Is land under pressure? A case study in the southern part of Murehwa District with significant variations observed in cropland area and forest cover over the past two decades

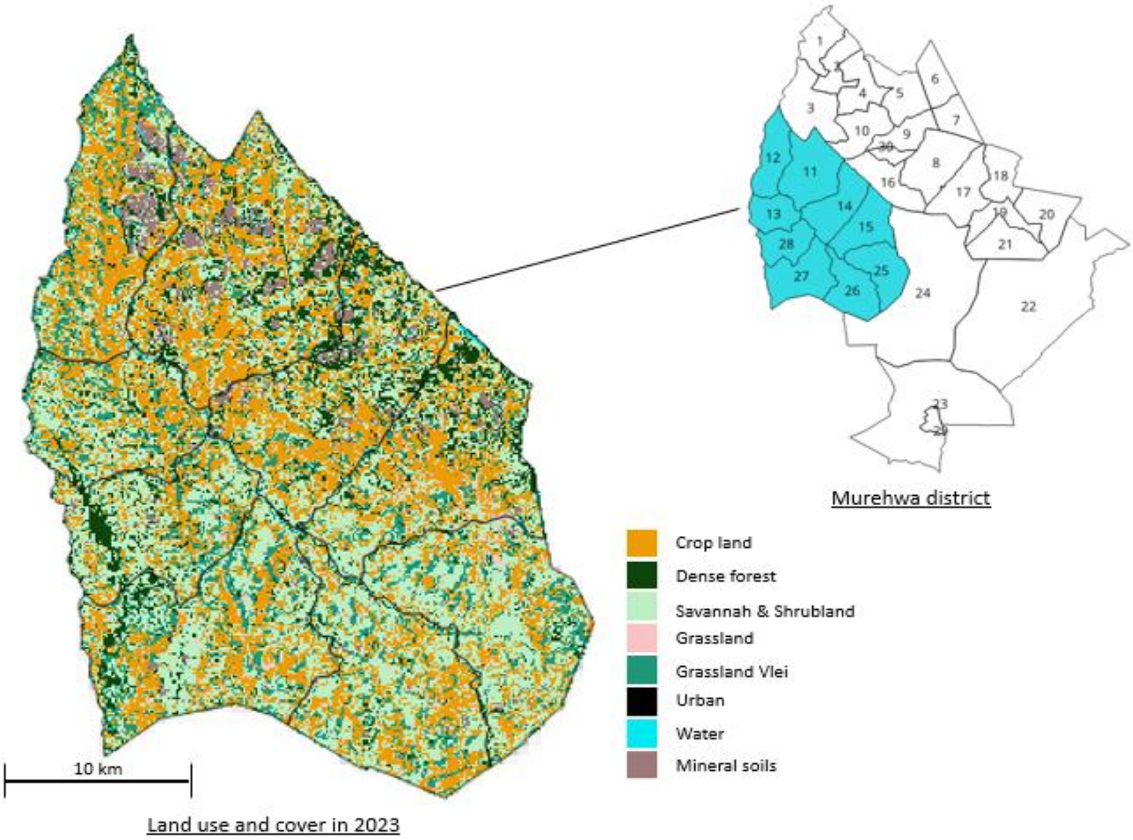


Figure 1: Land use and cover in the southern part of Murehwa District in 2023

Highlights:

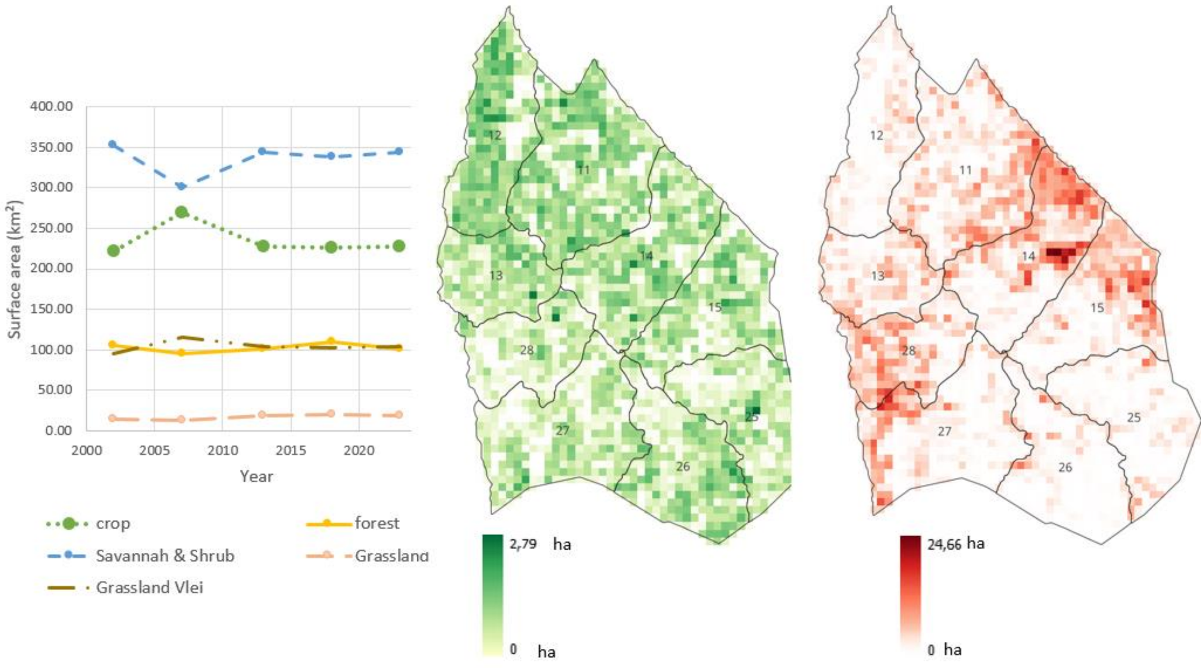
- Monitoring land use and cover change is essential to assess changes in the food production potential of a given area and pressure on ecosystem services other than provision.
- Cropland covers only 33% of the case study zone. Under current average yield for maize, the food produced on this surface area barely matches the basic needs (in calories, diversification and basic economic needs) of the rural population of the zone, censed in 2022.
- Forest area is today only 11% of the total and is mainly restricted to steep slopes, rocky zones and riparian areas.
- Forest cover decreased by 10% (20km²) over the past decade, through conversion not directly into cropland but into shrub & savannah, with wood extraction for cooking fuel being a key driver. Further decrease in the forest cover would severely threaten biodiversity and key ecosystem services such as the provision of fuelwood for populations.
- Without increasing maize yield and under continuing increase in the population, the pressure on shrubland, pasture and forest is highly likely to increase.

Details of the issue

Cultivated land often expand at the expense of the natural vegetation on which local people depend for firewood and other products, and which more generally provide ecosystem services that are key to the sustainability on the longer term. Monitoring land use and cover change is essential to assess the changes in food production potential of a given area, and in the ecosystem services associated to natural vegetation. This fact sheet presents findings from an analysis of land use and cover change since 2002 in the southern part of Murehwa communal lands, for which a set of appropriate satellite images was available. This area covers 851 km^2 and was taken as an example of communal lands under the influence of the relatively close (less than 100 km far) metropolitan area of Harare.

Findings:

- In 2023, the southern part of the district of Murehwa was mainly covered by shrubland and savannah (36% of the total area) and cropland (33 %). Under a current average yield of maize of 1t.ha -1, this surface area barely covers the basic needs of the rural population (in energy food needs, diversification and basic economic needs). The forest, mainly 'miombo' woodland, covered only 10% of the zone in the form of small fragmented patches, mostly on hillsides (steep slopes and rocky zones) and riparian areas (Figure 1).
- When looking at landscape changes (Figure 2A), we find that cropped areas increased by 24% over the past ten years. This expansion occurred everywhere across the studied territory (Figure 2C) and its rate was not constant over time: cropland expanded by 48 km^2 between 2002 and 2007 (+ 21%), and then actually decreased by the same amount of surface between 2007 and 2013. Cropland area remained constant between 2013 and 2018, and expanded again with an additional 49 km^2 since 2018. These additional 49 km^2 of cropland would correspond to the production of circa 5000 tons of maize - assuming all the cropland would be cultivated with maize under its current relatively low average yield in the region- and this amount of maize would cover the calorie needs of approximately 15% of the population censored in the area in 2022. Though this estimate is rough, and does not take into account the basic needs in food diversification and income, it demonstrates the importance of considering variations in land use for addressing food security.
- Changes in cropland area mainly resulted from conversion between cropland and shrubland and savannah (areas with lower tree density) rather than from clearance or regain of forest. However, over the last 10 years ,10 km^2 of forest were degraded, mostly into shrubland and savannah. Forest clearance occurred mostly in areas where there was the most forest area remaining in 2002 (Figure 2B). The degradation of forest without conversion into cropland may be due to the need for fuelwood for cooking or tobacco curing, as shown in previous studies based on smallholder's perceptions that also pointed at natural factors of degradation such as insects, tree diseases or climate change (Mataruse et al., 2022). These trends raise the issue of providing enough firewood to meet the future needs of the local population while preserving the forests and their biodiversity.



A) Changes in surface areas B) New cropland (2002-2023) C) Clearance of dense forest (2002-2023)

Figure 2: Changes in land use over the past two decades (A), spatial distribution of new cropland (B) and spatial distribution of forest clearance (C).

Discussion / limitations/ perspective:

These findings are based on the classification and analyses of remote sensing images. We assessed their accuracy by comparison with observed data, and obtained overall good accuracy in the range 90-93%. The classes 'forest', 'savannah and shrubland' and 'grassland vlei' were classified with the best accuracy (more than 92%). The class "grassland" was difficult to discriminate from cropland or shrubland and was less accurately classified (60%). The 'cropland' class was classified with an accuracy of 85% meaning that the classification had 15% of errors (e.g. 30 km² of the 221 km² of cropland in 2002). Even though the trends we observed are valid overall, this means that they could have been over or under estimated. Work is ongoing to confirm these conclusions with local populations through interviews and focus groups.

- The trends in cropland, shrubland and forest area now need to be further investigated by identifying the factors that drive the large changes that were observed in short periods of time. Understanding these factors would enable the identification of levers at the landscape level to promote better agricultural production while ensuring the preservation of forest resources and biodiversity.

Methodological details (Girod, 2023):

We produced five maps of land use and cover from Landsat remote sensing images for the years 2002, 2007, 2013, 2018 and 2023. Landsat is a satellite program that offers open access data for the period

2002 to 2023 with Landsat 5, Landsat 7 and Landsat 8 satellite sensors that have similar properties and resolution (30-m). One image during the cropping season and one image during dry season were selected to produce each map. The images were downloaded on USGS platform as Landsat collection 2 level 2 (data already radiometrically and atmospherically corrected). We developed a classification at pixel level based on a Random Forest algorithm (Breiman, 2001). The classification consists in classifying every single pixel within the images in one of the eight classes of land use and cover. Random Forest is a machine learning algorithm that works with a forest of decision trees. We run Random Forest on the bands of Landsat, some key radiometric indices (the Normalized Difference Vegetation Index, the Ratio vegetation index, the Normalized Difference Water Index and the Brightness Index), and a digital elevation measurement (DEM) from SRTM with a 30m resolution. We built a photo interpretation database on the whole area that gave the land use change of 600 observation points. The photo-interpretation was based on historical Google Earth images, the Landsat images of the concerned year and 2023 Pleiades image on the software QGIS 3.20.3. 80% of the data was used to train the random forest model and the remaining 20% was used for its validation. By comparing the true test set with the one obtained by the model (the estimated set), we can assess the robustness of the model through statistical indicators. The spatial analyses were then conducted using the software QGIS 3 and R Statistical Software.

References

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