

Seasonal Changes in Vegetation and Land Use in Lassa-Fever-Prone Areas (Kenema and Kailahun Districts) in Eastern Sierra Leone

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Abstract

Lassa Fever is endemic to the eastern region of Sierra Leone. It is a haemorrhagic disease that is often transmitted from rats to humans and then human to humans. Ecological disturbances such as changes in land use involving conversion of natural ecosystems to agriculture, mining or for urban expansion are reported to bring humans into close contact with animals such as the *Mastomys rat* that carries the Lassa Fever virus thereby posing health problems. The nature and extent of such ecological disturbances or land use changes within areas known to be endemic to Lassa Fever are not clearly understood from a research context in Sierra Leone. This study was therefore undertaken to identify the pattern of changes in land use and cropping practices and their potential to bring humans into close interactions with the *Mastomys rat* that is the host for the Lassa Fever virus. Four communities were chosen for the study, two rural (Lalehun and Majihun) and two urban (Lambayama section in Kenema City and Largo Square section in Segbwema Town). Different vegetation and land use/cropping practices were identified and observations were made on the pattern of changes at different times in the cropping year. There were four common vegetation and cropping practices found in all communities: upland rice intercropping, old fallow, young fallow, and swamp rice cultivation. The study revealed the variations in land use patterns and cropping practices between urban and rural settlements. Agro-forestry practices such as perennial cash crops cacao and rubber plantations were more common in rural communities. The study also revealed that while fallow vegetation persisted in rural areas there had been expansion of settlements into old fallow vegetation indicating a greater threat to the persistence of natural ecosystem in urban than in rural settlements. These disturbances resulted in habitat fragmentation and increased the likelihood of contact between humans and animal species (e.g. *Mastomys*

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rat) associated with various habitats.

Keywords

Lassa Fever, Vegetation and Land Use Changes, Cropping Patterns, Eastern Sierra Leone

1. Introduction

There has been an increase in concern over recent outbreaks of zoonotic diseases which cause haemorrhagic fever in humans, particularly those transmitted from animals to humans and can then spread from humans to humans, such as Lassa and Ebola. Lassa fever is transmitted by the *Mastomys rat*, a small mammal or rodent that is also known to cause major pre- and post- harvest destruction to food crops, especially rice, in Sub-Saharan Africa [1] [2]. Although the prevalence of Lassa fever is restricted to the West African sub-region, it is a threat to thousands of people and is responsible for causing many cases of life-threatening haemorrhagic fevers, most of which remain unknown to the international health community [3].

Lassa fever is known to occur in the south-eastern region of Sierra Leone and is responsible for hundreds of deaths. This region receives much higher rainfall than other parts of the country and accounts for most of the forested areas of the country. Such ecological and climatic conditions are key factors that drive primary production and are hypothesised to favour outbreaks of the *Mastomys rat* [4]. The extent to which such ecological and climatic variations influence the *Mastomys rat* is not clearly understood from a research context in Sierra Leone.

Changes in land use such as conversion of natural ecosystems to agriculture, mining and for urban expansion are emerging pervasive threats that bring humans into close contact with animals carrying pathogens thereby posing health problems. Many of the epidemics resulting from these close associations are continually exacerbating challenges to health systems in poor countries with inadequate resources, such as Sierra Leone. Little is known about the interplay among land use practices, land use changes, the prevalence of the *Mastomys rat* and its interactions with humans in the Eastern region of Sierra Leone. An understanding of the dynamics between human activities and rodent species diversity will increase our knowledge on the prevalence of the disease in the south-eastern region of the country and guide the development of management strategies to control the prevalence of the rat and Lassa disease. The objectives of this study were to 1) determine the different land use and cropping patterns in each study community, 2) the changes in land use and cropping patterns 3) evaluate how these changes increase the potential of human interactions with *Mastomys rat* in rural and urban communities

2. Materials and Method

2.1. Description of the Study Area

The study was conducted in four communities in eastern Sierra Leone, Lambayama and Majihun in Kenema District and Largo Square and Lalehun Kovoma in the Kailahun District (**Figure 1**). Lambayama and Largo Square are urban areas while Majihun and Lalehun Kovoma are typically rural.

The rainfall patterns in Kenema and Kailahun districts are similar with average annual rainfall of 2618 mm for Kenema and 2650 mm for Kailahun most of it falling between June and October. The dry season is short 2 - 3 months.

2.2. Site Selection

In each of the four villages, a field tour was conducted to identify the various vegetation and land use practices. From the results of these tours six common land use practices and hence six sites were selected for rodent trapping and for gathering data on land use and land use changes in relation to the population of the *Mastomys rat*. The selected sites are listed below

- 1) Young fallow (<4 yrs)
- 2) Old fallow (>4 yrs)
- 3) Upland rice farm (mixed cropping)
- 4) Swamp rice

- 5) Oil Palm Plantation
- 6) Cacao Plantation

The classification of young fallow as vegetation < 4 year and old fallow > 4 years was based on interviews with the villagers about the age of fallow bush they considered old enough for clearing and cropping.

2.3. Data Collection

For each of the selected sites, the general characteristics of the vegetation was described and changes in the vegetation and land use were monitored at different times of the year based on the general upland rice farming calendar (which is the predominant cropping system). Thus changes in vegetation and cropping patterns as well as land use were monitored at pre-planting (April/May), post-planting (July/August), pre-harvest (October) and post-harvest (January). The geographic location of each site was recorded with a GPS handset and shown on topographic map of the area (Figure 2). Boundary mapping of each village was also conducted using a GPS handset and shown on topographic map (Figure 2).

3. Results

3.1. Vegetation and Land Use Changes in Lalehun, Kailahun District

Table 1 shows the general characteristics of vegetation and land use and the changes that have occurred within one

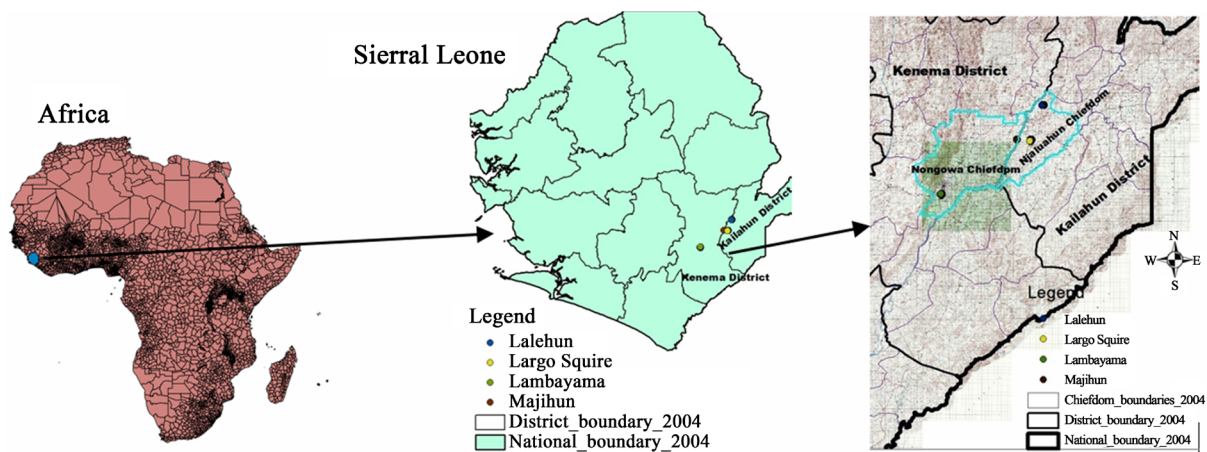


Figure 1. Geographic location of villages selected for study.

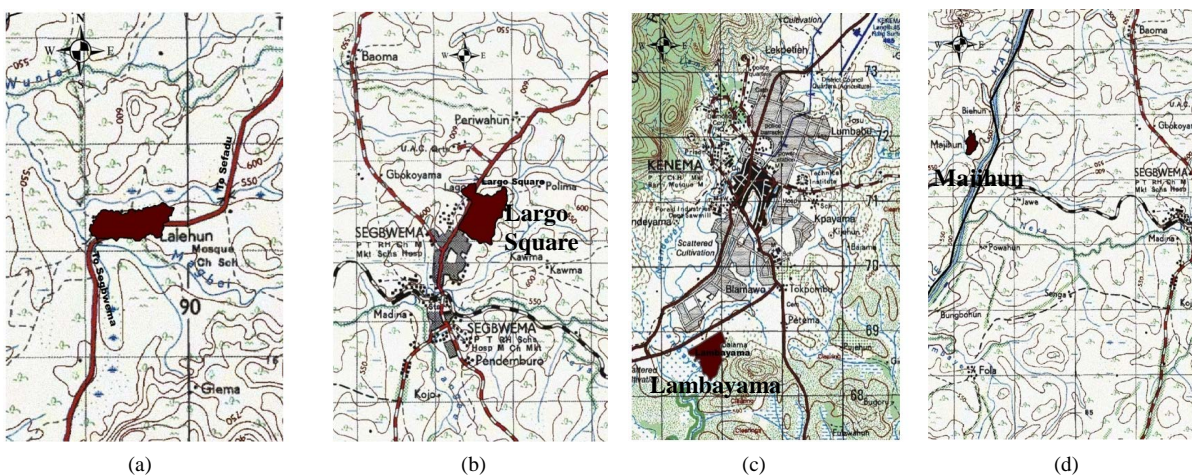


Figure 2. Location of Lalehun (a) and Largo Square in Segbwema town (b) in Kailahun district, Lambayama and Majihun (Kenema district) on topographic map of Sierra Leone.

Table 1. Vegetation and land use changes in Lalehun village, Kailahun district in eastern Sierra Leone.

Land Use/ Cropping system	2013/14 Cropping Season	2014/15 Season	
	Pre-Harvest (October)	Post-Harvest (January)	Pre-Planting (May)
Agriculture: Upland Farm	Intercropping: rice, sorghum, maize, Okra, pepper, cucumber, pumpkin	Mostly low regrowth of shrubs and remnants of rice crop (rice stalk), pepper	Young farm bush re-growth
Agriculture: Young Fallow (2 years)	Mostly shrubs and herbs	Mostly shrubs and few herbs	Mostly shrubs and herbs
Agriculture: Old Fallow (6 years)	Mostly young trees and shrubs, few herbs	Mostly young trees, and shrubs	Mostly young trees and shrubs, few herbs
Swamp	Paddy rice cultivation (monocropping), some weeds	Remnants of rice crop (rice stalk), some grass weeds	Remnants of rice crop (stalk), luxurious growth of different grass species
Agriculture: Oil Palm	Perennial cash crop with shrubs and herbs in the undergrowth	Rubber plantation, very few shrubs in the undergrowth	Rubber plantation, few shrubs in the undergrowth
Agroforestry: Cacao	Cacao plantation with scattered tall shade trees, very few herbs	Perennial cash crop with scattered tall shade trees, very few herbs	Perennial cash crop with scattered tall shade trees
Cemetery	Rubber plantation, few shrubs in the undergrowth	Rubber plantation, few shrubs in the undergrowth	Rubber plantation, few shrubs in the undergrowth
Diamond Mining	Old mining site with mixed vegetation, maize crop, oil palm, dominant tall forest trees (e.g. <i>Gmelina sp.</i> , <i>Tectonia sp.</i>)	Old mining site with mixed vegetation, oil palm, dominant tall forest trees (e.g. <i>Gmelina sp.</i> , <i>Tectonia sp.</i>)	Old mining site with mixed vegetation, oil palm, dominant tall forest trees (e.g. <i>Gmelina sp.</i> , <i>Tectonia sp.</i>)

cropping year in the Lalehun village. Most of the vegetation on fallow lands, plantations (oil palm and cacao), cemetery, and mining areas had remained unchanged during the period of observation (one cropping year). On the other hand, the vegetation or standing crop on cropped land such as upland and swamp changed after harvest. The different crops on the upland rice farm at pre-planting were rice (as the main crop) intercropped with six different crops (sorghum, maize, Okra, pepper, cucumber, pumpkin). After harvest, only pepper remained among the different intercrops. In addition, there were remnants of the previous rice crop and the remaining rice stubble as well as low regrowth of shrubs. In the swamp only rice was cultivated and after harvest only rice stalk and remnants of rice plants remained. The swamp was not utilized for vegetable cropping during the dry season as is commonly done in most swamps around the country. The cemetery was unattended and has been overgrown with rubber trees. At the diamond mining site only the maize crop disappeared after harvest.

3.2. Vegetation and Land Use Changes in Largo Square, Kailahun District

The characteristics of the vegetation, land use and land use changes on the study sites in Largo Square Section of Segbwema town in Kailahun District are shown on **Table 2**. Except for the presence of sour and sesame, the composition of the upland rice farm in Largo Square is similar to that found on the upland farm in Lalehun. After harvest, only remnants of rice crop remained. The vegetation on the young fallow remained about the same. However, for the old fallow, the vegetation remained about the same at pre- and post- harvest but was slashed and burnt for cropping at pre-planting. Paddy rice cultivation was carried out in the swamp and after harvest only rice stubble remained. No agricultural activities were undertaken in the swamp during the dry season. Backyard garden consisted of pineapple, eggplant, pepper, and a leafy vegetable “krainkrain” (*Amaranthus sp.*). Whereas pineapple, pepper and eggplant persisted throughout the year “krainkrain” appeared and disappeared.

3.3. Vegetation and Land Use Changes in Majihun, Kenema District

Table 3 shows the characteristics of the vegetation and land use changes in Majihun in the Kenema District. The vegetation on perennial crop plantations (cacao, and oil palm) as well as on cemetery, and fallow (young and old) had remained virtually unchanged through the cropping year. On the other hand, the vegetation on the cropped areas (upland rice farm site and swamp) considerably changed after harvest. On the upland rice farm site, rice

was intercropped with sorghum, maize and okra. At pre-planting, the land was cleared for groundnut cultivation. In the swamp paddy rice was cultivated during the rainy season and vegetables (okra, eggplant, pepper, tomato) during the dry season.

3.4. Vegetation and Land Use Changes in Lambayama, Kenema District

The characteristics of the vegetation and land use changes that have occurred on the study site in Lambayama Section in Kenema City are shown on **Table 4**. The vegetation on the young fallow study site was undisturbed during the cropping year. However, at the old fallow site, the vegetation was eventually cleared for housing construction. Enquiries from inhabitants in the community revealed that a portion of the old fallow land has been sold. At the upland rice site, rice was intercropped with pineapples, sorghum and maize. After harvest, pineapple remained as the only crop. It appeared as though the intention was to cultivate pineapples and in the first year, and rice was grown in the spaces between pineapples. The swamp site was under intensive rice cultivation on a continuous basis throughout the year (three times per annum).

4. Discussion

The need for increased space for meeting the variety of land use requirements as global population increases has

Table 2. Vegetation and land use changes in Largo Square, Segbwema town, Kailahun district.

Land Use/ Cropping system	2013/14 Cropping Season		2014/15 Season
	Pre-Harvest (October)	Post-Harvest (January)	Pre-Planting (May)
Agriculture: Upland Farm	Intercropping: rice, sorghum, maize, cucumber, pumpkin, sour, sesame	Mostly low regrowth of shrubs and remnants of rice crop (rice stalk)	Young farm bush re-growth
Agriculture: Young Fallow (3 years)	Mostly shrubs and herbs	Mostly shrubs and few herbs	Mostly shrubs and herbs
Agriculture: Old Fallow (5 years)	Mostly young trees and shrubs, few herbs	Mostly young trees, and shrubs	Slashed and burnt for cropping
Agriculture: Swamp	Paddy rice cultivation (monocropping)	Remnants of rice crop (rice stalk),	Remnants of rice crop (stalk), mixed grasses
Agriculture: Backyard garden	Pineapple, eggplant, pepper, 'krainkrain'	Pineapple, eggplant, pepper	Pineapple, eggplant, okra, pepper

Table 3. Vegetation and land use changes in Majihun village, Kenema district in eastern Sierra Leone.

Land Use /Cropping system	2013/14 Cropping Season		2014/15 Season
	Pre-Harvest (October)	Post-Harvest (January)	Pre-Planting (May)
Agriculture: Upland Farm	Intercropping: rice, sorghum, maize, Okra	Mostly low regrowth of shrubs and remnants of rice crop (rice stalk),	Land sown to groundnut
Agriculture: Young Fallow (3 years)	Mostly shrubs and herbs	Mostly shrubs and herbs	Mostly shrubs and herbs
Agriculture: Old Fallow (6 years)	Mostly young trees, and shrubs	Mostly young trees, and shrubs	Mostly young trees, and shrubs
Agriculture: Swamp Rice	Paddy rice cultivation	Remnants of rice crop (rice stalk)	Vegetables (okra, eggplant, pepper, tomato) Remnants of rice crop (rice stalk);
Agriculture: Oil Palm	Perennial cash crop with shrub and herbaceous undergrowth	Perennial cash crop with shrub and herbaceous undergrowth	Perennial cash crop with shrub and herbaceous undergrowth
Agro-forestry: Cacao	Perennial cash crop with scattered tall shade trees	Perennial cash crop with scattered tall shade trees	Perennial cash crop with scattered tall shade trees
Cemetery	Rubber plantation	Rubber plantation	Rubber plantation

Table 4. Vegetation and land use changes in Lambayam Section of Kenema City, Kenema District in Eastern Sierra Leone.

Land Use / Cropping system	2013/14 Cropping Season		2014/15 Season	
	Pre-Harvest (October)		Post-Harvest (January)	
	Pre-Planting (May)			
Agriculture: Upland Farm	Mixed cropping: rice, sorghum, maize, pineapple		Mostly pine apple and low regrowth of shrubs and remnants of rice crop (rice stalk)	
Agriculture: Young Fallow (2 years)	Mostly shrubs and herbs		Mostly shrubs and herbs	
Agriculture: Old Fallow (5 years)	Mostly young trees, and shrubs		Cleared for housing construction	
Agriculture: Swamp Rice	Paddy rice cultivation (mono-cropping)		Remnants of rice crop (rice stalk),	
Agriculture: Oil Palm	Oil palm		Oil palm	

resulted in shifts to areas previously uninhabited such as forested areas. This has resulted in wild life habitat destruction and closer contacts between humans and animals often exposing humans to zoonotic diseases. This study is beginning to throw light on the changing patterns of cropping and land use in the Kailahun and Kenema Districts in Eastern Sierra Leone where Lassa fever is prevalent.

This study also revealed variations in land use patterns and cropping practices between urban and rural settlements. In the identification of land use/cropping practices in the four communities, seven generalised land use/cropping practices were observed. However, not all of the identified cropping and land use practices occurred in each of the four communities. The most common cropping practices that cut across all communities were upland rice intercropping, old and young fallow, and swamp rice cultivation. Agroforestry land use practices such as perennial cash crops cacao and rubber plantations, and mineral mining were not encountered in the urban settlements, Lambayama in Kenema City and Largo Square in Segbwema town. Much of the fallow vegetation in the urban settlements were restricted to the periphery.

Cropping and land use change patterns also vary between rural and urban settlements. In general, whereas the old fallow vegetation remained unchanged in Lalehun and Majihun (which are rural settlements), it has been cleared for vegetable cropping in Largo Square indicating shorter fallow periods in urban than in rural settlements. In the Lamabayama section of Kenema City, the old fallow vegetation was converted to non-agricultural land use (i.e. housing). In Largo Square, a portion of the old fallow vegetation has been intruded by the construction of a new house. Apparently, the remaining piece that has been cleared and sown to vegetables may soon become a backyard garden considering its close proximity to the newly constructed house. These observations revealed the threat posed by urban expansion to habitat persistence and increased closeness between humans and animals. This is likely to increase the interactions between humans and animals particularly rodents such as the *Mastomys rat* which is the host of the Lassa virus and consequently greater exposure to zoonotic diseases such as Lassa fever in the study area. This is corroborated by the fact that land use change has been reported to be the key driver of emerging infectious disease [5] the majority of which are animals [6].

The pattern of disturbance in vegetation i.e. land use change, particularly that associated with upland rice farming in the study areas is such that it has resulted in fragmented vegetation patterns or patches of vegetation of different composition and at different stages of regrowth. For example, in the rural communities of Lalehun and Majihun, while the fallow vegetation on the selected study sites remained undisturbed, adjacent fallow vegetation has been cleared for the next cropping. On the other hand, in the urban settlements there has been expansion of settlements into old fallow vegetation. These multiple ecotones provide diverse habitats and increase the likelihood of contact between animal species (e.g. *Mastomys rat* associated with various habitats and humans) [7].

5. Conclusion

The study has shown that patterns of land use and land use change vary among communities but more peculiarly between rural and urban settlements and resulted in fragmentation of vegetation or habitat. Such habitat disturbance or land use change is likely to bring humans into close contact with animals and increases the risk of exposure to zoonotic diseases in the study areas. Tangible evidence will be obtained when these changes in land

use are related to the rat population in each study site. The study also revealed that urban expansion is threatening the existence of the natural ecosystem.

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