‘The diamond of Western Area is land’: Narratives of land use and land cover change in post-war Sierra Leone

Solomon Peter Gbanie
University of New South Wales
at Australian Defence Force Academy

Abstract
The impacts of human land use activities on land cover have occupied the research agenda of human-environment interactions for decades. Using different spatial and temporal time scales, these studies have helped establish an understanding of the main drivers of land use and land cover change. Although much research has addressed the dynamics of land use and land cover change, mostly in non-conflict environments, narratives that shape land use and land cover during war and post-war periods have received little attention. Using a mixed methods research approach, this study explored land use and land cover change in Western Area, Sierra Leone, between 2003 and 2011. Findings indicate that forest, mangrove and urban agriculture have plummeted over the years and built up and bare land has increased tremendously. This paper argues that the complex social structure that emerged after the war helped change the landscape of the Western Area. In particular, respondents identified high unemployment, urbanisation, high land values, weak government policies, and livelihood activities as the main drivers of land use and land cover change.

People just think that land has become [a] diamond. Formerly, when they talk about [the] diamond area, where there is diamond [and] everybody is welcome [to] legally or illegal mine, they just think the same thing has happened in the Western Area and [think] the diamond of Western Area is land. (Koroma, Gloucester, KI)

1 Introduction
Discussions about the hallmarks and consequences of civil wars are overshadowed by human rights, health, socio-political, and economic impacts (De Vos et al., 2008; Sidel & Levy, 2008; Teerawichitchainan & Korinek, 2012; Fofana, 2013). However, there has been less discussion about the environmental consequences of wars and few studies have specifically looked at land cover changes. The few studies that have examined the direct and indirect environmental effects of war including land cover (Suthakar & Bui, 2008; Gorsevski et al., 2012; Wilson & Wilson, 2013), and agriculture (Forkuor & Cofie, 2011; Temudo & Silva, 2011) have often provided superficial explanations. For instance, analysts of land use and land cover (LULC) change during and after civil wars have focused on statistics that estimate the observed changes, paying little attention to the ‘why’ question of change. A major exception is Wilson and Wilson (2013) who integrated people’s perspectives of observed changes in their analysis

Such studies have in part utilised remote sensing (RS) and geographic information systems (GIS) technology to assess such effects. The use of RS and GIS technology helps to
identify the extent of ecological destruction, particularly during the war period. Such research is often impossible during a war period with in situ techniques because of insecurity and difficulty of access by researchers. Moreover, studies utilizing spatial and temporal categorical data to explore the narratives that shape LULC change dynamics after civil wars are rare.

Post-war periods are delicate, fragile, and challenging because the economy is in transition from a complete breakdown of law and order to one that is configured to provide improved social protections and livelihoods for people (Lynch et al., 2013). Research suggests that one of the most contested and important resource issues during post-war periods is the ‘land question’ because unresolved land tenure problems can rekindle conflict (Bruch et al., 2008; Unruh & Williams, 2013). There is a growing literature that establishes an inextricable link between scarcity and competition for land based resources and civil wars (Doyle & Sambanis, 2000; Ross, 2004).

While it is important to acknowledge that land related problems often predate conflicts, some authors have argued that civil wars exacerbate problems with ‘access to’ and ‘ownership of’ land (Unruh, 2003; Bruch et al., 2008). This presents a chaotic situation because while returnees attempt to repossess their land, landless migrants make efforts to access unclaimed land parcels, causing urban sprawl leading to unplanned development.

In Sierra Leone, a civil war that lasted from 1991 to 2002 caused the displacement of the bulk of the country’s rural population, who later settled in urban centres. Using categorical data derived from classified satellite images between 2003 and 2011, this study examines LULC change trajectories of the Western Area of Sierra Leone. In particular, the study explores the narratives that have shaped LULC change since the war ended. The research demonstrates that post-war reconstruction effort reduced forest and mangrove land covers whilst built-up and bare land increased.

2 Materials and methods

2.1 Study Area

The WA of Sierra Leone is found on the edge of the Atlantic Ocean in West Africa (Fig. 1). The region is home to Freetown, Sierra Leone’s capital and largest city. During the civil war, the region’s urban and rural sections remained insulated from rebel activities until 1997. Its insular nature attracted a third of the country’s 2.6 million displaced persons and 500,000 farm families (Economist Intelligence Unit, 2002; Kaldor & Vincent, 2006). This led to a 70.9% increase in WA’s population from 1985 to 2004 (Sesay et al., 2006).

2.2 Geospatial data

Three satellite images representing the post-war period (2003 to 2011) were used in this study (Table 1). The Landsat images were obtained from the GLOVIS website (www.glovis.usgs.gov) and the SPOT image was obtained from Deutsche Welthungerhilfe. These images were selected to ensure that external factors like seasonal, phenological and the sun angle effects are avoided (Lu et al., 2004). Additionally, urban agriculture in swamps and house construction predominantly occur between January and March because of less rain.
Table 1: Remote sensing images

<table>
<thead>
<tr>
<th>Sensor</th>
<th>Spacecraft</th>
<th>Acquired Date</th>
<th>Path/Row</th>
<th>Bands</th>
<th>Sun Elevation &amp; Azimuth</th>
</tr>
</thead>
<tbody>
<tr>
<td>ETM+</td>
<td>Landsat 7</td>
<td>27-02-2003</td>
<td>202/54</td>
<td>1 – 5, 7</td>
<td>54.06; 117.57</td>
</tr>
<tr>
<td>SPOT</td>
<td>SPOT 5</td>
<td>10-03-2006</td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>TM</td>
<td>Landsat 5</td>
<td>09-02-2011</td>
<td>202/54</td>
<td>1 – 5, 7</td>
<td>50.81; 126.42</td>
</tr>
</tbody>
</table>

*Data unavailable*

Fig. 1. Location of Sierra Leone (inset) and Western Area.

2.3 Research methods

Contemporary LULC change research more strongly emphasizes the inclusion of human activities that link LULC change (Cheong et al., 2012). Mixed methods research techniques provide the synergy such studies require because it utilises the best of quantitative and qualitative research approaches, thereby providing a better understanding of the research problem than either approach used in isolation (Creswell, 2003; Cohen et al., 2007; Bryman, 2008). In land use science research, mixed methods research techniques have included the use of RS and GIS techniques in tandem with participatory mapping exercises, secondary data, and primary data generated through qualitative research approaches (Mendoza et al., 2011).

This research adopted a mixed methods research approach in order to examine LULC change trajectories and explore the narratives shaping LULC change dynamics in a post-war
context from 2003 to 2011. The adoption of mixed methods research techniques stems from one main consideration: the study focused on human-environment relationships, which requires the integration of interdisciplinary themes, and which link the natural environment with human activities.

2.3.1 Geospatial approach

2.3.1.1 Classification, accuracy assessment and change detection

The downloaded data needed no geometric corrections because they are level one product.\(^1\) However, because of the tropical conditions of the study area, radiometric correction of the images was necessary. Radiometric correction removes gray values that result from different sensors, atmospheric and illumination conditions. It also removes unwanted materials including errors and noise; thus establishing links between the image data and biophysical features (Coppin \textit{et al.}, 2004).

The Improved Dark Object Subtraction (IDOS) radiometric correction model used by Chavez (1988) and Lu \textit{et al.} (2002) was utilised because it accounts for the atmospheric multiplicative transmission component, which the Apparent Reflection and the Dark Object Subtraction models do not (Lu \textit{et al.}, 2002). This study used a two-part equation, Eqn1\(^2\) and Eqn2,\(^3\) to radiometrically correct the images. The corrected individual bands except the thermal and panchromatic ones were stacked together. This created an image from which the study area was extracted.

Using ENVI 4.3 image analysis software, this research adopted a supervised maximum likelihood classification algorithm because of its satisfactory implementation in studies of comparable environmental conditions and data (Braimoh, 2009; Lung & Schaab, 2010). Generated signature classes helped to classify the landscape into seven land classes including: 1) built-up, 2) old growth forest, 3) forest regrowth, 4) mangrove, 5) urban agriculture, 6) bare land and 7) water body. Reference data collected in December 2012 and January 2013 using a Juno Trimble GPS was used for accuracy assessment. An accuracy assessment of 350 stratified, randomly selected points using an error matrix-based approach produced an accuracy assessment for the three images.

\(^1\) See http://landsat.usgs.gov/Landsat_Processing_Details.php
\(^2\) See Chander \textit{et al.} (2009)
\(^3\) See Lu \textit{et al.} (2004)
2.3.2 Qualitative approach

Using geospatial techniques to assess LULC change independent of other data only answers the ‘what’ question of change, which gives a synoptic representation of the landscape. To give meaning to such categorical data, it is fundamentally important to explore the ‘why’ question of change because it documents the context of landscape modification over time. In an attempt to document these narratives, the research drew on qualitative research techniques including in-depth interviews, focus group discussions (FGD) and key informant (KI) interviews.

In-depth and key informant interview techniques and FGDs generated stories about the changing landscape. In particular, key informant interviews and FGDs helped to further explore the narratives that resonated from the in-depth interviews. The research used a purposive sampling method to select participants. For this research, 15 in-depth interviews (elderly and long-residing community members comprising four women and three men, four government officials and five youths⁴), three FGDs (each comprised of two females, three elderly and long-residing community members, and three youths) and six key informant interviews.

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⁴ In Sierra Leone, a youth is a person between 18 and 35 years. See National Youth Policy 2003 [http://planipolis.iiep.unesco.org/upload/Youth/Sierra%20Leone/Sierra_Leone_National_Youth_Policy.pdf]
interviews (two ‘head men’, five government officials and two youths) have been analysed. Selected participants have to meet a number of criteria including: resided in the WA for at least 20 years and ability to communicate in Krio or English.

The Human Research Ethics Advisory Panel (HREAP), University of New South Wales granted ethics approval number A-12-31 to undertake the research in September 2012. Ethical considerations for this research included obtaining informed consent and voluntary participation of all respondents. Interviews and FGDs were conducted at preferred locations of participants and recorded using an Olympus voice recorder. The author transcribed and thematically analysed the interviews using NVivo 10 software and used pseudonyms for verbatim quotes from participants to assure their confidentiality.

3 Result and Discussions
3.1 Results
3.1.1 Accuracy Assessment
The overall classification accuracy was 93.1% for the 2003 LULC map, 87.8% for the 2006 image, and 96.5% for the 2011 map (Table 2). In the absence of aerial photography from earlier images, the research draws on available high-resolution topographic maps to generate reference data. The 2011 image had the highest classification accuracy probably because of the short period between image acquisition and the ground truthing exercise in 2012/2013. At the land class level, water body had 100% producer’s accuracy for all the images and urban agriculture had the lowest (55.5%). Similarly, water body and built up had the highest user’s accuracies.

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5 In the context of Sierra Leone, ‘head men’ are surrogates of Paramount Chiefs who oversee the administration of rules and regulations at the village level.

6 Krio is the national lingua franca of Sierra Leone and it narrows the linguistic divide among speakers of different languages in the country (Worman, 2006).

Table 2. Accuracy assessment

<table>
<thead>
<tr>
<th></th>
<th>Built up</th>
<th>Old growth forest</th>
<th>Forest regrowth</th>
<th>Bare Land</th>
<th>Water body</th>
<th>Mangrove</th>
<th>Urban agriculture</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) 2003 image</td>
<td>99.66</td>
<td>99.55</td>
<td>98.56</td>
<td>85.89</td>
<td>100.00</td>
<td>81.62</td>
<td>78.62</td>
</tr>
<tr>
<td>Producer’s accuracy</td>
<td>100.00</td>
<td>96.10</td>
<td>68.79</td>
<td>84.34</td>
<td>82.08</td>
<td>96.90</td>
<td>94.72</td>
</tr>
<tr>
<td>User accuracy</td>
<td>97.45</td>
<td>98.33</td>
<td>79.89</td>
<td>82.80</td>
<td>100.00</td>
<td>90.28</td>
<td>57.14</td>
</tr>
<tr>
<td>Overall accuracy</td>
<td>98.96</td>
<td>100.00</td>
<td>96.24</td>
<td>97.88</td>
<td>100.00</td>
<td>82.33</td>
<td>98.31</td>
</tr>
<tr>
<td>(b) 2006 image</td>
<td>99.53</td>
<td>93.23</td>
<td>94.34</td>
<td>99.38</td>
<td>100.00</td>
<td>98.73</td>
<td>92.06</td>
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<tr>
<td>Producer’s accuracy</td>
<td>99.66</td>
<td>99.55</td>
<td>98.56</td>
<td>85.89</td>
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3.1.2 LULC change statistics

Old and regrowth forest dominate the vegetation of the region, which is part of the Upper Guinea Forest (Fig 2, left). The LULC change pattern exhibited by the region since the end of the war has varied significantly over time. Whilst forest (old growth and regrowth) shows a decline during this period, built up areas in both the rural and urban sections of the region have exhibited remarkable growth after the war. This unprecedented growth has caused the conurbation of villages along the Waterloo-Freetown highway with Greater Freetown, thereby eliminating the ‘urban and rural’ divide that existed prior to the war.

In 2003, forest regrowth accounted for a quarter of the region’s landscape (34.7%) closely followed by old growth forest (21.6%), mangrove (15.8%), bare land (10.0%), built up (9.3%) and urban agriculture (7.5%). It is worth noting that by 2011, the urban section of the WA almost had no old growth forest left (Fig 2, middle). In three years, whilst built-up became the third most prevalent land cover of the WA (13.2%), mangroves plummeted to almost half of the area they occupied in 2003 (8.3%).
Fig. 2. Land use and land cover 2003-2011.

LULC change statistics revealed that built up areas increased by 42.1% and 12.2% in 2006 and 2011, respectively (Fig. 4). In almost a decade since the end of the war (2003-2011), whilst built up recorded an increase of 59.5%, bare land 15.8% and water body 20.6%, a significant reduction in forest regrowth (-7.6%), old growth forest (-8.6%), mangroves (-38.2%) and agriculture (-32.5%) are shown. The change statistics and trajectories have varying magnitudes. Urban agriculture, for instance, accounted for 7.5% of the study area immediately after the war and increased to 8.7% in 2006, but shows a reduction in 2011 (5.0%). Sand mining along the coastline has caused the infiltration of brackish water into swamps, thereby increasing the area covered by the water body class.

Fig. 3. Mangrove vegetation cleared for housing development.
Photo credit: S. Gbanie 2012-2013 Fieldwork.
Fig. 4. Post-war LULC change percentage
Fig. 5. 2003 Land use and land cover map.
3.1.3 Land cover change narratives
FGD, key informant and in-depth interviews with state and non-state actors probe into the proximate and underlying factors that have shaped the landscape shown in Figs. 5-6. Almost all the participants agreed that LULC changes following the end of the war have been unprecedented. Some of the issues identified by participants as proximate and underlying factors for the changing landscape since the end of the war include urbanisation and land acquisition methods, and livelihood activities of inhabitants at the fringes of the WA Peninsular Forest.

3.1.3.1 Urbanisation and land access
The LULC change literature is conceptually rich with explanations of landscape change (Geist & Lambin, 2002). One simplistic underlying factor that dominates the debate is the increase in population. Whist discussions with participants support this argument, it is important to bear in mind that civil war became the main driver of population change. Participants...
underscored that those migrants’ ‘new found opportunity’ in the WA had caused them to become reluctant to go back to their homes.

After the war, almost majority of the people that came to the Western Area [during the war] did not bother to return to the provinces. They decided to stay within the Western Area and as such, everybody wants to get a shelter and for you to get a shelter and you do not have money all what you have to do is to grab land by force at least to manage with your family. (Jay, FGD).

The reluctance by migrants to return to their homes will undoubtedly exacerbate the ‘housing question’. Because of such pressure coupled with weak government policies and high youth unemployment, participants argued that land is the most valuable commodity and consider it the region’s ‘diamond’. The recognition of ‘land as a diamond’ has encouraged uncontrolled access. Participants described uncontrolled land access as ‘land grabbing’, a practice mostly understood as illegal land deals between multinational companies and governments for the cultivation of non-agricultural commodities and biofuels. ‘Land grabbing’ in the context of these respondents is different.

Land grabbing is when somebody does not want to buy land, it can be to private or state land sector, but just go and deforest the place and start to sell or sometimes just inhabit the place. (Mary, FGD).

Participants who identified land acquisition in this manner mentioned instances in their communities. In particular, some narrated their personal experiences with community members.

Some people use influential people [government officials, chiefs and community elders]. When they call their names, to say that this person is the owner of this land and because of their position in government, some land officials are scared of pushing them away. For example, many people have asked if I want land in the peninsula. They are looking for somebody who will be part of them, whose name would be strong enough for them not to [be removed] from the area. (Aruna, Ogoo farm, IDI).

3.1.3.2 Livelihoods

During the civil war, migrants with agricultural skills embarked on the cultivation of crops in available urban spaces. Although the cultivation of crops in the mountain rural villages of Leicester and Gloucester dates back to the colonial era (Binns et al., 2011; Maconachie et al., 2011), it became increasingly important for food security during the war period. An imposed international embargo on the country’s ‘Junta regime’ in 1998 together with increased rebel activities in rural areas cut off WA’s main food supply conduit. In order to compensate for lost food supplies, migrants undertook extensive agricultural activities in available urban spaces in WA. The practice of urban agriculture did not, as one might expect, end with the war, but is now regarded as a strategy for food security and income generation within the region (Thornton et al., 2012).

Participants acknowledge that ‘land grabbers’ have used this practice to gain access to upland farmland. During the discourse, they all agreed that forestry officials granted permission to individual farmers to undertake farming in the hills. In the process, ‘makeshift’ structures began to appear, and with time these structures developed into a built up area.

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8 See Messerli et al. (2013).
9 In 2007, the Armed Forces Revolutionary Council (AFRC) overthrow the democratically elected government.
The other livelihood activity that became clear during the FGDs was charcoal production and quarrying. Forestry was giving permit[s] to people for them to farm the land. The layman who has been given [a] permit to farm the land will think that he/she is the owner of the land. (Joe, Grafton, KI).

3.2 Discussions
Urbanisation driven by the decade long civil war has been and continues to be the major contributing factor to the changing landscape of the WA. The declining rates of forest (old and regrowth), mangroves and urban agriculture and increases in built up and bare land are substantial. If the trend continues, it may destroy the tourism potential of the region. Additionally, it will continue to affect the quality of life for WA residents by destroying the catchment of Freetown’s water source. While the end of the war is worth celebrating, it has contributed to the damaging to the region’s environment. Instead of reversing the mass migration rate, reviving resource exploitation and rural economies, increased opportunities has cause rural migrants to remain in the WA.

Participants narrated various factors that have given rise to the present landscape. Participants’ descriptions of the factors that have shaped the region’s landscape demonstrate the complex social structures have emerged after the war. These complex social structures clearly show the fragility of post-war societies, which because of fear of regressing into another conflict and lack of resources, weaken the implementation of policies that protect the environment.

4 Conclusions
This paper has given an account of post-war LULC change dynamics in the WA of Sierra Leone and the reasons for the observed trends. The aim of the study was to assess LULC trajectories and document the narratives that have helped modify the landscape. The research has shown that post-war urban expansion of the WA has occurred at the cost of other land cover types including mangroves, forest regrowth and urban agriculture. A significant finding to emerge from the study is how vulnerable post-war environments become amidst high youth unemployment, weak policies and the quest to own a house and make a living. The findings from this study provide a new understanding of LULC change in a post-war context, where government policies on the environment are often weakly predicated on the abandonment of environmental programmes because of the lack of funding from government and international agencies.

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6 References


