Landuse and Land cover Mapping of the Simiyu Catchment (Tanzania) using Remote Sensing Techniques

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Introduction

- Lake Victoria
  - Largest Lake - Freshwater (Africa)
  - Share resources (Tanzania, Uganda, Kenya)
- Water quality (declining)
  - Non-point sources & Point sources
- Non-point sources (Agricultural fields)
  - Fertilizer (P) and pesticides
  - Others: sediments, etc.
- LVEMP, 1997 (Tanzania, Uganda, Kenya)
  - Rehabilitation, Monitoring, Control (water quality of the Lake)

Fate/Transport and Objectives

- Trends of increasing contaminant (phosphorus and pesticides) concentrations in the Simiyu river originate from agricultural fields
- Transport: dissolved form or associated with sediments
- Study: to predict the transport of pesticides and phosphates in the Simiyu catchment, baseline data are prerequisite.
  - e.g. "Land use/Land cover map"
- Problem: do not focus on pollution issues, old & cover big area
- Objective: Integrating remote sensing techniques and field data to reasonably map landuse and land cover in the Simiyu catchment, which provides recent and reliable information for water quality and quantity simulations

Study area - Simiyu catchment

Catchment Characteristics

<table>
<thead>
<tr>
<th>Area</th>
<th>10800 km²</th>
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<tbody>
<tr>
<td>Topography</td>
<td>1140 - 1640 m</td>
</tr>
<tr>
<td>Soil type</td>
<td>Sandy loam (60%)</td>
</tr>
<tr>
<td>Landuse</td>
<td>Cultivated, Grassland, Bushland</td>
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<tr>
<td>Climate</td>
<td>Annual rainfall: 700 – 1000 mm</td>
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<td></td>
<td>Temperature: Average 23°C</td>
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<td></td>
<td>Annual evaporation: 1973 mm</td>
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<tr>
<td>Hydrology</td>
<td>Discharge: 0 - 208 m³/s</td>
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Topography

<table>
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<tr>
<th>Elevation (m)</th>
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<tbody>
<tr>
<td>1135 - 1230</td>
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<tr>
<td>1231 - 1325</td>
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<td>1326 - 1421</td>
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<td>1422 - 1516</td>
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<td>1517 - 1612</td>
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<td>1613 - 1707</td>
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<td>1708 - 1803</td>
</tr>
<tr>
<td>1804 - 1898</td>
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<td>1899 - 1994</td>
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**Soil map**

**Landuse and Land cover Mapping**

- **Steps involved**
  - Purchasing satellite images, satellite images preprocessing (Idrisi32 release 2) & interpretation, field data acquisition (supervised classification), images classification

- **Satellite images data acquisition**
  - LANDSAT7 ETM+, 170/062 of 3/4/2001 and 169/062 of 12/5/2001, each 8 bands, USGS, GEOTIFF format, resolution band 1-5 and 7 (28.5 m)

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**Landuse and Land cover Mapping cont.**

- **Image registration**
  - Images were registered using GCPs, topographical maps scale 1:50,000, criteria at most RMS 0.5 pixel = 14.25 m

- **Images processing (enhancement + interpretation)**
  - Differences among 2 scenes (different dates), colour composite band 345 (insignificant differences), scenes mosaicked and processed single images (Fig.)

- **Results:** Not all land use and land cover identified

- **Alter. solution:**
  - Use field data for supervised classification to classify satellite images, land-use & land cover in the Simiyu catchment

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**Landuse and Land cover Mapping cont.**

- **Field data acquisition**
  - **Prior field campaign:** collection of all possible land-use & land cover categories, using frequency histograms of six bands, color composite images, principal component images, and general prior knowledge of land-use; 11 dominant categories were identified

  - **Training sites selection:** 11 dominant categories in images 3, 4, and 5, principal component. Criteria: large coverage, uniformity and accessibility

  - **Training sites data collection**
    - Extensively 2002 and 2003, sites visited tallying image acquiring dates & digitized and stored in LT computer

  - **Note:** Crops individually not identified (mixed)

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**Landuse and Land cover Mapping cont.**

- **Classification (Idrisi32, Supervised & Maximum likelihood)**

  - **Step 1:** Training sites and signature development
    - Training sites were digitized (band 345), uniformity, avoiding mixed pixels, ensuring at least 100 pixels & evenly distributed over study area

  - **Signature development (MAKESIG), evaluation (SIGCOMP), similar and overlapping signatures detected using box plots & HISTO

  - **Condition:** maximum likelihood method: means of signatures be significantly separable and uniformity of training sites maintained

  - **Step 2:** Classification, using maximum likelihood algorithm was performed to developed signatures
Landuse and Land cover Mapping cont.

Conclusions

- Combining remote sensing, Idrisi32 image processing software, GIS and extensive/detailed ground information to reasonably map landuse and land cover of the Simiyu catchment has been achieved. Landuse and land cover is extremely valuable especially for water quantity/quality predictions, and assessing hydrological effects of landuse changes.

- The use of frequency histograms of the bands, general prior knowledge of landuse, together with colour composite images features existing in the Simiyu catchment could be predefined and mapped.

- Using well defined training sites, better separability and uniformity, supervised classification procedures and maximum likelihood classifier prove to be useful in the classification of satellite images.

- The Simiyu catchment is by far dominated by mixed short grasses and open land (46.5%), suggesting that the Simiyu catchment is highly subjected to erosion.

Recommendation

- Possible improvement and subject for future work:
  The use of various sets of satellite images covering all seasons, to discriminate crop types from cultivated land or if existing from mixed short grasses and open land.