Remote Sensing: Tackling the Coffee Rust Epidemic

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Introduction

As field of growing importance, remote sensing is highly applicable in the prediction and analysis of a vast array of natural phenomena. Although remote sensing techniques have been used frequently within the agricultural industries of the western world, little attention has been paid to third world producers of globally traded products (*cite). Coffee is currently the world's leading agricultural commodity with millions of smallholder farmers in developing countries reliant upon coffee as a source of income. Within the early 21st century, on-farm coffee yields have faced heightened threats from coffee rust disease.

This paper seeks to: (1) discuss and sample the uses of remote sensing particularly within the agricultural sphere and (2) address the potential for tackling coffee rust through remote sensing technologies.

Background

Coffee rust, or Hemileia vastatrix, was first documented in East Africa and Ceylon (now Sri Lanka) in the 1860's. Within 20 years, the disease had spread to most of Southeast Asia's coffee producing nations and, in 1970, it was first reported in Brazil (Jandermeer et. al. 2014; Arneson, 2011). Concern for the overall susceptibility of coffee plants to the coffee rust fungus began growing in the early 2000's as the disease began devastating regions of Central America.

Climate change has been tightly linked to the growing prevalence of crop diseases such as Hemileia vastatrix. Since the virus grows during periods of rain or heavy dew and occurs in temperatures ranging from 59 - 82 degrees Fahrenheit (15 - 22 Celsius), the relationship between the growth of the fungus and climate trends is not difficult to ascertain (Arneson, 2011).

This link could prove devastating for Arabica coffee farmers, given that many live at elevations previously cold enough to prevent the spread of coffee rust to their plants. Although coffee rust targets both Arabica and the lower quality Robusta coffee species, Robusta plants are considerably less vulnerable to the fungus. Indeed, when coffee rust struck Indonesia in the 1880's a widespread shift to Robusta coffee was seen in areas of lower elevation (Neilson, 2008).

The American Phytopathological Society (APS) considers coffee rust "the most economically important coffee disease in the world" (2011). Furthermore, coffee is arguably the world's leading agricultural product, in that it effects the lives of millions of consumers and producers globally. Thus, it is increasingly pertinent for players in the global coffee industry to understand, manage, and combat coffee rust.

Remote Sensing

In its simplest sense, remote sensing involves obtaining data of a particular location or region from a distance. Satellite imagery is often used for the acquisition of this data. Considering the growing concerns over coffee rust and the sustainability of the coffee industry, remote sensing could serve as a valuable tool for understanding and analyzing coffee growth patterns. There have been a few studies pertaining to the use of remote sensing in analyzing the general environmental aspects of coffee and fewer still targeting the issue of coffee rust.

more of a broad overview of remote sensing here and cite more specific applications to agriculture (particularly disease monitoring and climate change)

One exemplary study relating coffee growth and remote sensing was conducted in 2012 using satellite imagery to observe trends of coffee plantation productivity in Brazil (Bernardes et. al.). This study suggested that foliage indexes discovered using MODIS, NDVI and EVI satellite technologies could be a predictor of plot yields. Further studies could be conducted using precipitation and temperature data as additional predictors.

Similarly, research based on remote sensing could, in the long term, be used to identify potential coffee plot locations. This could be accomplished by monitoring weather patterns, soil composition, forest type/coverage, and elevation. These studies, in addition to studies on specific agricultural practices, could provide a solid backbone for government-based and NGO projects targeting the spread of sustainable agricultural practices within the coffee industry by identifying key planting regions.

Applications of Remote Sensing to the Coffee Industry

In order to fully assess the variety of remote sensing applications to the problem solving of coffee rust issues, it is first necessary to identify major environmental correlations to coffee rust. Avelino et. al. list "wind, rainfall, leaf area, leaf wetness, light, temperature, fruit load, soil moisture and stomatal density" as the primary contributors to the life cycle of the coffee rust fungus. In the same vein - as mentioned earlier - climate change has been cited frequently as a major coffee rust and pest aggravator.

Talk about how each of the environmental correlations can be useful in using remote sensing for coffee rust

Data Availability

Historically, a major limiting factor to the use of remote sensing in agricultural production was the lack of substantial data. Although the constraints of data availability have continued to effect the scope of studies into the early 21st century, trends indicate that this issue will become increasingly less relevant within the coming years.

*add more to this section once more reading is done on the specific technologies relevant to studying coffee rust / environmental factors effecting coffee rust *

Maps

Figure 1: Site Locations in Indonesia

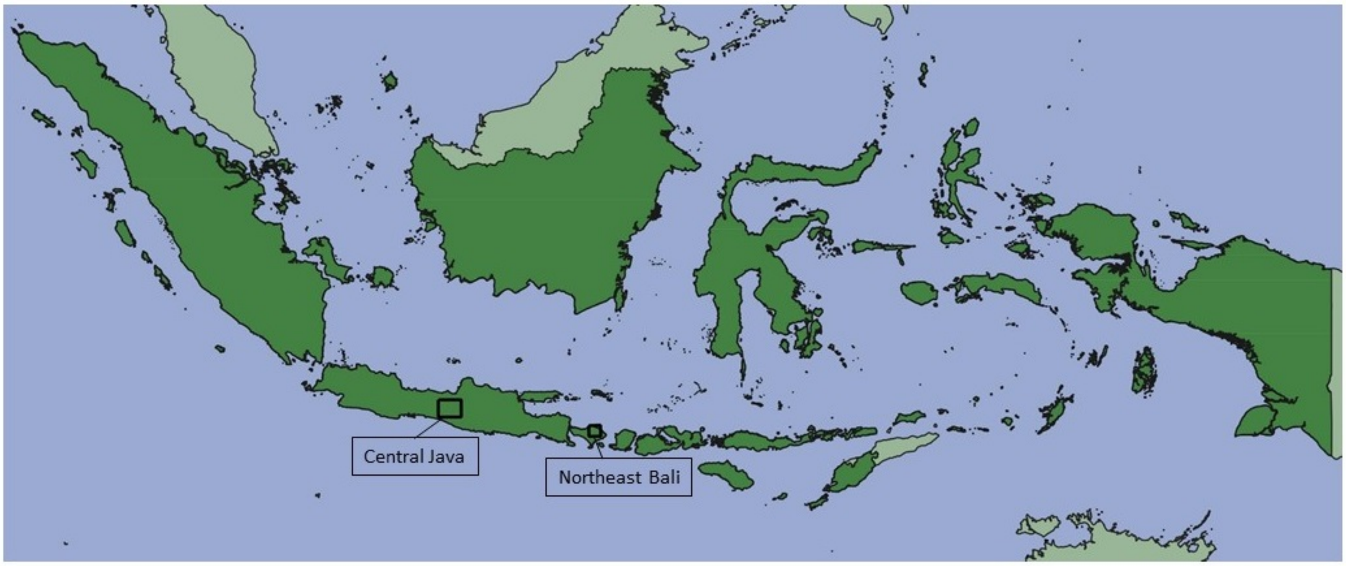


Figure 2: Central Java Landsat

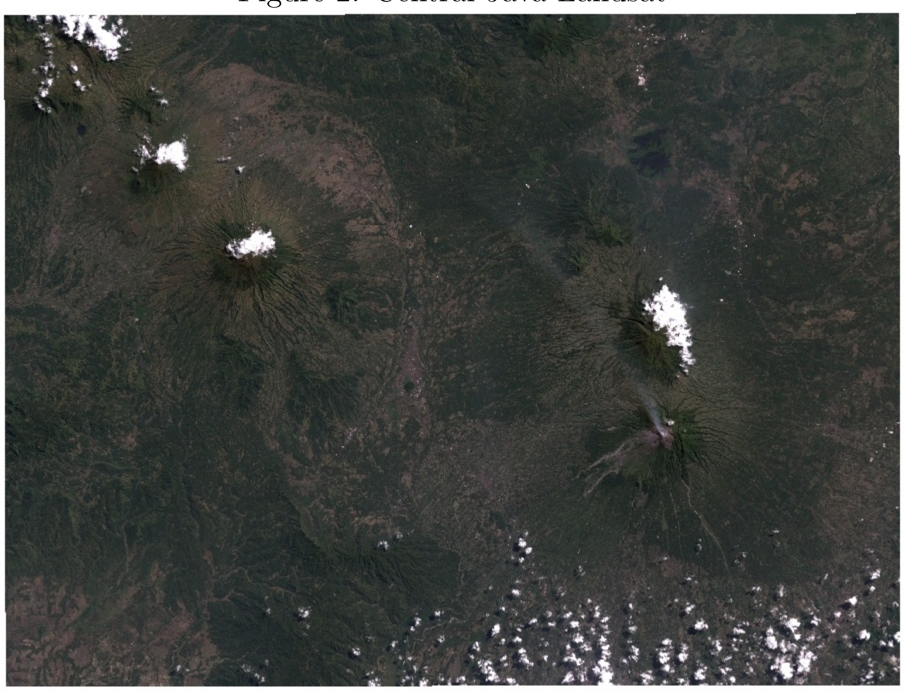


Figure 3: Central Java Elevation Map

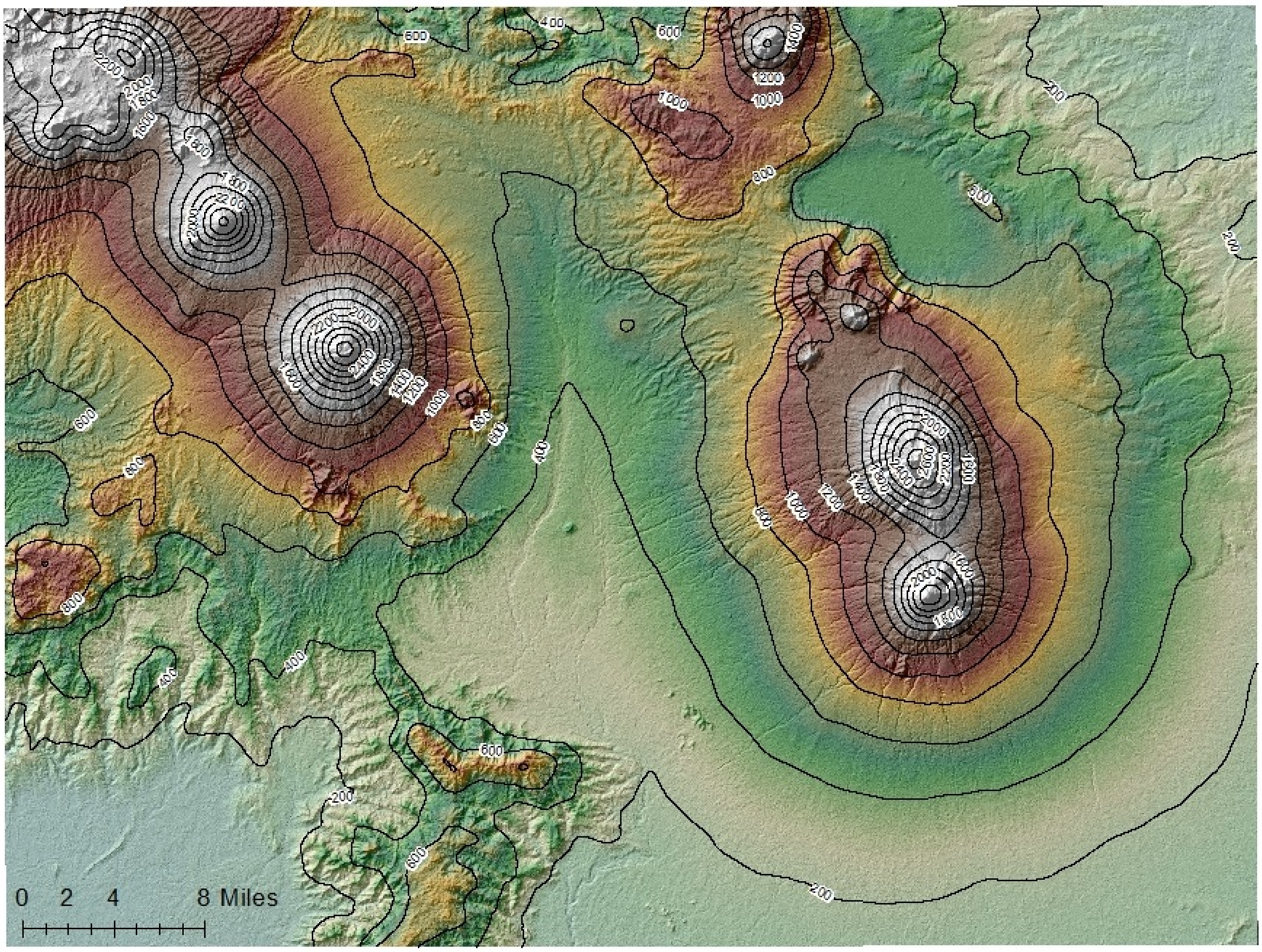


Figure 4: Central Java NDVI

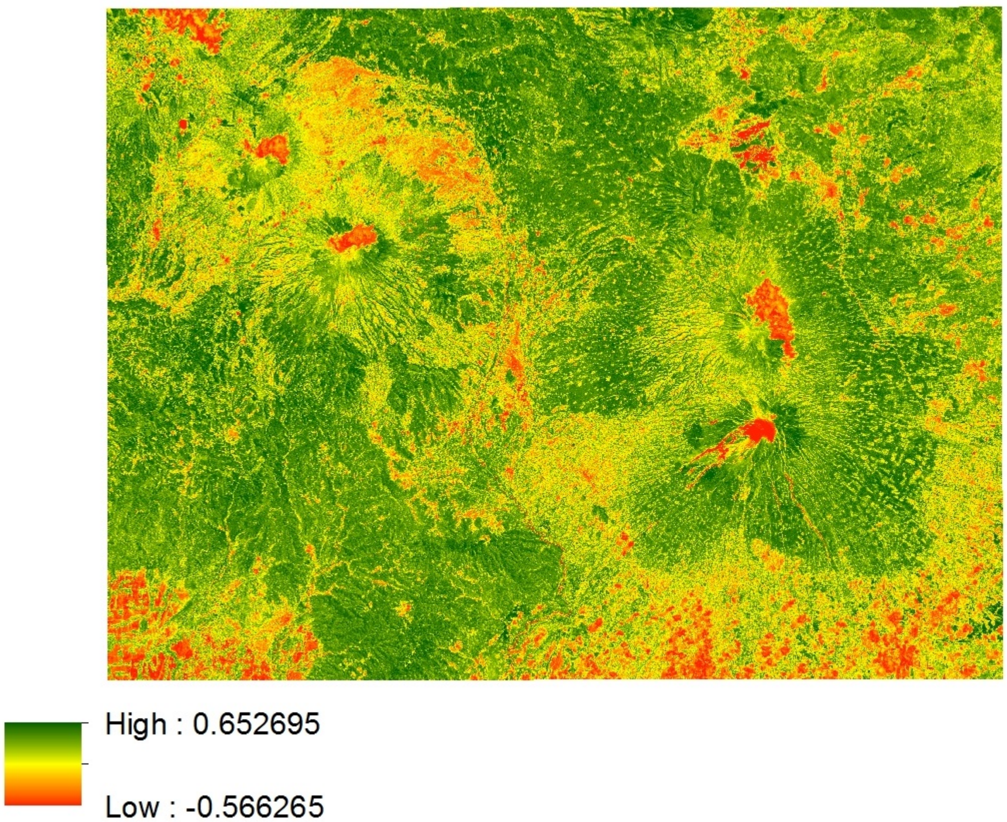


Figure 5: Central Java EVI

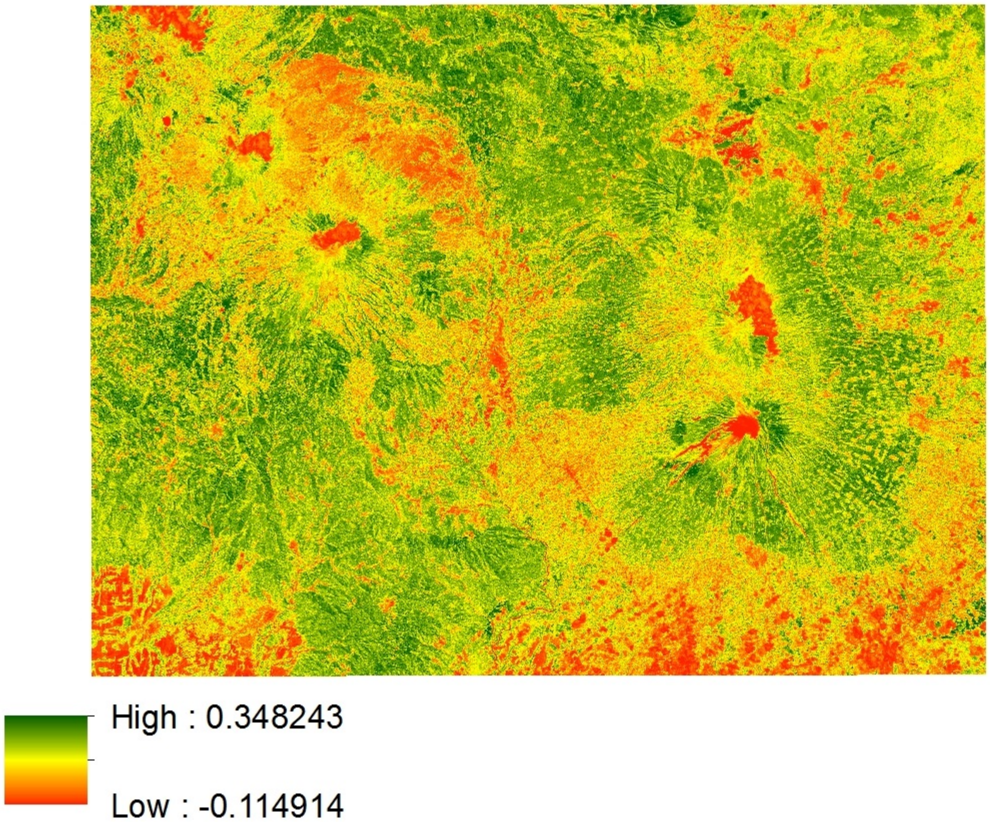


Figure 6: Northeast Bali Landsat

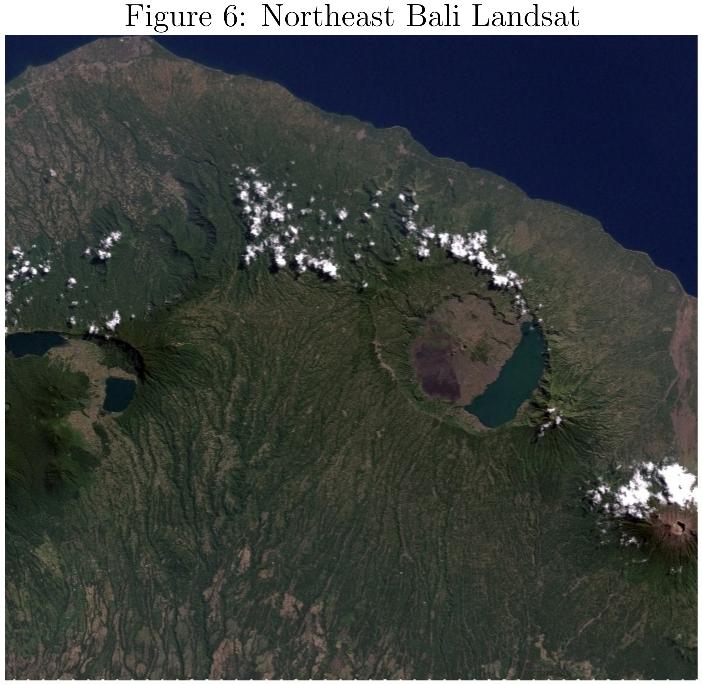


Figure 7: Northeast Bali Elevation Map

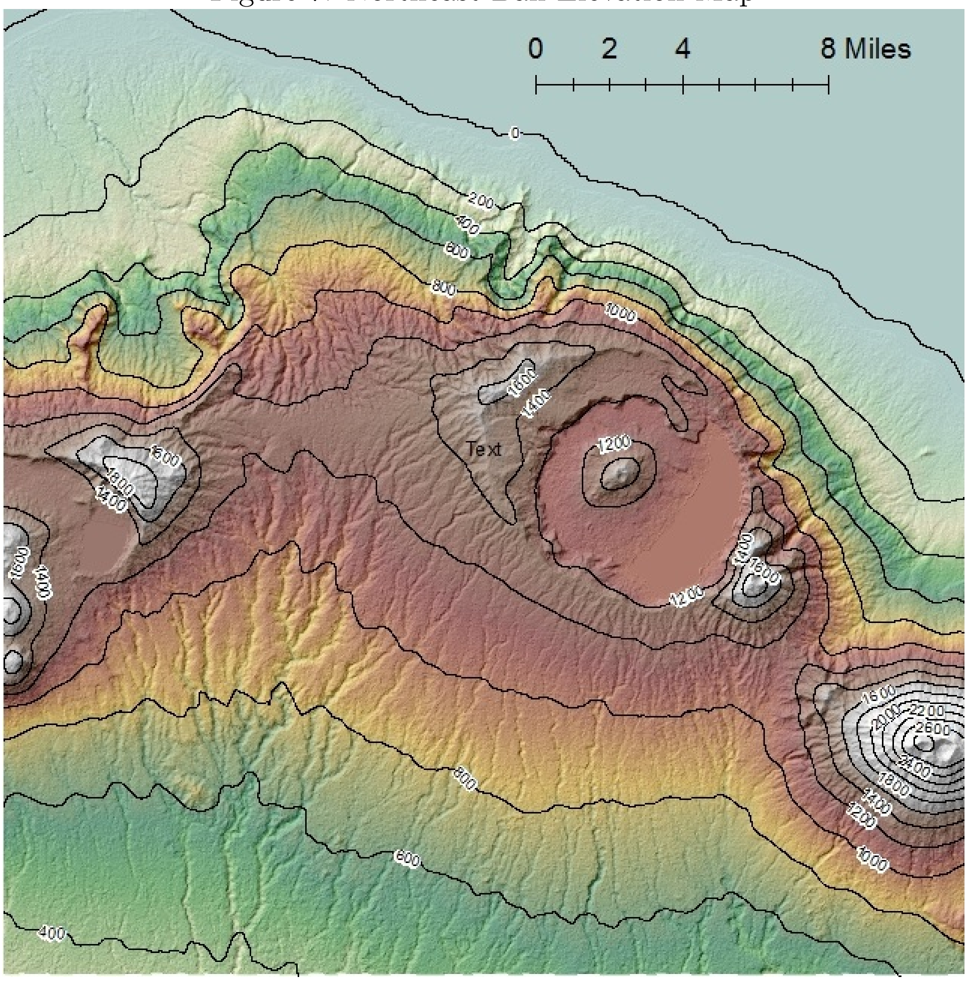


Figure 8: Northeast Bali NDVI

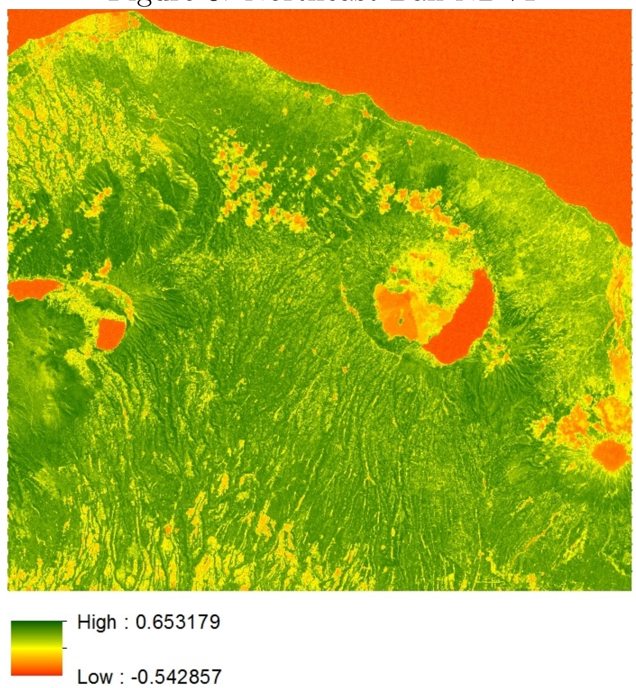
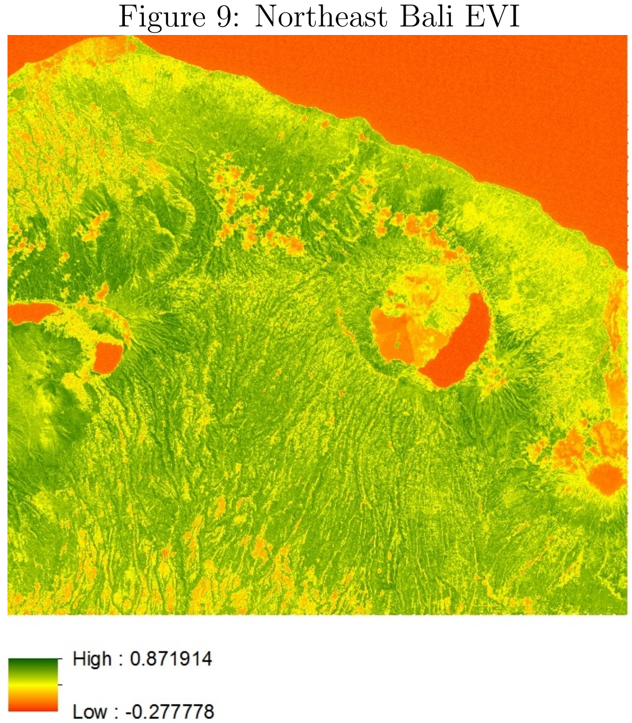


Figure 9: Northeast Bali EVI



References

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