Land Use Policy 68 (2017) 287–294

Contents lists available at ScienceDirect

Land Use Policy

journal homepage: www.elsevier.com/locate/landusepol

Quantification of landscape transformation due to the Fast Track Land Reform Programme (FTLRP) in Zimbabwe using remotely sensed data

Simbarashe Jombo[a], Elhadi Adam[a,*], John Odindi[b]

[a] School of Geography, Archaeology and Environmental Studies, University of the Witwatersrand, Private Bag 3, Wits 2050, Johannesburg, South Africa
[b] School of Agricultural, Earth and Environmental Sciences, Pietermaritzburg Campus, University of KwaZulu-Natal, Scottsville P/Bag X01, Pietermaritzburg, 3209, South Africa

ARTICLE INFO

Keywords:
Land use and land cover
Fast track land reform programme
Remote sensing
Change detection

ABSTRACT

After independence, Zimbabwe adopted two major land reform programmes to address the racially skewed land ownership. Due to the perceived failure of these programmes, the country embarked on a highly politicised and forceful acquisition and re-distribution of white owned commercial farms under the Fast Track Land Reform Programme (FTLRP). Whereas a large number of Zimbabweans have been allocated land under the programme, there has been a significant decline in agricultural productivity and an increase in degradation of land and associated resources. Popular opinion has even suggested the country's current socio-economic challenges are linked to the programme. Mitigating land degradation, enhancing agricultural productivity and promoting natural resources sustainability requires an objective understanding and determination landscape transformation within relevant administrative decision making spatial extents. In this study, we adopted multi-temporal remotely sensed imagery to determine landscape transformation after the implementation of the FTLRP in Chipinge administrative district, characterised by heterogeneous land usage and natural resources. Major land-use-land-cover types were determined using the Support Vector Machine classification algorithm and accuracy established using field survey and ancillary data. Results show significant landscape transformation after the implementation of the FTLRP. Specifically, there was a decline in plantations, small farms, water bodies and forests and an increase in bare areas and settlements. This study demonstrates the value of remotely data in monitoring landscape transformation arising from a shift in policy. Furthermore, these results provide an insight into multi-temporal spatial changes in cultivated, natural and degraded lands, valuable for designing measures to improve landscape productivity and to adopt relevant rehabilitation measures. Understanding multi-temporal landscape change within an administrative boundary is particularly valuable for area specific planning, policy formulation and adoption of desired mitigation measures.

1. Introduction

At independence, Zimbabwe inherited land ownership that was racially skewed (Ministry of Lands and Rural Resettlement, 2015). To address the imbalance, the country embarked on a land reform programme that was implemented in two phases; the pre-1985 that involved market sales led by state acquisition and redistribution and the 1986–1999 that involved expropriation and market mechanisms. Due the perceived limited success in the two phases, the government initiated an aggressive and highly politicised post 2000 Fast Track Land Reform Programme (FTLRP) that involved extensive expropriation of white owned commercial farms (Moyo, 2011; Coldham, 1993; Ministry of Lands and Rural Resettlement, 2015). This phase was commonly accompanied by illegal and often violent land occupations (Chigumira, 2006 Clover and Eriksen, 2009). By 2009, Moyo (2011) and Bonarjee (2013) note that 6214 white owned farms covering over 10 million hectares had been occupied by 168,671 families, either through government acquisition and redistribution or forceful occupation. The government re-allocation programme was modelled as either A1 or A2 allocation schemes. The A1 scheme aimed to decongest the often heavily populated communal areas, re-organise peasantry and improved subsistence production while the A2 scheme aimed at increasing the number of small, medium and large-scale black commercial farmers (Moyo, 2011).

Since the initiation of the programme, land-use-land-covers (LULCs) have changed from commercial agriculture to small scale farming, characterised by mixed crop and livestock production (Scoones et al., 2010; Fakarayi et al., 2015). This is in keeping with the programme's

* Corresponding author.
E-mail addresses: simbarashejombo@gmail.com (S. Jombo), Elhadi.Adam@wits.ac.za (E. Adam), Odindi@ukzn.ac.za (J. Odindi).

http://dx.doi.org/10.1016/j.landusepol.2017.07.023
Received 13 September 2016; Received in revised form 8 April 2017; Accepted 10 July 2017
Available online 10 August 2017

objective of transforming agriculture by strengthening rural socio-economic institutions, increasing agricultural productivity, enhancing food security and bringing as many black Zimbabweans as possible into the country's agro-based economy (Ministry of Lands and Resettlement, 2015). According to Harvey (1991), such programmes are often considered important as they can be used to relieve overcrowding from other places and offer livelihoods through farming, thereby enhancing socio-economic and environmental sustainability. However, the Zimbabwean FTLRP led to a degeneration of the agricultural sector, hence nationwide famine as the majority of the beneficiaries had little capacity to mantain farm production (Richardson, 2005). Whereas a significant number of landless black Zimbabweans acquired land during this phase, most of it is either currently underutilised or substantially degraded (Maguwu, 2007; Matsa and Muringaniza, 2010; Zamuchiya, 2011).

Deforestation, land degradation, overgrazing, reduced fallow periods and other anthropogenic activities attributed to the FTLRP have led to significant land use and land cover changes (LULCC) (Matsa and Muringaniza, 2010; Zamuchiya, 2011; Matavire et al., 2015). This transformation falls into two broad categories; conversion − change from one cover or use type to another and modification − maintenance of the broad cover or use type but with changing attributes (Duadze, 2004; Stolbovoi, 2002). LULCC studies are necessitated by the intent to quantitatively establish the nature, extent and rate of transformation and forms an ideal baseline to evaluate past, present and future policies affecting the landscape (Wright and Morrice, 1997). Recently, there has been a growing understanding of the nexus between landscape transformation and socio-ecological and political systems (Gillanders et al., 2008; Odindi et al., 2012). Hence, precise knowledge of LULC characteristics provides a basis for understanding landscape transformation, valuable for decision making (Dai and Khorram, 1998). Specifically, generation of reliable LULC classes is necessary for a better understanding of a state of a landscape arising from physical, ecological and social process.

Reliable determination of rapidly transforming landscapes using traditional ground based mapping techniques is often time consuming, expensive and tedious, particularly on large spatial extents (Adam et al., 2014; Prakash and Gupta, 2006; Rawashdeh and Saleh, 2006). Whereas other techniques like visualization and analysis of aerial photographs have been commonly used in understanding landscape transformation, their common adoption is often impeded by their high cost per unit area, limited availability in digital formats and unsuitability for digital manipulation (Rawashdeh and Saleh, 2006; Thapa and Burtch, 1991; Longley, 2002; Odindi and Mhangara, 2000). However, remotely sensed data and its characteristic repetitive coverage, consistent image quality, cost effectiveness as well as the emergence of robust and reliable change detection algorithms have recently increased its popularity in understanding landscape transformation (Mhangara and Odindi, 2013; Rawashdeh and Saleh, 2006; Longley, 2002; Mas, 1999; Singh, 1989; Foody, 2002). Within a Geographic Information System (GIS) environment, remotely sensed data provide superior analytical power necessary for understanding the state and transformation of the landscape, valuable for planning, management and adoption of relevant mitigation measures (Jensen, 1996; Lu et al., 2004; Chen et al., 2005; Abd El-Kawy et al., 2011).

Previous studies have indicated that huge tracts of land were cleared for crop farming and settlement under the FTLRP (Fakarayi et al., 2015). Some of the land was abandoned, while rangelands and forests were threatened by continuous grazing, veld fires and deforestation (Sibanda et al., 2016; Fakarayi et al., 2015). According to Chigumira (2010), literature has shown that FTLRP resulted in significant changes in natural resource use, landscape configurations and farming sizes. Whereas studies have asserted significant LULCC due to the FTLRP (Matsa and Muringaniza, 2010; Jowah, 2009), the degree of landscape transformation within specific administrative boundaries based on objective landscape quantitation remains unclear. A number of studies e.g. Kamusoko et al. (2009) and Mapedza et al. (2003) have adopted remotely sensed datasets in understanding LULC distribution. However, very few studies have sought to determine changes in landscapes resulting from the FTLRP. Few studies that have adopted remotely sensed data in landscape transformation e.g. Matavire et al. (2015) and Sibanda et al. (2016) have been restricted to farm level analysis, with a focus on local forestry resources and tree diversity. Generally, there is paucity in literature on the implication of FTLRP on landscape patterns and transformation at a broader scale like a district administrative boundary that is often a critical socio-economic and natural resources decision making hierarchy. Chipinge district, characterised by a productive and heterogeneous landscape, is an important agricultural zone in Zimbabwe and therefore ideal for determining the implication of the FTLRP on land use patterns. Within the broader framework of political ecology that link hierarchical political and economic circumstances and rural livelihood adaptation as major drivers to landscape change, we adopt remotely sensed data to determine multi-temporal landscape transformation arising from the FTLRP. In this study, we acknowledge that major socio-political events and policies like the land apportionment by the British South Africa Company (BSAC) in the 1890s, the promulgation of the South Rhodesian Land Apportionment Act and creation of the Tribal Trust Land in the 1930s, the African Land Husbandry and Land Tenure Acts of 1960s and the liberation struggle in the 1970s could have led to significant landscape transformation. Consequently, contextualizing the effect of the FTLRP on LULC transformation within the broader framework of major historical socio-political events could have been greatly insightful. However, our study explores the potential of emerging objective analytical techniques and approaches in understanding landscape transformation arising from a policy shift. Hence we delimit our study to the availability and increasing adoption of remotely sensed data in landscape analysis in the late 1990s, which coincide with a major policy and socio-political event in Zimbabwe, the FTLRP.

2. Materials and methods

2.1. Study area

Chipinge district is located in Manicaland province, south eastern Zimbabwe (Fig. 1). It covers a total area of 539,303 ha (Central Statistics Office CSO, 2012). The study area is characterised by three major seasons, hot and wet (mid-November to March), hot and dry (August to mid-November) and cold and dry (April to July) (Gambiza and Nyama, 2000). Average annual mean rainfall is approximately 1105 mm while the mean annual temperature is 21 °C (Masaka and Khumbula, 2007; Dube and Guveya, 2013). The area is divided into four major farming zones determined by rainfall namely; diversified, intensive, semi-intensive and extensive (Zamuchiya 2011; Cliffe et al., 2014). Unlike most other districts in Zimbabwe, Chipinge is characterised by all major landscape regions, hence an ideal representation of the possible LULC types and variations due to the FTLRP (Zamuchiya, 2011).

2.2. Data acquisition

Cloud free Landsat images for 1992, 2000, 2006, 2011 and 2014 (detailed in Tables 1 and 2) from the United States Geological Survey (USGS), Earth Science Data Interface (http://www.usgs.gov/) were used in the study. A portion in the southernmost part of the study area was not covered in the analysis due to data unavailability (Fig. 1). Landsat dataset was chosen due to its well documented success in landscape mapping, free availability and rich archival data, suitable for short and medium term landscape monitoring. Images were acquired during the wet seasons, at highest vegetation vigour to enhance spectral variability between major LULCs like natural vegetation, crops and degraded areas. We considered the time gap between the five satellite