MAPPING SPATIOTEMPORAL VARIATIONS OF LAND SURFACE TEMPERATURE IN SOUTH EAST NIGERIA WITH LANDSAT

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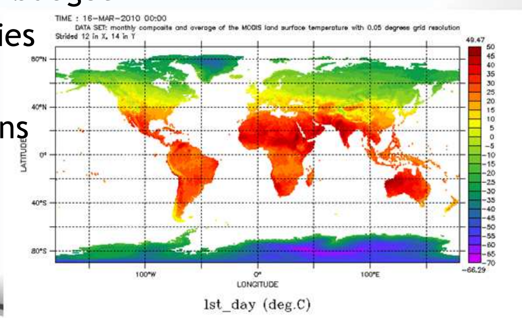
Introduction

- Land Surface Temperature (LST) important variable in:
  - Climate – drought monitoring, global warming
  - Hydrology – soil moisture
  - Ecological – radiation budget
  - Biogeochemical Studies
  - Agricultural studies
  - Geothermal detections

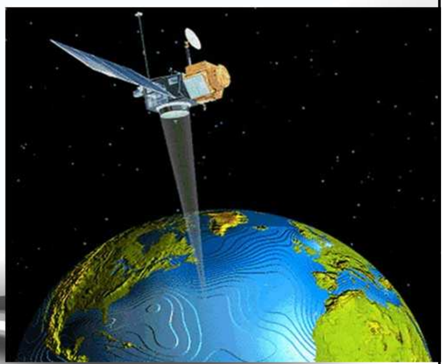
No comprehensive information of LST in southeast Nigeria



Global Mean monthly MODIS land surface temperature for March 2010 (Integrated Climate Data Center, 2012)

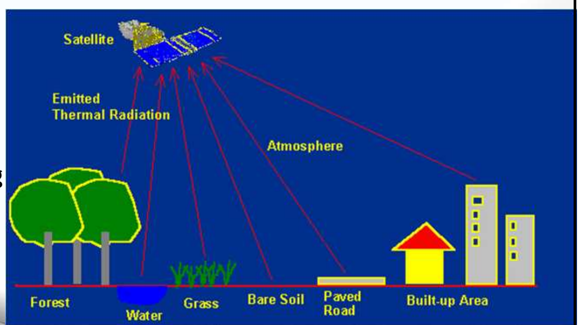
Introduction (contd.)

- Research highly relevant:
  - Potential geothermal resources in southeast Nigeria
    - presence of hot and warm springs at Oghe-Amansiodo and Umumba
  - Long term inventory of LST
    - future research and predictions
  - Detections of spatiotemporal variations
    - LST anomalous areas
- Remote sensing adopted:
  - most suitable
  - cost effective
  - Continuous coverage of LST
  - Long term mapping
    - past and future



Thermal infrared remote sensing

- TIR used in accurate estimation of LST
- Also applied in
  - Identification of geological units and structures
  - Soil moisture studies
  - Volcanology
  - Forest fires detections
  - Coal fires detections
  - Seismology
  - Environmental modelling
  - Meteorology
  - Heat loss from buildings



CRISP, 2001

Data

- Primary data:
  - Landsat TM4 and TM5
  - ETM+
    - cloud-free images available in December and January
    - 9:03am to 9:47am (minimised effects of solar irradiation)
    - Five Landsat scenes used
    - six epochs (1984, 1987, 2000, 2003, 2005 and 2013) chosen
    - 35 scenes processed (see paper for full list)

Estimation of LST

- DN to Radiance

$$\text{Radiance} = \frac{\text{LMax}_\lambda - \text{LMin}_\lambda}{\text{QCALMax} - \text{QCALMin}} * \text{QCal} - \text{QCalMin} + \text{LMin}_\lambda$$

  - QCAL = digital number
  - LMINλ = spectral radiance scales to QCALMIN
  - LMAXλ = spectral radiance scales to QCALMAX
  - QCALMIN = minimum quantized calibrated pixel value (usually = 1)
  - QCALMAX = maximum quantized calibrated pixel value (usually = 255)

NASA, 2011

- Radiance to LST

$$T = \frac{K_2}{\ln\left[\frac{K_1 * \varepsilon}{Radiance} + 1\right]}$$

  - T = Effective at-satellite temperature in Kelvin
  - K2= Calibration constant 2 (see Table 2)
  - K1= Calibration constant 1 (see Table 2)
  - ε = Emissivity (typically 0.95)
  - Radiance = Spectral radiance

Satellite	K1	K2
Landsat 7	666.09	1282.71
Landsat 5	607.76	1260.56

Southeast LST

- The LST datasets classified into 5 temperature ranges
  - <=300K
  - 300K – 305K
  - 305K – 310K
  - 310K – 315K
  - >=315K)
- to obtain a more meaningful spatial distribution of the land surface temperatures.

Supervised Classification

- To understand variations in landuse distribution of the region
- 15 Landsat images used
  - 1987, 2003 and 2013 periods
- High resolution imageries available on Google Earth used for
  - Training/validation
- 8 major land cover classes
  - thick vegetation, light forest, sparse trees, water, sands (in rivers), agriculture, bare land and built environment

NDVI

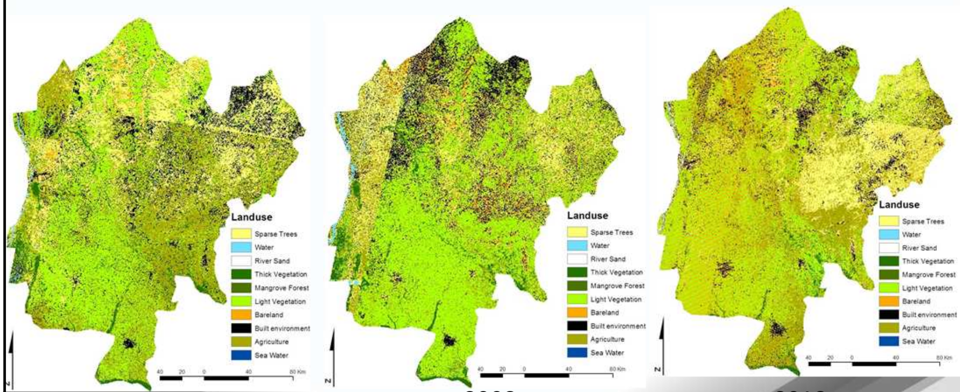
- To corroborate results obtained from classification
- NDVI used mainly for vegetation
- But also could identify:
    - built environments
    - water bodies
    - bare lands
- usually dis-highlighted (low values)

Geothermal Anomalous Areas

- LST datasets bi-modally reclassified
- Average maximum =305K
- If LST >= 310K
    - Reclassify as LST anomalous areas
    - Results from LST datasets overlaid
    - To identify consistently anomalous high LST areas

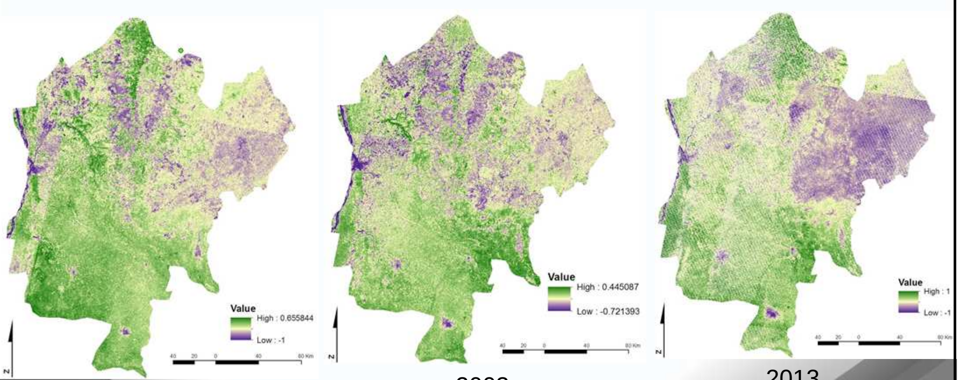
Results

Supervised classification



1987 2003 2013

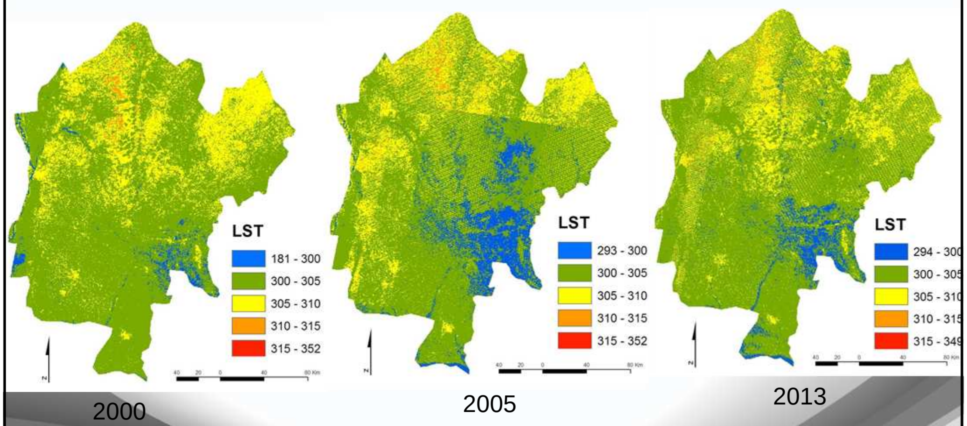
NDVI Results



1987 2003 2013

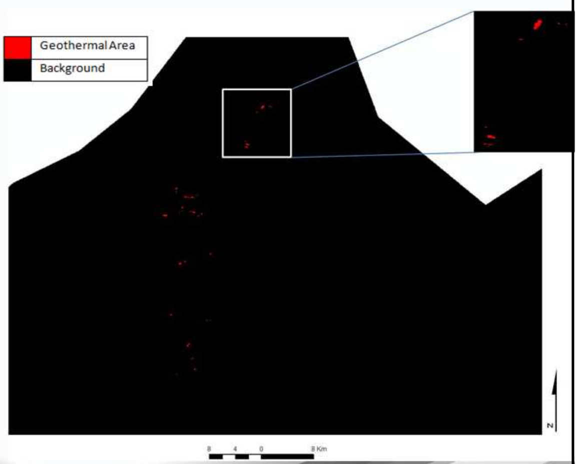
SLC correction error from 2003

Some LST Results



Potential Geothermal Areas

- Areas identified in Enugu State
- Further investigations ongoing with night time MODIS data



Conclusion

- Detailed LST information in Southeast Nigeria lacking
- Research has filled this gap
  - Long term LST mapping
  - Average LST = 305K
- Potential geothermal areas identified
- Variations in urban growth identified
  - Owerri expanding
  - Aba stagnant
- Research expected to boost further interests on LST application in the country

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Thank you

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