

# Land use/cover change from 1868 to 2000 in the north Ethiopian highlands

## Integration of satellite imagery and terrestrial photography

S. de Mûelenaere<sup>(1)</sup>, E. Meire<sup>(1)</sup>, A. Frankl<sup>(1)</sup>, Mitiku Haile<sup>(2)</sup>, J. Nyssen<sup>(1)</sup>

### Problem statement

The combination of erosive rains, steep slopes and human land use have caused severe land degradation in the north Ethiopian highlands. Since the 1980s however, land rehabilitation programs have been established.

The objectives of this study are (1) to methodologically compare two Landsat classification methods, and (2) to assess land use and cover changes (LUCC) in the north Ethiopian highlands from 1868 to 2000.

### Methodology

In order to characterize and quantify the transformations in the north Ethiopian highlands, a study was carried out in an 8884 km<sup>2</sup> study area (1300 - 4000 m a.s.l.) in eastern Tigray (Fig. 1).

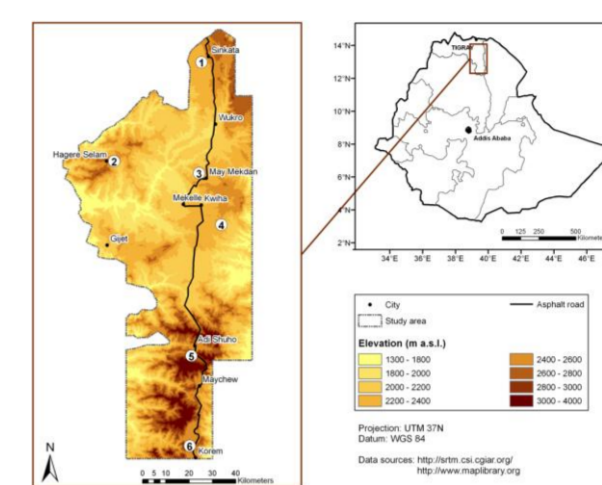


Fig. 1: Location of study area and areas of ground truthing

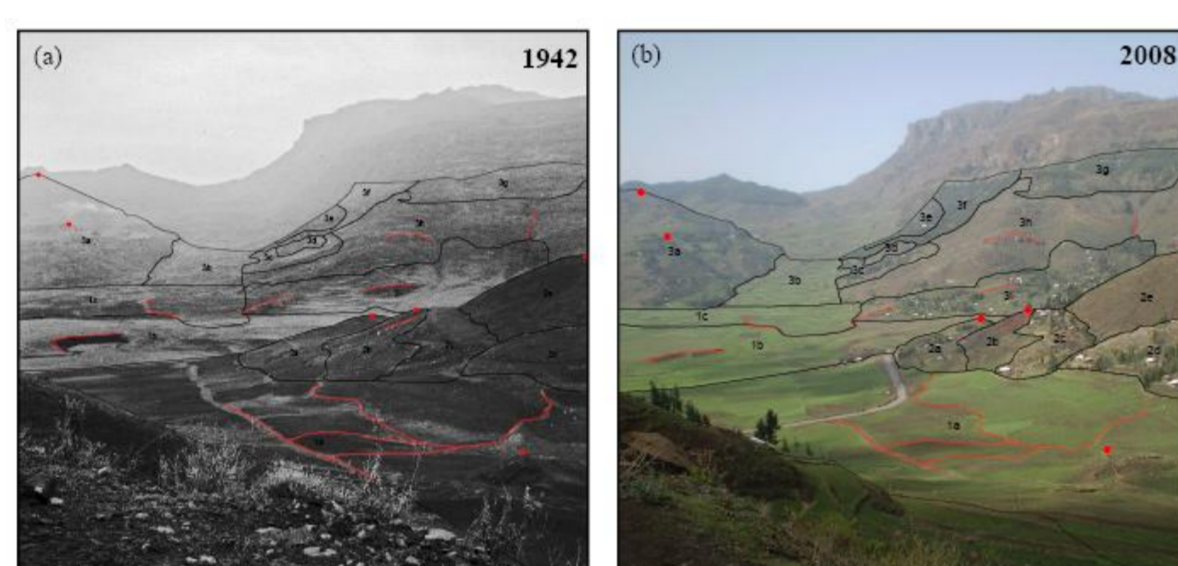


Fig. 2: Historical (left) and repeated (right) photograph, Ayba area

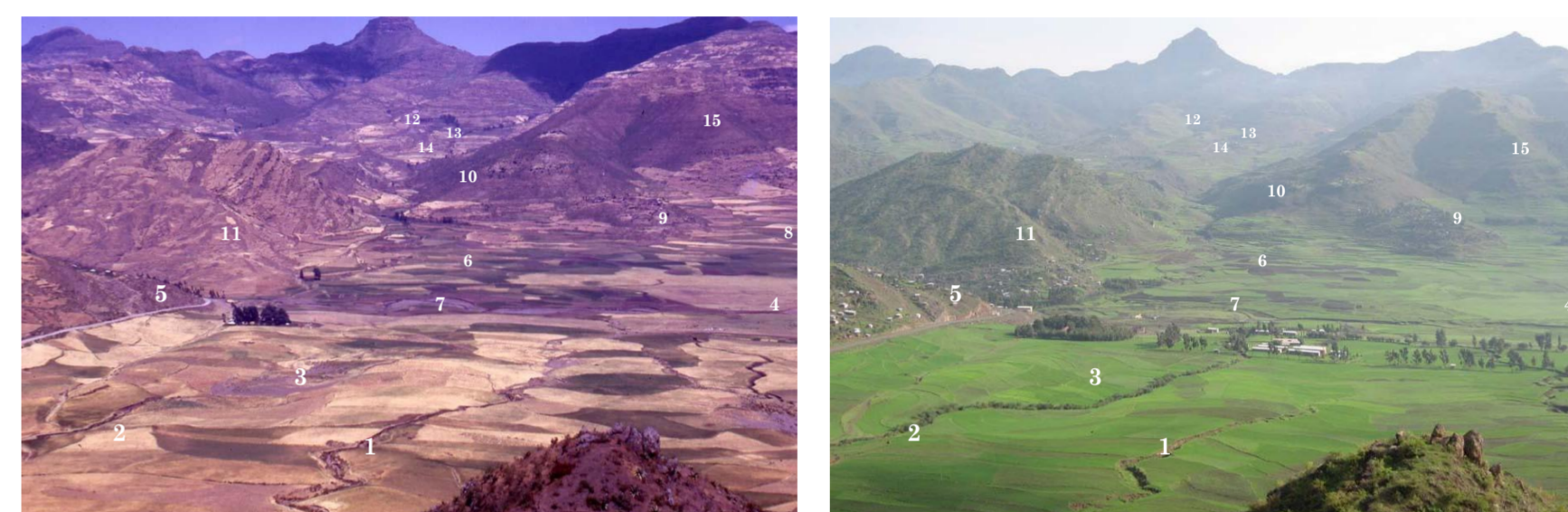


Fig. 3: Historical (Oct 1975, left) and repeated (Aug 2008, right) photograph, Adi Shuho area

### LUCC from 1868 - 2008 using historical photographs

#### 1. Data sources:

- Historical terrestrial photographs (1868, 1936, 1942, 1944, 1961) (Fig. 2)
- Aerial photographs (1965, 1986, 1994)
- Fieldwork (2008)

#### 2. Land use and cover maps were created by:

- a) Creating DEMs based on aerial photographs
- b) Warping terrestrial photographs on DEMs

### LUCC from 1972 - 2000 using historical photographs and satellite imagery

#### 1. Data sources:

- Landsat MSS, TM and ETM+ imagery (1972, 1984/86 and 2000)
- Historical terrestrial photographs (1975) (Fig. 3)
- Fieldwork (2008)

#### 2. LUC maps were created and two image classification methods were tested for the Landsat 1 MSS (1972) images:

- a) Conventional change detection (image differencing)
- b) Ground truthing (using historical photographs)

### Results

1. The use of historical terrestrial photographs for satellite image classification purposes is promising. The classification accuracy based on this method was better (Kappa coefficient 0.54) than the classification accuracy of the method based on image differencing (Kappa coefficient 0.46).

2. Land use and cover changes between 1868 and 2000 are:

### LUCC from 1868 - 2008 based on historical photographs

Major changes are

- Relatively less cropland area
- Large-scale introduction of Eucalyptus
- Increase of villages
- Increase of woody vegetation limited during 1868-1960 but significant during 1960-2000

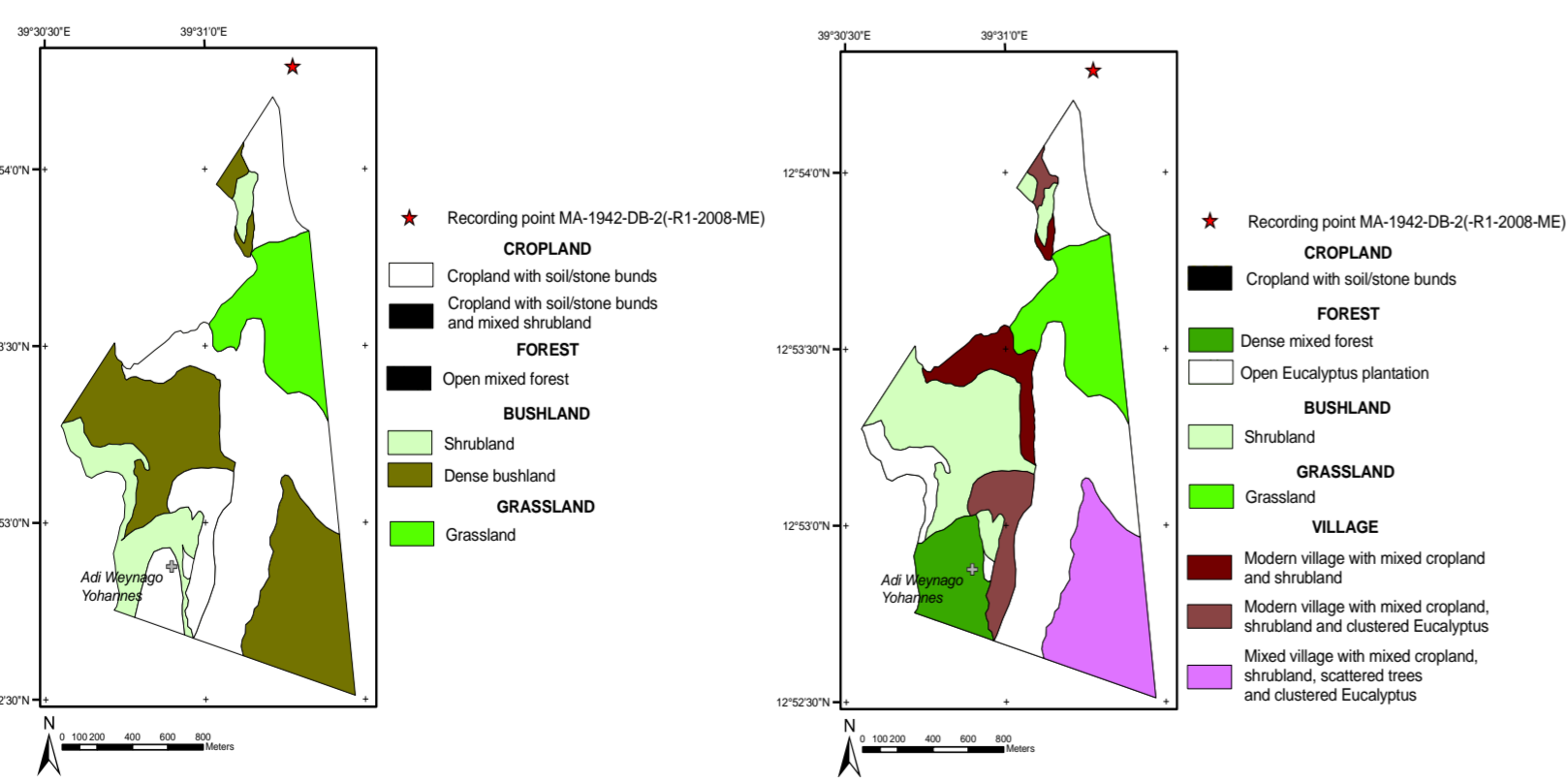


Fig. 4: Resulting LUC maps for the Ayba area

### LUCC from 1972 - 2000 based on photographs and satellite imagery

Major changes are (Fig. 5 and 6)

- a gradual but significant decline in bare ground (from 32% to 8%)
- a significant increase of bushland (25% to 43%) and total forest area (including *Eucalyptus* plantations, 2.6% to 6.3%)
- creation of lakes and ponds
- Dominant change trajectory: gradual or recent vegetation increase (27% of study area)

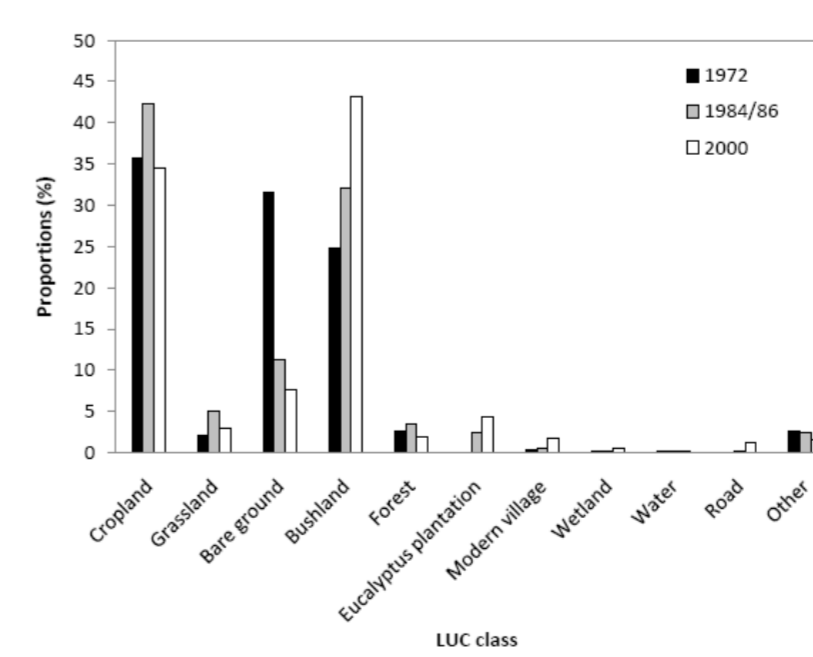


Fig. 5: Evolution of land use/cover proportions

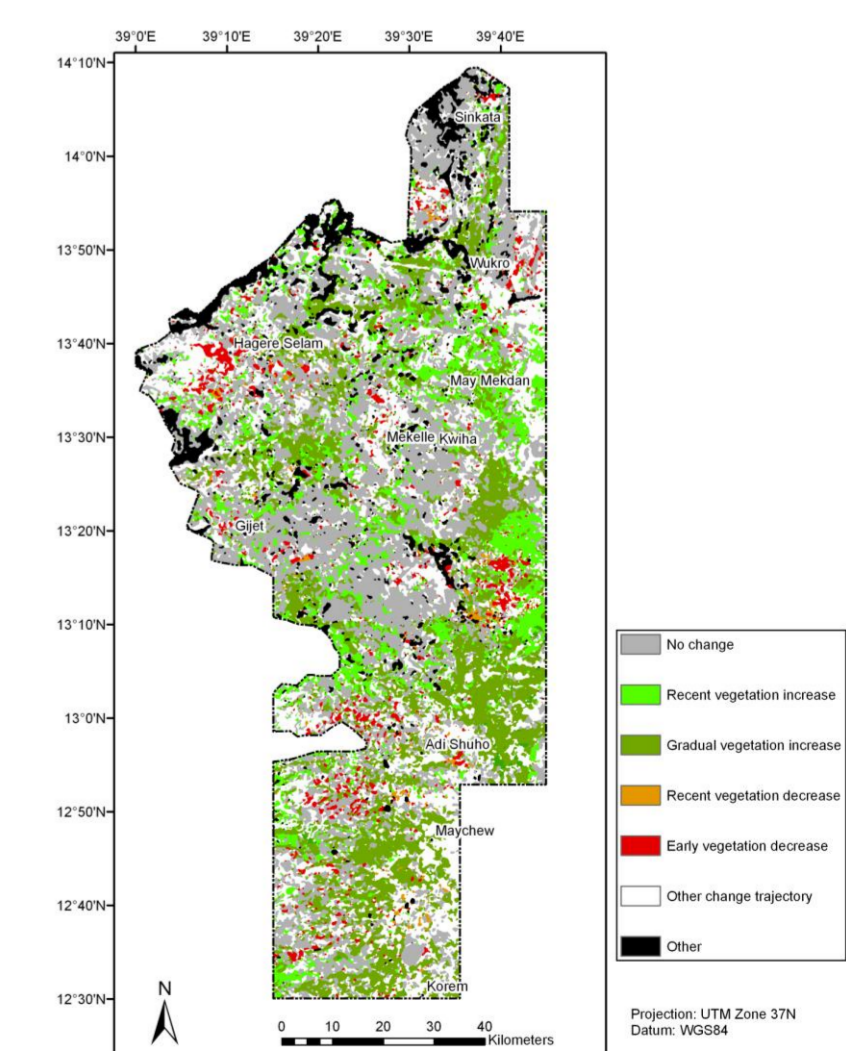


Fig. 6: Land use/cover change trajectories map (1972 - 1984/86 - 2000)

These changes can be linked to changes in the land tenure system, population growth and introduction of land rehabilitation initiatives, complemented by growing land holders' awareness (but this requires further study).

<sup>(1)</sup>Department of Geography, Ghent University, Krijgslaan 281-S8, BE-9000 Gent, Belgium

<sup>(2)</sup>Land Resources Management and Environmental Protection Department, Mekelle University, PO Box 231, Mekelle, Ethiopia

Contact: stephanie.demuelenaere@ugent.be (S. de Mûelenaere)