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# LAND USE LAND COVER CHANGE (LULC) AND ITS EFFECTS ON FOOD SECURITY (CASE STUDY OF KIAMBU COUNTY – KENYA )


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# Introduction

## Background of study

- **RS and GIS**

- benefits of handling **spatial**, **multispectral** and **temporal** data
- **availability** and **ease** of data manipulation
- have become very handy tools in analysing, assessing, monitoring of LULC change, crop production and loss of agricultural land.
- **GPS** has also played an important role as a tool for collecting the spatial data for the same.

- Urbanisation - physical growth of urban area as a result of rural migration and even suburban concentration into cities

  - depends on the factors driving growth

- Urban population is increasing at a much faster rate than was expected – **(Karuga 1993)**

## Background(Cont')

- United Nations - projected ½ of the world's population would live in urban areas by the end of 2008.

  By 2050 – **64.1%** and **85.9%** - developing and developed world respectively will be urbanised **(Tibaijuka, 2007)**

- Would require food and services
- In the past two decades Africa's population growth

  - has been averaging about 5% per year with concentration in large urban centres

  - due to **security**, **availability** of good services, **accessibility** and with **good infrastructure**.

- Unfortunately - the growth is taking place at the expense of the **agricultural land decreasing** and destruction of the environment.

## Background(Cont')

- In Kenya Land is the most important resource (***factor of production***).
- Only **17%** of its total area of 582,646 km² is suitable for rain fed agriculture.

- Agriculture sector in Kenya is the fundamental part of the economy contributing **25%** of the total Gross Domestic Product (GDP) **(Food and agriculture policy decision analysis, 2012).**

➢ Understanding the changes is very critical for planners and resource managers.

➢ helps control and restrict urban growth from eating into agricultural land which is vital but scarce.

# Background (cont’)

**Image showing improved roads (Thika Super Highway) runs through the County**

**Source: Field Survey, 213 @ M.K Musa**

# Problem Statement

Urban migration has created demand for residential housing in the County and thus building haphazardly without coordinated planning.

- Acreages of coffee and tea are being cleared

  - mainly for urbanisation (provision of more houses)

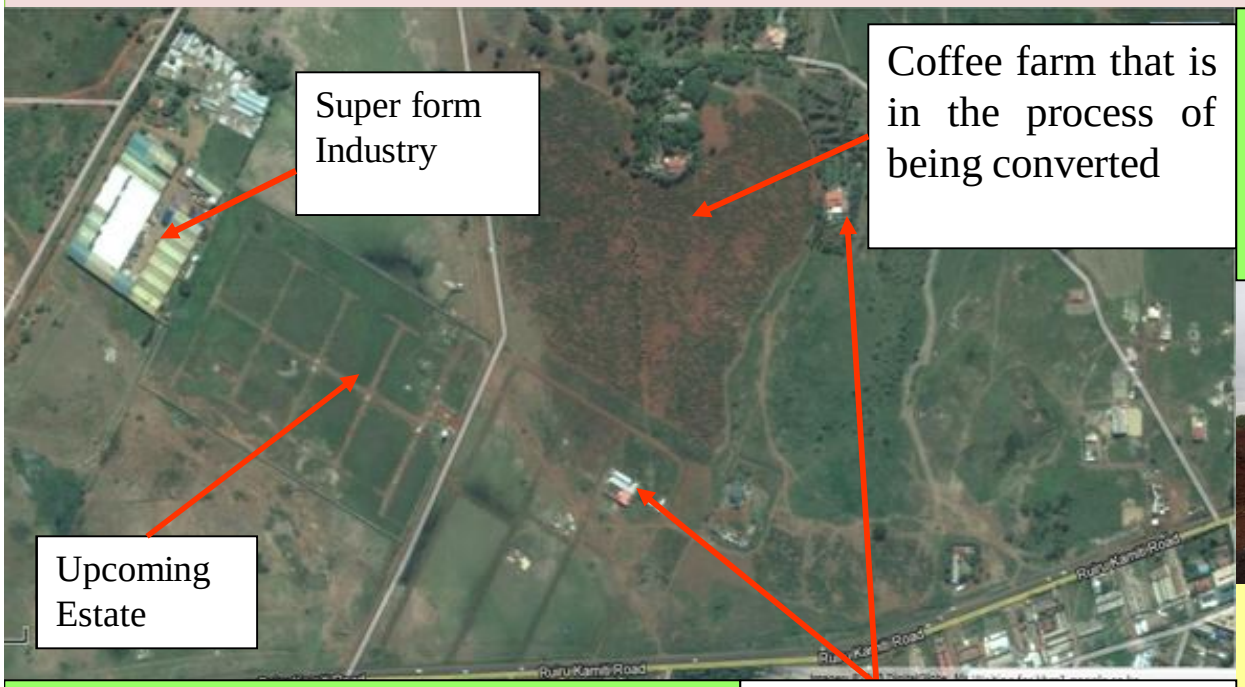
- Indiscriminate, uncontrolled and haphazard land subdivisions on agricultural land has increased

  - uneconomical parcels next to the new estates

- Uncoordinated expansion

  -rules & regulations of zoning not adhered to

# Problem Statement (cont')




***The growth of housing estates at Ruiru, Kiambu County, is encroaching on agricultural land and changing the zoning pattern. (Extract from Google maps)***

• Residential houses build on land that was agricultural.

*•Excavation of Red volcanic soil at Kangaita Coffee Farm near Ruiru municipality for Road construction*

R.I.M showing Sub-division of land that was agricultural

- Conflicts - in land use and
  - between economic development, environmental and social cohesion
- No urbanisation and agricultural land policies

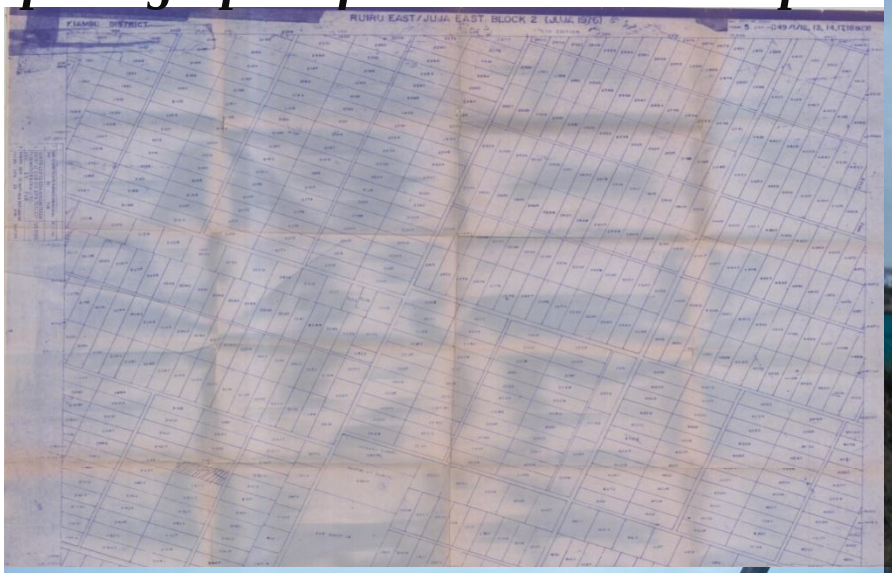
# Problem Statement (cont')

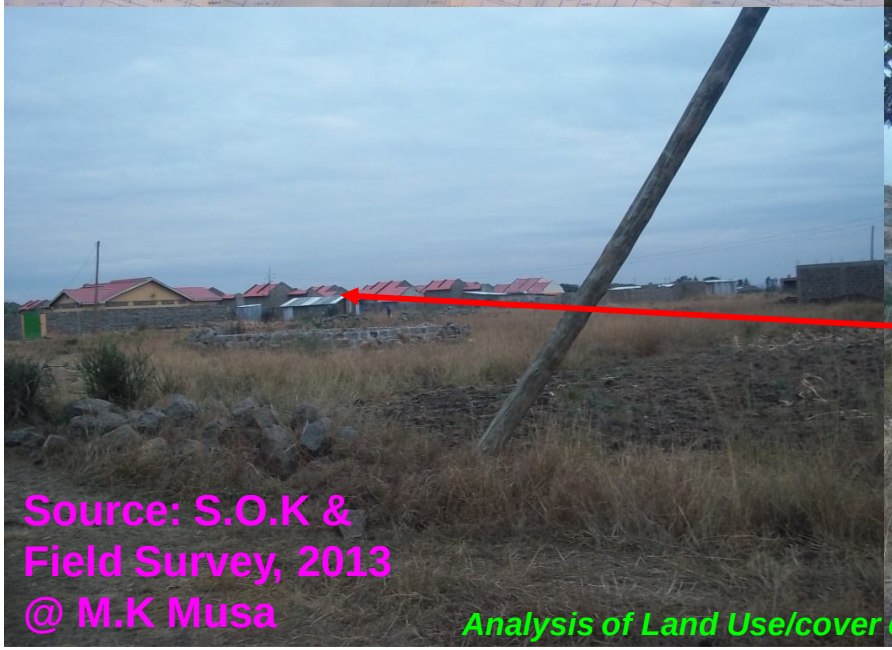
**The growth of housing estates at Thika town - Kiambu County, is encroaching on both agricultural land and industrial areas and it is changing the zoning pattern**


Source: Field Survey, 213 @ M.K Musa

# Problem Statement (cont')

***Scanned Registry Index Map (RIM) Showing Sub-division of parcels and photographs of new Estates developed on plots that were earlier agricultural***



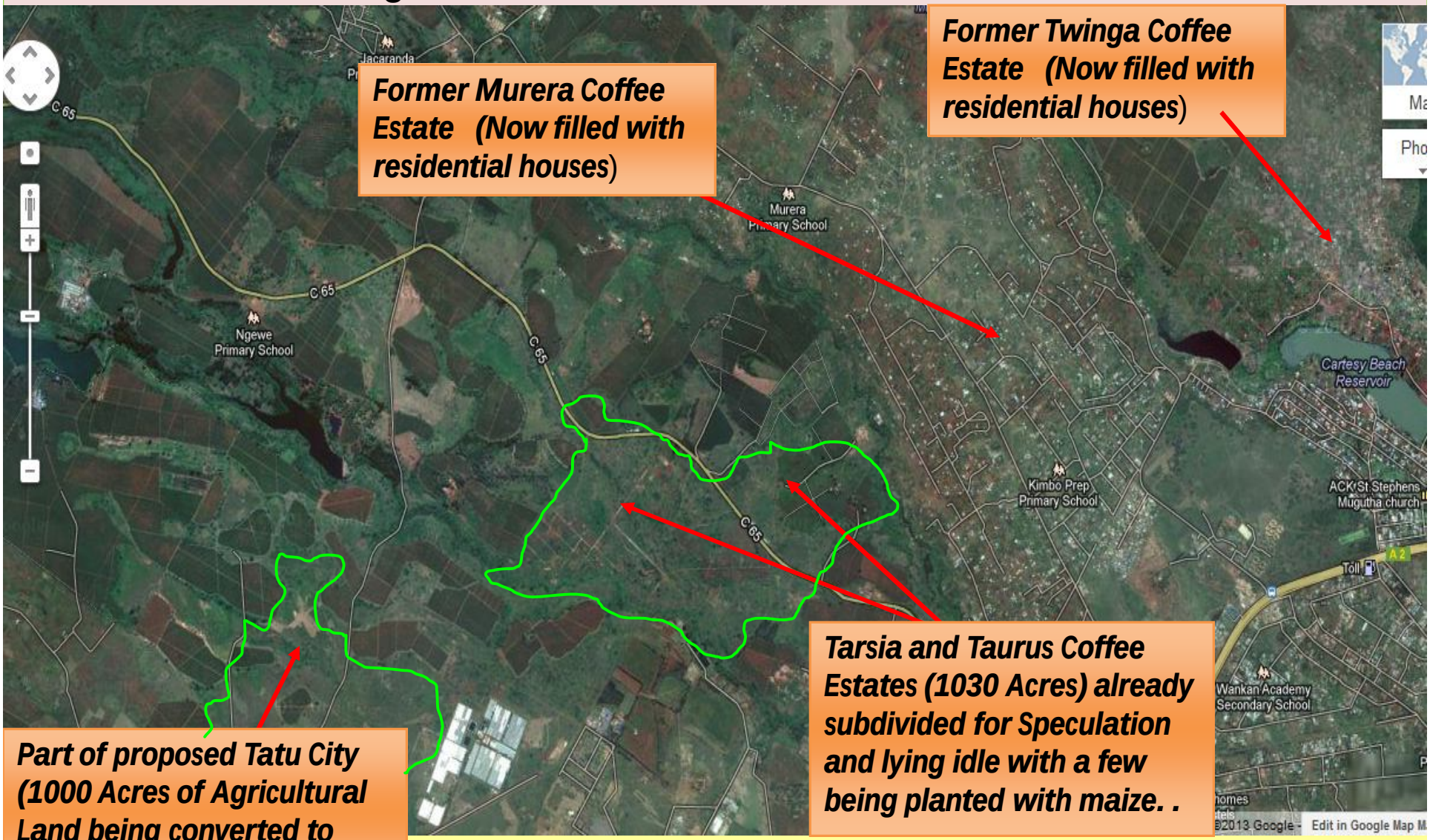


**Residential Estate in a 2 acre plot in Murera Sisal area (agricultural land)**

**Source: S.O.K & Field Survey, 2013 @ M.K Musa**

# Problem Statement (cont')

**Geo-eye Google Image showing some of the agricultural land farms that have been or are being converted into real estate near Ruiru town centre.**



# Objectives

## Main Objective

To analyse the effects of Land use Land cover change on food security in Kiambu County using Geospatial Technologies

**Specific Objectives**

1. To evaluate the temporal and spatial patterns of land use/cover change in Kiambu County in determining the .
   - Trend of Land use/Land cover change
   - Determine the rate of change and the most affected areas

2. To determine the main driver(s) of land use/Land cover change in Kiambu County which is (are) behind the high rates of food insecurity:-
   - Agricultural Land
   - Build area/urban
   - Other land uses
   - Population increase

3. Establish the relationship between rapid population growth, land use/land cover changes and its effects on agricultural land.

# Study area

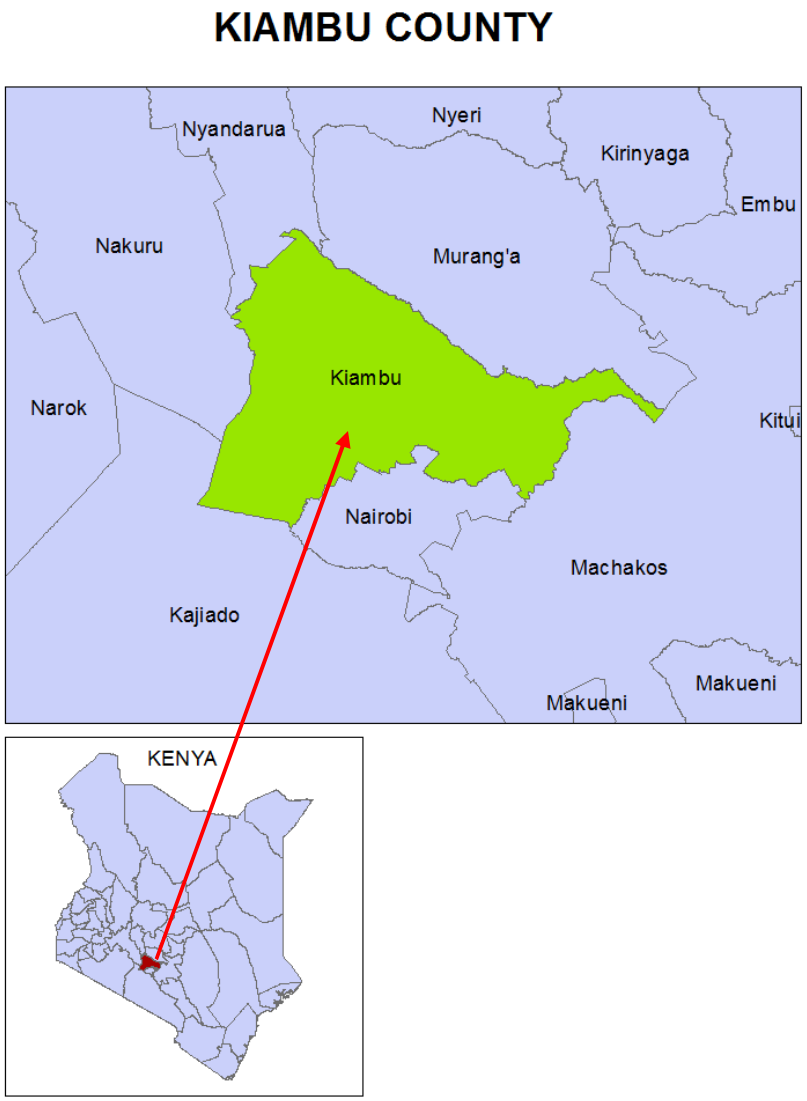
**Latitudes** 01º 09' and 01º 18' S
**Longitudes** 36º 40' and 37º 22' E

**Area** 2,543.4 km²
**Population** 1,623,282
**Households** 496,244
**Population density** 638 persons per sq.km *(2009)*

**Rainfall.** Min. 800 - Max 1200mm
Average rainfall of 989mm
**Temps.** Min. 12.8ºC – Max. 24.6ºC
Arrange of 18.7ºC

-It lies within the high and medium agro-climatic zones I to III
-Main land uses

- Agriculture, urbanisation, dairy farming



# Justification

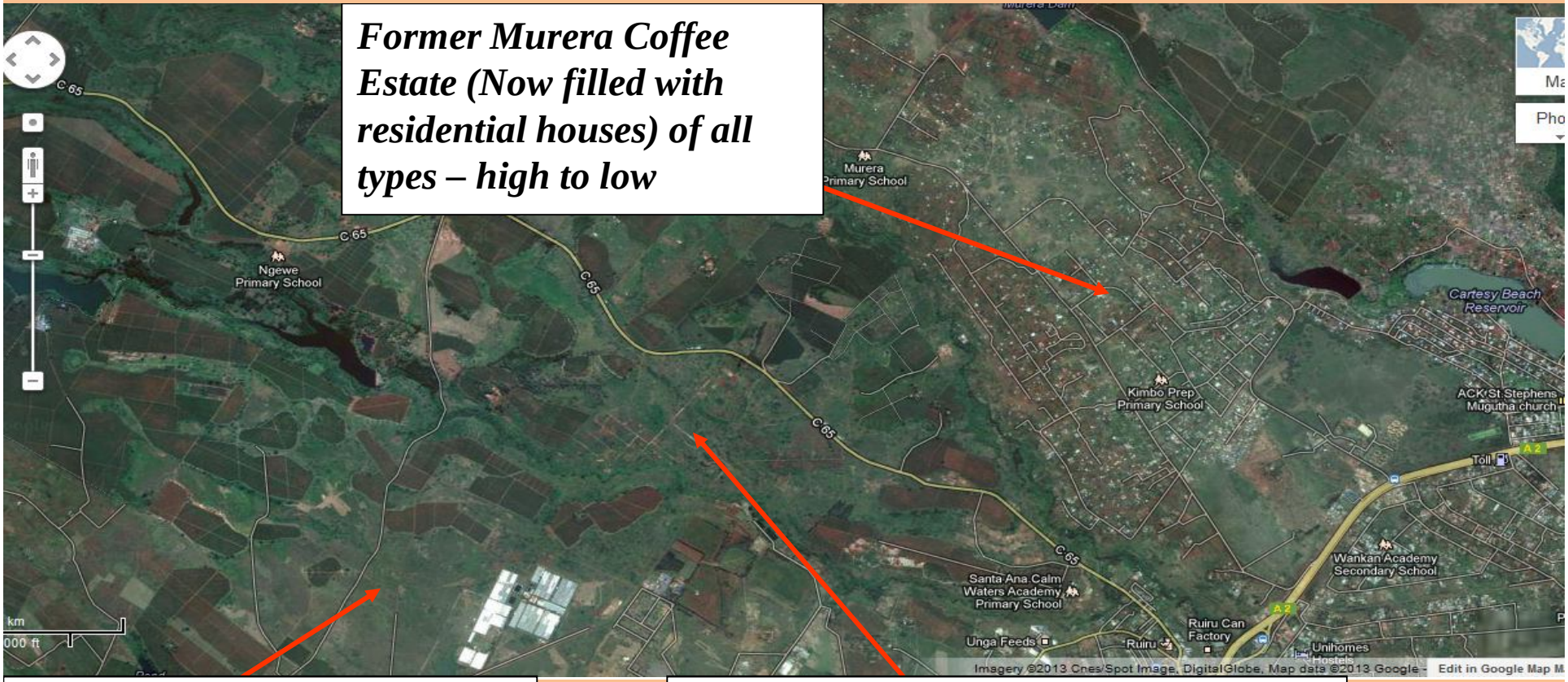
- Kiambu County has been a leader in the production of coffee, Tea, Dairy farm products, maize and vegetables being consumed in Nairobi and its environs.
- Production of coffee and other farm products has declined tremendously and could be as result of agricultural land being converted into built area and other land uses
- The rapid growth does not have a policy framework and this may lead to the creation of more slums next to posh estates.
- Leading to poor provision of facilities , services and demand for food.
- Minimal monitoring of urban expansions due to ill-equipped land monitoring system
- No zoning plans and legal framework for planning.

**NOTE:**

- Evident with the (Sept/Oct 2013) suspension of all Change of uses in Kiambu County

# Justification

Evidence of small parcels of land next to the new upcoming Tatu city and crop land that is being eaten up by the build area as the main driver




***Former Murera Coffee Estate (Now filled with residential houses) of all types – high to low***

***Part of proposed Tatu City (1000 Acres of Agricultural Land being converted to Urban)***

***Tasia and Taurus Coffee Estates (1300 Acres) subdivided in 2010 (into various sizes for speculation purpose- not yet settled)***

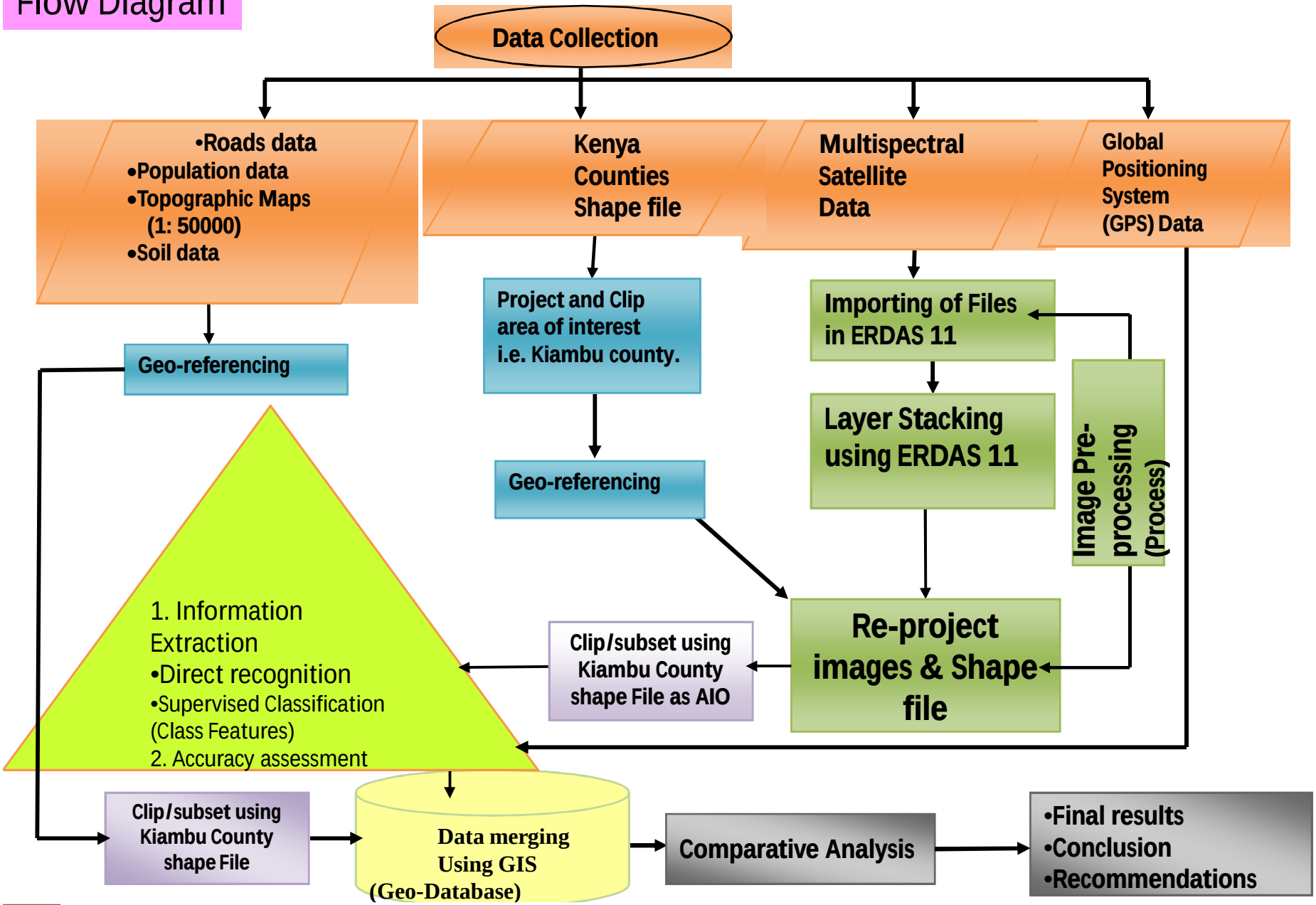
# Data sources

| Data type | Source | Description | Resolution |
|---|---|---|---|
| Multispectral Images | USGS Earthexplorer.usgs.gov<br>GLOVIS.usgs.gov<br>RCMRD | Landsat 5 TM 1984<br>Landsat 5TM 1993<br>Landsat 7 ETM+ 2002 & 2013 | 30m<br>30m<br>30m |
| Road Network | Kenya Roads data (thro' RCMRD) | Classified roads for Kenya | - |
| Kenya Population | KNBS (thro' RCMRD) | 1979,1989, 1999 & 2009 (Shape file) | - |
| Kenya Counties | Kenya Data (thro' RCMRD) | Shape file | |
| Topographic Maps Scale 1: 50,000 | Survey of Kenya | Scanned and covering the area of study | - |
| Kenya soils | IRLI (International Livestock Research Institute) | Shape file | - |
| Google Maps | Google | Geo-eye | 1.65/0.5m |
| Global Positioning System (GPS) | Field survey using Handheld GPS | UTM coordinates well distributed in area of interest | - |

RCMRD – Regional Centre for Mapping of Resources for Development
MSS – Multispectral Scanner, TM - Thematic Mapper, ETM+ - Enhanced Thematic Mapper (whisk broom)
OLI – Operational Land Image (push broom) – UTM – Universal Transverse Mercator

# Methodology

## Flow Diagram



# Methodology (cont')

## Software used

- **ArcGIS 10.1** – Projecting, Georeferencing, sub-setting/clipping of images, Thematic maps, Data base generation and analysis
- **Erdas imagine 2011** - Layer stacking, mosaicking, sub-setting/clipping, Image classification, recording of features and Accuracy assessments
- **Quantum GIS 1.6 -** Conversion of KML files to shape files

- **Microsoft office excel** - calculation of areas, drawing of histograms and graphs.
- **Arcpad 10.1** – for Handheld GPS collection of data

# Image Processing

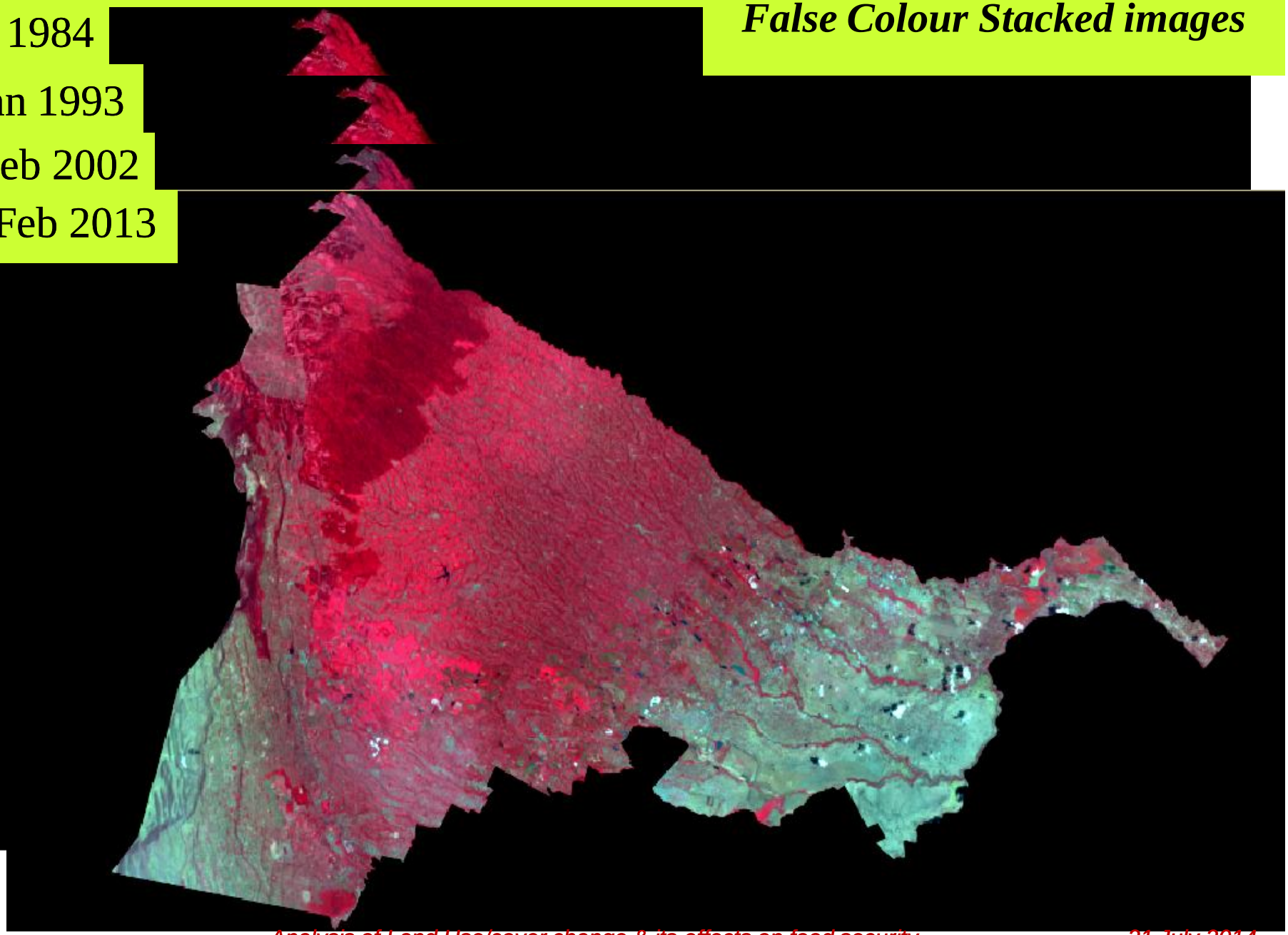
*False Colour Stacked images*

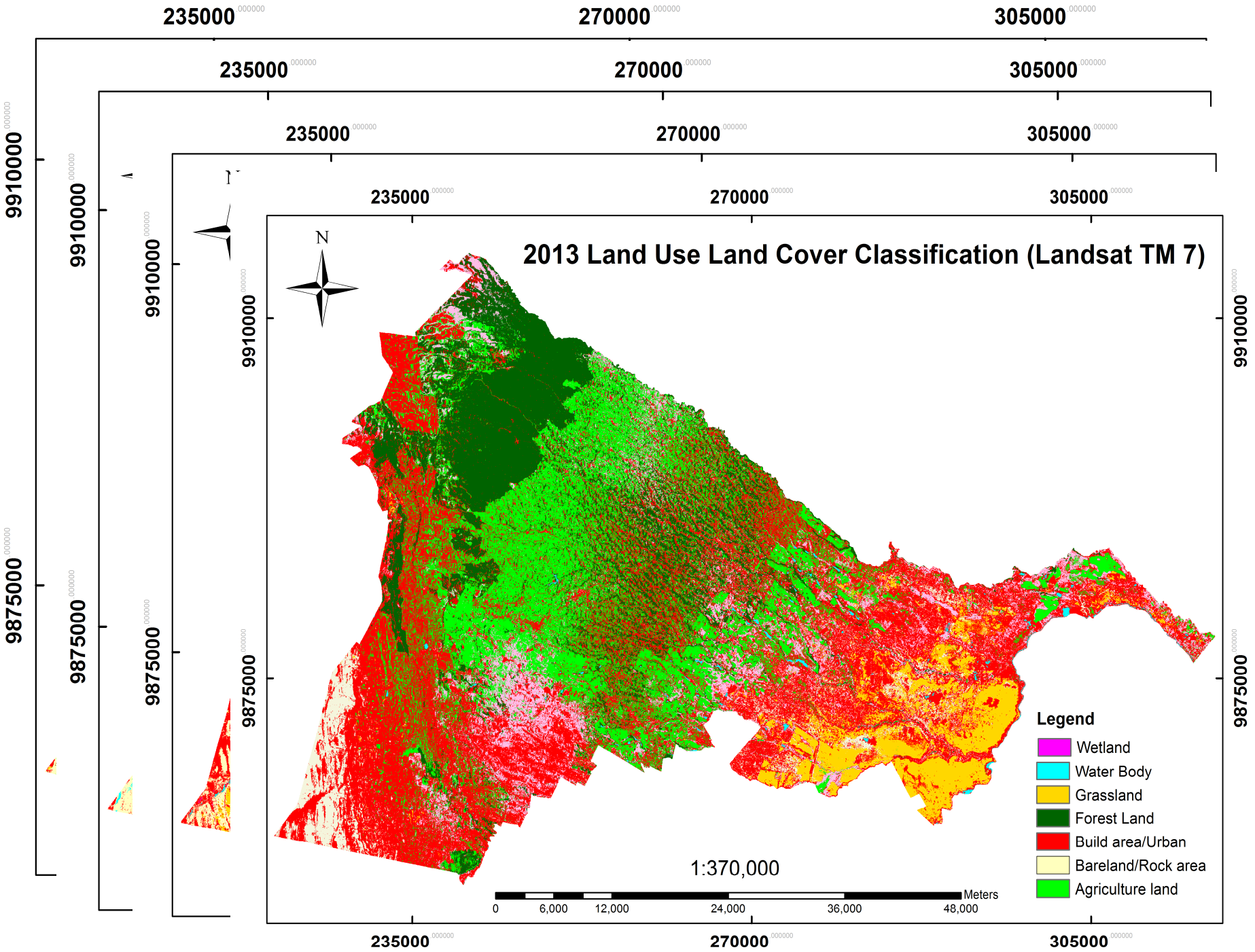
Feb 1984

Jan 1993

Feb 2002

Feb 2013




2013 Land Use Land Cover Classification (Landsat TM 7)
N
235000
270000
305000
9910000
9875000
Legend
Wetland
Water Body
Grassland
Forest Land
Build area/Urban
Bareland/Rock area
Agriculture land
1:370,000
0
6,000
12,000
24,000
36,000
48,000
Meters

# Accuracy assessment results

| YEAR / LULC | 1984 | | 1993 | | 2002 | | 2013 | |
|---|---|---|---|---|---|---|---|---|
| | Producer Accuracy | User Accuracy | Producer Accuracy | User Accuracy | Producer Accuracy | User Accuracy | Producer Accuracy | User Accuracy |
| **Agriculture land** | 91.05 | 88.32 | 90.61 | 85.87 | 91.68 | 88.73 | 90.85 | 88.69 |
| **Build-area / Urban** | 86.38 | 91.47 | 89.95 | 93.82 | 90.49 | 93.60 | 89.85 | 94.54 |
| **Forests** | 92.21 | 91.75 | 89.95 | 92.57 | 92.04 | 92.58 | 91.96 | 91.89 |
| **Water body** | 88.42 | 87.90 | 87.99 | 90.33 | 87.86 | 93.66 | 92.52 | 91.99 |
| **Wet lands** | 86.07 | 86.31 | 90.47 | 85.12 | 90.66 | 86.53 | 87.28 | 88.85 |
| **Grasslands** | 85.71 | 90.81 | 88.38 | 91.44 | 85.93 | 92.34 | 88.36 | 88.52 |
| **Bare land / Rocky** | 85.06 | 83.82 | 85.08 | 82.83 | 89.81 | 85.84 | 87.18 | 85.48 |

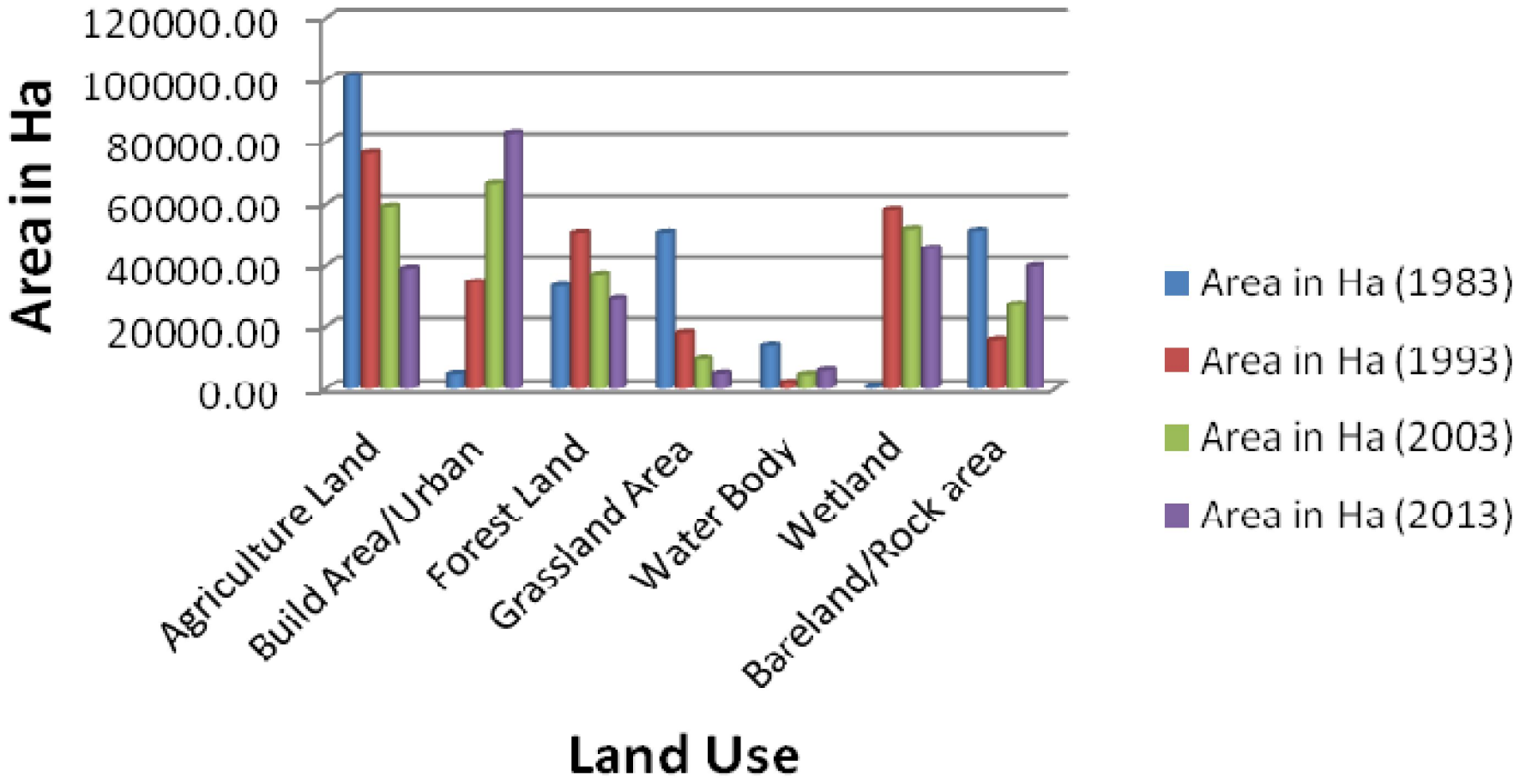
# Overall accuracy and Kappa Coefficient

| Year | 1984 | 1993 | 2002 | 2013 |
|---|---|---|---|---|
| **Overall Accuracy %** | 89.70 | 89.73 | 90.98 | 90.71 |
| **Kappa Coefficient** | 0.86 | 0.87 | 0.88 | 0.87 |

# Change Detection Results

| Class \ Area | Area in Ha (1984) | % Area | Area in Ha (1993) | % Area | Area in Ha(2002) | % Area | Area in Ha(2013) | % Area |
|---|---|---|---|---|---|---|---|---|
| **Agriculture Land** | 101192.00 | **39.69** | 76190.50 | 29.88 | 59136.70 | 23.19 | 38901.07 | **15.75** |
| **Build Area/Urban** | 4803.66 | **1.88** | 34502.90 | 13.53 | 66166.10 | 25.95 | 82720.42 | **33.50** |
| **Forest Land** | 33245.00 | 13.04 | 50331.10 | 19.74 | 36989.00 | 14.51 | 29183.71 | 11.82 |
| **Grassland Area** | 50342.60 | 19.74 | 17998.60 | 7.06 | 9415.98 | 3.69 | 4925.98 | 1.99 |
| **Water Body** | 14097.70 | 5.53 | 1981.8 | 0.78 | 4586.40 | 1.80 | 6027.72 | 2.44 |
| **Wetland** | 427.23 | 0.17 | 58142.90 | 22.80 | 51387.60 | 20.15 | 45417.16 | 18.39 |
| **Bare land /Rock area** | 50858.10 | 19.95 | 15818.10 | 6.20 | 27284.10 | 10.70 | 39777.31 | 16.11 |
| **Total Area** | 254966.29 | 100.00 | 254965.90 | 100.00 | 254965.88 | 100.00 | 254965.92 | 100.00 |

# Kiambu county Land use land cover change (1983-2013



# Supervised classification Change analysis

| | Year | | |
|---|---|---|---|
| **Class** | **1983-1993** | **1983-2003** | **1983-2013** |
| **Agriculture Land** | 14192 | 21921 | 39366.2 |
| **Build Area/Urban** | -41801.6 | -40652.1 | -30151.6 |
| **Forest Land** | 10949.1 | 16493.7 | -10866.1 |
| **Grassland Area** | -4663.1 | -15289.2 | 11418.1 |
| **Water Body** | -765.45 | -171.36 | -259.56 |
| **Wetland** | 17306.48 | 18708.41 | -17817.81 |
| **Bare land/Rock area** | 4782.5 | -1010.6 | 8310.6 |
| **Total Area** | -0.07 | -0.15 | -0.17 |

| | Year | | |
|---|---|---|---|
| **Class** | **1983-1993** | **1993-2003** | **2003-2013** |
| **Agriculture Land** | 14192 | 7729 | 39366.2 |
| **Build Area/Urban** | -41801.6 | 1149.5 | -30151.6 |
| **Forest Land** | 10949.1 | 5544.6 | -10866.1 |
| **Grassland Area** | -4663.1 | -10626.1 | 11418.1 |
| **Water Body** | -765.45 | 594.09 | -259.56 |
| **Wetland** | 17306.48 | 1401.93 | -17817.81 |
| **Bare land/Rock area** | 4782.5 | -5793.1 | 8310.6 |
| **Total Area** | -0.07 | -0.08 | -0.17 |

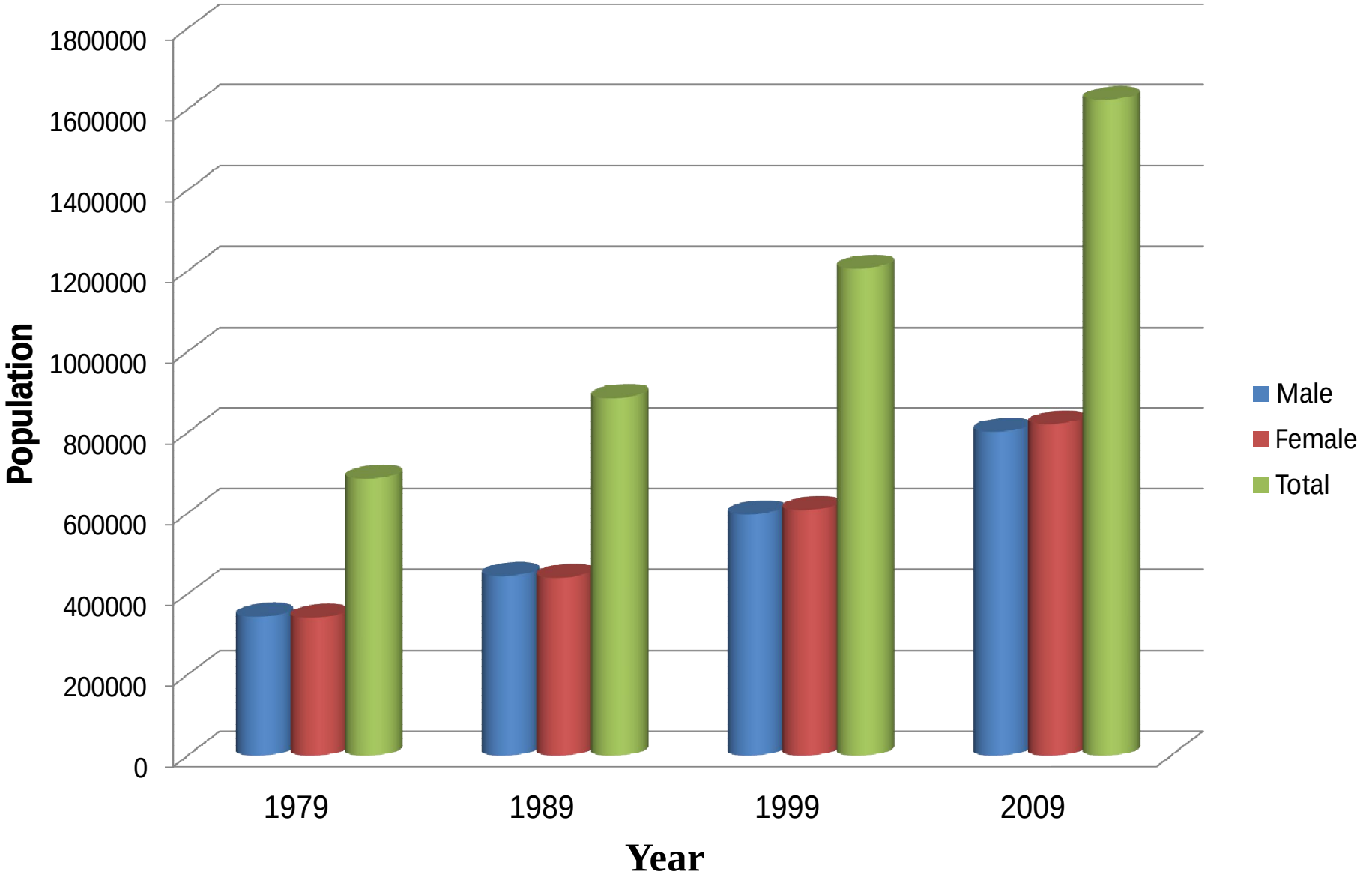
# Kiambu County Population trend (1979-2009)

| Year | Male | Female | Total Population | Area in Ha |
|---|---|---|---|---|
| **1979** | 344366 | 341924 | 686290 | 253700 |
| **1989** | 445083 | 441007 | 886090 | 259200 |
| **1999** | 598329 | 608363 | 1206692 | 254400 |
| **2009** | 802609 | 820673 | 1623282 | 254342 |

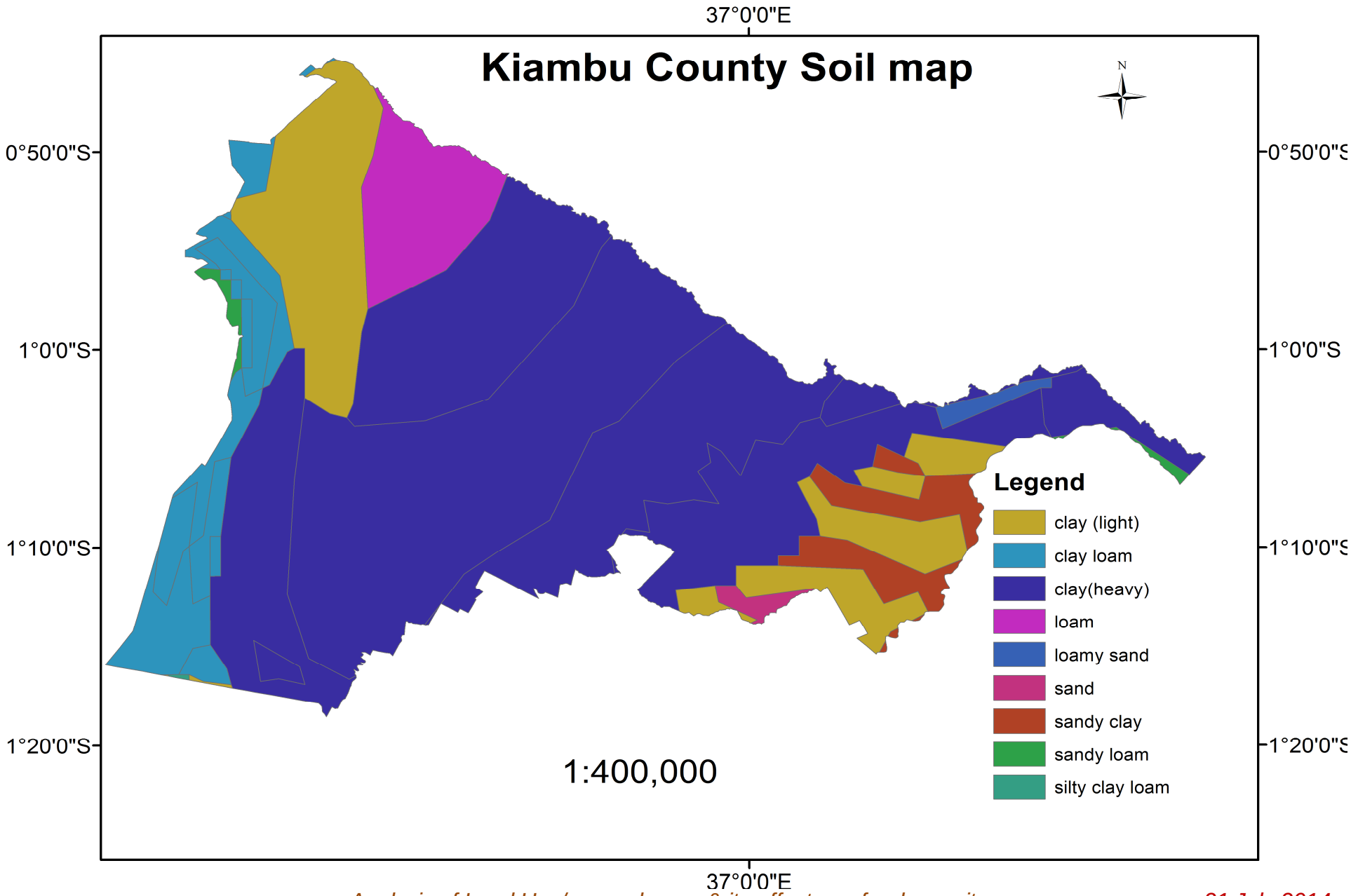
# Kiambu County population changes

| Year | Changes | % Change |
|---|---|---|
| **1979-1989** | 199800 | 29.11306 |
| **1989-1999** | 320602 | 36.18165 |
| **1999-2009** | 416590 | 34.52331 |

# Kiambu County Population trend (1979-2009)



# Analysis (Cont)



# Challenges

- Data Source
  - -Availability (same time) and bureaucracy
  - -Harmonizing the formats
  - -Technical challenges

- Software usage
  - -Not being familiar with some of the software

# Conclusion and Recommendations

- From the results obtained the trend is very clear that with high population increase there is loss of agricultural land and mostly to build area leading to food insecurity.
- Most affected areas are those with good and fertile soils for crops
- LULC change is negatively impacting the County.
- I recommend that the land use in Kiambu County be harmonized as build

  - Create a buffer that will preserve the areas with good soils for agriculture.
- Other factors be incorporated in the study. E.g. Soils

The county needs to have a zoning plan and come up with a policy framework for implementation.

Thank you All

Questions Comments Welcomed