Land cover changes and its effect on the burden of malaria in Mangalore, India

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INTRODUCTION

Every year, an estimated 247 million people are infected with malaria and about 881,000 of these cases lead to death. India's coastal environment is perfect for malaria growth and is therefore the reason why it is responsible for 60% of Southeast Asian malaria incidences. Although there was a drastic decrease of malaria cases from 75 million cases annually in 1947 in India to less than 50,000 in the 1960's, due to national control procedures, there has been a steady increase since 1995 because of insecticide resistance and population growth. There are numerous environmental factors that influence malaria rates, such as rainfall and humidity, but urbanization is rising as important factor related to the increase in malaria in India. In Brazil, a study explained that for the years 1997 and 2006, a 4.3% increase in deforestation per year was associated with a 48% increase in the risk in malaria. Due to the fact that the incidence of malaria in Mangalore, India has been considerably increasing in the last two decades, the objective of this project is to analyze the changes in land cover types, especially water bodies, and relate them to the change of malaria incidence between 1998 and 1999 using remote sensing imagery (30m resolution). Through supervised classification using maximum likelihood technique, NDVI and density slicing of vegetated areas, and change detection statistics between the two time points, it was observed that the percentage of water bodies, in addition to vegetation change, has a high correlation to malaria incidence rates.

Figure 1: Location of Mangalore in South India.

Figure 2: Trend of malaria in Mangalore from 1990 to 2007

METHODOLOGY

◆ Remote sensing data for the study area was obtained as Landsat TM images from the U.S. Geological Survey data repository

◆ The statistics for the malaria incidences in the region for the period 1990 to 2007 were obtained from the National Vector Borne Diseases Control Program division of the State of Karnataka

◆ The images were preprocessed, mosaicked, classified using maximum likelihood technique and ground truthing, and change detection statistics were employed for the major land cover types in the study area

◆ In addition, NDVI transformation of mosaic images was done and closed and open canopy vegetation were identified using density slicing.

RESULTS

Figure 2a & 2b: True color composite mosaicked Landsat TM image of Mangalore for the year 1998 (left) and 1999 (right):
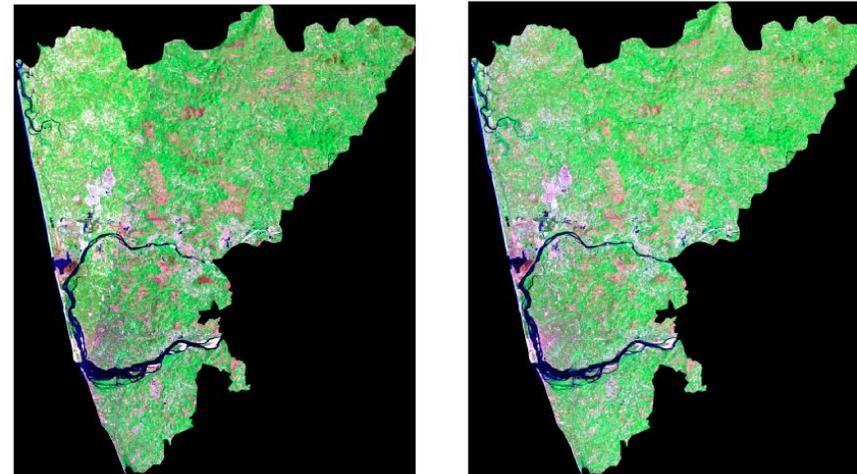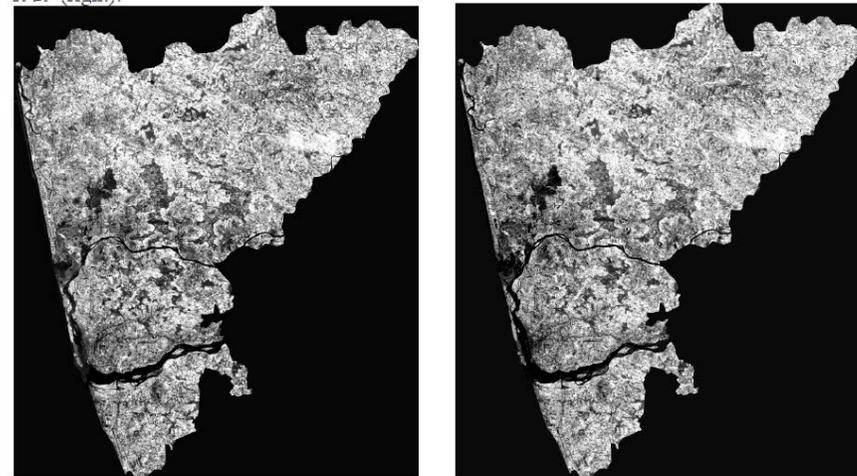

Figure 3a & 3b: Classified integrated land cover map of Mangalore for the year 1998 (left) & 1999 (right).
Red: Urban area **Green:** Water **Purple:** Dense vegetation **Yellow:** Open canopy vegetation **Aquamarine:** Bare soil

Figure 4a & 4b: NDVI transformation of raw, mosaicked images for the years 1998 (left) and 1999 (right):
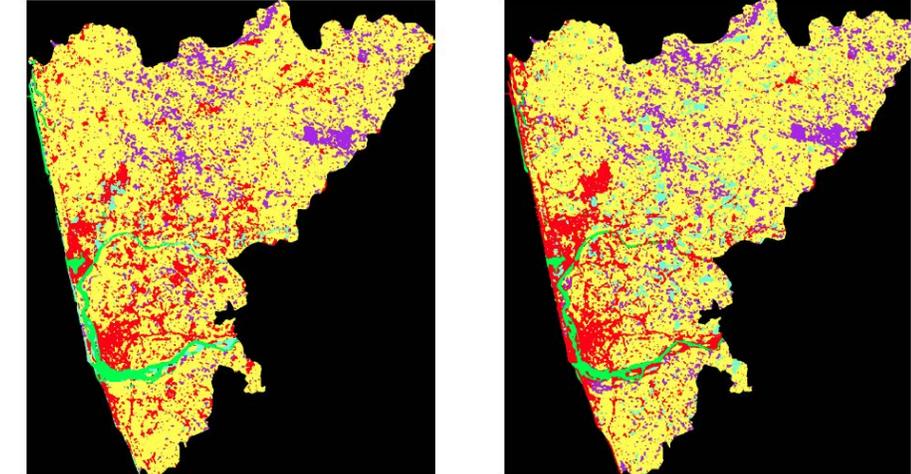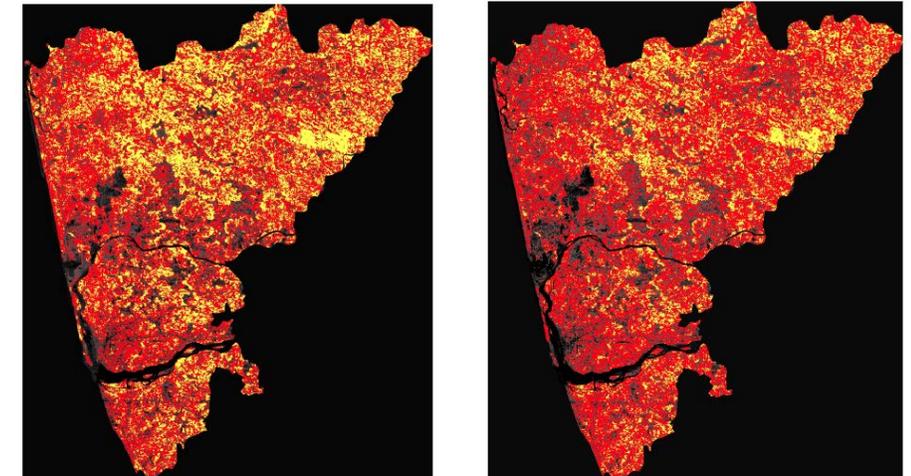

Figure 5a & 5b: density sliced transformed images of open canopy and dense vegetation for the years 1998 (left) and 1999 (right) where Red= 0.2-0.4 Yellow >0.4

DISCUSSION

Table 1: Change detection statistics for land cover types between years 1998 and 1999

Parameter	Annual percent difference between 1998 and 1999
Land cover type	
Urban (km^2)	8.96
Water (km^2)	-18.68
Dense Vegetation (km^2)	-15.34
Open Canopy Vegetation (km^2)	4.40
Bare Soil (km^2)	20.66

Table 2: Difference in malaria cases between years 1998 and 1999

Parameter	1998	1999	Absolute Difference	Annual percent change
Cases of Malaria in Mangalore	6475	3415	-3060	-47.26%

 Between the years 1998 and 1999 the number of malaria cases dropped from 6475 cases in 1998 to 3415 cases in 1999. This 47.26% decrease is important in identifying if land cover changes influence malaria rates in the region of Mangalore. Using the supervised classified maps of the study area (shown in Figures 3a and 3b) it can be seen that there is an increase in the area of urbanization. Change detection statistics performed on the classified maps showed that the urban area had increased by 8.96% with a decrease of fresh water and stagnant water by 18.68%. These water collections are necessary for favorable mosquito breeding and transmission of the disease and could be the reason why there was a decrease of 47.26% in cases of malaria between the years 1998 and 1999. The dense vegetation had a decrease of 15.34% and an increase of open canopy vegetation of 4.40%. Finally, there was an increase in bare soil by 20.66%. The increase in urbanization was noted more in the regions neighboring the rivers and the coast in the study area. The NDVI and density sliced images also showed a decrease in the amount of dense vegetation (depicted in yellow) in the study area and increase in open canopy vegetation (seen in red). In conclusion, the change in land covers coincides with the drop in malaria cases in 1999 since the percentage of water areas decreased, whi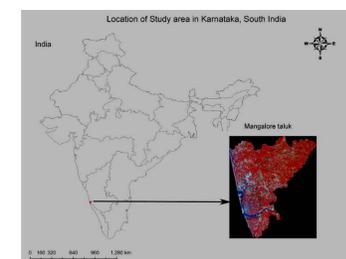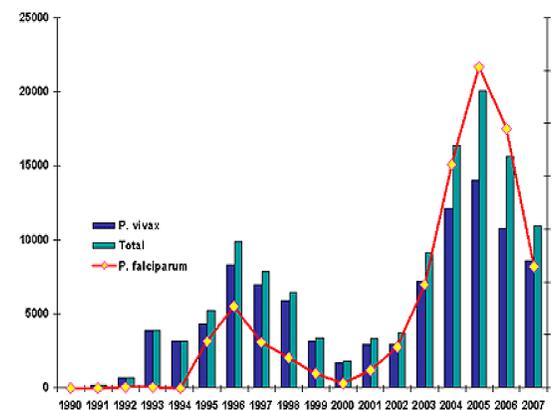ch are breeding zones for malaria transmission.