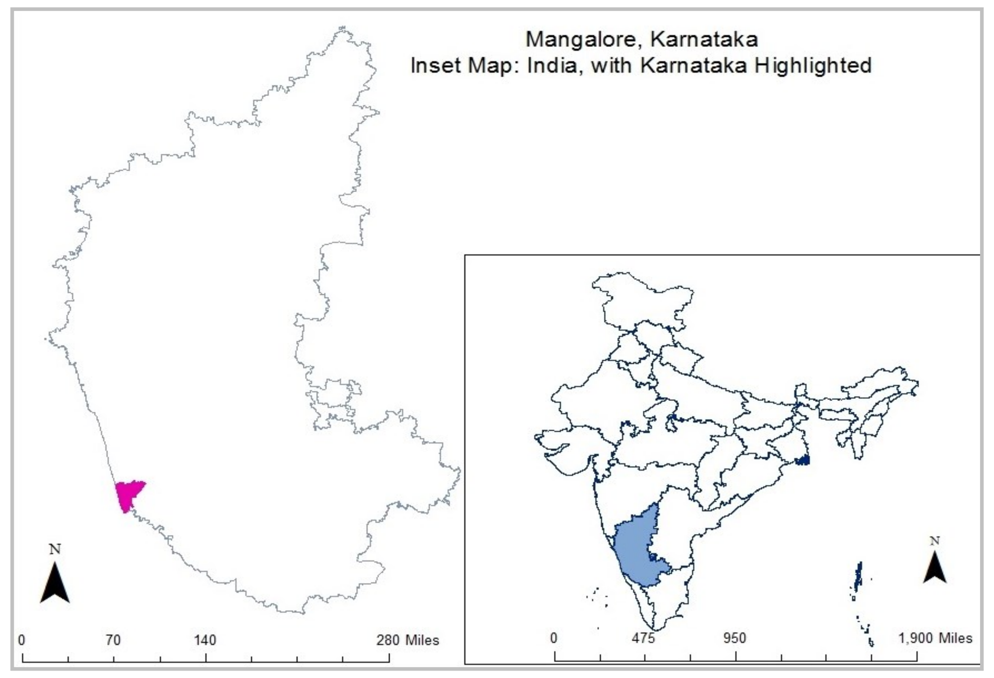
Changes in Land Cover and Malaria Incidence in Mangalore, Karnataka, India: 1998-2013

Poster Design: Emily Lynn, May 2, 2015

Projection: WGS 1984 UTM zone 43N

Map Data Sources: Earth Explorer; Alexander Liss, Tufts University



Introduction

Malaria is transmitted by infected *Anopheles* mosquitoes and is endemic in regions in India. While the rates of malaria in India as a whole, and the percentage of malaria cases that occur in Karnataka state (Figure 1) , have been declining, cases of urban malaria in the sub district of Mangalore make up an increasingly large percentage of malaria cases in Karnataka [1]. Development of urban areas has been shown to increase malaria transmission[2]. Construction sites and urban environments create temporary breeding grounds for mosquitoes. This has the compounding effect of increasing mosquito populations and putting them in close proximity to large human populations, which makes transmission of malaria very easy[2]. A study in Mangalore from 2000-2003 showed an increase urban areas and raised concerns about the future effects on malaria in the area[3]. This project examines the relationship between increasing urban environments in Mangalore and malaria in the area, both the overall incidence and the incidence as a percentage of total incidence in Karnataka.

Methodology

The images of Mangalore are from the years 1998 to 2013 (with the exception of 2003 and 2012), from the months November through March to minimize the impact of clouds and the effects of different seasons on land cover categorization. Images from 1998 and 1999 came from Landsat 5, Images from 2000 to 2011 came from Landsat 7. For the years 2004 to 2011, the images were gap-filled using two to four images to correct for the lack of the Scan Line Corrector on the satellite. The image from 2013 is from Landsat 8.

Regions of Interest (ROIs) were selected for six classes which were combined into four final classes (Vegetation, Water, Urban, and Mountain). Minimum distance supervised classification was chosen because it was the most accurate. In order to assess the accuracy of the classifications in the absence of true ground truth ROIs, the ROIs that were created were divided into two sets, and 20% were removed to create a test class. The remaining ROIs became were used to classify the images. The test ROIs were then used to assess accuracy. Urban and vegetation land cover percentage and the change in land cover from year to year were compared to malaria rates in Mangalore and those rates as a percentage of total malaria incidence in the state of Karnataka.

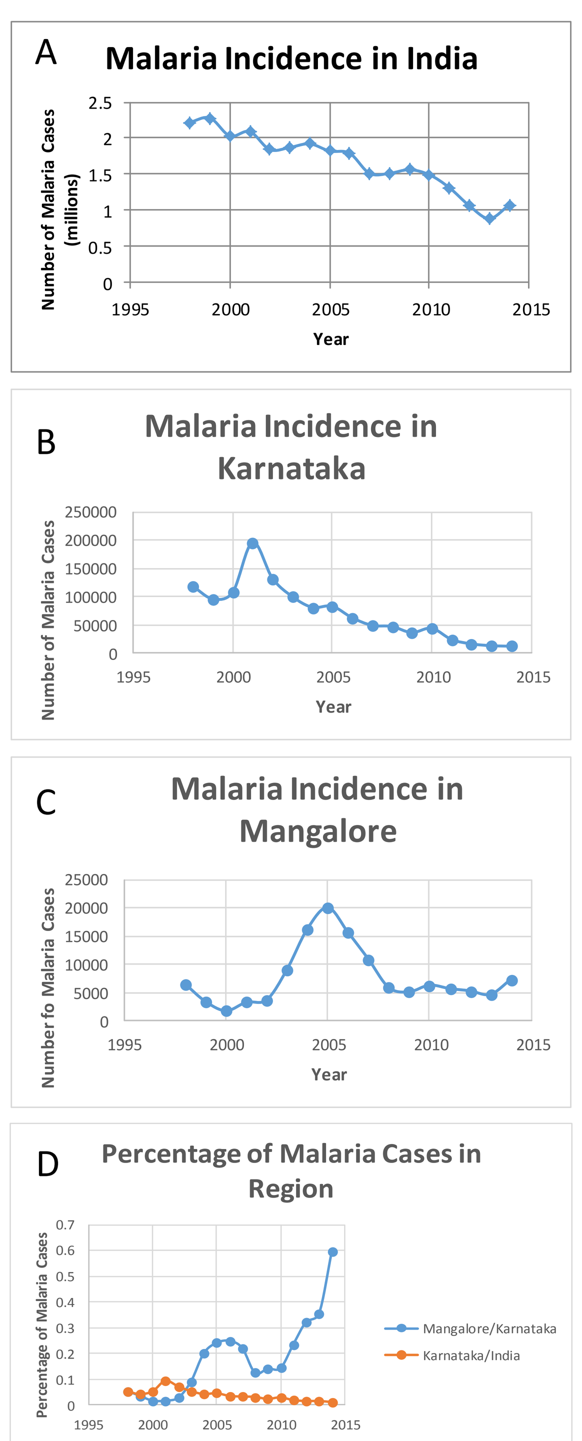


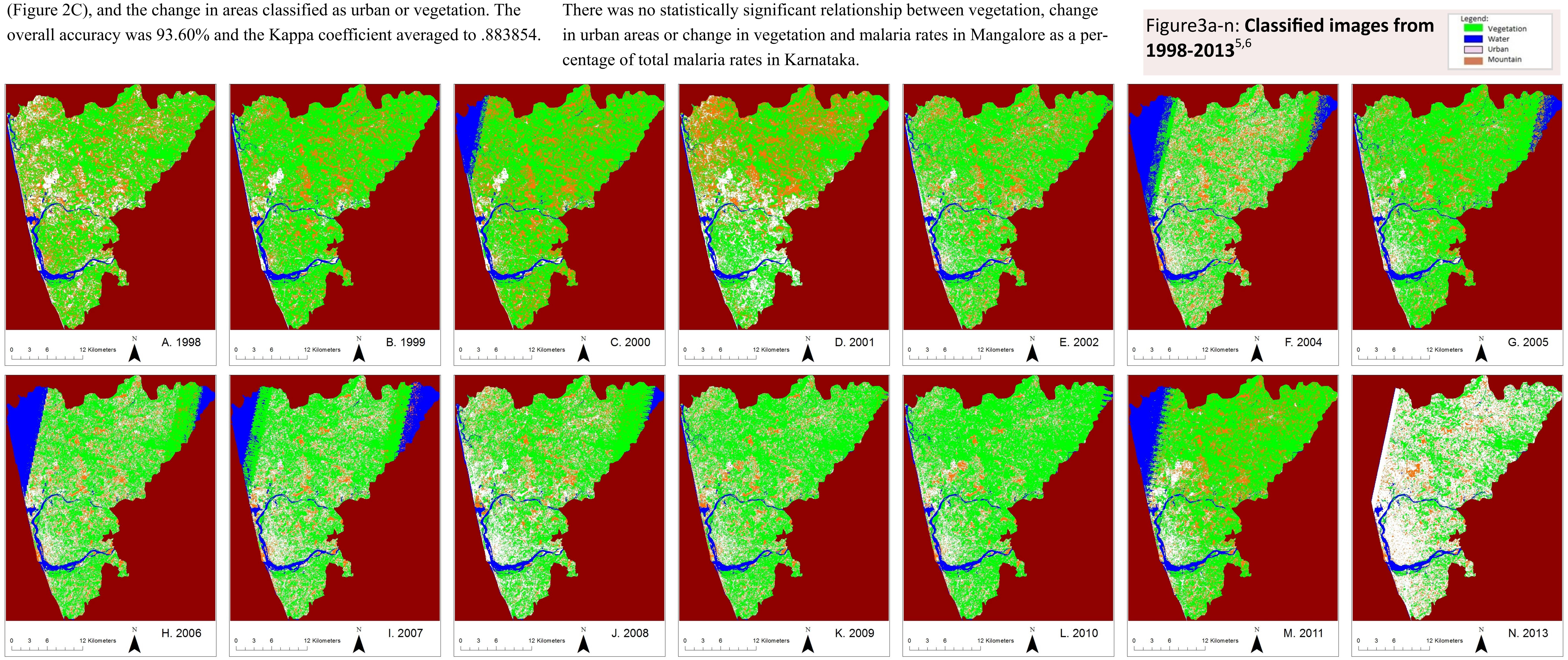
Figure 2a-d: Graphs showing malaria incidence by region, and as percentage of incidence in a larger region[4].

Results

The classified images are shown in Figures 3a-n. The average percentages for each class over the fifteen-year period were 2.42% water, 25.73% vegetation, 9.26% urban and 9.56% mountain. Vegetated areas decreased from 23.79% to 12.43%, while urban areas increased from 6.44% to 26.76%. SPSS was used to determine whether there was a statistically significant correlation between the percentage classified as urban or vegetation, the percentage of malaria cases in Karnataka that occurred in Mangalore (Figure 2D), the incidence of malaria (Figure 2C), and the change in areas classified as urban or vegetation. The overall accuracy was 93.60% and the Kappa coefficient averaged to .883854.

The statistical analysis showed that the only statistically-significant correlations were between percentage of urban areas and percentage malaria rates (Pearson's Correlation = .598, sig. .024), change urban and urban (Pearson's Correlation = .704, sig. .007), and change vegetation and change urban (Pearson's Correlation = .709, sig. .007). There was no statistically-significant correlation between percentages of vegetation- or urban-classified areas, or change in vegetation- or urban-classified areas and malaria rates in Mangalore. There was no statistically significant relationship between vegetation, change in urban areas or change in vegetation and malaria rates in Mangalore as a percentage of total malaria rates in Karnataka.

Figure3a-n: **Classified images from 1998-2013**[5,6]



Discussion

Although the results did show a relationship between urban areas and malaria incidence in Mangalore as a percentage of incidence in Karnataka, it was not strong and there was no relationship between vegetation and change vegetation, which is surprising. One possible explanation is classification errors. The expected trend would show the percentage of urban areas increasing steadily over time, but that was not the case. This could be due to slight differences in time of year, which might result in differences in vegetation classification. This is supported by the fact that the area classified as vegetation changes from year to year and does not fit with a consistent trend. Another possibility is potential misclassification between urban and mountainous land cover. A higher overall accuracy rate would address these problems. Additionally, there are many likely confounding factors. India has increased efforts to reduce malaria transmission in the last decade in the form of vector control[7]. If these practices are being implemented to greater effect in other districts of Karnataka, that could explain why malaria cases in Mangalore represent an increasingly large percentage of malaria cases in Karnataka.

In looking at malaria and urbanization in Africa, other studies have also found that although urbanization results in increased breeding grounds for mosquitoes and a larger population that is then exposed to the malaria vectors, urbanization also comes with behavior changes that reduce the spread of malaria[8]. If something similar is happening in Mangalore, then increasing urbanization, population growth and reduction of vegetation could be increasing malaria transmission, while at the same time, new anti-malarial programs are reducing transmission, resulting in a malaria incidence that is relatively steady.

Future Directions:

Using malaria incidence rates for smaller areas, ideally point data, and the proximity of these cases to new urban areas, deforestation or construction sites, a correlation might be more easily detected. It would also be interesting to look at the rest of the state of Karnataka. Malaria incidence in Karnataka has been decreasing, and I would be interested to see what the land use changes for the rest of the state have been.

It would be interesting to look at different types of vegetation. Certain NDVI values are correlated with malaria incidence and an analysis of vegetation types and changes thereof in comparison to changes in malaria incidence or percentage of malaria incidence occurring in Mangalore might yield interesting results[9].

Sources

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