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The environmental imprints and complexes of social dynamics in rural Africa: cases from Zimbabwe and Ghana

Jennifer A. Elliott *, Michael Campbell

School of the Environment, University of Brighton, Brighton BN2 4GJ, UK

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Abstract

This article analyses land use and vegetation change in the savanna contexts of central Zimbabwe and coastal Ghana. The results of analyses based on field surveys, time series aerial photographs/satellite images and GIS methods challenge current assumptions of linear vegetation change under social dynamics in these two contexts. The evidence from these areas rather points to multi-directional and patch dynamic change. It is thus concluded that more detailed and broadly based studies are necessary to enable more insightful and effective management of land use issues. © 2001 Elsevier Science Ltd. All rights reserved.

Keywords: Africa; Vegetation; GIS; Narrative; Multi-directional change; Patch dynamic change

1. Introduction

The African landscape has been interpreted and re-interpreted over the last four centuries, with variable results. In the 20th century, a generalised paradigm emerged that linked linear environmental change (usually deforestation and resultant soil erosion) with population. So powerful have the resultant images of environmental change in Africa been, that they achieved the status of 'received wisdom' according to Leach and Mearns (1996) and became 'common knowledge among development professionals in African governments, international donor agencies and non-governmental organisations' (p. 1). Yet, whilst deforestation and soil loss continue to be important contemporary issues in African livelihoods, interventions in resource management and environmental policies more widely, are generally considered to have had only 'patchy successes' (Batterbury and Bebbington, 1999, p. 285).

This paper is a contribution to the growing literature that illustrates the complex dynamics of social and ecological change in Africa. Recent studies, such as that of Fairhead and Leach (1995) in Guinea and Tiffen et al. (1994) in Kenya have been important in redressing the predominant 'crisis narratives' of environmental change, in providing evidence, for example, of forest expansion and soil conservation under increased human management in areas previously believed to be degraded landscapes. In particular, such work has been central in exposing the plurality of interests surrounding contemporary resource issues and the potential of longer term historical analysis in revealing the patterns and driving forces of environmental change. However, more case study research is needed which incorporates further historical and time-series data sets (Leach and Mearns, 1996, p. 30) and in particular, comparative research is required that goes beyond exploring narrative and counternarrative based on single studies.

The paper also explores new plural methodologies for investigating landscape change and in particular exemplifies the use of GIS technologies in illuminating multi-directional socioenvironmental change. As Haberl et al. (2001) have summarised, 'by its very nature, the study of changes in land use and land cover is an interdisciplinary endeavour' (p. 3) that 'requires bridging the gap between social science, natural science and the humanities' (p. 6). However, the conceptual and methodological challenges of realising what Batterbury et al. (1997) term 'hybrid research' on landscape change are substantial. Klepeis and Turner (2001), for example, note that much of the science of global and environmental change has not connected well to date with the 'rich historical-based scholarship on changing human-environment conditions and landscapes' (p. 28). Yet as

* Corresponding author.
E-mail address: j.a.elliott@bton.ac.uk (J.A. Elliott).

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Beinart (2000) has suggested, historians themselves have often been 'uneasy about incorporating environmental questions into their work' (p. 269), preferring to engage with the 'essentially corrective and anti-colonial approach' (p. 270) of African history and fearing the 'strong environmental determinism' evinced by some earlier Western intellectual traditions (p. 269). However, Beinart goes on to identify the many ways in which African and environmental history would be better informed through an engagement with a 'more sophisticated and multi-faceted science' (p. 295) rather than a simple rejection of scientific methodologies. As Haberl et al. (2001) suggest, such thinking is causing historians to reach out to new techniques including GIS, for analysing landscape change.

The need to frame an understanding of land use changes at any point in time within a longer history of society–environment interactions is now well accepted as central to more effective environmental policy making (Batterbury and Bebbington, 1999). Time series aerial photographs are a significant source of such historical transformations in Africa. In combination with detailed field surveys, aerial photography was important in establishing the counter narratives of landscape change in the work cited above for Guinea and Kenya, for example. However, the degree of quantification within these studies was low, relying in the main on the qualitative appraisal of successive sets of photography. Authors such as Sullivan (1996) in Namibia, Crummey (1998) in Ethiopia and Lindblade et al. (1998) in Uganda have similarly utilised detailed social survey and aerial photography to question unilinear processes of landscape change.

Other works to date that have documented multi-directional changes have tended to be based on change detection using satellite-derived images (Singh, 1989, Collins and Woodcock, 1996). Similarly, whilst many other works have used GIS methods to allow detailed quantification of landscape feature change, they have been used in the main to emphasise sequential, percentage change in classified features and the primary focus has been towards constructing new visual models for the enhancement of image interpretation and analysis as the key to more effective monitoring and understanding. Examples are the works of Millington et al. (1992) on general land use change in sub-Saharan Africa and Nsiah Gyabaah (1992) on desertification in Northern Ghana.

Few of these works to date, however, have explicitly documented multi-directional, patch dynamic changes as in the case studies presented here. Patch dynamic vegetation change refers to vegetation change that is locationally differentiated (for example, deforestation and reforestation in patches) and may be periodically discontinuous (possibly due to human activities). Multi-directional change therefore describes vegetation change that is not unilinear, but may include increases and reductions in species numbers and/or vegetation forms rather than simple reductions or increases. Therefore, while changes such as deforestation may be documented by percentage change, the extent of the landscape features that replaced, or were replaced by particular wooded landscapes have not been revealed. A focus on patch dynamic change also enables the identification of the extent of locational variation that may underpin the gross land use changes seen.

A further limitation of previous works in this field of multi-directional landscape change has been the relative failure to articulate sufficiently the contextual variables that influence environmental change i.e. those features that may have a particular relationship with the processes for change (for example, topography, ecology, location and socioeconomic factors) that influence the speed and direction of possibly locally specific changes. For Vadya and Walters (1999) this is symptomatic of what they consider is a general overemphasis currently given to 'politics' within political ecology, that tends to miss 'the complex and contingent interactions of factors whereby actual environmental changes often are produced' (p. 167). Their call is for political ecology to become reacquainted with the 'externally-real' biophysical processes referred to above by Batterbury et al. (1997). Arguably, such work has become more important with the paradigmatic shift that has occurred in the ecological sciences over the last 30 years that, in short, has moved the emphasis to non-equilibrium dynamics over earlier 'balance of nature' perspectives. Within the 'new ecology', many of the central concepts and models of ecological theory have been recast such as those relating to mechanistic succession, vegetation climaxes and human/nature separation. Within the new paradigm, non-linear and multi-directional ecological change are to the fore (Pickett et al., 1992) which may be subject to 'multiple interpretations' (Scoones, 1997). Notions of irreversibility (Solbrig, 1993) are central and chaotic change can now be viewed as intrinsic rather than necessarily due to external interference (Nicolis, 1994).

There is now much evidence that social science is increasingly articulating with these same concerns of uncertainty and complexity and is leading to more inclusive social analysis and alternative readings of social and ecological theory that has both practical and political implications (Rowe, 1997; Scoones, 1997; Sullivan, 1996). Scoones (1999) suggests that one of the most significant bodies of work that 'has the potential to take central elements of new ecological thinking seriously' (p. 490) is that which is concerned with the processes of landscape change, 'developed in detailed and situated analysis of "people in places", using, in particular, historical analysis as a way of explaining environmental change across time and space' (p. 490). However, 'the way environmental change is conceptualised is crucial'

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(Scoones, 1997, p. 162) and there is a need for further studies that emphasise 'non-linear, multi-directional, punctuated. . .dynamic and non-equilibrium possibilities for processes of transformation' (p. 162).

This article seeks to contribute to the continued rethinking of 'orthodox' notions of landscape change in Africa via new case study materials from two locationally distinct but manifestly related African forest/savanna mosaic contexts: in the Tokwe region of central Zimbabwe and the Tuba/Aplaku plains of the Coastal Savanna of Ghana (see Figs. 1 and 2, respectively). The principal objective of this research was the description, quantification and analysis of patch dynamic, discontinuous and multi-directional vegetation change across the study sites, via a multiple tool analysis (using GIS methods, time series images, field measurements and social surveys) and with an explicit concern also to identify the contextual environmental factors and landscape features driving these changes. The broader relations of these social and environmental contexts have been described elsewhere (for Zimbabwe see Elliott, 1995 and McGregor, 1995; for Ghana see Campbell, 1998), but the comparative analysis of dynamics within a broader African context (taking several local snapshots) is not a common theme in the literature as already identified.

2. Methodology

The data presented here are drawn from two larger research projects investigating the sustainability of environmental changes under a government-directed resettlement programme (in the Zimbabwean case) and under spontaneous population expansion and movement in the Ghanaian example. The primary research was carried out in 1992–1993 and 1995–1996, respectively. A core resource within both studies was time-series panchromatic aerial photographs. In Zimbabwe, systematic blanket photography at the 1:25,000 scale was flown at approximately five-year intervals from 1963 to the late 1980s during the dry season, May–October. This enabled sets of photography to be accessed for the case study areas across the period of population resettlement, namely 1972 (8 years prior to resettlement) and 1985 (5 years following resettlement). In the Ghanaian case study, the analysis was based on black and white aerial photographs at the scale of 1:10,000 flown in September 1960 (towards the end of the second rainy season) combined with data from a SPOT satellite image dated September 1998.

Aerial photographs enable the identification of changes in visible representations of plant structures (crown height, position, perimeter canopy dynamics and open spots, etc., assessed by the parameters of tone, shape, texture, size and pattern of the features) over time giving powerful impressions of phytogeographical change (Roscoe, 1960; Rubben, 1960; Salami, 1999). Land use characteristics can similarly be readily identified at these scales on the same basis of patterns and tone, for example. Whilst the generally higher resolution of aerial photographs over satellite images has been cited as an advantage (Ihse, 1994; Innes, 1998), supporting information is essential for detailed feature identification in both cases (Jensen, 1996; Hertwitz et al.,

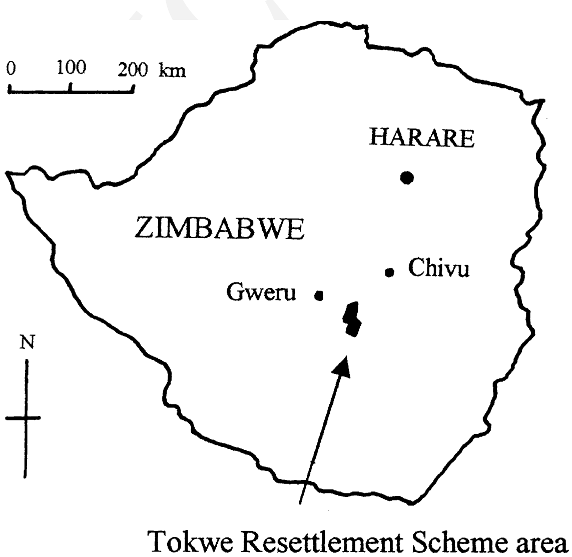

Fig. 1. The Tokwe area of Zimbabwe.

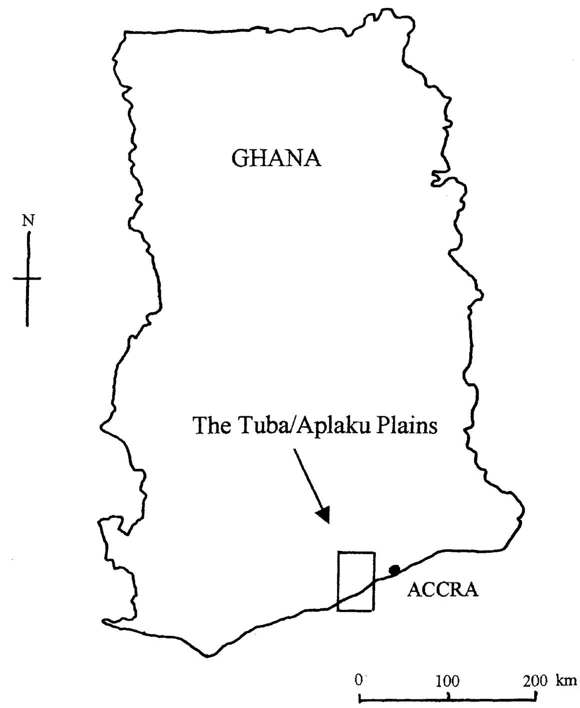

Fig. 2. The Tuba/Aplaku plains of coastal Ghana.

1998). The concern within this research was to investigate landscape changes that cover a period within the living memories of land users rather than a more extended period of time (as could be revealed by further historical sets of photography or the incorporation of more recent satellite images). Such 'shorter term environmental histories' have been identified as particularly useful for identifying those forces driving contemporary environmental transformations and of changes in the intensity and patterns of land use change (Batterbury and Bebbington, 1999).

For each set of aerial photographs and in both case studies, landscape features were identified and mapped from the contact prints using the conventions described in Table 1. Although these stages were carried out as elements of wider, separate research projects, the conventions of aerial photograph and satellite interpretation are well established as identified above. All such land use maps were subsequently scanned and converted for use with the IDRISI GIS system for the purposes of this research as reported here. This GIS software then enabled the use of the Area, Overlay and Cross-tabulation functions to investigate linear and multi-directional land use changes within the two case studies.

In each case study, field surveys and semi-structured interviews were conducted with residents in the area centring on the factors underpinning contemporary land and resource use decision-making and perceptions of environmental changes. In the Zimbabwean research, villages within the wider resettlement scheme were identified randomly. Adult representatives of all households in those villages were then interviewed subsequently. In total, 550 households were visited on a single occasion as part of the widest research, although this paper draws on the particular cases of two villages comprising 79 households. In the Ghanaian case, the wider research worked with several members of over 150 households identified randomly within the villages of the Tuba/Aplaku region. This paper draws on all these interviews but distinguishes between those residents of Aplaku/Densu and those from Kokrobite/Oshiyie (approximately one-third and two-thirds of the total respondents, respectively).

The hypothesis is that this GIS approach in combination with plural methodologies for accessing social data gives sufficient groundwork to answer, at least partially, complex socioenvironmentally based questions that would be less completely answered by more narrow methods. Evidently, the dates of the time series images and the field survey were not perfectly established in either case study. However, it is asserted here that the extensive area covered by the images and the comprehensive focus of the field survey enable good insights to the linkages between the social activities described and the environmental changes documented by the GIS methods that offer a basis for reliable generalisations to be made about socioenvironmental relations in the areas under study.

3. Case study 1. The Savanna/woodlands of central Zimbabwe

3.1. A narrative

The core narrative of environmental change in Zimbabwe (formerly the British colony of Rhodesia) has historically been one of linear, demographically related degradation. The main problems identified during the early part of the 20th century were deforestation and soil erosion (McGregor, 1995; Whitlow, 1988). Although initially, it was largely settler activities of agriculture and mining that were suggested as underpinning these environmental changes, the issues of deforestation and soil erosion were quickly reinterpreted as problems caused by peasant farmers (McGregor, 1995; Elliott, 1991). Factors for this shift were largely political and reflected events in the international economy and the wider mindset of the colonialist scientific universalism seen in Africa generally at this time, rather than an objective

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Table 1
Vegetation classification for aerial photograph analysis

Zimbabwean vegetation classification	Ghanaian equivalent	Details
Woodland	Tree/shrub	> 50% canopy of trees
Open woodland	Tree/shrub	10–50% canopy of trees
Bushland	Tree/shrub	> 50% canopy of trees, smaller than those of woodland and including bushes and scrub
Open bushland	Grass/shrub	10–50% canopy of small trees including bushes and shrub
Grassland	Grass/shrub	Mainly grass covered but including areas of scattered trees and vleis
Cultivation	Cultivation	Includes all areas showing evidence of present or past cultivation
–	Developers	Areas visibly modified for building purposes. Rectangular bare soil plots connected by networks of dirt paths
Water bodies	–	Dependent on water levels at time of photography
Settlement	Settlement	Areas of current habitation and close environs
–	Other	Including beach areas and road networks

worsening of the environmental situation nationally in Rhodesia (Beinart, 1984; Phimister, 1986). Increased compulsion and enforcement associated with the conservation effort in the country did little to address the real needs of African farmers or the environment (Elliott, 1995).

The introduction of colonialist land policies that concentrated Africans in reserves and provided the sources of migratory labour for capitalist production elsewhere in the economy, undoubtedly created overcrowding and environmental degradation in the communal sector (Scoones, 1995; Cliffe, 1988a). When Zimbabwe attained independence in 1980, a major issue was the relief of population congestion in communal areas through the resettlement of the population and the creation of a settled peasantry through the requirement for such settlers to engage in 'full time' farming. However, despite that fact that environmental issues were principal factors in the rationale for and the arguments against land reform, the monitoring of the environmental impacts of the resettlement programme over its 20 year history remains particularly lacking (Elliott, 1994). By 1996, 71,000 families largely from the communal areas had been resettled to former European-owned commercial farmlands (Kinsey, 1997). Further measures designed to reduce land pressure were the improved infrastructure, credit, marketing and extension services in communal areas considered widely to underpin the production improvements amongst small scale African farmers in the country, once heralded as 'Africa's success story' (Cliffe, 1988b).

However, not all appraisers were satisfied with these methods for deriving relief from environmental degradation. The The Commercial Farmers Union (1991, p. 1), for example, noted that except for a "few notable cases" the result of resettlement was 'a serious loss of productivity, denudation of resources, insufficient income and even food aid being required by settlers'. Similarly, Kinsey (1997, p. 174) has confirmed that the land reform programme was 'widely criticised, both from within the government and by outside observers' including on the basis of the insufficient understanding of the environmental impacts of resettlement.

Enhancing the pace of land transfers in Zimbabwe remains central for ensuring social, economic and political stability in the country (GoZ, 2001; World Bank, 1999). Since the launch of the "second phase" of land reform and resettlement in 1998, substantially new models for land acquisition and land use planning have been forwarded in recognition of the need to accelerate the delivery of lands, to develop more optimum land use and production options and to promote participation amongst wider stakeholders. However, the land issue in Zimbabwe currently remains highly contested at the local, national and international scales as evidenced by extensive farm invasions in early 2000, by legal disputes concerning compulsory acquisitions of land and by the fluctuating commitment of donor resources. Furthermore, pressures on the natural resources of resettlement scheme areas are increasing (Harts-Broekhuis and Huisman, 2001). These patterns confirm the timeliness of further study of the outcomes of resettlement to date.

3.2. Time series images and environmental change

The Tokwe Intensive Resettlement Area was one of the earliest resettlement scheme areas established by the independent government of Zimbabwe. Between 1981 and 1987, over 1000 families were voluntarily recruited and moved largely from the neighbouring communal areas of Shurugwi and Chirumanzu to 34 newly created village areas within the area of former European owned farmlands. The analysis here focuses on two villages, namely Devon Ranch and The Falls, located in the central and southern regions of the scheme area, respectively.

The climate of the region is semi-arid with a single rainy season occurring typically between October/November and March/April. Rainfall varies from around 600 mm annually in the south of the Tokwe scheme area to 750 mm in the north. Soils are mainly coarse-grained shallow sands and loamy sands, which have low inher-

Table 2
Percentage land feature change in Tokwe villages, 1972–1985

Landscape features	Devon Ranch			The Falls		
	1972	1985	% Change	1972	1985	% Change
Woodland	47.0	42.1	−4.9	28.6	29.8	1.2
Open woodland	6.2	2.7	−3.5	24.8	25.6	0.8
Bushland	0	0.3	0.3	10.6	0.8	−9.8
Open bushland	0.9	6.1	5.2	2.2	5.5	3.3
Settlement	0.1	0.6	0.5	0	1	1.0
Water	0	0	0	0.3	0.5	0.2
Grassland	45.8	35.6	−10.2	29.2	25.1	−4.1
Cultivation	0	12.6	12.6	4.2	12.0	7.8
Total	100	100		100	100	

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ent fertility and water holding capacity, based on an underlying geology of granite with intrusions of dolerite. Most of the area lies at between 1000 and 1100 m above sea level and falls within 'agro-ecological' region III, determined on the basis of soils and rainfall characteristics. The vegetation is dominated by miombo woodland, (typical of a large portion of southern, central and eastern Africa) comprising largely *Brachystegia spiciformis, Julbernardia globiflora* and *Brachystegia boehmii*, alongside some *Mopane* and *Acacia.*

Livelihoods in the area are based almost wholly on rainfed agricultural production. Conditions for maize (the staple) or tobacco (a principal cash crop in Zimbabwe) are marginal and semi-extensive livestock production is a more suitable option in the light of severe mid season dry spells. In continuity with the communal areas from which people were resettled, trees/woodlands are closely linked into the cropping and livestock management systems.

Table 2 displays the linear changes in land use in the two case study villages as quantified through the aerial photograph and GIS analyses. As seen, there were significant differences between the villages in terms of the woodland status prior to population movement and in the changes over the period of resettlement. In Devon Ranch, where initial woody cover was more extensive at the time of designation, there has been a small reduction in the area covered by woodland (47–42%), a 10% decrease in grassland and a significant increase in area covered by open bushland (from less than 1% to over 6%). In The Falls, the total area under woodland actually increased slightly as did the open woodland and open bushland. There was a significant reduction in bushland (from 10% to less than 1%) and a smaller decline in grassland (from approximately 30–25%).

However, the limitations of the information presented in Table 2 (i.e. linear expressions of environmental change) are apparent when the data is presented in the form of multi-directional matrices as in Tables 3 and 4. The matrices based on a cross-tabulation function of IDRISI, document the total values for 1972 and 1985 figures (the bottom row and the extreme right column, respectively) and each column gives the percentage of the 1972 figure that changed into the variable in the rows (the 1985 figures). For example, the figures in the woodland column show the percentages of the total

Table 3
Transitional matrix of landscape change in Devon Ranch 1972–1985

Landscape features (1985)	Landscape features (1972)							Total (1985)
	Woodland	Open woodland	Bushland	Open bushland	Settlements	Grassland	Cultivation	
Woodland	69.7	22.8	0	30	0	16.6	0	42.1
Open woodland	1	27.4	0	0	0	1.1	0	2.7
Bushland	0.4	0	0	0	0	0.4	0	0.3
Open bushland	2	16.6	0	51.4	100	7.8	0	6.1
Settlements	0.5	0.7	0	0	0	0.7	0	0.6
Grassland	20.2	19.8	0	18.5	0	53.9	0	35.6
Cultivation	6.2	12.6	0	0	0	19.5	0	12.6
Total (1972)	47.0	6.2	0	0.9	0.1	45.8	0	100

Deforestation, Reforestation.

Table 4
Transitional matrix of landscape change in The Falls 1972–1985

Landscape features (1985)	Landscape features (1972)								Total (1985)
	Woodland	Open woodland	Bushland	Open bushland	Settlements	Water	Grassland	Cultivation	
Woodland	52.2	31.2	12.3	21.7	0	0	16.7	10.4	29.8
Open woodland	19.3	27.3	78.3	27.8	0	0	14.5	3.1	25.6
Bushland	1.3	0.3	0.1	0.8	0	0	0.4	6.0	0.8
Open bushland	5.8	3.5	0.5	9.1	0	0	7.5	11.4	5.5
Settlements	0.6	1.7	2.4	0	0	0	0.3	0	1
Water	0.5	0	0	2.9	0	62.0	0.1	0.5	0.5
Grassland	10.7	27.0	6.1	30.1	0	38.0	43.6	26.9	25.1
Cultivation	9.6	9.0	0.4	7.5	0	0	16.8	41.8	12.0
Total (1972)	28.6	24.8	10.6	2.2	0	0.3	29.2	4.2	100

Deforestation, Reforestation.

Table 5
Vegetation dynamics in Tokwe

Vegetation type and land use	Evidence of dynamics: area and percentage change (1972–1985)	
	Devon Ranch	The Falls
Woodland	Small reduction (47–42%). High overlap (69.7%)	Small increase (28.6–29.8%). Moderate overlap (52.2%)
Open woodland	Reduction (6.2–2.7%). Low overlap (27.4%)	Small increase (24.8–25.6%). Low overlap (27.3%)
Bushland	Very small increase (0–0.3%)	Large decrease (10.6–0.8%). Very low overlap (0.1%)
Open bushland	Small increase (0.9–6.1%). Moderate overlap (51.4%)	Increase (2.2–5.5%). Very small overlap (9.1%)
Grassland	Decrease (45.8–35.6%). Moderate overlap (53.9%)	Decrease (29.2–25.1%). Moderate overlap (43.6%)
Cultivation	Increase (0–12.6)	Increase (4.2–12.0%). Moderate overlap (41.8)

Table 6
Deforestation/reforestation in different contexts

Former vegetation	Tree loss (1972–1985) as percentage of total percentage of features in column		Tree gain (1972–1985) as percentage of total percentage of features in column	
	Devon Ranch	The Falls	Devon Ranch	The Falls
Open bushland	2	2.6	0.3	1.1
Grassland	0.3	10.4	8.3	11.3
Cultivation	10.7	5.0	0	0.8
Settlements	3.7	1	0	0
Total tree loss as percent of total area.	16.7	19	8.6	13.2

woodland for 1972 that have changed into the variables in the first column, or remained woodland (the top entry of the first column of Tables 3 and 4). The tables confirm the dynamism of the environment and land use across the period and point to the processes of both deforestation and reforestation (identified by shading) occurring in different places that underpin the gross changes identified in Table 2.

The variable ‘overlaps’ recorded in Table 5, confirm that what appeared to be linear deforestation in the Devon Ranch case (indicated, for example, by the reduction of woodland of 4.9%) was actually the result of locationally distinct increases and reductions in wooded areas; 69.7% of the area under woodland in 1972 was still woodland in 1985. However, there was substantial variation in the degree of overlap found in respect to the other land uses and between the two villages studied as also shown in Table 5. For example, the situation in Devon Ranch was less stable in terms of grassland (53.9% overlap), open bushland (51.4%) and open woodland (27.4%) than in terms of woodland. In The Falls, the woodland overlap was less (52.2%), as were the overlaps in terms of all other land uses. Clearly, these patterns are further evidence of the complexities of environmental change enabled through GIS analysis.

Table 6 shows the vegetation cover changes described above, documenting tree stand losses and expansion as percentages of the total area under study, differentiated according to the non-forest land categories. Using this method, the gross increases and decreases in various vegetation covers may be presented. This therefore goes further than the presentation in Table 2 (which merely shows gross changes) and also Table 5 (which shows the gross changes as well as the areas of minimal changes, termed overlaps, between the two dates). It also goes further than the presentation in the matrices, which show percentage change within the categories (for example, the percentage area of grass lost to bushland) but not the area thus modified as a percentage of the total area covered. For example, Table 3 shows that in Devon Ranch open bushland lost 30% of the 1972 coverage (0.9% of the total study area) to thicker vegetation. The 30% change in the 0.9% open bushland area is presented as approximately 0.3% in Table 6: this figure thus represents the total losses of open bushland to forested growths over the period 1972–1985, expressed as a total percentage of the total study area. Clearly, in the case of open bushland, the relatively high percentage change translates into a very small loss of biomass when considering the study area as a whole.

In summary, the data presented in the above tables reveal the highly dynamic and multi-directional changes that have characterised vegetation modification over the period of study that raise a number of questions concerning the underlying processes supporting these patterns which may challenge the dominant linear narrative of environmental change under rising population numbers. For example, why was there such a small change in

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Table 7
Main sources of wood in Tokwe (percentage of respondents)

Area	Purpose of wood collection			
	Cooking	Brewing	Brick making	Construction
Devon Ranch	O = 100	O = 79	FW = 52 CW = 14 O = 24	FW = 69 W = 28 CO = 3.4
The Falls	O = 100	FW = 5 CW = 24 O = 72	FW = 50 CW = 20 O = 30	FW = 62 CW = 33 O = 5

FW – Felling wet trees; CW – Cutting wet branches; O – Other sources (dead branches, coppicing, etc).

total woodland area, but a large change in distribution? What contextual factors are operating in each village to explain the small change in total open woodland in one area, a loss in the other, and large changes in distribution in both villages under study? Similarly, why was there a small increase in bushland in one area, a large decrease in the other and such a low overlap in both cases? Furthermore, a linear narrative offers little in terms of an explanation for the small increases in open bushland, but the large variation in the overlaps across the two village areas. Further insight to these questions and their reconciliation may be made through reference to the dynamics of social activity as revealed through field surveys and interviewing that enable both woodland losses and expansion.

3.3. Factors for woodland losses

Under the land resettlement programme in Zimbabwe to the late 1990s, settlers to the Model A schemes were given permits to cultivate a standard 5 ha (12 acres) of arable land and rights to access communal grazing resources. In contrast, within communal areas, households typically have access to much smaller arable plots and tenure is based on usufruct rights. The extent of common grazing lands in these areas has been declining in recent years (Campbell, 1996). In the interviews conducted with 79 adult members of resettled households in the case villages, over three-quarters reported that it was land shortage in their home areas that had been their primary reason for moving to the Tokwe resettlement scheme. All households reported cultivating an enlarged acreage subsequent to moving to the resettlement areas; over 80% of households in each case village were utilising their full allocation of 12 acres with the availability of the land in the resettlement scheme given as the main reason for the expansion in cultivation since moving. Ownership of cattle had also increased during the period of resettlement amongst all respondents. Cattle remain one of the principal assets in rural areas of Zimbabwe and as wealth rises, demand for woodland-derived goods necessary for cattle maintenance (for example, graze and browse) and use (poles for kraals or yokes, for example) also increase (Clarke et al., 1996). Long-term panel data for three resettlement scheme areas has confirmed that resettled household are larger, more wealthy and own more cattle than communal area households (Hoogeveen and Kinsey, 2001).

In the course of expanding cultivation, respondents suggested that trees were not always removed from new fields, rather clearing was highly selective as found in the communal areas of Zimbabwe (Campbell et al., 1993; McGregor, 1991) as well as more widely in southern Africa (Munslow et al., 1988). In Devon Ranch, for example, only 11% of respondents removed trees, the main reason given as the restriction on ploughing caused by stumps and roots. Where trees were left, the main reasons cited were for shade (48%), fruits (19%), and a combination of factors (11%). For a small number of respondents, a lack of labour availability was suggested as the reason why trees were left in fields. In The Falls, more respondents (29%) removed trees from their farms and again the principal underlying motive for removal was the impediment to ploughing. Here, however, the main reasons for leaving trees in fields were the picking of fruit (29%), a lack of labour for clearing (24%), shade (24%), and fruit and shade considerations (19%).

In the absence of rural electrification, households remained almost wholly dependent on biomass sources of energy. In the cutting of firewood, rather than the felling of live trees, the main sources were ground collection, dead trees and dead branches. In the corresponding communal areas, households reported a greater dependence on the branches from living trees as well as the collection of dead material; i.e. the greater access to wood in the resettlement areas had reduced the need for live tree cutting. Most of the respondents described access to wood currently as easy (over 90% in each case) compared with less than 10% whilst resident in the respective communal areas. Whilst most people considered ease of access to be due to the improved supply and proximity to woodland resources in resettlement areas, the impact of greater resource availability on resource demand was highly varied. In particular, factors of ecology (the location of desired species) and time available in relation to agricultural labour demands

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(woodland resources are collected and processed using household labour) were found to mediate the link between resource supply and demand.

It is well known that wood management techniques are highly varied in the communal areas of Zimbabwe (Clarke et al., 1996) and this was evidenced in the diverse patterns across and within the resettlement villages. For example, Table 7 details the source of wood in the two case study areas in relation to different consumption purposes. The felling of wet trees and cutting of wet branches are contrasted with the collection of dead branches and the cutting of dead trees, (the use of living plants being more likely to contribute to deforestation). The table shows that the felling of wet trees (the only method that directly reduces tree numbers) was highly variable. In short, it was highest for construction and lowest for cooking consistent with patterns found in communal areas where the range of usable species in construction (species substitutability) is smaller than for fuelwood (Clarke et al., 1996). The cutting of wet branches (coppicing or trimming) was also variable within and between the study areas. This type of activity contributes to the reduction of tree stands to shrub sized growth, and the result may thus be termed mild deforestation.

The above figures show that woodcutting was a widespread but socially and spatially variable activity in the case study villages and indeed, fuelwood demand also varied over time. As shown in Table 7, most of the felling of live trees occurred when wood was needed for brick making and construction rather than for more regular demands for fuelwood. Distant places and grazing and riverine areas may thus be inferred as the main areas of tree losses. Where there was a difference between wood harvesting in the communal and resettlement areas, the increased supply of wood in the former areas was cited as the main factor, followed by access to woodlots, changes in participation and the use of trees felled in the clearance of farms. In all cases there was easier access to trees in the resettlement area than in the communal areas, which had led to more wood being used generally, although over one quarter of respondents reported using less wood currently enabled by the improved supply of required species and desired forms of wood resources currently available.

3.4. Factors for woodland expansion

The field survey also revealed a number of factors for woodland expansion such as tree planting. Respondents in the two villages reported widespread tree planting, although the levels of planting and the expressed motivations for it were very varied. Most people in Devon Ranch (57%) planted two or three trees, typically indigenous fruit trees and usually planted on household dry fields, with the most common reason being for household consumption of fruit products (82% of households). In The Falls, a higher proportion of people planted trees and in slightly larger numbers than was common in Devon Ranch. Fruit was again the most common reason for planting (76%) and the main areas for planting were the dry fields (85%). This level and extent of tree planting in the resettlement cases is much higher than has generally been found in other rural areas of Zimbabwe where typically, between 1% and 10% of households have planted indigenous fruit trees (Campbell et al., 1993). Deforestation was not mentioned as a factor influencing tree planting in the study areas except in a small minority of cases, a pattern that has been found in Zimbabwe more widely (Clarke et al., 1996).

Over half of the respondents referred to the existence of woodlots in their area and noted that residents were allowed to use such resources with permission from the resettlement officer (civil servants who constituted the main interface between government and settlers for the first 20 years of the programme, but a position which has now been removed). For trees in homefields and dry fields, male heads were reported to be the main people who took care of these plots and families were the main users. However, for trees in grazing areas there were varied views with regard to the management of the resource and the authority for wood use. This is consistent with what Campbell et al. (2001) has identified as a general pattern for woodland management in Zimbabwe, as being directed at 'those components that are found in privately controlled niches in the landscape' (p. 593). It also confirms wider findings that local control and management of common property resources, including woodlands, are complex and dynamic.

Respondents in the Falls, for example, suggested that the control and authority for management of trees within the grazing areas of their communal homes rested with traditional leaders, but only 6% suggested that this system continued to be the case in the resettlement area. In Devon Ranch, settlers reported wholly that other agencies, including conservation groups and 'new' local institutional authorities (such as Village Development Committees) now had control and authority. This decline in the importance of traditional control and multiple understandings of where authority lies in regard to common resources is illustrative of what Nhira and Fortmann (1993) referred to a 'special problem' of resettlement scheme areas; the situation whereby the settlement together of households drawn from different locations, traditions and religions tends to weaken traditional controls and often occurs in the absence of any strong externally derived rules or institutions. However, the majority of people within the case studies expressed a confidence regarding the efficacy of their understood systems for woodland management in preventing future deforestation.

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Table 8
Land use in the Tuba/Aplaku plains

Settlements	Aplaku/Densu			Kokrobite/Oshiyie		
Date	1960	1998	%Change	1960	1998	%Change
Trees/shrub dominated areas (woodland, open woodland, bushland)	52	7	−45	66	45	−21
Grass dominated areas (open bushland, grassland)	36	59	23	24	15	−9
Cultivation	4	13	1	5	14	9
Developers	1	10	9	1	16	15
Settlements	2	7	5	1	1	0
Other (roads, rivers and beach)	5	4	−1	3	9	5

In summary these dynamics of social activity and the reported nature, extent and change within livelihood activities of resettled households have confirmed the possibilities for both deforestation and reforestation as revealed and quantified by the GIS analysis. Factors that contribute to the loss of tree stands include the increased cattle herds, increased farm area and easier wood collection. Factors contributing to reforestation include the improved availability of desired species, tree planting and new institutional controls. The following section investigates the possibilities for such an analysis in the coastal savanna of Ghana.

4. Case study 2. The Tuba/Aplaku plains of coastal Ghana

4.1. A narrative

In Ghana, formerly the British colony of the Gold Coast, the predominant historical narrative is also one of linear environmental degradation under increased human activity and population expansion, with the details of such change being contested and unresolved (see Fairhead and Leach, 1998, for example). As in the Zimbabwean case, factors such as large scale agriculture and mining, shifting agriculture, population growth and the conflict between local indigenous social norms and colonial economic models have been blamed for vegetation change (Kay, 1972; Howard, 1978). In the coastal savanna of southern Ghana, the driest area of the West African coast, authors have argued for either climatic or historical anthropological factors as the cause of the long-term degradation of what is identified as an ‘originally’ forest vegetation (Dickson and Benneh, 1988). Whatever the perceived historical factors for change, the area is believed to be undergoing further linear degradation due to human factors (Lieberman, 1979; Oduro-Afriyie, 1996) although there has been little documentation of the contextual variables of environmental change.

In colonial Ghana, like in the Zimbabwean case and in the wider African situation, the broad mindset of scientific universalism enabled the development of agriculture models with strong environmental consequences. Here, forest reserves were set up widely during the 1920s (Kay, 1972) and have persisted to the current day (Hawthorne, 1994). Other measures taken to arrest environmental degradation during the 1970s and 1980s included the creation of the Anti Bush Fire Law, the National Plan of Action to Combat Desertification (NPACD) and the National Environmental Policy. However, the lack of supporting institutional structures and comprehensive environmental research have limited the impact of these policy actions on the perceived problems of deforestation, soil erosion and ground water depletion and pollution, for example (Campbell, 1994).

Despite the lack of evidence of substantial population movements and resultant conflicts as described in the first case study, marked problems exist in the coastal savanna of Ghana that appear to have resulted in similar environmentally related tensions. Primarily, land use policy issues are concerned with conflicts over land between farmers, developers and the government. Some of these conflicts have involved actual violence, and have led to bans on sales of farmland to developers (Mensah, 1996). In the Densu Ramsar Conservation Area, ‘excessive farming’ and ‘unsuitable fishing methods’ as well as the work of developers and particularly the extraction of sand for building are considered to be causing the ‘wanton destruction’ of this site (Mezikpih, 1996).

4.2. Time series images and environmental changes

The second case study area was a 50 sq km section of the Tuba/Aplaku plains of the coastal savanna of Ghana, located 20 km southwest of the capital, Accra (Fig. 2). This area contains a number of villages of Bortainor, Oshiyie, Kokrobite, Tuba, Aplaku and Langma, the population of which increased from under 2000 persons in 1948 to over 7000 by 1984 and to an

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Table 9
Transition matrix of land use and vegetation change in Aplaku/Densu (1960–1998)

Landscape features (1998)	Landscape features (1960)								Total (1998)
	Tree/shrub	Grass/shrub	Cultivation	Developers	Settlements	Rivers	Beach	Roads	
Tree/shrub	11	2	5	0	0	0	0	0	7
Grass/shrub	59	66	47	0	4	47	65	12	59
Cultivation	13	16	22	0	0	1	0	5	13
Developers	13	6	16	0	0	0	0	2	10
Settlements	3	8	10	0	85	0	22	21	7
Rivers	1	1	0	0	0	52	12	0	3
Roads	0	1	0	0	11	0	0	60	1
Beach	0	0	0	0	0		1	0	0
Total (1960)	52	36	4	1	2	2	2	1	100

Deforestation, Reforestation.

Table 10
Transition matrix of land use and vegetation change in Kokrobite/Oshiyie (1960–1998)

Landscape features (1998)	Landscape features (1960)								Total (1998)
	Tree/shrub	Grass/shrub	Farms	Developers	Settlements	Rivers	Beach	Roads	
Tree/shrub	47	45	60	0	17	0	0	0	45
Grass/shrub	16	19	6	0	10	0	0	20	15
Farms	11	24	18	0	0	0	0	8	14
Developers	23	1	14	0	0	0	0	9	16
Settlements	0	3	1	0	30	0	0	3	1
Rivers	0	0	0	0	0	0	0	0	0
Beach	2	4	0	0	41	0	0	6	5
Roads	1	4	1	0	2	0	0	34	4
Total (1960)	66	24	5	1	1	0	1	1	100

Deforestation, Reforestation.

excess of 10,000 by 1996 (Campbell, 1998). The annual rainfall of the Tuba/Aplaku plains area is between 500 and 600 mm, and the soils are mainly ultisols, entisols and alfisols, overlying igneous and metamorphic rocks. The area is generally undulating topography, lying below 300 m elevation. The vegetation is a patch mosaic of trees, shrubs and grasses, mostly *Azadirachta indica*, *Mangifera indica*, *Andropogon guyanus* and *Panicum maximum*. Households in the area typically base their livelihoods on a combination of farming, hunting, fishing, firewood cutting, and trading in food and non-food items. Land use disputes are common in the area, and these have had pronounced social, political, economic and environmental externalities such as in Bortianor where such conflicts revolved around the sales of cultivated farmland by traditional authorities to developers and resulted in riots (Campbell, 1998). A comparison with the Zimbabwean case therefore shows some similarity in that a region covered by patch mosaic of trees, shrubs and grass, arguably the relic of richer vegetation, has been the scene of stakeholder conflicts in which the result has been complex multi-directional environmental change.

Table 11
Vegetation dynamics in Tuba/Aplaku

Vegetation type and land use	Evidence of dynamics area and percentage change (1960–1998)	
	Aplaku/Densu	Kokrobite/Oshiyie
Woodland/open woodland/bushland	Large reduction (52–7%). Small overlap (11%)	Moderate reduction (66–45%) Moderate overlap (47%)
Open bushland/grass land	Moderate increase (36–59%). Moderate overlap (66%)	Moderate reduction (24–15%) Small overlap (19%)
Cultivation	Small increase (4–13%) Small overlap (22%)	Small increase (5–14%) Low overlap (18%)

Table 12
Deforestation/reforestation in different contexts

Former vegetation	Tree loss (1960–1998) as percentage of total percentage of features in column		Tree gain (1960–1998) as percentage of total percentage of features in column	
	Aplaku/Densu	Kokrobite/Oshiyie	Aplaku/Densu	Kokrobite/Oshiyie
Open bushland/grassland	31	11	1	11
Cultivation	7	7	0.2	3
Developers	7	15	0	0
Settlements	2	0	0	0.2
Total tree loss as % of total area	47	33	1.2	14.2

Note: the vegetation classified as Forest includes the categories: woodland, open woodland and bushland (tree/shrub mosaic).

In the same manner as for the Zimbabwe case study, the output maps of the aerial photograph interpretation were digitised and analysed using GIS techniques. Two sample sites, the Aplaku/Densu and the Kokrobite/Oshiyie environs, were selected from the wider study. Table 8 shows the linear changes in land use over the study period. It is apparent that there is greater deforestation here than in the Zimbabwean case (over 20% change as opposed to less than 5%) and there are quite different trajectories of grassland change. In the Zimbabwean cases, there had been losses of between 4% and 10%, but in the Ghanaian examples, grass dominated areas expanded very significantly in Aplaku/Densu, but declined in Kokrobite/Oshiyie by 9%. These differences, as argued in the next sections reflect slight differences in the intensity of the human activities.

Tables 9–11 are the matrices generated through IDRISI that express the multi-directional nature of environmental change and point to the more complicated story of land use in the two sample sites. In Table 9, the first column for example, shows that 59% of the lands in Aplaku/Densu that were under tree/shrubland in 1960 were defined as grass/shrubland in 1998 indicating some deforestation possibly representing the short fallows of farming, loss through firewood cutting or via the activities of developers. The gross increase in grassland/shrubland in the area is also shown, rising from 36% in 1960 to 59% in 1998. Table 10 shows the very contrasting situation in the Kokrobite/Oshiyie region in terms of these same land use changes; there was a much smaller loss of woodland to grassland (16%) and an overall loss of grassland from 24% of the total area in 1960 to 15% in 1998.

Table 11 provides further illustration of the complexities of landscape change through highlighting the variable overlaps between the extent of the classified associations in 1960 and 1998. As discussed previously, where there is a large overlap between similarly classified areas across the two dates, it implies that there has been little change in either land use or the spatial distribution of a particular land use category. However, where there is a small overlap between, for example, forested areas in 1960 and 1998 the implication is that land use patterns between the two dates have been spatially variable. This may have allowed new tree growth in some areas, which may balance deforestation in other areas. Such changes would be less obvious where total figures were considered, but easily appraised where multi-directional change could be documented.

Combining the insights of these tables, it is seen that in the Aplaku/Densu area, wooded areas were reduced very markedly and the overlap very small (Table 11). Over one-quarter of total woodland losses were to developers and to cultivation (in equal measure) as shown in Table 9, however, the major woodland losses were to grass dominated vegetation as already discussed. Counteracting these changes were the tree/shrub growths that replaced 5% of former farmland and 2% of grassland as also shown in Table 9 (columns 3 and 2, respectively). In the Kokrobite/Oshiyie area, there was a

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much larger overlap in terms of woodland areas (47%) and a much smaller reduction in forested areas over the period in comparison to the Aplaku/Densu case. Overlaps for grassed areas (19%) and for cultivated areas (18%) were much smaller than for woodland in Kokrobite/Oshiyie and smaller in comparison to the Aplaku/Densu area experience in these terms. Woodland losses in this case area were more evenly spread; being to grass dominated vegetation (16%), farms (11%) and developers (23%) in the main (Table 10). There were also gains in woodland via tree/shrub expansion into formerly grass-dominated areas (45%) and on farmlands (60%).

Table 12 shows the actual percentage expansion and retraction of wooded areas, in relation to other landscape features (open bushland, grassland, cultivated areas and settlements). As in the Zimbabwe case and as revealed in the matrices above, in most cases both deforestation and woodland expansion were apparent, despite the evidence that in terms of gross change, deforestation was more noticeable.

In summary and in continuity with the Zimbabwean case, the data indicates that a more comprehensive assessment and analysis of vegetation change is possible only when multi-directional and spatially variable change is documented using GIS methods. In these two cases the dynamics of change documented by the analysis of the time series images preclude the linear change hypothesis dominant in scientific and policy circles and raise questions including why was there a much larger change in woodland in Aplaku/Densu than in the Kokrobite/Oshiyie example, and such small overlaps in both cases? Further differences between the case study areas that require explanation include the large losses of grass-dominated and farmland areas to woodland in Kokrobite/Oshiyie compared to much smaller losses in Aplaku/Densu. Similarly, why was there an increase (and a large overlap) in grassland in Aplaku, but a decline (and a small overlap) in Kokrobite/Oshiyie?

These questions may be answered in a similar fashion to those posed in relation to the Zimbabwean case study. Human activities change the landscape in many ways and these may cause both degradation and enrichment. Environmental change can only be understood through an assessment that includes these dynamics of human activity as revealed in this study through informal interviewing at the household and community levels.

4.3. Factors for woodland losses

In coastal Ghana there was evidence of a greater variation of farming types than in the resettlement area of Zimbabwe (where the ‘model’ for agricultural production has been more closely controlled). This has translated into more complex environmental outcomes in Ghana. Respondents in the field argued regularly for the expansion of permanent cultivation (as contrasted to shifting cultivation, the balance between the two creating complex variations) as the principal factor explaining woodland loss over previous decades. Shifting cultivation was detailed as a common practice in the past, although this had gradually declined during the 1980s. Under this system, land cultivated for several years would be left fallow for 3–5 years with the objective of recovering soil fertility. Extensive shifting cultivation over the period under study would therefore modify areas dominated by older forest, creating a patch mosaic of trees, shrubs and grasses, as fallowing of this length enabled some regrowth to shrub sized trees. However, as population increased in the area, more land was needed and respondents reported landowners as becoming more reluctant to lease land to farmers. The result was the collapse of the shifting cultivation system by the mid-1980s in favour of intensively cultivated permanent plots. After this period, farms could still be left fallow for long periods, but the common reasons for such practice were farm abandonment (as people sought the promise of alternative livelihoods), land purchases by developers, and/or permanent moves in response to desiccation, erosion and severe fertility decline in the area. All the respondents who had practised farming, fishing, trading and/or wood cutting (about 95%) argued that they had practised multiple activity livelihoods for at least one season during their life in the area.

A further reported change in farming activity was the increase in farm diversification across the period. In this system, farmers cultivated widely spaced plots, usually as a coping strategy in reaction to the threat of loss of one farm to desiccation, water logging, fire, rodents/insects or external developers. 30% of respondents in the sample argued that they had farms in widely spaced areas and the main reason given was the fear of the loss of cultivated plots to such localised problems. Other farmers stated that they knew that this strategy was a good method for ensuring the retention of at least one plot when another plot was lost, even though they did not practise it themselves. Lack of land and physical effort were cited as discouraging factors.

Wood was the main fuel source in the area. In the survey, 40% of the total sample said they participated in woodcutting. Of these, 52% admitted regular woodcutting (almost wholly women) and indeed, defined themselves as woodcutters in the sense that they practised part time cutting and trading during the farming season and then engaged full time in woodcutting and sales during the dry season. The remaining 48% of the sample participated in sporadic cutting for household use. 3–5 trips would be made each week and headloading (either tied bundles of small branches or carried in large aluminium pans on the head) were the main transport system. Small wheeled carts were used in most instances were roots and larger stumps were transported.

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Respondents reported a range of management techniques in relation to fuelwood cutting. In approximately one fifth of cases, collection was of dead branches and from the cutting of dead trees. Selective coppicing was also practised widely and total stem extraction and root digging of live trees on a smaller scale. The main source areas were farms (farmers argued that about one third of their needs were from this source, especially where the fallow was long), as well as from forest clumps, grazing and other non-farmed areas.

The distances covered to collect adequate wood supplies in the area had increased from less than 2 km in the 1970s to between 4 and 10 km in the mid-1990s. In some cases due to the scarcity of wood, trees were cut over 100 km away and transported by truck to the villages. Respondents identified population increase and the expansion of fishsmoking as a livelihood option for women as factors in both deforestation (in the case of the total plant removal method) and the increased patches of shrub sized tree species in areas already bearing the imprints of farming.

A further factor for woodland losses was hunting, which is a fairly common element in local livelihoods. The main contexts for hunting were woodland and bushland and particularly on hilly slopes where farming was more restricted, vegetation thicker and antelope (various species of duika and bushbuck in the main) more common. Hunting was considered to contribute to deforestation largely through the practice of bush burning (employed to flush out the game). In some cases up to two hectares could be burnt in a single day. However, respondents blamed farming, settlement expansion and firewood cutting for the perceived habitat loss in the area, the impacts of which were reportedly felt in terms of the shifting of hunting grounds to more marginal, steeper slopes where farming is less prevalent but where 'catches' were falling over time.

Increased cattle ownership was also evident. A small number of farmers held relatively large stocks of cattle (45 individuals owning on average 100 head). Sheep, goats and pigs are also kept on a small scale. Preferred grazing areas for livestock were the shrub/grass mosaics (open bushland) and over 70% of the respondents in the survey mentioned cattle grazing on seedlings and shrub sized trees as a factor for deforestation.

4.4. Factors for woodland expansion

As in the Zimbabwean case, there was evidence of woodland expansion. Here, however, this was due principally to the common practice of farm abandonment, rather than extensive tree planting. 80% of farmers had abandoned their plots for some time (a few months to over a decade), the main reasons being to take on alternative or replacement livelihood activities (whether on a temporary, semi-permanent or permanent basis). Similarly, the purchase of farmland by developers would result in the immediate cessation of cultivation and commonly, building in developers' plots would be delayed as owners rarely had enough cash for ready progress and sometimes land would be purchased with the intention of a later resale at a profit. Both scenarios enable fallow regrowth of shrubs and trees and these areas were utilised by firewood cutters, and where there was animal re-colonisation, by hunters.

A further factor in maintaining woodland status was the continued prevalence of fetish power in the area. Respondents in the survey identified four fetish groves where traditional religious authorities had the power to prohibit farming, woodcutting and hunting in certain areas believed to be inhabited by gods. The prohibition of land use in these areas allows the regrowth of forest. Despite a gradual exploitation of the edges of some of the fetish groves, more than 80% of the respondents admitted that they would not farm or otherwise exploit the groves, even though most of the people privately said they did not believe the power of the "touch it and die" edict of the priest. Changing cultural patterns (Islam and Christianity, Western science and materialism, and declining respect for rural traditions) were recognised by all the respondents as factors that may contribute to the eventual demise of fetish groves.

Woodlots also existed, but unlike in the Zimbabwean case, these were limited to four fixed plots, rather than in dispersed locations. Therefore, the contribution of these woodlots were more locationally specific. The woodlots were planted by the Forestry Department and fishsmokers in the area in the early 1990s. Each lot is about half a hectare and has about 40 trees (all *Casia simea*). The local farmers and fishsmokers maintained these areas. Occasional trimming of branches is allowed but all the respondents agreed that regular woodcutting was prohibited, and this edict was generally obeyed.

These activities illustrate the reforestation possibilities in local land use patterns and support the position that land use intensification does not necessarily contribute to deforestation. As was also revealed in the Zimbabwean cases, land use variations created spatial variations in vegetation degradation and enrichment. Enrichment in both cases involved variable activities: tree planting and in the Ghanaian cases farm abandonment and traditional protection schemes. However, as argued below, the impacts of these activities were sufficient to create changes of such complexity, that a linear sequence of vegetation modification was difficult to discern. A closer comparison of the evidence presented above illustrates this point further.

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5. A comparison of the cases and the implications for wider research

A comparison of the received narratives of historical landscape change in Zimbabwe and Ghana revealed that in both cases, there has been an historical assessment of gradual environmental degradation, manifested largely by deforestation and soil erosion. The transition in both cases is from a largely forested biome, to a tree and grass patch mosaic and political and economic factors are the main issues at stake, rather than ecological factors. Despite slightly different sets of stakeholders, power relations were essentially similar; the local farmers and foreign dominated large-scale farming and mining interests were in clear competition for arguably insufficient land resources. Furthermore, the marginalisation of the former did not prevent these local groups being blamed for the degradation, despite evidence of shared responsibility. Similarly, in both cases, there has been no evidence of a counternarrative of environmental change, where human activities have reversed trends of landscape degradation, or even created new enriched forms.

The detail presented for the case studies concerning the forms and factors for multi-directional environmental change also revealed similarities across the study areas. For example, in both cases there are two main activities that contribute to deforestation, woodcutting and farming. In terms of reforestation and environmental enrichment, the field studies also revealed that these activities were not wholly destructive, with evidence of tree planting in Zimbabwe and farm abandonment and land protection in Ghana, for example. In both cases these activities were not imposed by powerful stakeholders, but emerged from the local context, as a response by the local people to perceived environmental issues and livelihood opportunities. Externally derived environmental management increased, rather than solved environmental problems and may be seen as factors behind the development of coping strategies among the local people. Therefore, the role of local actors in landscape enrichment appears in these contexts to be indicative of an understanding of the concept of environmental renewal among local actors, and provides evidence that the blame assigned to these people for degradation in the conventional narrative was at least partially misplaced.

In the larger sense of the implications for rural Africa, these findings do not entirely refute established narratives of linear complex change, rather they contest the predominant narratives in terms of both the contributory factors for change and the direction of change. The analysis presented here thus opens a wider debate that must assess more evidence. Useful information could be derived from more comprehensive time series images (including, for example, more recent photography in the Zimbabwean case which may capture the differences between 'one-off' responses to population movement and longer term resource management decisions), longer term field studies, and a larger number of case studies. However, the use of two widely spaced sets of air photos (as was the case in the studies by Fairhead and Leach, 1995, and Tiffen et al., 1994) was revealed to be appropriate for the study of 'landscape' level changes such as in woodland status and of 'longer term' social dynamics such as settlement expansion. In both case studies the lack of detailed information on environmental change (resulting in disputes and the ill-informed apportionment of blame) was a major constraint to effective rural policy. The multiple tool methodology employed in this paper has certainly enabled a more accurate identification of the spatial patterning of those features that represent or reveal the human imprint on the landscape at a number of scales.

From a methodological perspective it has also been demonstrated that GIS techniques can readily produce results which support the attempts by current researchers to investigate the complex dynamics at the socioenvironmental interface. For social scientists the strength of this methodology lies in its ability to represent the results of human impacts on the environment as multidirectional change. The methodology also proved supportive of the ecological disequilibrium paradigm in new ecological theory, which emphasises multi-state and unpredictable changes in vegetation distribution. The results displayed in the matrices, for example, provide evidence for multi-directional changes, and can portray the dynamics of disequilibrium more effectively than linear graphs.

The current study has provided one more step forward in answering the question of whether the current knowledge of the rural socioenvironmental dynamics in these contexts is sufficient to explain observed landscape changes. The answer was no, and evidently new studies are needed. Nevertheless, by demonstrating how this question may be answered at the landscape level over the medium term, groundwork was provided for studies at more detailed scales and in more contexts across Africa.

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