Quantifying Weather and Climate Impacts on Health in Developing Countries (QWeCI)

Linkage Between Climatic and Environmental Factors and Malaria Vector Habitat in Mpumalanga Province, South Africa

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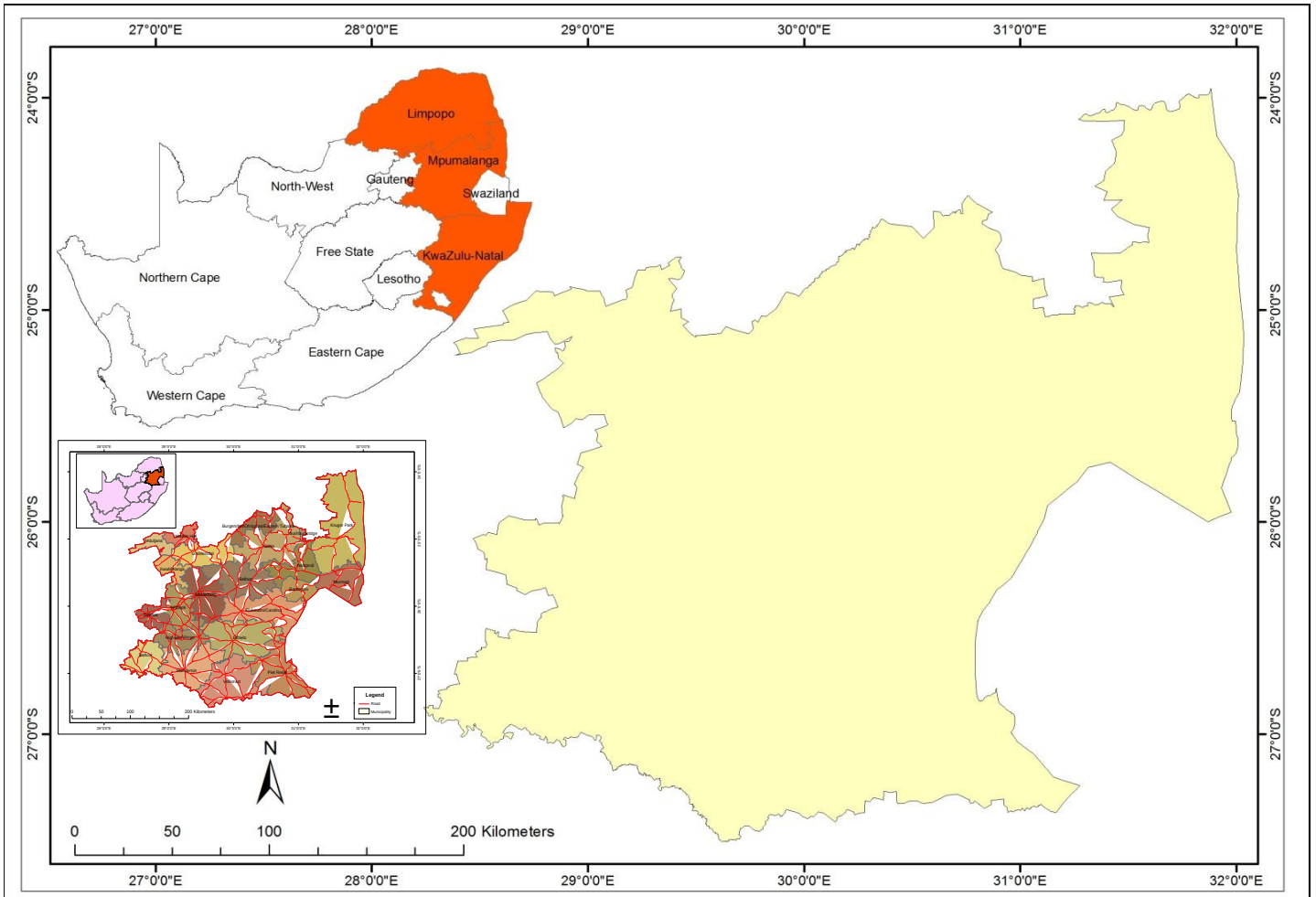
Introduction

- Many studies have demonstrated that Malaria infection exhibits both spatial and temporal dependency: related to both climatic and environmental variability.
- Climatic and Environmental factors affect the biological cycle of both vector and parasite.
- Hence, system that will:
  - allow the prediction of the malaria vector,
  - determine the spatial and temporal distribution of malaria cases

Introduction Cont'd

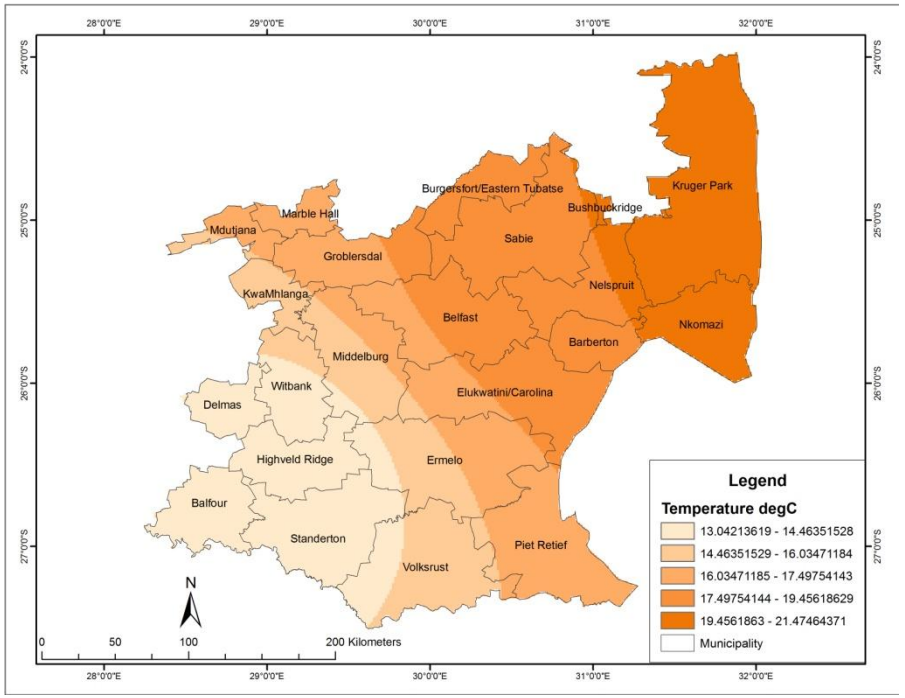
- A deeper understanding of the role of rainfall, temperature, elevation and vegetation in the spatial-temporal distribution of Malaria is vital for developing robust malaria prevention and control strategies.
- Present focuses on:
  - identifying potential habitats
  - analyse the influence of climatic and environmental factors on the spatial-temporal distribution of the malaria causing vector.
- Significance:
  - This work will contribute towards the development of robust Malaria Early Warning Systems for South Africa using GIS and Remote Sensing (RS).

Introduction Cont'd

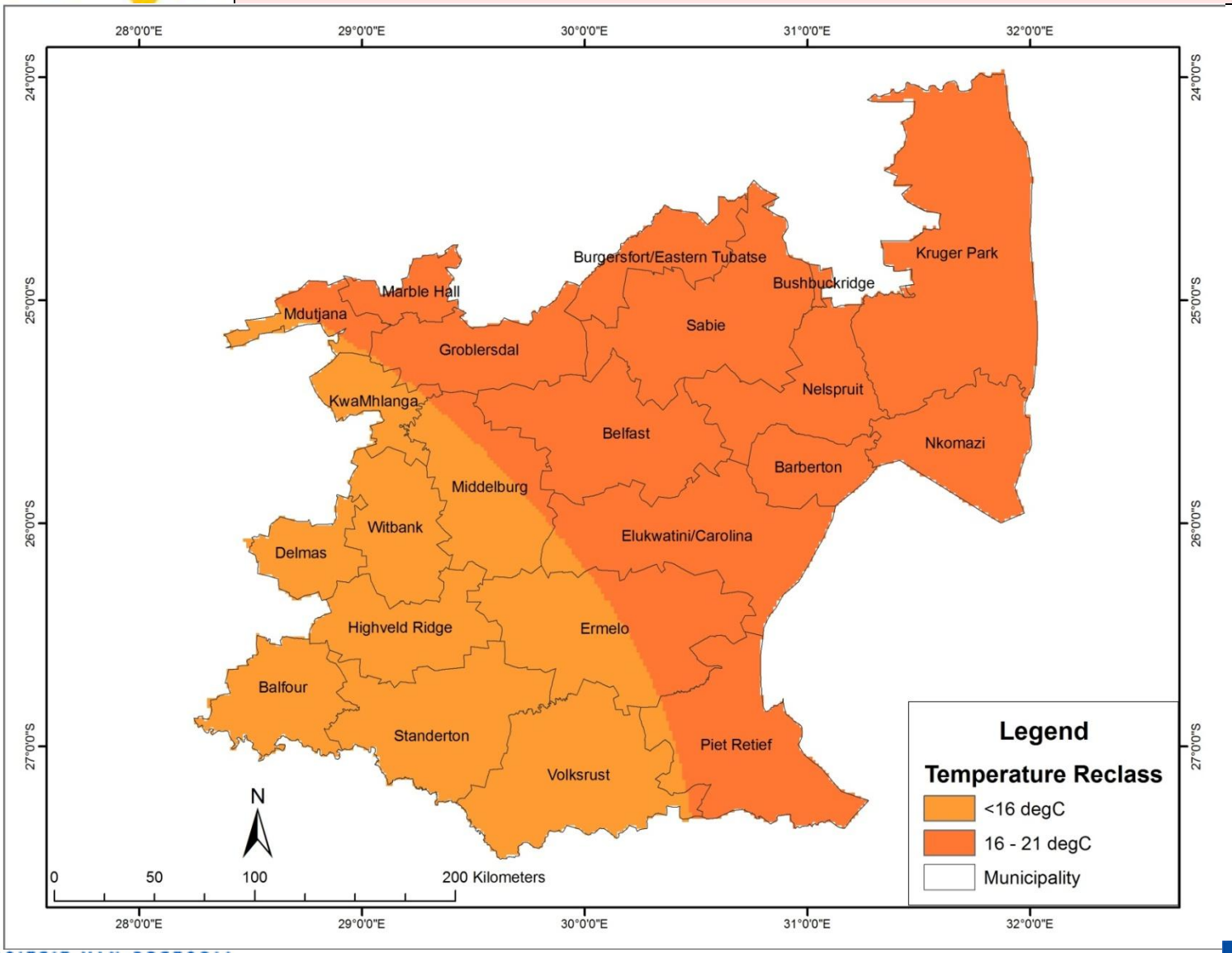


Data and Methodology

- Temperature (Source: South African Weather Service)
  - Both the parasite and the vector are affected by temperature.
  - The extrinsic incubation period of *Plasmodium falciparum* is about 9-10 days at 26 °C whereas at 20- 22 °C it takes as long as 15-20 days.
  - The minimum temperature required for transmission of *P. falciparum* is 16 °C
  - A map of minimum temperature based on 5 classes (set up during classification) from <12 °C to > 21 °C was considered.
  - Temperature values between16 °C to 21 °C were categorised as 1=favourable and those less than 16 °C as 0=Not favourable in the Boolean Analysis. Areas with 1 were taken as favourable zone.

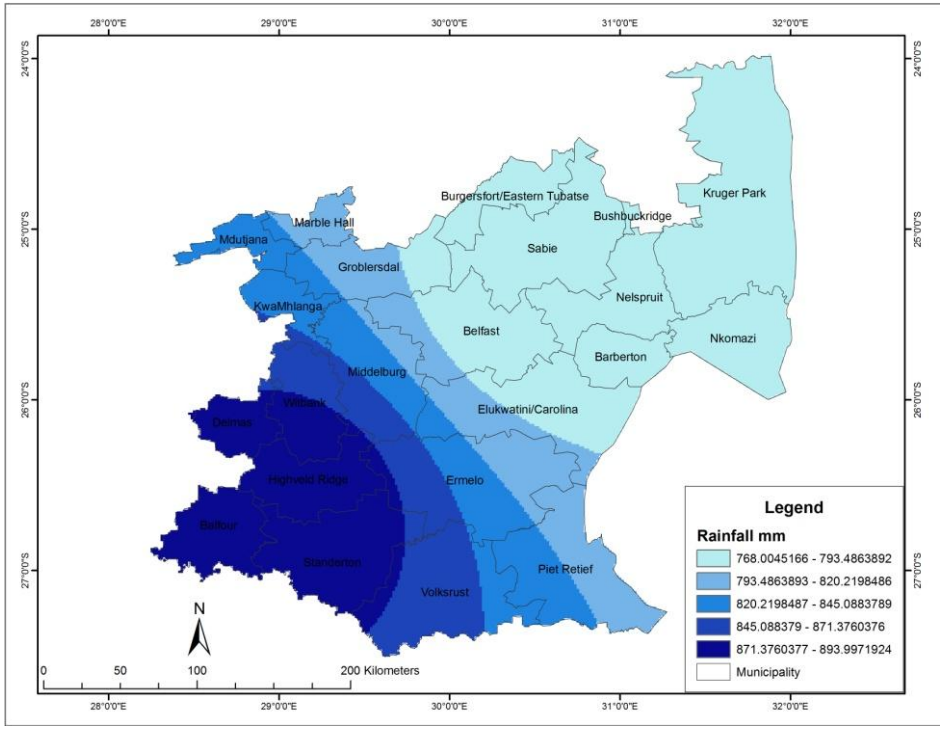


Boolean Temperature

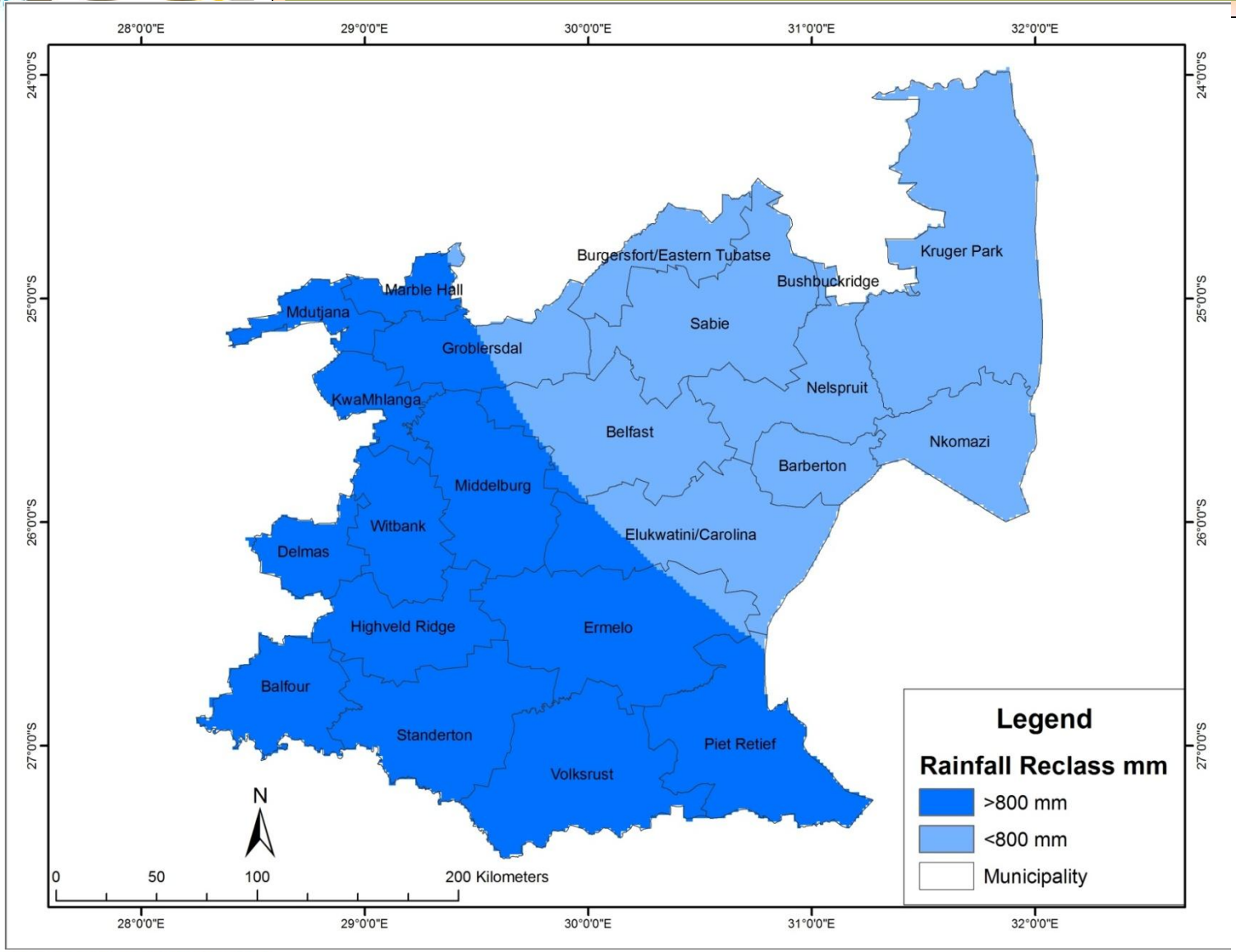


Data and Methodology Cont'd

- Rainfall (Source: South African Weather Service)
  - Increase in rainfall, can increase mosquito's population by making more available favourable sites for the breeding of the anopheles, (R.M. Fox, 1957)
  - five classes of rainfall ranging from 760 mm to 900 mm were considered. Rainfall < 800 mm was categorised as 1=favourable and rainfall above 800 mm as 0=Not favourable for the Boolean Analysis. Therefore, areas with 1 were taken as favourable zone.

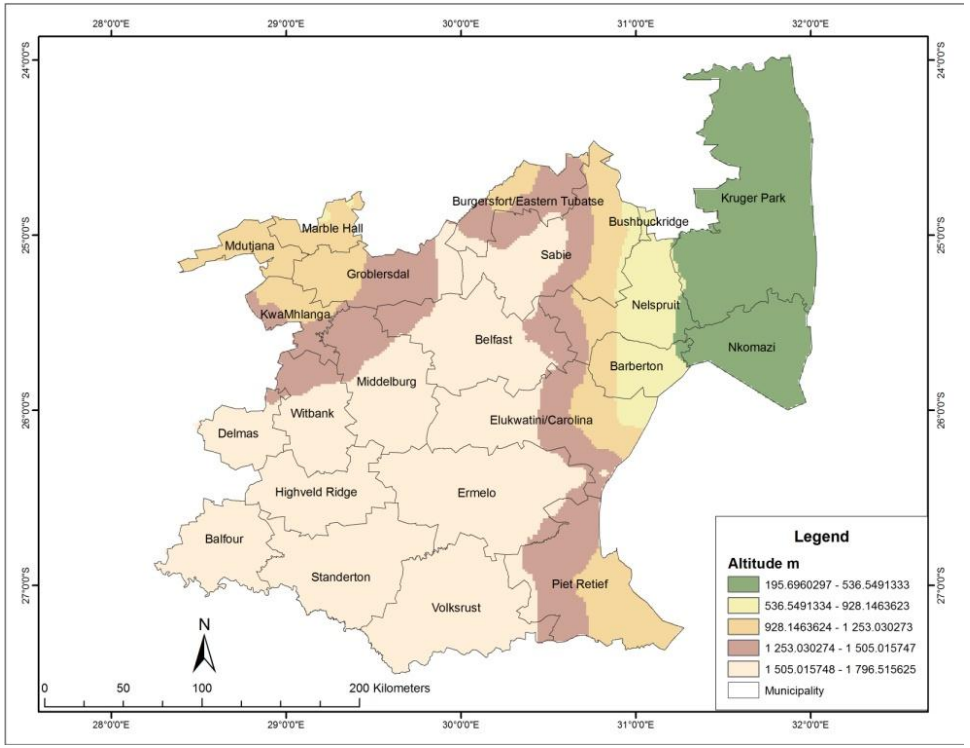


Boolean Rainfall



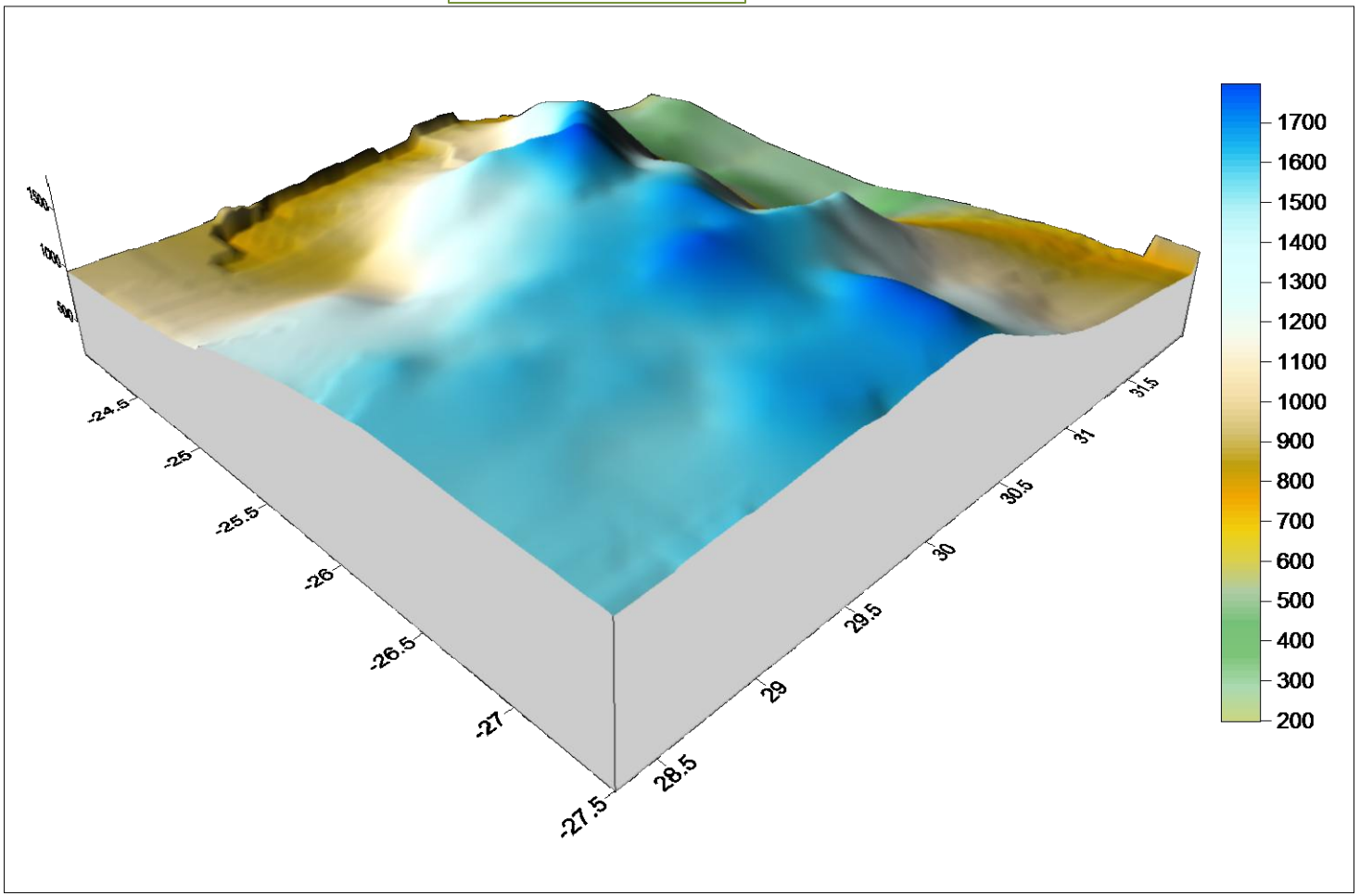
Data and Methodology Cont'd

- Altitude(Extracted from SRTM)
  - Heights at which ecological conditions are met optimally are mostly preferred by mosquito species for the breeding of their population and to ensure their survival (U. Haque *et al*. 2011).
  - A 90m resolution SRTM data was used.
  - The elevation was reclassified into five categories. The height of <1000 m was selected as the species favourable range above the sea level.

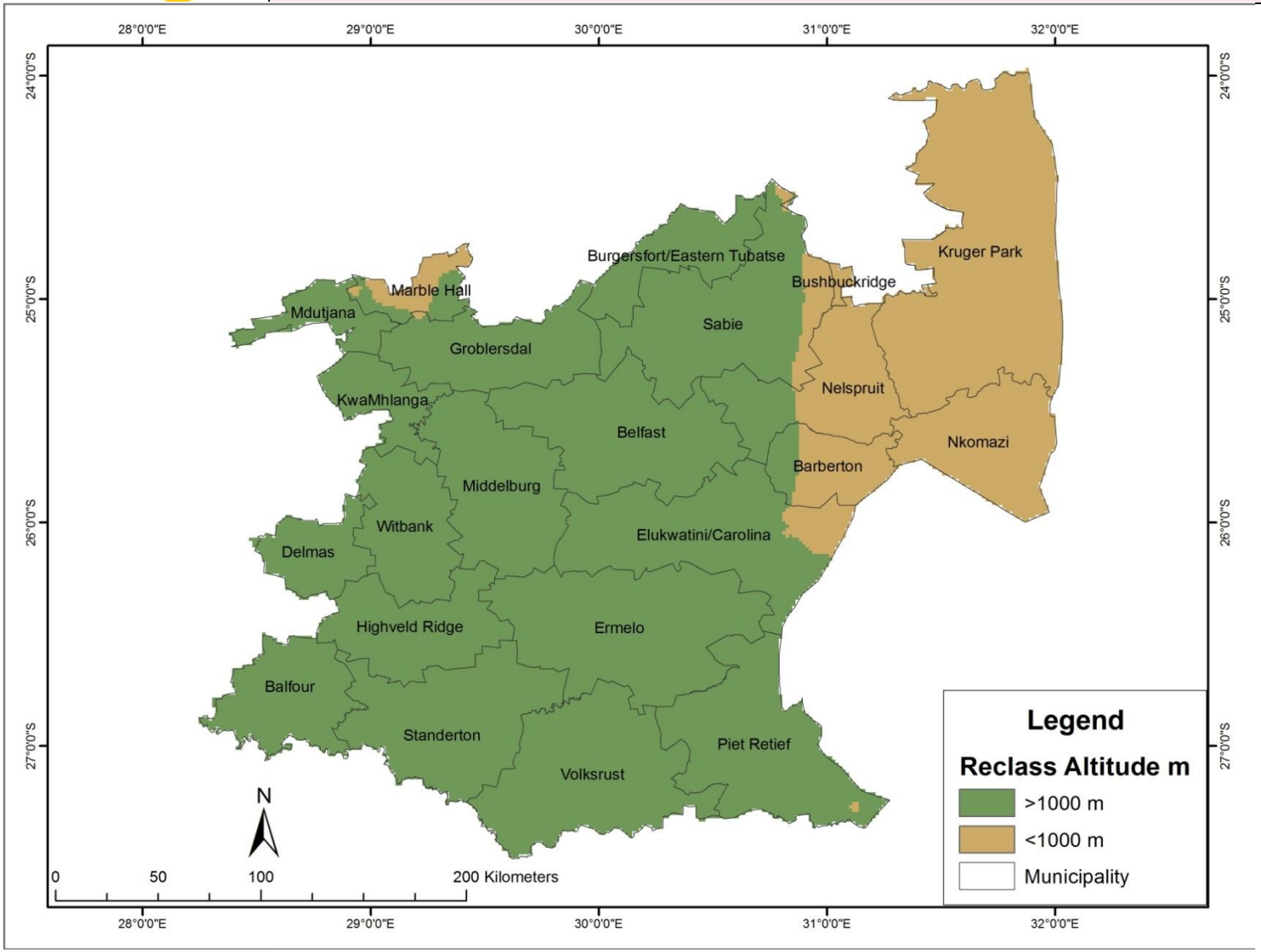


Data and Methodology Cont'd

3D DEM



Boolean Altitude



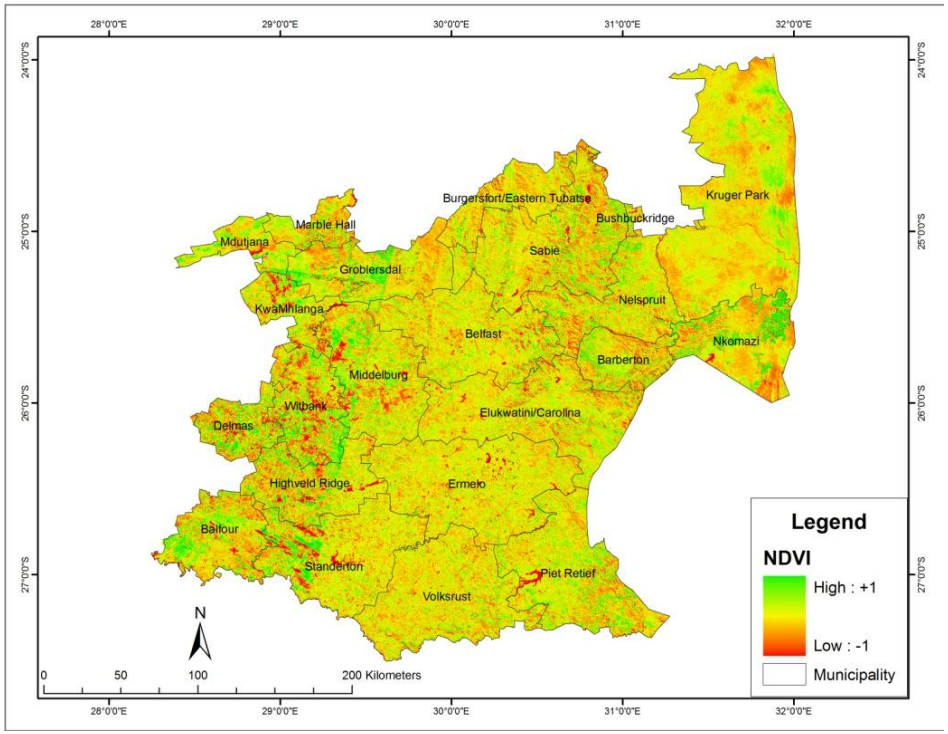
Data and Methodology Cont'd

NDVI (Landsat 2007 ETM+)

- Normalized Difference Vegetation Index (NDVI) gives an indication of the quantity of the biomass and the health of the vegetation.
- Calculation of NDVI for a given pixel always results in a number that ranges from -1 to +1. No green leaves give close to 0, water body give -1 and high dense vegetation give close to +1. Therefore, areas with close to +1 were selected as 1= Vegetation and area below 1 as 0=Non vegetation in the Boolean Analysis.

Conversion of Digital Number to Radiance

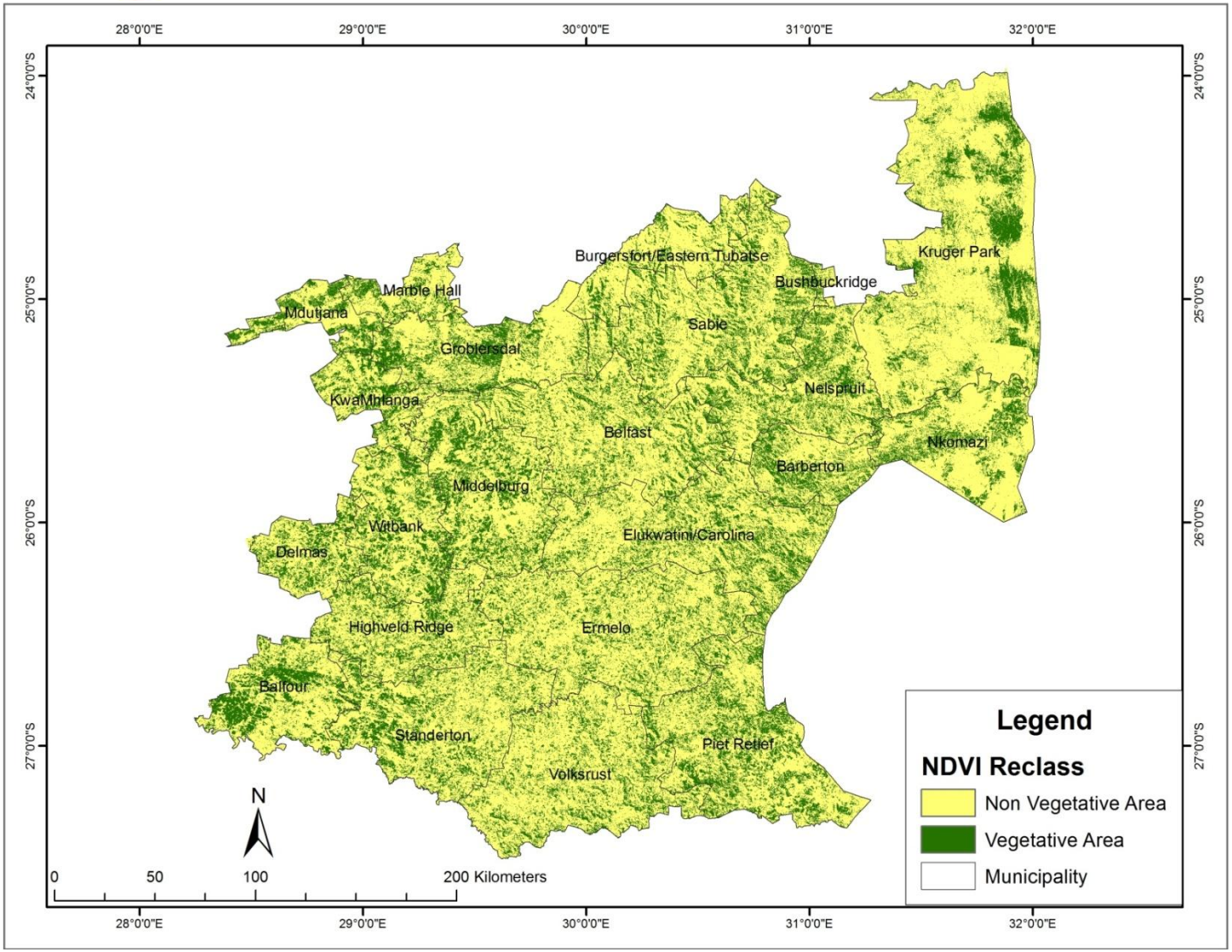
$$L_\lambda = ((LMAX_\lambda - LMIN_\lambda)/(QCALMAX-QCALMIN)) * (QCAL-QCALMIN) + LMIN_\lambda$$



Conversion of Radiance to Reflectance

$$\rho_p = \frac{\pi \cdot L_\lambda \cdot d^2}{ESUN_\lambda \cdot \cos\theta_s}$$

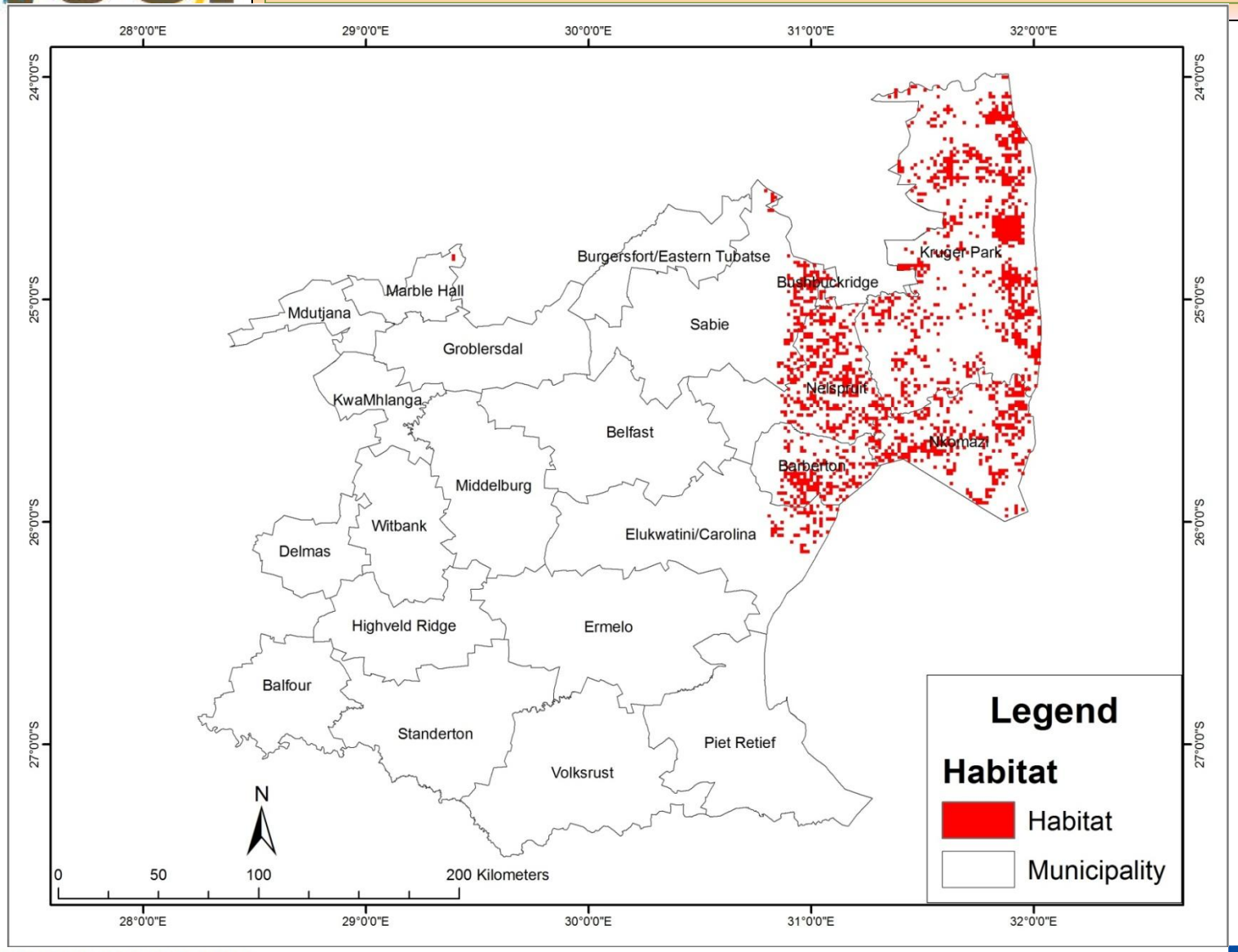
Boolean NDVI



Summary

- Result
  - Weighted Overlay was performed to the generate the habitat/risk map
  - The same proportion of weights (25% each) was assigned to all the Boolean maps (Rainfall, Temperature, Elevation and NDVI).
  - The result shows habitats for Malaria vector or areas prone to Malaria incidence

Mosquito Habitat



Conclusion

Conclusion

- The habitats are majorly situated in the north-eastern part of Mpumalanga.
- As observed from the spatial pattern of distribution of the habitats over the study areas, it can be deduced that the areas overlap with the areas where malaria cases have been earlier reported e.g. Skukuza and Pretoriouskop in Kruger Park, Malelane and Sibayen in Nkomazi, Hazyview in Nelspruit, others include Tonga, Mgobodi, Mangeweni and Shabalala.
- Also, it can be seen that there are new favourable breeding sites which major cases of malaria as not been report. This can be traced to changes in both the climatic and environmental conditions over the new place when the historical data was compared.