VAST Challenge 2017 Reviewer Guide: Mini-Challenge 3

This document provides information to support peer review of submissions to VAST Challenge 2017, Mini-Challenge 3. This document covers background about the submission structure, the challenge problem, tasks and questions presented to participants, potential answers, and evidence found in the Challenge data supporting these answers. For a full description of the challenge problems and to access the data provided to the participants, please visit http://vacommunity.org/VAST+Challenge+2017.

Submissions

Participants are required to submit their entries on a standard answer form, along with a video explaining how visual analytics were used to help solve the challenges. Please consider both parts of the submission in your review. If you have difficulty reading the answer form or playing the video, please contact us at vast-challenge@ieee.org for assistance.

Scenario

Overview

Mistford is a mid-size city is located to the southwest of a large nature preserve. The city has a small industrial area with four light-manufacturing endeavors. Mitch Vogel is a post-doc student studying ornithology at Mistford College and has been discovering signs that the number of nesting pairs of the Rose-Crested Blue Pipit, a popular local bird due to its attractive plumage and pleasant songs, is decreasing! The decrease is sufficiently significant that the Pangera Ornithology Conservation Society is sponsoring Mitch to undertake additional studies to identify the possible reasons. Mitch is gaining access to several datasets that may help him in his work, and he has asked you (and your colleagues) as experts in visual analytics to help him analyze these datasets.

Mini-Challenge 3

As Mitch works independently, he realizes that he cannot continually visit all areas of the Preserve to inspect for environmental impacts as well as he would like to. He realizes that his analysis would be incomplete without thorough surveillance and knowledge of the Preserve health over time. Fortunately, Mitch has acquired data from some commercial multi-spectral imagers that have been routinely covering the nature preserve every few weeks. Mitch believes that a visual analytics approach can help him achieve an understanding of the preserve health and alert him to possible conditions that may be impacting his birds.

Ground Truth

There is dumping of some substance that is being picked up by the multi-spectral images. It is in the northeast region of the image, and is highlighted on the maps below. The left hand side map shows only channel 6 of one of the multispectral images; the right hand side highlights the location on a traditional image. The spot appears on the 2015-02-15 image and grows through the rest of the images.

Figure 1 Ground truth

Data

This mini-challenge also has a description of the Lekagul Preserve, and it has a primer on multi-spectral imaging, as an introduction to the visual analytics researchers who may not have had much exposure to this kind of data. There is an image of Boonsong Lake with an annotated dimension, so that contestants could use that as a judge for image size. The data are 24 images over three years over the Preserve. The .tif images include all of the channels. The .csv files contain a delimited format with pixel values for each image. Either type of data can be used. This is reviewed in more detail in the dataset description.

Challenge Questions

1. *Boonsong Lake resides within the preserve and has a length of about 3000 feet (see the Boonsong Lake image file). The image of Boonsong Lake is oriented north-south and is an RGB image (not six channels as in the supplied satellite data). Using the Boonsong Lake image as your guide, analyze and report on the scale and orientation of the supplied satellite images. How much area is covered by a pixel in these images? Please limit your answer to 3 images and 500 words.*

Simply put, a pixel is about 30 m square.

2. *Identify features you can discern in the Preserve area as captured in the imagery. Focus on image features that you are reasonably confident that you can identify (e.g., a town full of houses may be identified with a high confidence level). Please limit your answer to 6 images and 500 words.*

   A quick review of the images shows that there is quite a lot of seasonal change in the vegetation and drastic changes in cloud cover, with some dates almost completely occluded by clouds. A statistical anomaly analysis of an individual band is likely to highlight only those pixels affected by clouds (either extremely bright clouds or dark shadows), snow or the sensor artifacts (Figure 2).

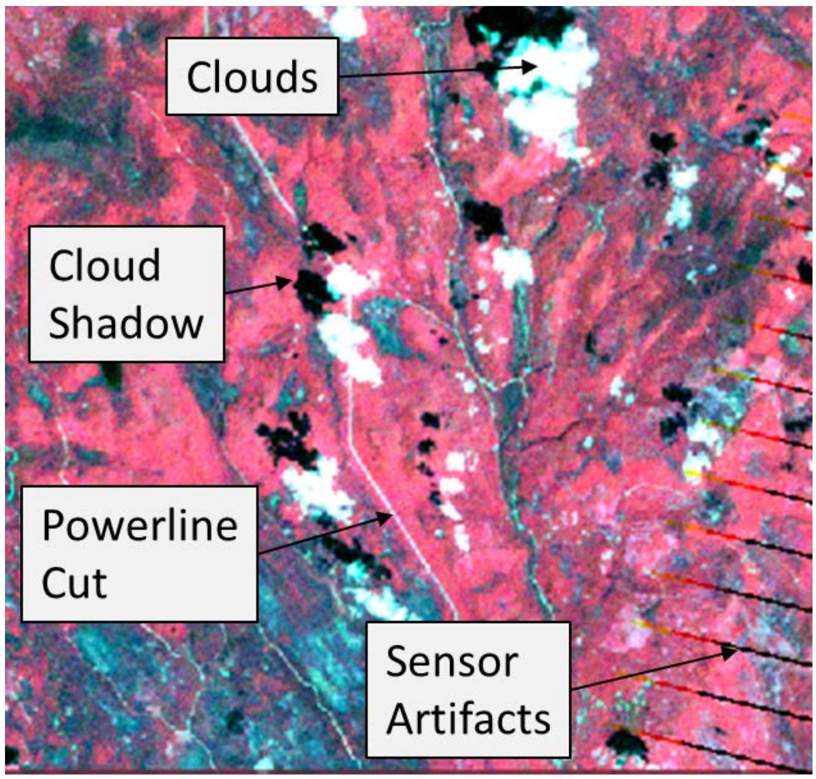

Figure 2. Example image showing natural and sensor "artifacts" that may be detected

   Note the sensor artifacts will not appear on all of the images, so a reasonable conclusion is that these are imaging anomalies. The Powerline Cut is constant through the images, but too regular to be a natural feature of the area.

3. *There are most likely many features in the images that you cannot identify without additional information about the geography, human activity, and so on. Mitch is interested in changes that are occurring that may provide him with clues to the problems with the Pipit bird. Identify features that change over time in these images, using all channels of the images. Changes may be obvious or subtle, but try not to be distracted by easily explained phenomena like cloud cover. Please limit your answer to 6 images and 750 words.*

The scenario represented in this series of images is that Kasios Manufacturing is disposing of nasty chemical sludge in the preserve, causing an effect on the habitat and thus, the Pipit population. The sludge dumping starts after December 30, 2014 and is detectable by February 2, 2015, albeit slightly as it affects an area only 6 pixels in size and is only perceived in the infrared bands (bands 4-6). By September 06, 2016 the sludge has the largest footprint, affecting an area 34 pixels in size and is perceived in both visible (bands 1-3) and infrared wavelengths (bands 4-6). The signature across all visible and infrared bands and spatial extent of the sludge varies by season and year (Figure 3). The seasonality of the signature is due to the effect on vegetation; in the spring before the vegetation has started growing, the signature is indicative of the actual sludge, whereas in the summer and fall the signature is indicative of the effect on vegetation vigor. This vegetation effect shows contrast with the surrounding areas, especially in the infrared bands.

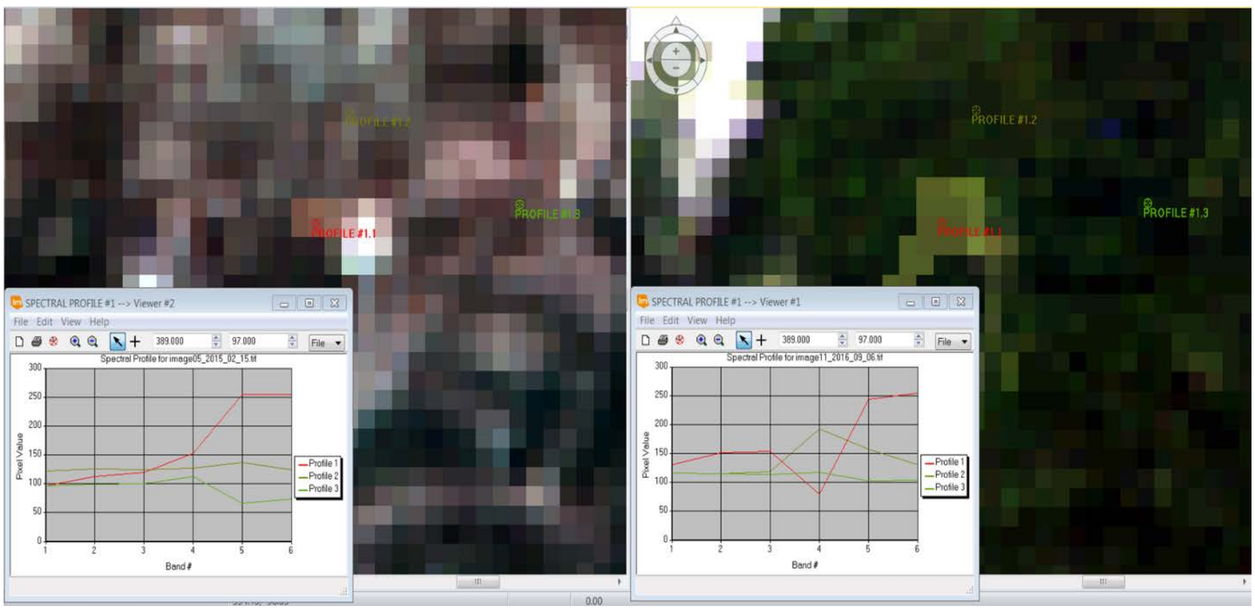

Figure 3. Zoomed in portion of the image with sludge dumping showing the summer effect (left panel) and winter/spring effect (right panel). The red profile in both images is centered on the sludge. The inset graphs represent pixel value (y-axis) by band number (x-axis), band designations: 1-blue, 2-green, 3-red, 4-near infrared, 5- infrared and 6-infrared. Note that the signature changes between seasons based on vegetation growth but remains unique in comparison to other pixels in the image.

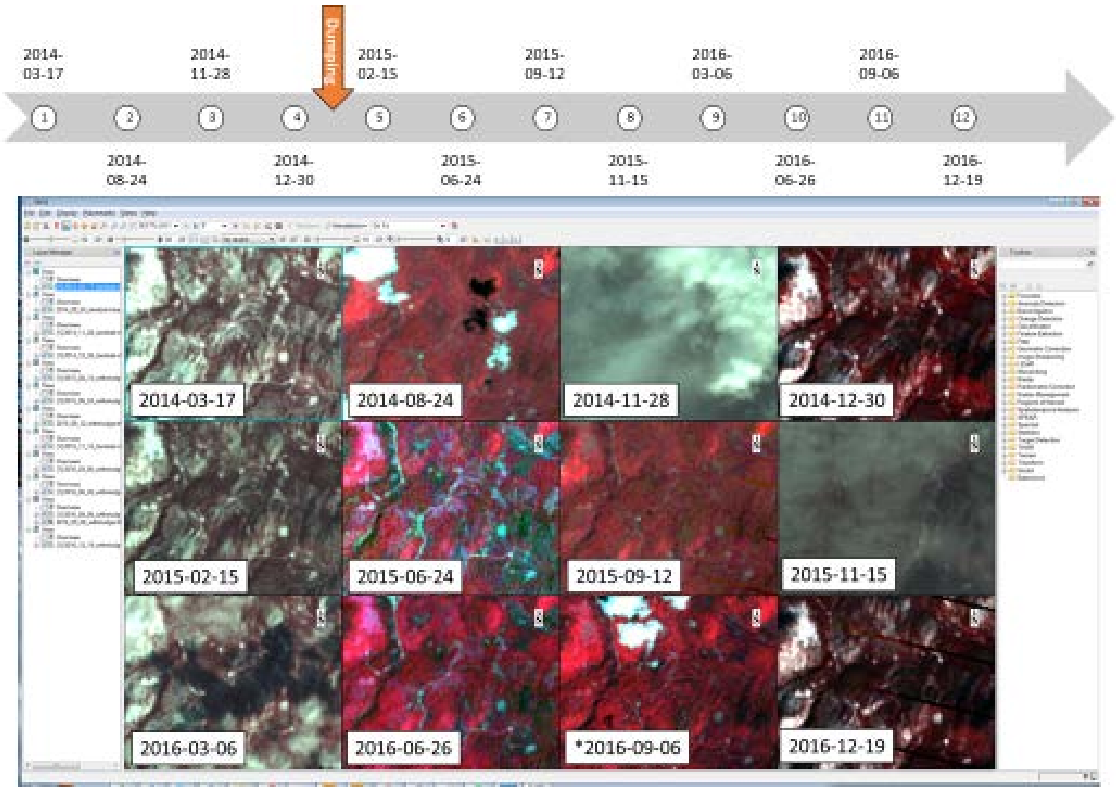

Figure 4. Progression of image changes through the three years of interest. NOTE: Images are shown here in false-color (bands 4,3,2 true color would be 3,2,1) to accentuate vegetation (in red).

The most effective analytical and visualization techniques should consider all bands of all the images, or at least a combination of visible and infrared bands to highlight vegetation anomalies referred to in the scenario description (i.e., "...there have been changes in the flora that are related to issues with fauna") (Figure 4).

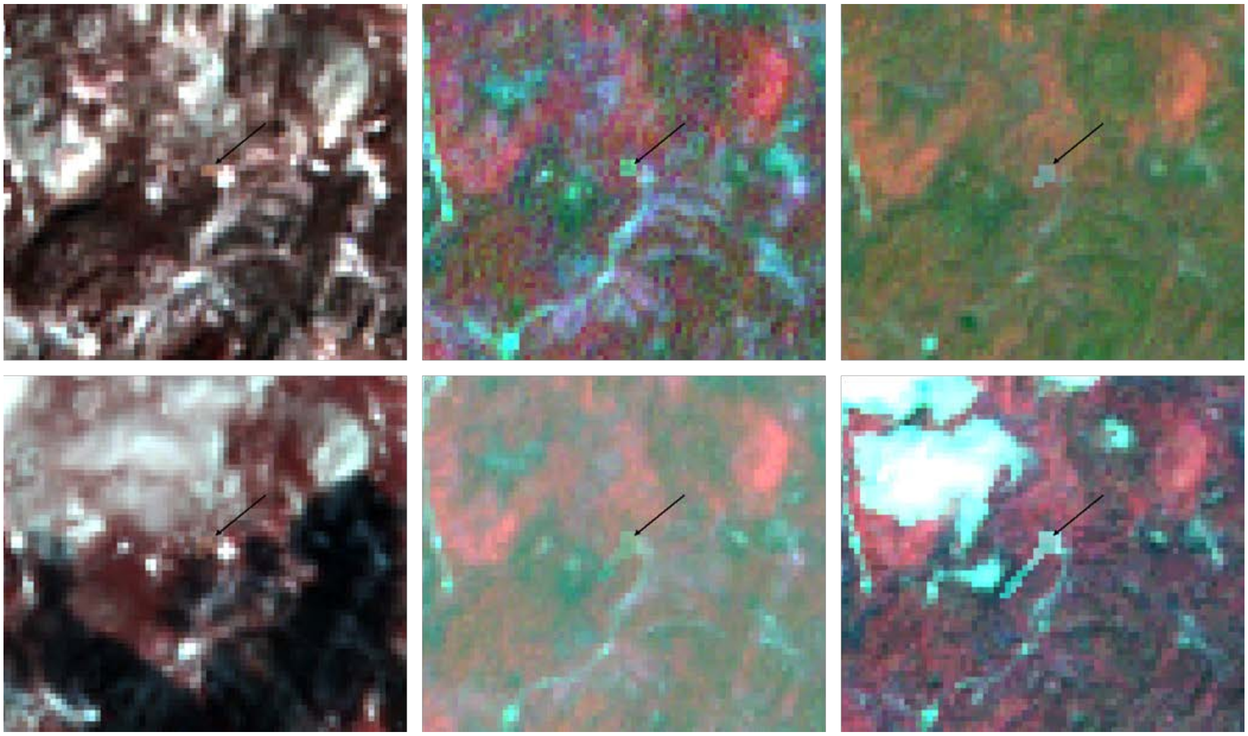

Figure 5. Progression of sludge over time. Arrow points to pixel coordinate 477, 287. Top row left to right, year 1 spring to fall. Bottom year 2.

Reviewer Considerations

MC3 Questions and Approach:

- Did the submission find a specific problem location in the preserve that could be impactful to wildlife?
- Did the submission identify non-problem-causing features of the images (e.g., clouds)? If so, were they dismissed?
- Did the submission identify significant potentially problem-causing features over time?
- Were visual presentations key to the solution submitted by the authoring team? What purpose did they serve (e.g., primary identifying tool? Support to statistical analysis? Other?)

MC3 Application of visual analytics:

- Did the team develop an innovative visual analytic tool? Alternatively, did they use an existing tool in an innovative way?
- Did visualizations enable the analysis process? Or did they merely illustrate conclusions? Did the submission rely more heavily on non-visual analytic approaches?
- Did their tool allow useful interactions?
- Did they use all the available data?
- Was the submission clear?

Additional information

Example of a workflow to uncover anomalies:

1. Identify and remove non-target areas
    a. Each image has different regions affected by clouds and/or sensor artifacts. Isolating and removing these artifacts can aid detection of more subtle spectral features
    b. Investigate band values in each image that are associated with visible non-target regions
    c. Screen or mask the pixels matching the band values using single or multi-band threshold, supervised classification or interactive removal
2. Compare full images from similar seasons
    a. The images are co-registered to represent the same ground area so pixel-based differencing can potentially show areas of change
    b. Most of the differences between images are due to changes in vegetation so leaf-on images should only be compared to other leaf-on images (summer and fall) and leaf-off should be compared to leaf-off (winter and spring)
    c. Individual bands should only be subtracted from the same band in the seasonally-matched image
    d. The difference images may visually show small regions of pixels associated with the changes of interest
3. Compare vegetation or soil images
    a. Multispectral images are often simplified to a single band that represents a phenomena of interest (vegetation, water or soil condition) via a simple band ratios or more sophisticated indices
    b. Once again, images from the same season should be compared to one another to minimize differences due to natural changes
    c. The difference images may visually show small regions of pixels associated with the changes of interest