Implementing NASA remote sensing to protect and monitor our waterways
NASA Langley Research Center
Earthzine/DEVELOP Virtual Poster Session, Summer 2011
Video Transcript

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Greetings, my name is Joshua Scott and I will be representing the Pacific Disasters Team of the DEVELOP National Program.

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Many people are familiar with the common hazards associated with volcanic eruptions such as lava flow, tremors, and ash clouds that disrupt air travel. However, it is a little known fact that volcanic eruptions can also severely impede maritime operations. So these past few weeks we at DEVELOP have been investigating a relatively unknown byproduct of oceanic volcanic eruptions called pumice rafts, similar to that portrayed in the upper right. These rafts are comprised of the volcanic rock pumice, which is characteristically lightweight, highly porous, and can stay buoyant for loooong periods of time. Although these rafts appear to be harmless, they pose a great threat to coastal communities for they can accumulate to widths equivalent to 300 football fields and nearly double that size in length. As a result, pumice rafts have the potential to bring powerful naval vessels to a halt and upset the delicate ecological balance by ferrying invasive species to new locations.

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For this project, we partnered with Dr. Greg Vaughan of the USGS, Dr. Richard Wunderman of the Smithsonian Institute, and Dr. Vasco Mantas of the University of Coimbra. The needs of our partners included the development of robust remote sensing techniques which could be used to detect and monitor pumice rafts, as well as the creation of a database containing pumice raft event information. Thus, the goals of this project were to develop and evaluate remote sensing techniques useful for the identification of pumice rafts, as well as developing a user-friendly database of pumice raft information. We would also like to thank our science advisors Dr. Kenton Ross and Jamie Favors.

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For this research study, we focused on three pumice raft events: one in Tonga during the year 2006, another in Yemen during the year 2007, and an additional occurrence in Chile during June

of 2011. Although we are the pacific disasters team, we took a more globally expansive approach. Hence, the inclusion of the 2007 eruption in Yemen.

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Because the primary purpose of this research was to create an effective methodology usable by our partners to detect pumice rafts, various techniques were developed for different levels of identification. MODIS imagery was used for visual identification of known pumice rafts events. Higher spatial resolution imagery including those acquired from ALI, Landsat 5 and Landsat 7 were then processed using two primary techniques. In order to classify small areas of pumice automatically, the Material of Interest subpixel classification technique was used, which creates a thematic map of pumice based on its per-pixel material make up. Another technique used was a false color composite, which enhances pumice raft definition for visual identification. For Landsat imagery, a composite of bands 1,3, and 7 as RGB, or red green and blue, respectively, was then converted into Intensity-Hue-Saturation values, a format more intuitive to the human eye. Then, the Saturation values were replaced with the high-gain thermal band.

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MODIS imagery was extremely useful in identifying large areas of pumice in the open ocean, as MODIS has a large frame extent. Additionally, MODIS imagery was used to monitor pumice raft movement, due to the sensors high temporal resolution. The movement of the raft is shown in this time series where it travels over 200km to the north-west over this 5-day period.

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Alternatively, for smaller areas of pumice, Landsat 5, 7 and ALI were used, as these sensors have a relatively high spatial resolution. The time series towards the bottom shows the development of a pumice raft in a small lake in Argentina, an area directly affected by the Chilean eruption, over a 15-day period. Such analysis would not have been possible using MODIS imagery.

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Both illustrations shown here are examples of false-color composite images, with the high-gain thermal band as saturation. As you can see, in both Argentina on your left and Tonga on your right, areas of pumice become white, and the definition of the rafts becomes more visually apparent. We found that bands 1,3, and 7 as RGB were more accurate in locations with extensive land areas such as Argentina, while bands 2,3, and 7 as RGB were more effective in open ocean areas like Tonga.

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One of the most robust techniques we used was the Material of Interest subpixel classifier, otherwise known as the MOI subpixel classifier. Both images shown here are thematic overlays of MOI classifications on false color images. The product of the classification includes 8 output ratios of pumice material to 'other' material, and is scaled on a color ramp for visual analysis. This technique allows for automatic identification of pumice in areas previously not identifiable using visual analysis.

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Interestingly enough, pumice rafts were also found to have thermal anomalies when compared to the surrounding water using spatial profiles. The magnitude and direction of the temperature anomaly was attributed to several factors including water temperature, air temperature, raft thickness, and solar heating. By overlaying the MOI classification on the spatial profile, we were able to establish a correlation between the MOI classification and the thermal anomaly.

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For our partners, we also went the extra mile to create a Google Earth Application which contains useful information regarding pumice raft events, as well as imagery useful in studying these occurrences. Additionally, this tool will allow future research efforts to quickly commence for they will no longer have to start their investigation from scratch.

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In conclusion, MODIS was found to be useful in detecting large scale pumice rafts, as well as monitoring them over time. Landsat 5, 7 and ALI were found to be useful in identifying small scale rafts, especially in closed bodies of water. To identify rafts, several remote sensing techniques were found to be effective. The false color composite improves the contrast of pumice rafts for visual identification, and requires little computing time. Thermal anomalies were found for several pumice rafts, but only larger extents were found to have variation. Finally, the Material of Interest subpixel classification was extremely effective at automatically identifying small areas of pumice, but requires extensive computing time.

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Thank you for your attention and we hope you enjoyed your time with us, the Pacific Disasters Team.