

# MAWARI PROJECT

Scientific Meeting, Orleans, France  
26<sup>th</sup>-27<sup>th</sup> May 2006

## Sustainable management of water resource in the East-African Rift system

*“Vulnerability of Groundwater to Pollution in  
the East African Rift System in Kenya”*

Justus Barongo & Simon Onywere



## Required data and assignment of roles

- Soils, land use land cover – biodiversity (what is available, where available, format and at what scale? What do you need to measure?)

*Action: – Gicheru, Ottichilo, Onywere*

- Lithology (geology) and structures *Action: – Korme, Onywere, Barongo*
- Hydrology/hydrogeology; hydraulic parameters *Action: – Barongo, Irungu, Onywere, Korme*
- Pollution/Urban-population settlements and human impacts on environment; population and industrialisation; water quality and quantity *Action: – Onywere, Irungu, Ottichilo*
- Isotope/soil-water chemistry/geo-chemistry meteoric water, base flow *Action: – Olago, Gicheru, Irungu*

Ground water modelling, borehole data, well logs and aquifer characterization – water balance, ground water flow *Action: -*

*Barongo, Olago, Korme*



## Identification of Masters Students & Research Projects

### P. M. Mubinya (MEPM - KU):

- Assessment of groundwater/surface water quality relationship in Lakes Naivasha-Elementaita-Nakuru Drainage basin

### Demis Alamirew (MSc - UoN):

- Geology, hydrogeology and hydrostratigraphy of Lakes Naivasha-Elementaita-Nakuru Drainage basin area

### John Ogalo (MSc - UoN):

- Use of *depth* to water-table and *topography* in modelling vulnerability of groundwater to pollution in the southern part of Lakes Naivasha-Elementaita-Nakuru Drainage basin

### Ezekiel Kemboi (MSc - UoN):

- Aquifer media characteristics and vadoze zone influence on vulnerability to groundwater pollution in Lakes Naivasha-Elementaita-Nakuru Drainage basin

### Immaculate Simiyu (MEPM - KU):

- Anthropogenic and groundwater resources around Naivasha

Urban and Peri-urban areas



## Proposed PhD Students & Research topics

**Ms. Lydia Olaka, (PhD – RCMRD/UoN)**

**Groundwater vulnerability to contamination: systematic mapping of the rock aquifers in the East African Rift System in Kenya**

**Ms. Marietta Mutonga (PhD – UoN)**

**Rock and the water chemistry of the Lakes Baringo-Bogoria Area, Rift Valley, Kenya**

**Robert Magutu Wanjara (PhD – UoN)**

***Application of numerical, isotope and Geo-chemical modeling and GIS in the characterization of the hydrogeology of a closed Rift valley basin, Kenya: Implication to ground water contamination***

***Two more PhD students are to be identified?***



## Current Status of Data Collection

- 942 borehole are on record for the whole of the Rift Valley area (map & An example of unrefined borehole data)
- Not all are functional
- Contact made to various authorities in project area
- Assessing level of accessibility to borehole
- Sampled borehole and surface waters to cross-check with the Ministry data
- Measured depth to welhead

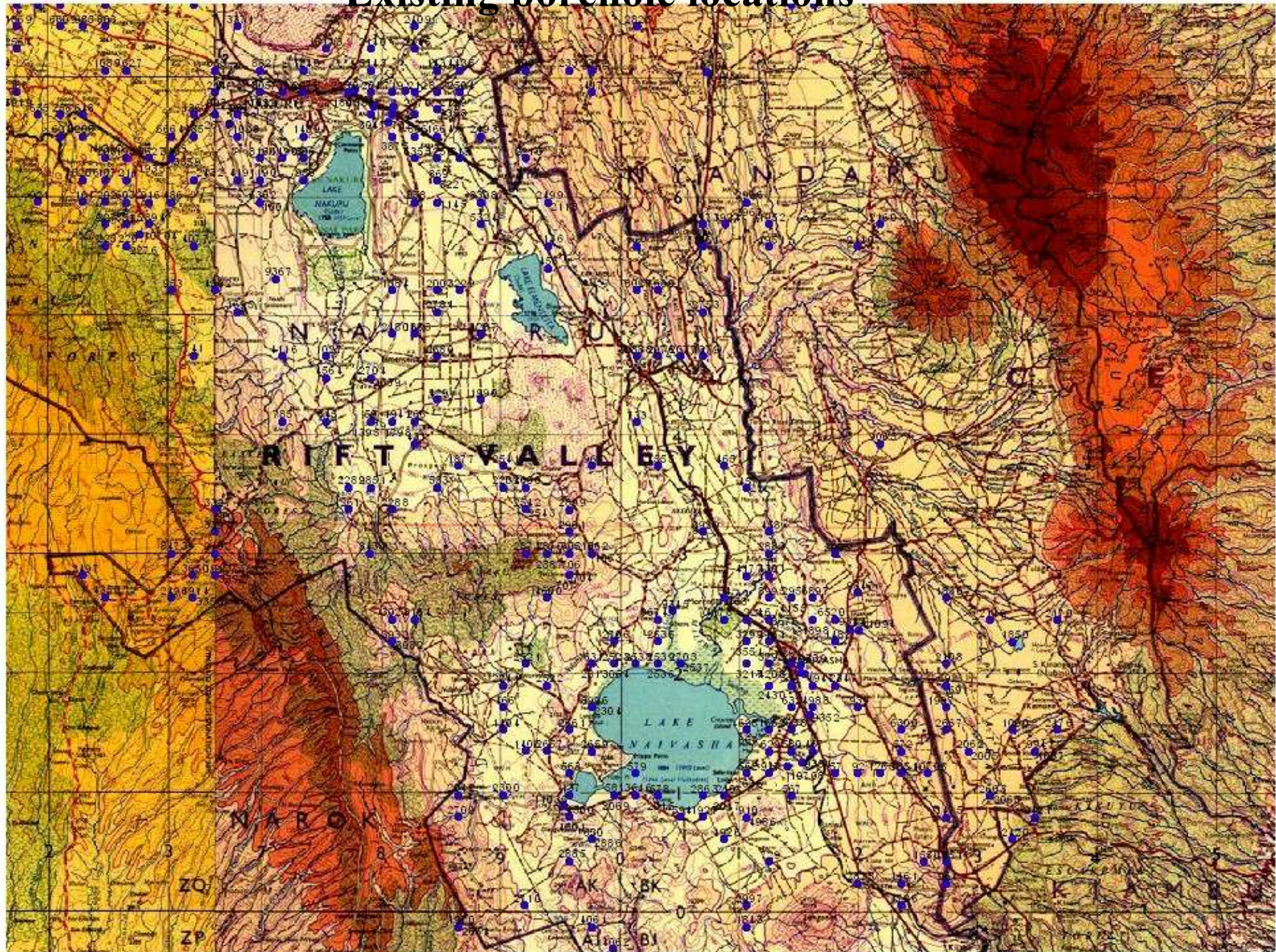
### Nakuru Area

#### Wellhead depth and water samples

- Kabatini Nawasco boreholes Site–3 boreholes
- Bahati Nawasco boreholes Site – 2 boreholes
- Road Nawasco boreholes Site- 2 borehole
- Bahari Nawasco borehole Site – 2boreholes



# Existing borehole locations



## **Current Status of Data Collection.....**

- **Armed Forces Canteen Organization boreholes (AFCO) boreholes Site, Lanet – 1 borehole**
- **Private borehole Site in Lanet Settlement Scheme \_ 1 borehole**
- **Nakuru Sewage Site –**
- **Nakuru waste damp site**

### **Elmenteita area:**

### **Wellhead depth and water samples**

- **Crecent construction company borehole site – 1 borehole**
- **Lake emeneteita water sample**



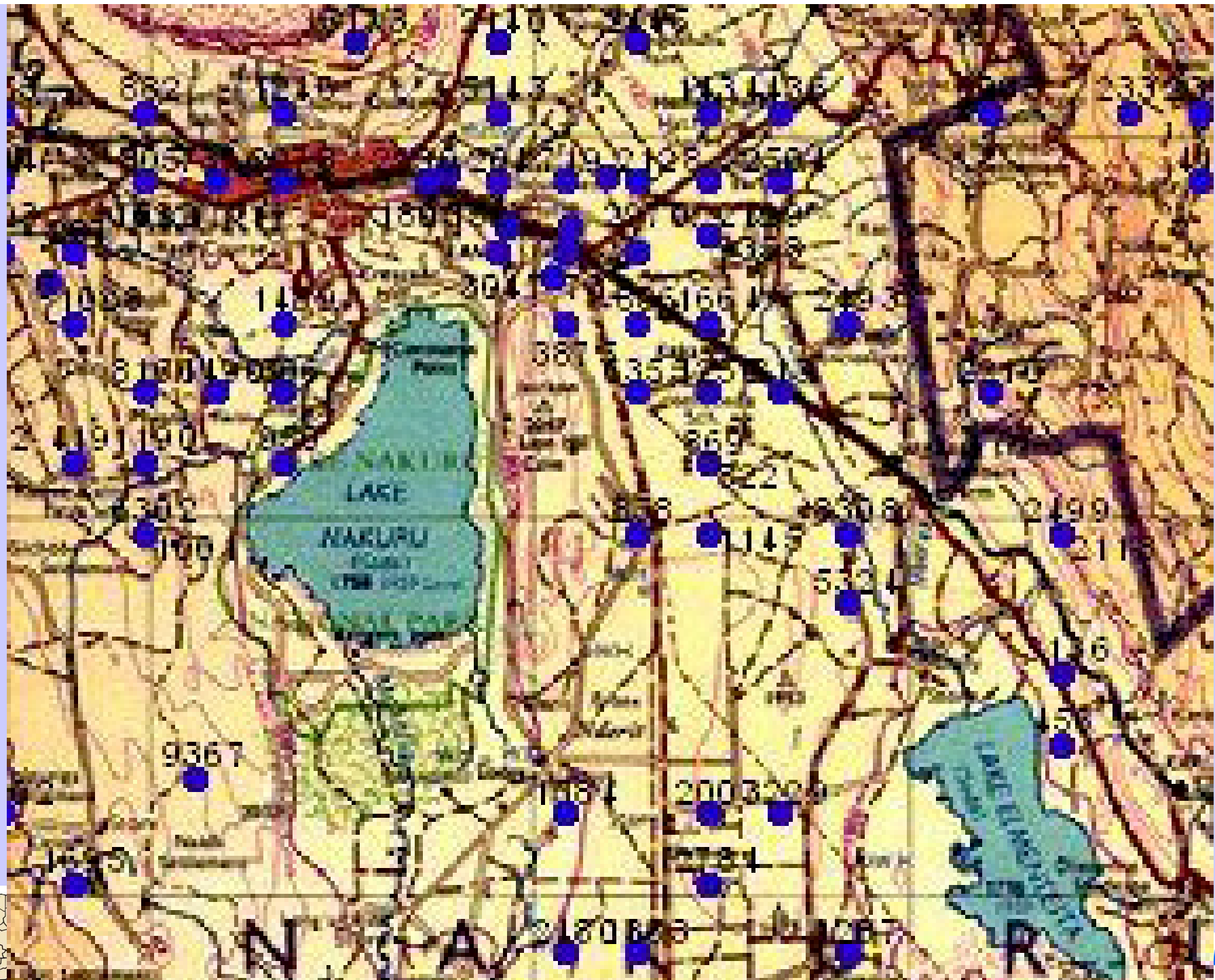
## **Current Status of Data Collection....**

### **Naivasha area :**

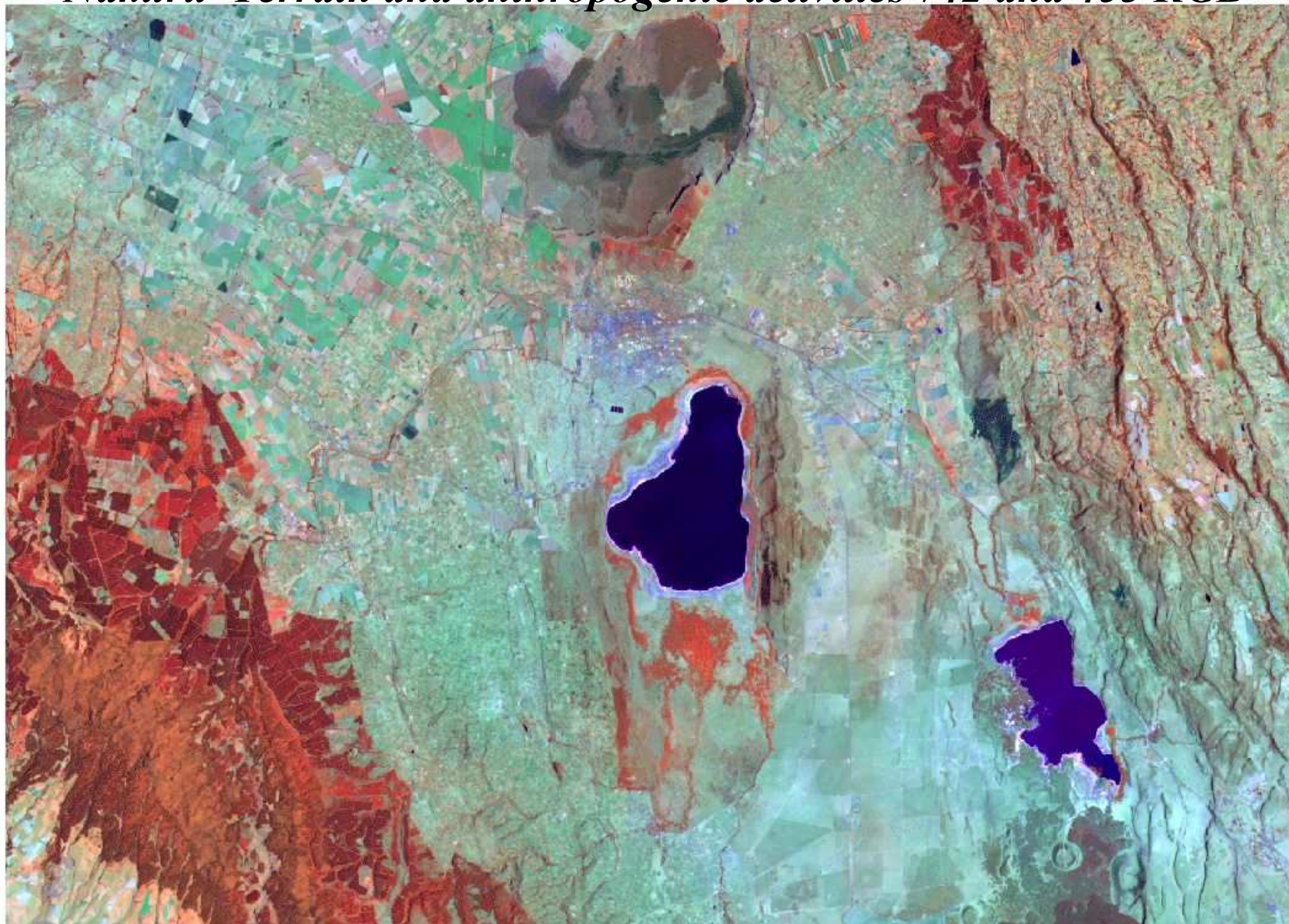
#### **Wellhead depth and water samples**

- **Panda Flower Company – 2 boreholes and waste water from flower green houses**
- **Delamare farm – 1 borehole and water sample**
- **Naivasha sewerage site - water sample**
- **River water sampling – Malewa river at Naivasha road bridge**
- **River water sample – Gilgil River**
- **River water sampling - Soysambu farm**
  
- **All water sample delivered to Ministry of Water labs in Nakuru and Nairobi for analysis for common elements, heavy metals and microbios/bacteriological organisms**
  - **Monitoring data were also acquired from Nakuru Regional Office**

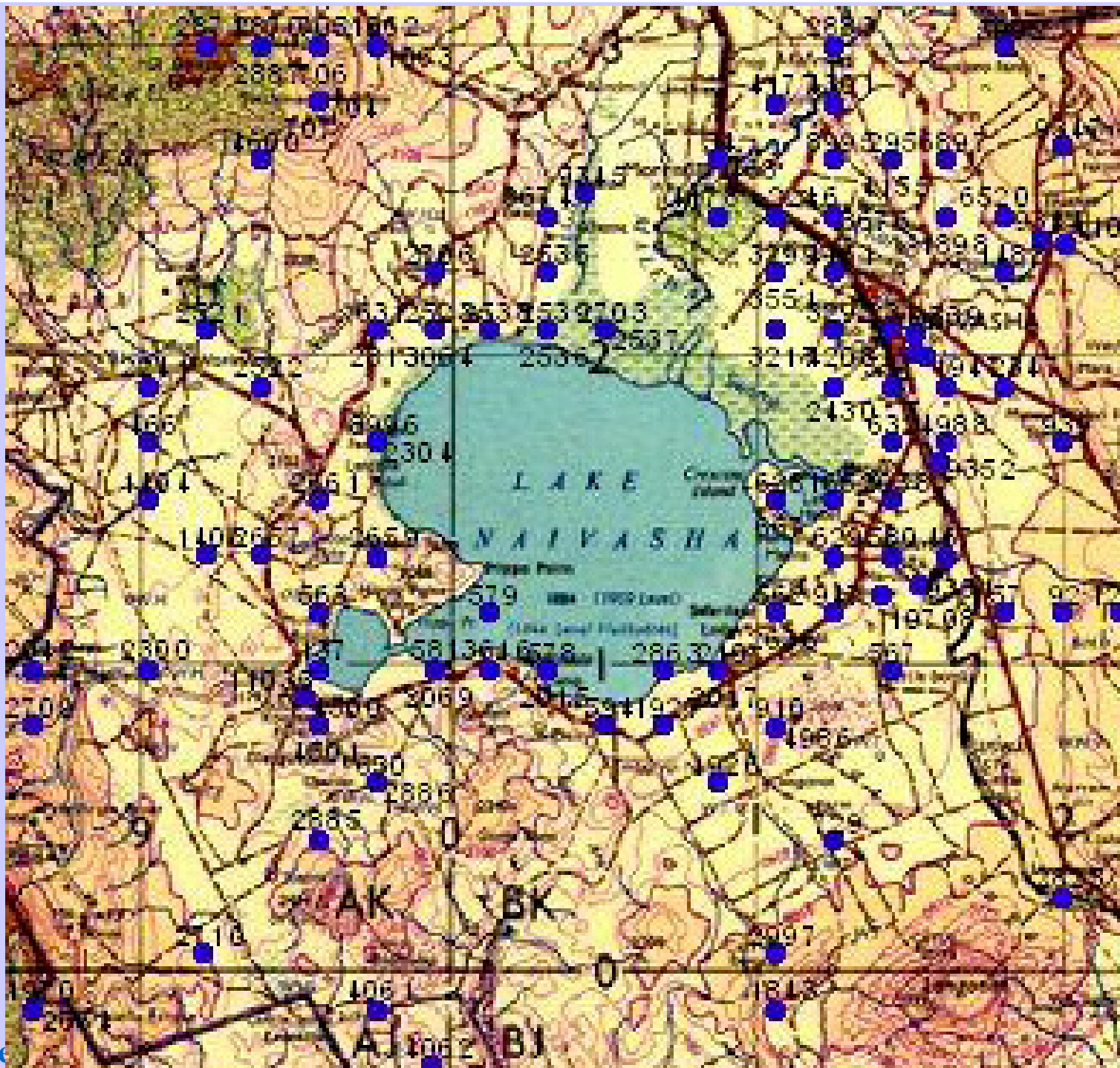




*Nakuru Terrain and anthropogenic activities 742 and 453 RGB*



0 9 18 Kilometers



## Activities for the next 6 months

### Main field trip for the purpose of:

- Identification and Selection of suitable boreholes for measurement
- Further data collection – geological, hydrological, geophysical, geochemical meteorological, pedological etc

### Database development

- Acquisition of relevant equipment and computing resources
- Acquisition of SPOT satellite imagery
- Keying-in of attribute data and spatial data digitization
- Supervision, analysis and interpretation of acquired data will be concurrent
- Actualise exchange and interaction among the participating institution's students and staff





**An Example of work carried out:**

**Spatial Distribution of Fluorides in the Groundwater Resources of  
the Lakes Baringo-Bogoria Area, Rift Valley, Kenya**

*An Extract*

*from*

*Ms. Marietta Mutonga's MSc. Dissertation, Department of Geology  
University of Nairobi, Kenya  
(2006)*

*(With Permission from Ms. Mutonga) prospective PhD student in the  
Mawari Project*

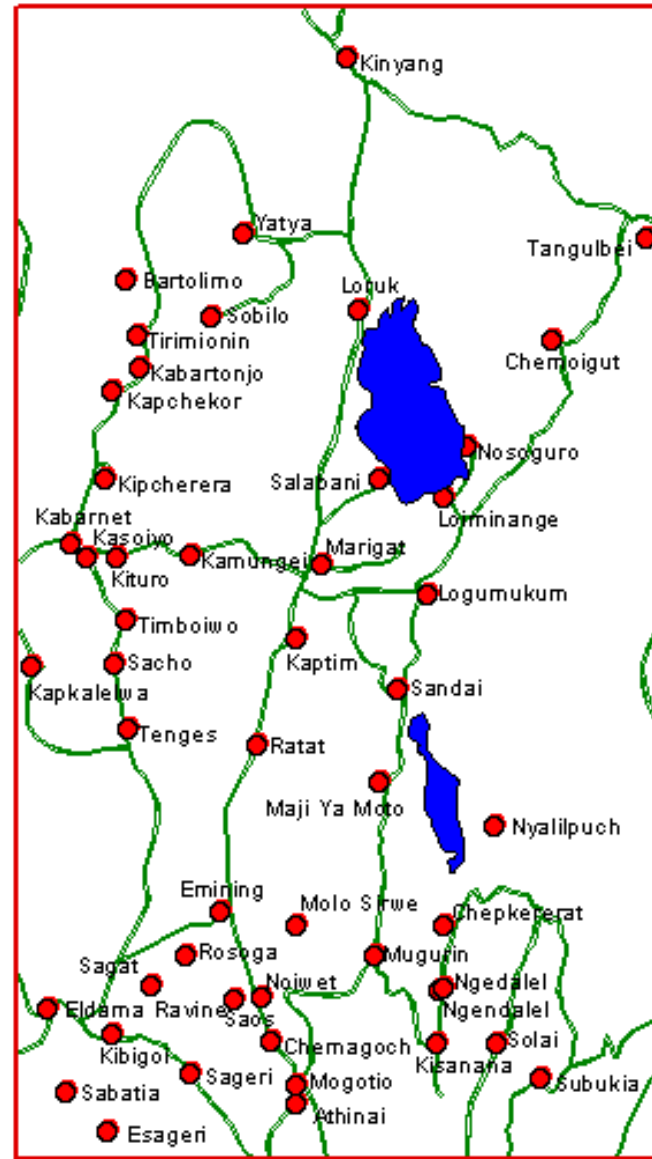
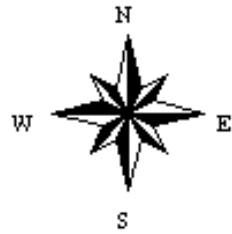
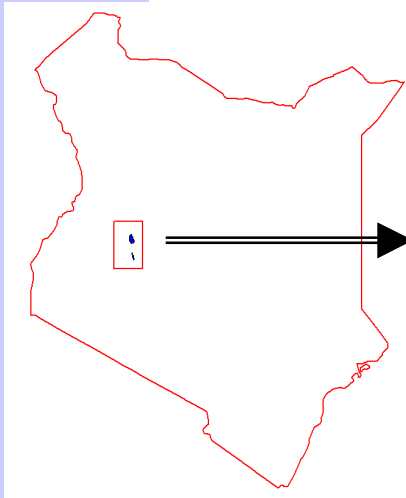
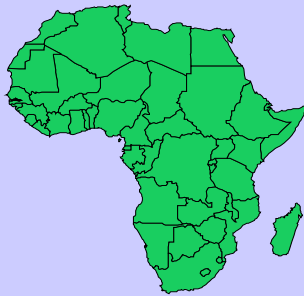


## Introduction

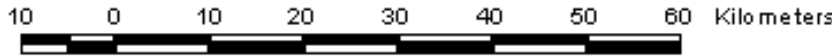
- The study area extends from the southern shores of Lake Bogoria to the north of Lake Baringo
- It lies within the geographical co-ordinates  $35^{\circ} 45'$  -  $36^{\circ} 20'$  E ,  $1^{\circ} 00'$  -  $0^{\circ} 15'$  N
- The average general elevation in the area is 965 metres above sea level
- The area falls within the central part of the eastern arm of the Great Rift Valley
- The area is sparsely populated, Kambi ya Samaki, in the western shores of lake Baringo is the largest settlement in the area and further to the north, there are small centres of population; Loruk, Nginyang, Chemolingot, Tangulbei,



# Location the Study Area



- Boundary
- Lakes
- Towns
- Roads

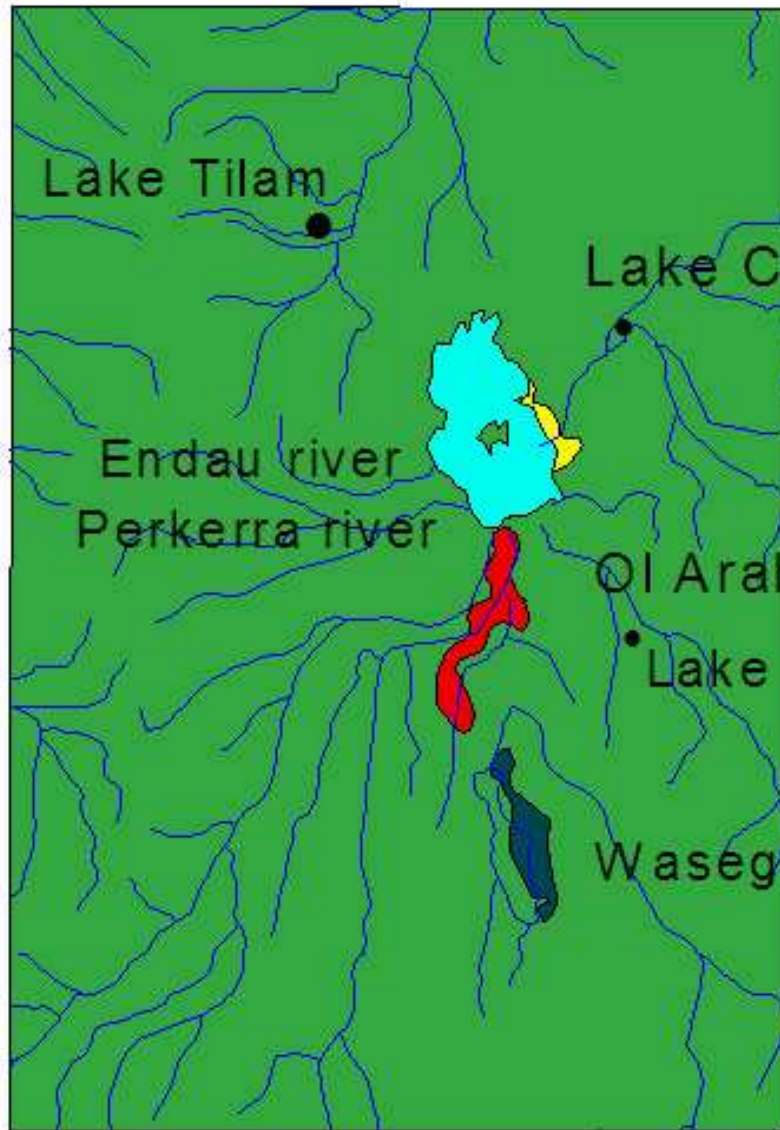


## Land Use

- **Conservation of biodiversity**
- **Pastoralism and livestock grazing**
- **Honey gathering for local and external markets**
- **Irrigation- small scale projects.**
- **Tourism for local and foreign visitors**
- **Community access to medicinal plants**
- **Sacred prayer (used by the Pokots, Njemps Turkana and Kalenjin communities).**
- **Fishing for domestic and commercial purposes**
- **Watering of livestock**
- **Subsistence farming of mainly maize and vegetables**
- **Settlements of communities at appropriate sites**



# Drainage of the study area



-  Rivers.shp
-  Lake.shp
-  LAKE BARINGO
-  LAKE BOGORIA
-  Swamps.shp
-  Molo River
-  Tangulbe River
-  Drainage study area

30 0 30 60 90 Kilometers

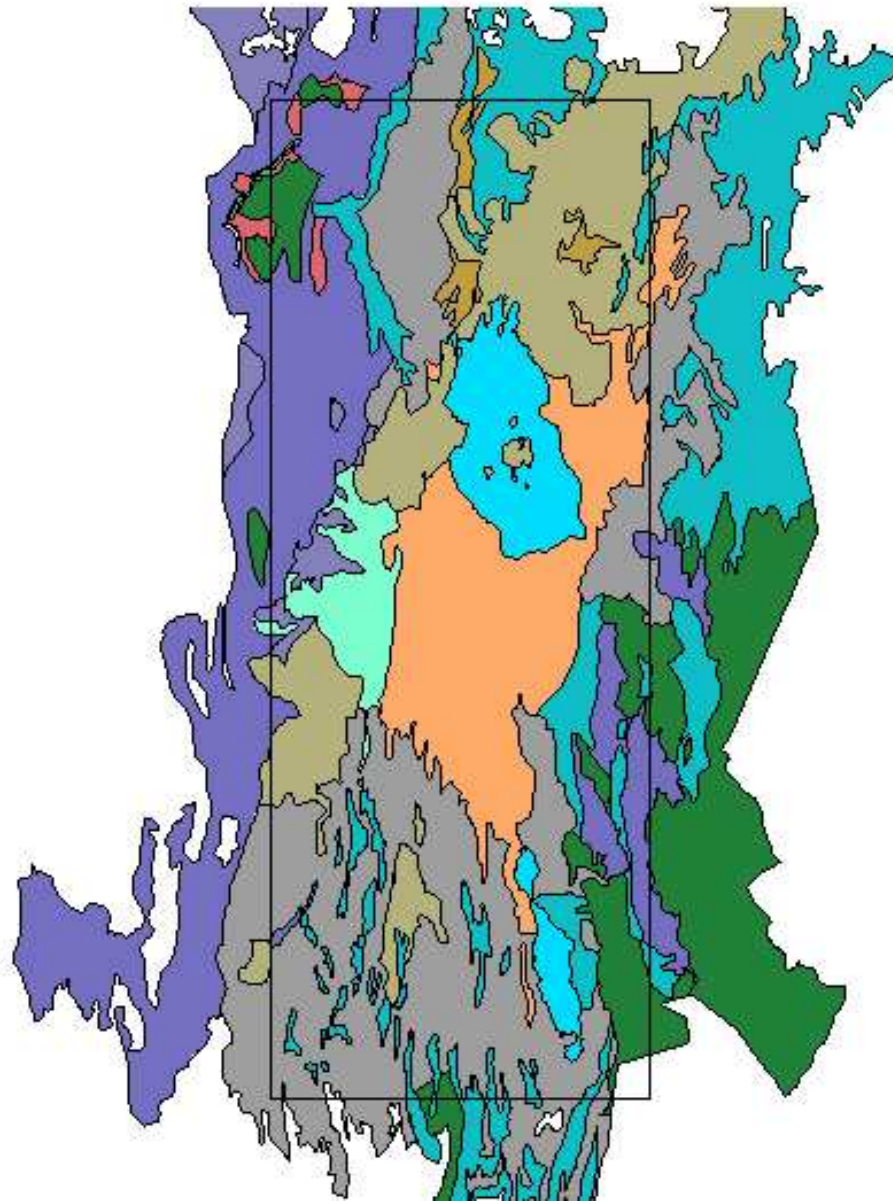


## Study Objectives

- **Determine the spatial distribution of fluoride**
- **Show the effects of fluoride on human groundwater consumers in the area**
- **Propose mitigation measures through use of bone char**



# Geology of the study area



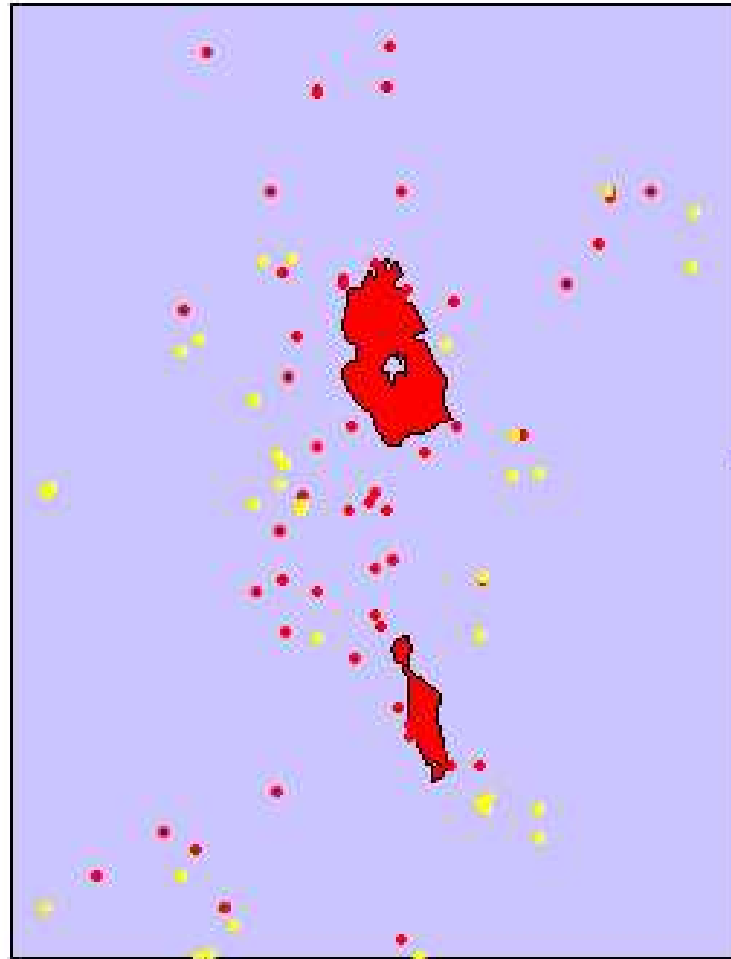
Geo.shp

- ?
- Alluvial\_fan\_&\_pedmont\_deposit
- Basalts
- Intrusive\_Rocks\_Pematio\_veins\_&\_dykes
- Lakes
- Sediment1\_lakes\_&\_river\_deposits
- Sediments
- Superficial\_Deposits
- Tuffs\_&\_Agglomerates
- Trachytes,Phonolites
- Volcanic1\_Tuffs\_&\_Agglomerates
- Volcanic\_rock2\_Basalts
- Volcanic\_rocks1\_Trachytes,Phonolites





**FLUORIDE CONCENTRATIONS  
< 1.5 (GREEN) and >than 1.5 (RED)  
(The range is from 0.2 to 120.2 mg/l)**



30 0 30 60 Kilometers

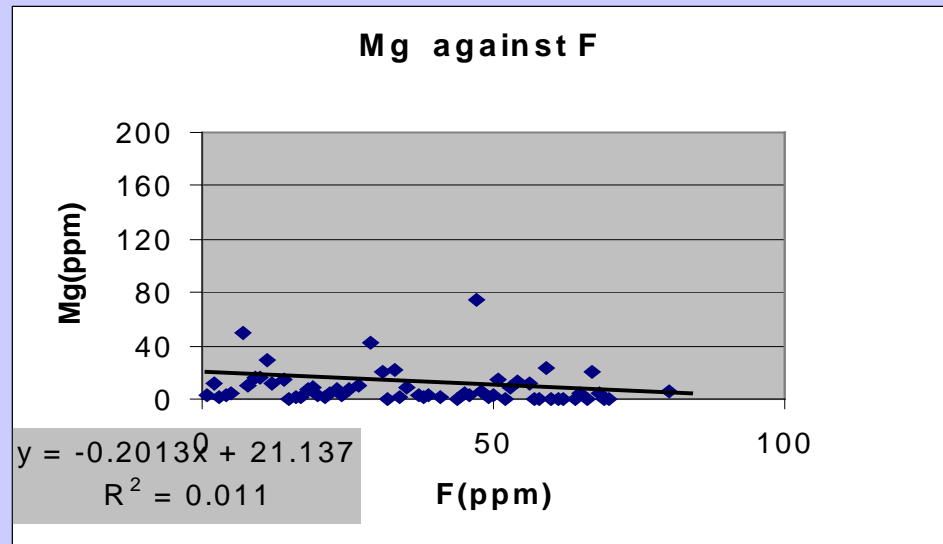
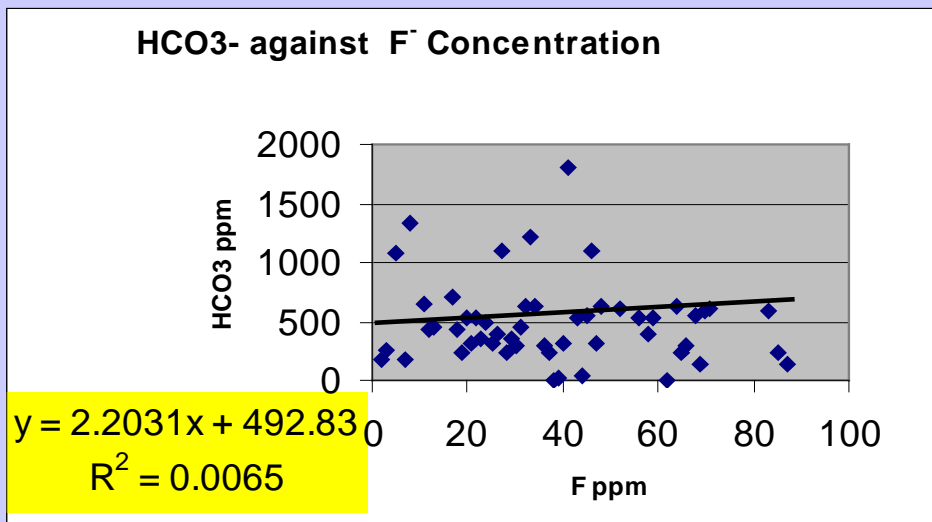
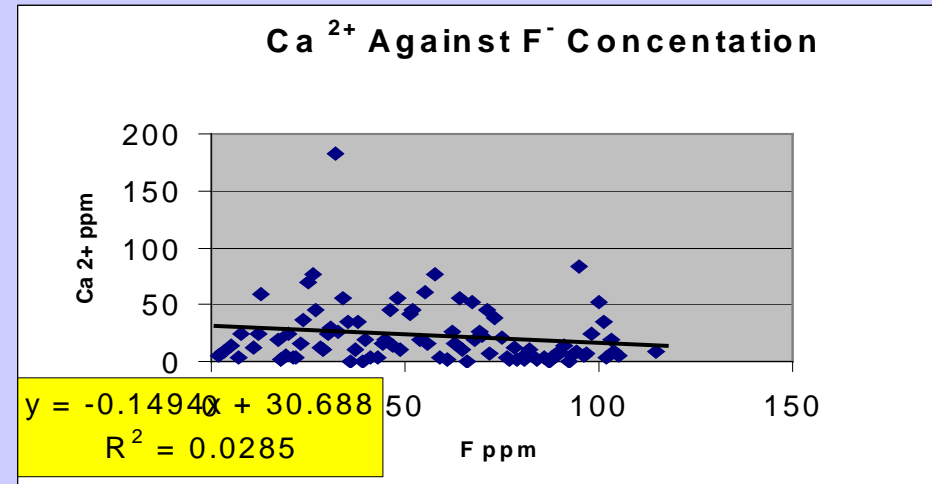
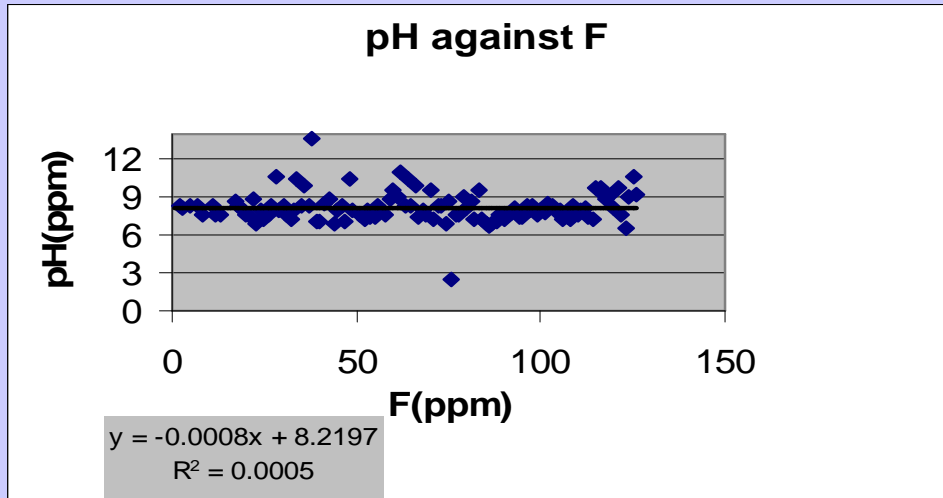


## **Fluoride in Natural Waters Depends On:**

- **Availability and solubility of the parent fluoride minerals with which the water interacts,**
- **Porosity of the rocks or soils through which the water passes,**
- **The concentration of calcium and magnesium ions in water,**
- **The temperature of interaction between rock and water**
- **The hydrogen ion concentration of water i.e. pH.**



# Characteristics of Waters Containing Fluoride in the Study Area



## Fluorosis

- **For many years in several developing countries fluoride research has been in progress**
- **The role of fluorine in animal or human metabolism is not known with certainty, from the information available, however it is clear that a certain quantity of fluorine is essential for the formation of caries-resistant dental enamel and for the normal process of mineralisation in hard tissues**
- **The element is metabolized from both electrovalent and covalent compounds**



## Fluorosis cont...

- **Low fluoride concentrations stabilizes the skeletal system by increasing the size of apatite crystals and reducing their solubility**
- **The element is metabolized from both electrovalent and covalent compounds**
- **Low fluoride concentrations stabilizes the skeletal system by increasing the size of apatite crystals and reducing their solubility**
- **The great affinity of fluorine for calcium phosphate is perhaps the most important from the accumulation in all tissues exhibiting physiological or pathological calcification**
- **Age is also an important factor in deciding what extent fluorine is incorporated in the skeleton**



## Effect of Fluoride on Teeth of Young Girl



## Discoloration of Teeth Among Primary School Pupils in Kambi Ya Samaki near Lake Baringo

Class	Pupils in Class	Number affected	% Affected
1	87	75	89.3
2	74	68	91.9
3	74	69	93.2
4	55	47	85.5
5	61	55	90.2
6	65	59	90.8
7	56	50	89.3
8	28	26	92.9





- A pattern similar to that in bones is followed by the fluoride concentration in teeth.
- The uptake almost ceases in dental enamel after the age of about 30 years.





**About 95% of the fluoride in the body is deposited in hard tissues and it continues to be deposited in calcified structures even after other bone constituents**

**(Ca, P, Mg, CO<sub>3</sub> and Citrate) have reached steady state.**





## Bone char pallets



**Two forms of bone char, the improved composite is white**





Kenyatta University

You are all welcome to the Rift Valley in Kenya  
The Geology and the topographic variation  
and the problems associated with it  
need collaborative efforts

Asante sana!  
Bravo!

Thank you  
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[onyweres@yahoo.com](mailto:onyweres@yahoo.com)

