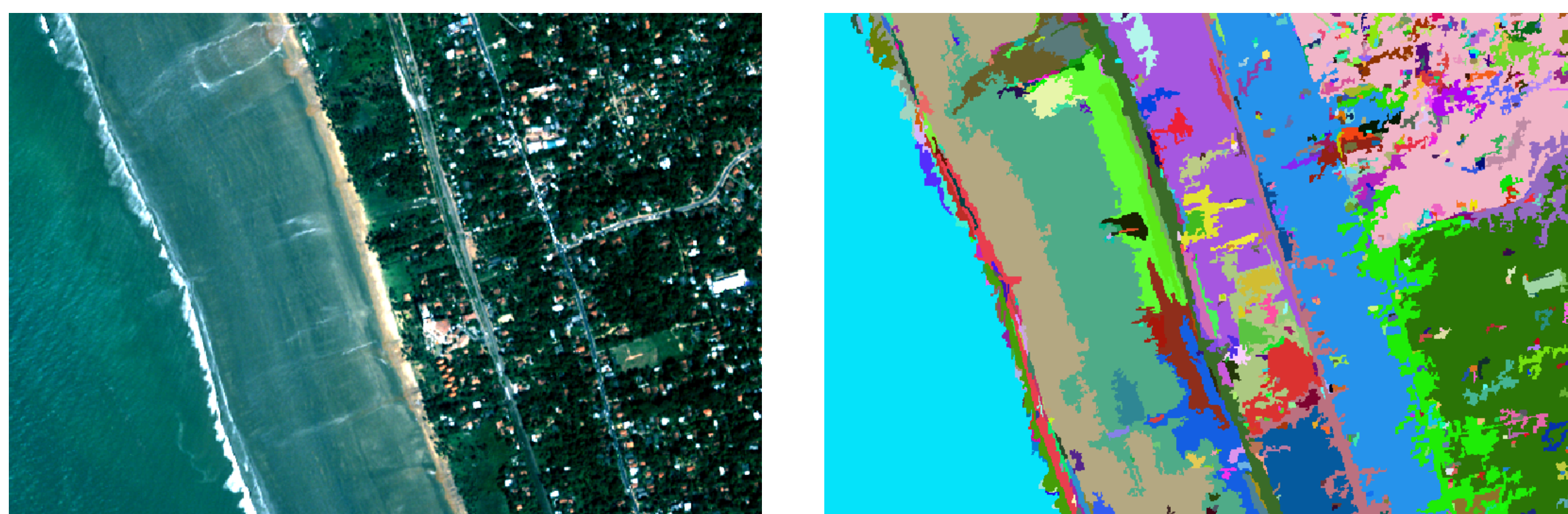

Figure 2: Image segmentation (2.4x2.4m) of the 2004 tsunami wave, West Coast Sri Lanka

Satellite imagery products

- **i.vi** 15 vegetation indices available
- **i.albedo** Broadband Albedo (snow ≈ 0.6-0.8, water=0.05)
- **i.emissivity** Emissivity approximation from vegetation index
- **i.biomass** biomass growth for crop yield

Reference/Potential ET: i.evapo.* modules

- **i.evapo.mh** ETo Hargreaves, modified-Hargreaves & Hargreaves-Samani
- **i.evapo.pm** ETo Penman-Monteith
- **i.evapo.pt** ETpot Priestley-Taylor

Actual ET: i.eb.* modules using thermodynamic heat flux modeling
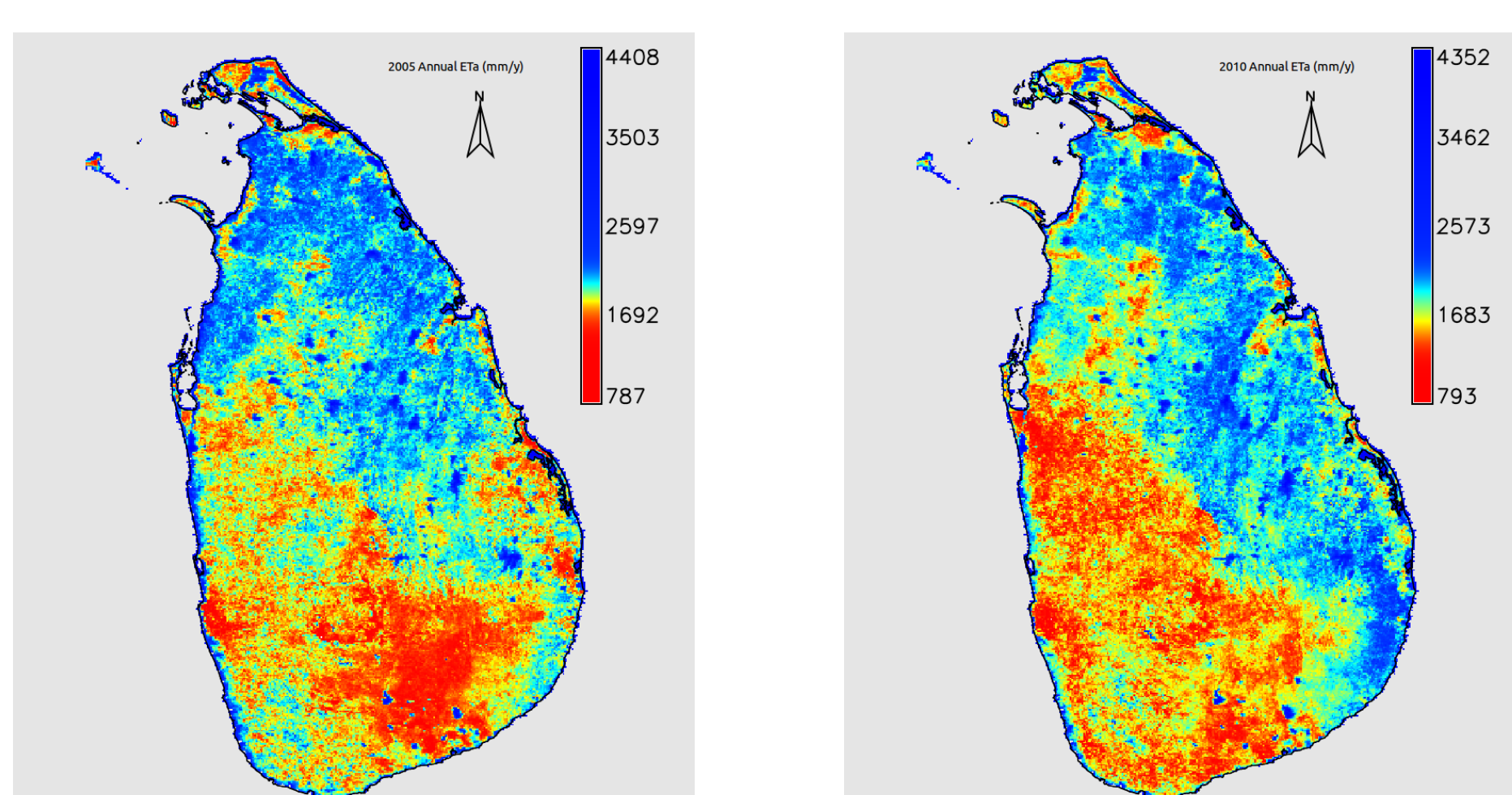

Figure 3: Actual evapotranspiration (i.eb.*) for water monitoring and management [6]

Interactive supervised classification

This interactive tool [7], aims at greatly simplifying quantitative surpervised class training areas creation. It calculates the spectral signatures based on the cells within the specified areas. The resulting signature file can be used by a maximum likelihood classification module (i.maxlik). During the process the user is shown a histogram of the area cell values for each image band, and coincident plot which shows the separability of classes.

Another way the user can inspect the suitability of the created training areas is by displaying the cells of the image bands which fall within a user-specified number of standard deviations from the means in the spectral signature. This helps to estimate how much of the image is likely to be classified as a particular class.
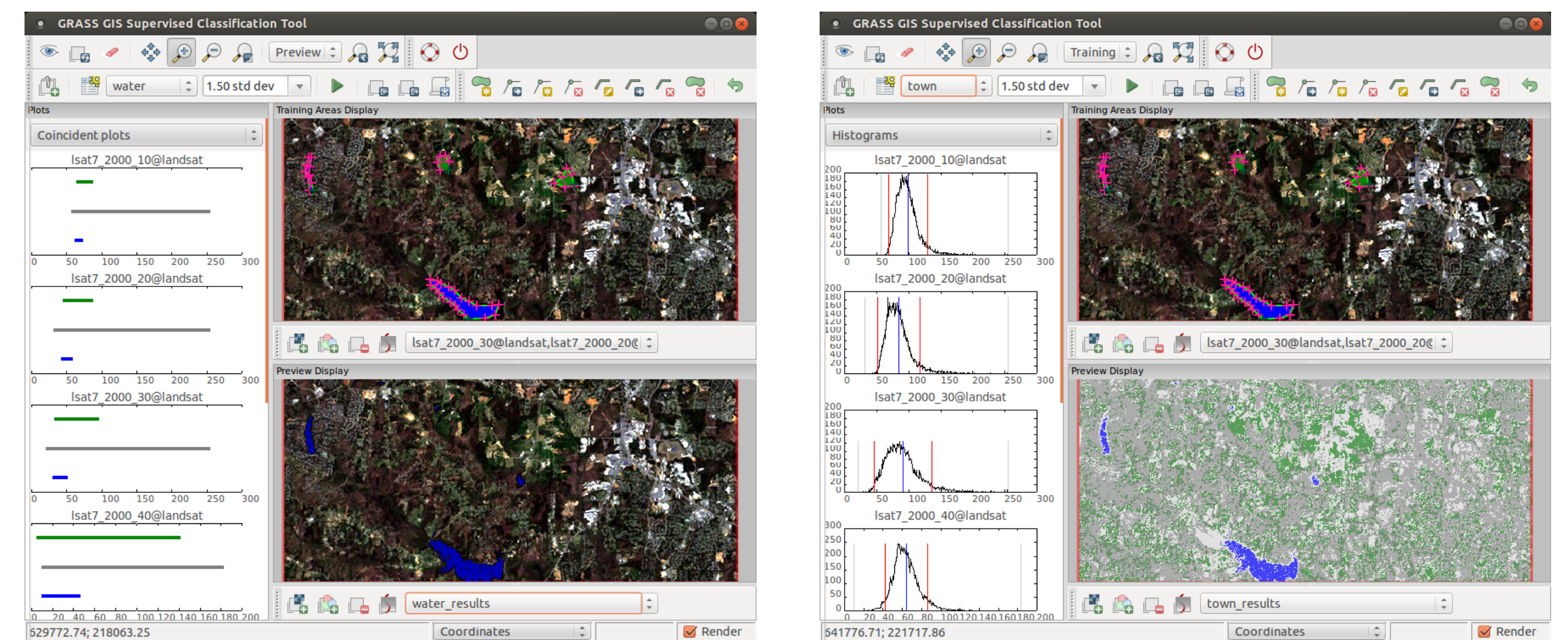

Figure 4: Interactive image classification with coincidence plots (left side) & histograms (right side)

Lidar

The Lidar library (`www.liblas.org`) included in GRASS GIS permits the import of Lidar (.las) data in raster (r.in.lidar using statistics of choice) or in vector format (v.in.lidar). Author Markus Metz tested r.in.lidar with a 705Gb .las file. On-farm water storage study with lidar data in NSW (Australia) developed a full remote sensing monitoring methodology of water availability with lidar-based bathymetric survey and multi-source remote sensing survey [8].
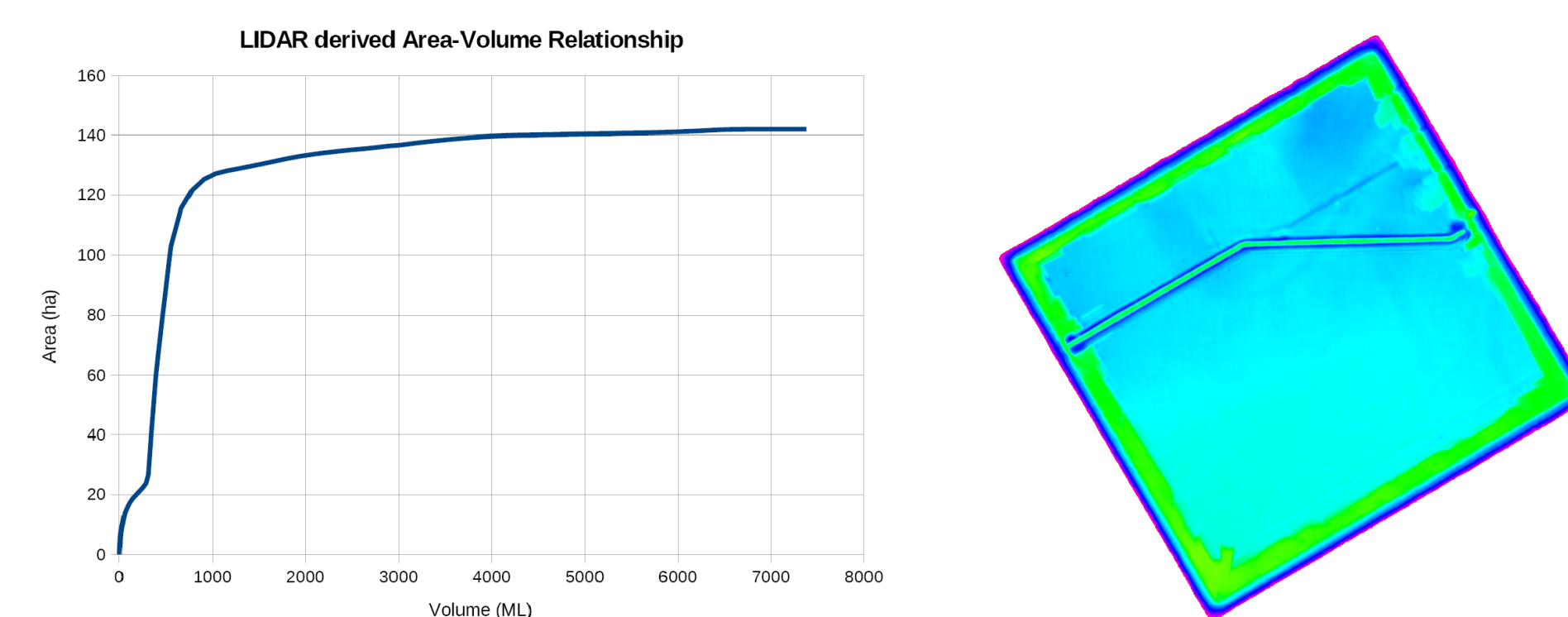

Figure 5: On-Farm-Water-Storage Lidar survey and Depth-Volume-Area surveying [8]

Other Improvements & Additions

Remanufacturing, performance improvement

- **i.ortho.rectify** new rewritten & optimized version of i.ortho.photo
- **i.atcorr** atmospheric correction, more satellite sensors configured, faster
- **i.pca** backward modeling implemented

Preparing Landsat, Aster and MODIS datasets

- **i.landsat.toar** TOA reflectance correction for Landsat satellite series
- **i.aster.toar** TOA reflectance correction for Terra-ASTER
- **i.modis.qc** Quality flag interpretation for Terra/Aqua MODIS

Geographical and astronomic functions

- **i.latlong** maps latitude or longitude (dd.ddd)
- **i.sunhours** maps potential hours of sunshine in a day at a given location (hh.hhh)
- **r.sun.angle** maps the sun elevation and sun azimuth angles for the given time of day

Temporal cleaning and smoothing

- **r.hants** Fourier temporal smoothing
- **i.lmf** Local maximum fitting of temporal data

Multi- and hyperspectral data analysis

- **i.spec.unmix** Spectral Unmixing

References

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www.iwmi.org

grass.osgeo.org

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