

**Institutional capacity building for urban agriculture research using
Participatory GIS in a post-conflict context:
a case study of Sierra Leone¹**

Alec Thornton

University of New South Wales and University of Witwatersrand

Jinnah Momoh

University of Sierra Leone

Paul Tengbe

University of Sierra Leone

Abstract

In post-conflict societies, cities often experience drastic change in settlement and land-use patterns that transform human-environment relationships. These changes include internal displacement, often to urban areas, and environmental degradation. In many African cities, these patterns and relationships are being shaped by urban and peri-urban agriculture (UPA), a production system that ensured food security for thousands of rural migrants seeking relative safety in urban areas. In a post-conflict scenario, UPA continues to provide food security and employment in an environment struggling to physically and emotionally recover. Methodologies using a geographical information system (GIS) for urban ecosystem assessment (UEA) are gaining currency among researchers, planners and practitioners to improve understandings and find solutions for sustainable urban development. This article will discuss the use of a GIS for post-conflict urban assessment of human-environment relationships in Sierra Leone, where a ten-year civil war, which ravaged the countryside, resulted in the internal displacement of thousands of rural inhabitants to the capital city, Freetown.

Introduction

The use of a geographical information system (GIS) is a valuable tool for spatial analysis, used for revealing land use types, such as urban and peri-urban agriculture (UPA) and its distribution patterns. The use of GIS software and a hand-held global positioning system (GPS) are powerful tools for gathering, storing and analyzing spatial data. Interest in the use of a GIS for livelihoods and land use mapping and as a participatory tool

¹ The study discussed in this article was funded by a joint British Council-Department for International Development (DfID) initiative *Developing Partnerships in Higher Education (DePHE)*. A Learning and Teaching Project Grant from the University of New South Wales at Canberra, Australia, funded a subsequent visit to Sierra Leone for the corresponding author.

is increasing. Participatory approaches can enhance at the micro level the resilience of small scale farmers in coping with disaster and mitigate risk; at the macro level, through strengthening the capacity of institutions, such as in higher education, to conduct independent studies to inform government policy for social and economic development. In this article, a case study of UPA in Sierra Leone is used to inform the discussion of the use of a GIS as a participatory tool revealing the location of UPA plots and patterns within the built-up urban areas and the peri-urban 'fringe.' On a broader level, the study illustrates that a GIS may be useful to other local municipalities, urban planners and researchers as a tool for identifying and monitoring changes in the scale, type and spatial distribution of existing UPA activity.

In the absence of adequate government and external support, urban and peri-urban agriculture (activities related to food production in towns and cities and along the 'fringe' or boundaries) provided a lifeline of sustenance for urban dwellers. In a post-conflict scenario, the value of urban agriculture as a food production system endures. This fact has attracted the attention of policymakers and urban planners concerned with national food production, particularly during crises, including price 'shocks' in agro-commodity markets and oil affecting food supply. However, limited understanding of the geographical extent and economic viability of urban agriculture is a constraint to its emergence as a national strategy to safeguard the domestic food supply. To lessen this constraint, geographers from Sierra Leone, the United Kingdom, New Zealand and Australia collaborated on a three-year research project to identify the location and spatial characteristics of open-field urban agriculture and collect baseline data from its practitioners in the greater Freetown urban area. In this article, the discussion will focus on methodological and practical implications of Participatory Geographical Information System (PGIS) use in research on post-conflict urban food production, or urban and peri-urban agriculture in Freetown.

Participation and GIS

There is considerable potential in the use of spatial tools, such as a GIS, as an informative tool for policy makers and town planners. However, the use of these tools is dependent on the availability and reliability of an infrastructure for information technology. Moreover, the extent that a GIS can be truly 'participatory' is not only an issue of infrastructure capacity, but also the capacity and capability of a broad range of potential user groups to access the technology and use it. Its participatory credentials have been questioned, in terms of ownership of the process, control and

representation of local and indigenous knowledge.² GIS is, obviously, a complex technical tool requiring a high level of skill and expense (computers, software and maintenance), which creates concern regarding its applicability beyond (or ‘below’) the level of top-down planning. Issues regarding control of technology have been raised where community development, including computer centres (or ‘cyber cafes’) have been prone to ‘elite capture.’³ In situations like this where local elites exclude intended beneficiaries of a community-driven project or process, it is perhaps short-sighted to hypothetically ‘suggest’ a PGIS approach without actually subjecting it to a field-test or pilot study.

Of primary concern to this article, is the use of a PGIS approach in areas where certain phenomena, such as UPA, are not well understood, both in spatial terms and production potential. Freetown, the capital of Sierra Leone, experienced rapid and sustained population growth as a result of a prolonged civil war. In this post-conflict context, information regarding the spatial extent of UPA can provide critical information for rebuilding the local economy, identifying types of land tenure and land use, creating employment, housing and improving health and local food supply.

In Sierra Leone, a GPS and GIS was used to collect spatial data that included the local knowledge of urban farmers. The participatory process had a positive effect on ‘good governance’ outcomes through encouraging dialogue among urban farmers, non-government and governmental stakeholders in a workshop to discuss present and future urban and peri-urban land use for agriculture and its broader implications for urban development. Although the UPA study was collaborative, between institutions in developed and developing countries, it was the latter partner that implemented the GIS component of the study. Funding from a research grant (collaborative application) made possible the purchase of laptops, GIS software and GPS units (research partners at Fourah bay College, University of Sierra Leone assumed ownership of these items).

What is UPA?

There are several useful definitions of urban agriculture (UA) or urban and peri-urban agriculture (UPA) can be understood as any agricultural activities, including production, processing, distribution and marketing,

² Christine Dunn, “Participatory GIS—a people’s GIS?” *Progress in Human Geography*, 31:4 (2007): 616-637

³ Jean-Phillipe Platteau, “Monitoring elite capture in community-driven development,” *Development and Change*, 35:2 (2004): 223-246

occurring in built-up ‘intra-urban’ areas and along the ‘peri-urban’ fringes (often ‘green-belts’) of cities and towns.⁴ The concept of ‘peri-urban’ is generally understood as the physical interface where complex rural-urban interactions take place.⁵ In sub-Saharan Africa, a peri-urban area is typically not spatially zoned, can be near a city centre and occupied by poor households and the socially excluded.⁶ A range of constraints exist that can discourage and prevent UPA from developing into a formidable development tool for poverty alleviation. These constraints include (but are by no means conclusive),

- Lack of clarity and disputes over land use and land tenure⁷
- City by-laws that effectively ‘ban’ UPA⁸
- Limitations due to environmental and climate conditions⁹

UPA in postconflict Sierra Leone

In Freetown, the war destroyed lives and property including the physical environment. People were displaced from major economic activities such as mining, farming and forestry. More significantly, there was mass immigration of people from the surrounding adjacent areas into Freetown. These new arrivals and displaced people were basically farmers who turned to urban farming in and around Freetown. As a result, bush and forest cover were degraded in providing land for the construction of makeshift or temporary accommodation and farming. This immigration of people for security reasons also increased the population in Freetown, thereby putting pressure on existing facilities and inadequate food supplies. This resulted in the increased activities of urban and peri-urban agriculture.

Although research on UPA in Sierra Leone is scarce, previous studies have indicated its prominence on the urban and peri-urban landscape.¹⁰

⁴ Alec Thornton, “Beyond the Metropolis: Small Town Case Studies of Urban and Peri-urban Agriculture in South Africa,” *Urban Forum*, 19:3 (2008): 243-262.

⁵ Kenny Lynch, *Rural-urban interaction in a developing world* (London: Routledge, 2005).

⁶ Beacon Mbiba and Marie Huchzermeyer, “Contentious development: Peri-urban studies in sub-Saharan Africa,” *Progress in Development Studies*, 2:2 (2002): 113-131.

⁷ Alec Thornton, “Pastures of Plenty?: Land rights and community-based agriculture in Peddie, a former homeland town in South Africa,” *Applied Geography*, 29:1 (2009): 12-20.

⁸ Daniel Maxwell, “Alternative food security strategy: A household analysis of urban agriculture in Kampala,” *World Development*, 23:10 (1995): 1669-1681.

⁹ Andre Viljoen, *Continuous Productive Urban Landscapes (CPULs): Designing Urban Agriculture for Sustainable Cities* (Oxford: Architectural Press, 2005).

There have been several notable advancements in UPA gaining official recognition in Sierra Leone at the level of local and national government.

A UPA project by researchers at Njala University investigated the characterization of soils, land uses and the socioeconomics of urban agriculture and its implications for urban agricultural policy. The Ministry of Forestry and Food Security (MAFFS) teamed with the International Network of Resource Centers for Urban Agriculture and Food Security (RUAF) and launched the recently concluded Freetown Urban and Peri-Urban Agriculture Project (FUPAP). It has trained people in multi-stakeholder processes for action planning and policy making for urban agriculture. It was concluded that the foundation of life in Freetown since pre-colonial times was marginalized by non-farm land uses during colonial and post-colonial urbanization, but it resurged in importance during the decade long civil war of the 1990s.

Deciding on a UPA research framework

Local variances exist, regarding how UPA is practiced, as well as who practices it and reasons for deciding to engage in it. Identifying appropriate research frameworks that can best conceptualise an activity that reflects the reality of those who practice it, as well as its significance and ecological impact, is challenging. Increasingly, researchers are adopting creative and resourceful approaches to understand the diversity of UPA, in terms of its practitioners, production systems and levels of public, private and grassroots involvement. In our study, a GIS approach was adopted to determine the extent of UPA activity in the greater Freetown municipality. Although UPA research has increased in Sierra Leone in recent years, a GIS approach to identifying UPA locations in Freetown has not been implemented. Such an approach is necessary, as the local government is actively seeking information regarding the relevance and geographic extent of UPA for decision making at the municipal planning level.

Geographical orientation

Sierra Leone has a tropical climate. Politically, it is bounded from the north-west to north-east by the Republic of Guinea, from the south-west

¹⁰ Roy Maconachie and Tony Binns, “‘Farming miners’ or ‘mining farmers’?: Diamond mining and rural development in post-conflict Sierra Leone,” *Journal of Rural Studies*, 23:3 (2007): 367-380; Gerald Forkuor and Olufunke Cofie, “Dynamics of land-use and land-cover change in Freetown, Sierra Leone and its effects on urban and peri-urban agriculture - a remote sensing approach,” *International Journal of Remote Sensing*, 32:4 (2011): 1017-1037.

to south-east by the Republic of Liberia, and on the West by the Atlantic Ocean (Figure 1). Geographically, it is bounded on the North by Latitude 10° N, on the East by Longitude $10^{\circ} 16^1$ W, on the South by Latitude $6^{\circ} 55^1$ N, and on the West by Longitude $13^{\circ} 25^1$ W. This UPA study was conducted in the Western Area (Figure 2), which is divided into the Western Rural and Western Urban (Figure 3).

Materials and Methods

Maps and Equipment

The materials used for mapping UPA sites in the Western Area include Google Earth images, 1:50,000 topographic map of Sierra Leone, with particular focus on the Western area, shapefiles (country, regions, districts, hydrology and settlements), Trimble GeoXM 2005 Handheld Global Positioning System (GPS) Series and ArcGIS 9.3 GIS software.

Field Methods

The field survey was conducted in two phases, namely: pilot survey and actual field data collection on the spatial distribution of UPA sites. During the pilot survey, Google Earth was used extensively to download images to provide a useful base map of agricultural sites in the Western Area. Fifty-nine (59) sites (Figure 4) were downloaded with their coordinates and estimated areas identified, cross checked with town survey maps and, finally, grouped in West I, II, III; East I, II, III, Central and Mountain Rural Districts. During the actual mapping of spatial distribution of UPA sites, the Trimble GPS was used to capture measurements of the geographic locations of agricultural sites. For small gardens on the one hand, where the coordinates do not vary from point to point, their geographic locations were recorded and represented as point data. For large gardens where the coordinates vary from point to point considerably, the coordinates were recorded and represented as polygons for which estimates of a real extent could be achieved. Heights of the UPA sites above mean sea level (MSL) were also recorded from the GPS. Other relevant and related data recorded during the mapping exercise include: ownership of gardens (individual or associations), name of garden (if any), and dominant vegetables grown in each garden.

Laboratory Methods

The laboratory methods comprise UPA database development and, cartographic analysis and products generation. Data on coordinates of UPA sites, site name, common vegetable types grown, ownership of gardens, and height of sites above sea level were entered into Microsoft Excel. This data were then converted into ASCII (American Standard

Code for International Interchange) and exported into ArcGIS 9.3 GIS software for cartographic analysis. Exporting and storing these UPA data sets within GIS software provides more easy and flexible ways of data analysis and preparation of maps. During the cartographic analysis, the UPA sites were digitised and symbolised to group agricultural sites based on dominant vegetables grown as shown in Table 1 below.

Table 1: Dominant Vegetable Types Grown

L	=	Lettuce
Ca	=	Carrot
Cb	=	Cabbage
T	=	Thyme
Cu	=	Cucumber
P	=	Potato leaves
C	=	Cassava leaves
O	=	Okra
Pea	=	Peanuts

The heights above mean sea level data were also used to generate contour maps to provide useful information on the relationship between topography and agricultural activities. To validate the accuracy of the GPS data captured, the UPA maps were overlaid on the 1:50,000 topographic map of the Western Area, which provided a close match between settlements and UPA areas map. Having captured all UPA sites using the Trimble GPS, the point and polygon data were overlain on a 50K Topographic Map of Sierra Leone to ascertain the accuracy of the GPS. It was observed that the location of UPA sites obtained by the GPS perfectly matched the sites on topographic maps and Google Earth images

Discussion

A key aspect of the project, from which this paper is based, is in building the capacity of our research partners at Fourah Bay College (FBC) to contribute and participate in geographic knowledge. The ten-year civil war had a profound impact on the potential for economic and social development, including education. Improving the capabilities of higher education institutions to provide tertiary education at a global standard is crucial for achieving several targets outlined in the Millennium Development Goals. Partners from the United Kingdom, New Zealand and Australian institutions in this project facilitated the process of

strengthening the capabilities of geography department at FBC, which included visits to partner countries to re-establish important teaching and research networks. For research using geo-spatial tools, a reliable power supply is obviously important. Although the civil war in Sierra Leone ended a decade ago, rebuilding the infrastructure, even in the capital city, has been a slow process. There were times when we experienced national electricity shutdowns for days getting into weeks. We overcame this by firstly procuring a 5KVA generator and later soliciting funds from the UNDP through the Ministry of Lands, Country Planning and Environment to procure a UPS inverter, which can now serve the Geoinformatics laboratory for a period of 6 hours or more.

Participatory elements of the project

Throughout the study, we were careful to ensure farmers' participation, seeking their input and to identify potential obstacles to their participation in the mapping process. Although we initially identified gardens through Google Earth images, extensive groundtruthing was carried out to confirm the location of gardens and make contact with the farmers. Farmers assisted in identifying individual and community-based gardens. Land ownership, if self-owned, government-owned or rented was clarified as well. In terms of the actual mapping, the farmers were accommodating and ready to provide answers to the questions asked. They also confirmed that indeed the maps were true replicas of where they do their gardening. They commended the department for the use of the technology in bringing all gardening sites and activities into a simultaneous view.

During the workshop, the stakeholders (farmers, Government officials, planners) agreed that the mapping activities were helpful for recording and monitoring UPA sites. In addition to UPA site location, stakeholders confirmed other forms of data entered on the maps, such as dominant vegetable types and associations of growers linked to the cultivation of particular crops. This information was used to create a 'market map' that can provide important marketing information for consumers and suppliers, as well as provide advice to planners in establishing markets nearer to the gardens. The relationship between farmers and the mapping team was very cordial and interactive. Effective partnerships with other institutions, including DACO and Statistics Sierra Leone, were instrumental in acquiring existing GIS, town planning and household data, as well as access to printing services. The majority of farmers indicated satisfaction with the mapping exercise and outputs, especially with open discussions regarding successes and problem solving among

the farmers and issues of land ownership and land tenure. In future projects, what needs to be improved upon is transportation for the movement of produce from farmgate to the market. Finally, it is not known if a different approach could have brought better results, as all mapping exercises successfully met the aims of the project.

Survey findings

Although this article is concerned with the PGIS methodology, it is worthwhile to briefly outline some key findings from the survey of households, which were identified from the mapping activities.

Similar to studies of agriculture in rural and urban areas on the African continent, UPA in Freetown is largely practiced by women, ages ranging from 31-60 years. For the majority (64.4%) of urban agriculturalists, income was cited as the primary reason for farming. Land for farming was identified as their main constraint or problem. Land ownership among the farmers is limited, as 42.1% farmed on rented land, 27.6% used government land and only 10% owned the land they farmed. Land under cultivation is about an acre for the majority farmers (92.1%). Transport to market of their products was mainly by head portage (77.5%). Only 14.4% of farmers had access to extension services through agents of the Ministry of Agriculture Forestry and Food Security (MAFFS). Extension services were mainly for the provision and use of fertilizer (26.3%) and improved planting materials. A low level of employment was observed among the farmers (80.3%); of those employed, only 12.3% had jobs in the formal sector. Obviously, the civil war had a crippling impact on the economy, which explains the importance of the informal sector. Income categories of farmers ranged between USD\$5-10 per day. This can be attributed to a number of variables including plot size, access to markets, skilled labour and extension services.

Conclusions

The primary methodological contribution of this study was to develop and field test a PGIS approach to UPA research. Including the use of a GPS, the research involved a participatory process to inform dialogue and build relationships among a range of stakeholders regarding the current and future use of urban and peri-urban land and resources for post-conflict development. In the process, it was hoped that the research would provide UPA observers, researchers, as well as local policy makers and urban planners, with factual local knowledge integrated with geo-referenced data. This data was interpreted using a GIS, revealing spatial distribution patterns of existing UPA activity. The creation of GIS maps

was invaluable in creating a sample frame for a household survey and as a participatory tool revealing, UPA patterns, available natural resources that could support it (i.e. catchments), proximity to markets and sensitivity of ecosystems in the research areas. For both Government and municipality, a comprehensive record of UPA sites, the intensity of the activity and a strong basis for informing policy towards UPA in the city and other urban centres were highlighted by the stakeholders as crucial for urban development planning. On a broader level, a GIS may be useful to other local municipalities, urban planners and researchers as a tool for identifying and monitoring changes in the scale, type and spatial distribution of existing UPA activity.

Bibliography

- Dunn, Christine. "Participatory GIS—a people's GIS?" *Progress in Human Geography*, 31:4 (2007): 616-637.
- Forkuor, Gerald and Olufunke Cofie. "Dynamics of land-use and land-cover change in Freetown, Sierra Leone and its effects on urban and peri-urban agriculture - a remote sensing approach." *International Journal of Remote Sensing*, 32:4 (2011): 1017 – 1037.
- Lynch, Kenneth. *Rural-urban interaction in a developing world*. London: Routledge, 2005.
- Maconachie, Roy and Tony Binns. " 'Farming miners' or 'mining farmers'? : Diamond mining and rural development in post-conflict Sierra Leone." *Journal of Rural Studies*, 23:3 (2007): 367-380
- Maxwell, Daniel. "Alternative food security strategy: A household analysis of urban agriculture in Kampala." *World Development*, 23:10 (1995): 1669-1681.
- Mbiba, Beacon and Marie Huchzermeyer. "Contentious development: Peri-urban studies in sub-Saharan Africa." *Progress in Development Studies*. 2:2 (2002): 113-131.
- Platteau, Jean-Phillipe. "Monitoring elite capture in community-driven development," *Development and Change*, 35:2 (2004): 223-246.
- Thornton, Alec. "Beyond the Metropolis: Small Town Case Studies of Urban and Peri-urban Agriculture in South Africa," *Urban Forum*, 19:3 (2008): 243-262.
- Thornton, Alec. "Pastures of Plenty?: Land rights and community-based agriculture in Peddie, a former homeland town in South Africa." *Applied Geography*, 29:1 (2009): 12-20.
- Viljoen, Andre. *Continuous Productive Urban Landscapes (CPULs): Designing Urban Agriculture for Sustainable Cities*. Oxford: Architectural Press, 2005.

Figure 1: Map of Sierra Leone



Source: The Commonwealth Secretariat (www.thecommonwealth.org)

Figure 2: Regional Map of Sierra Leone Showing the Western Area Project Site

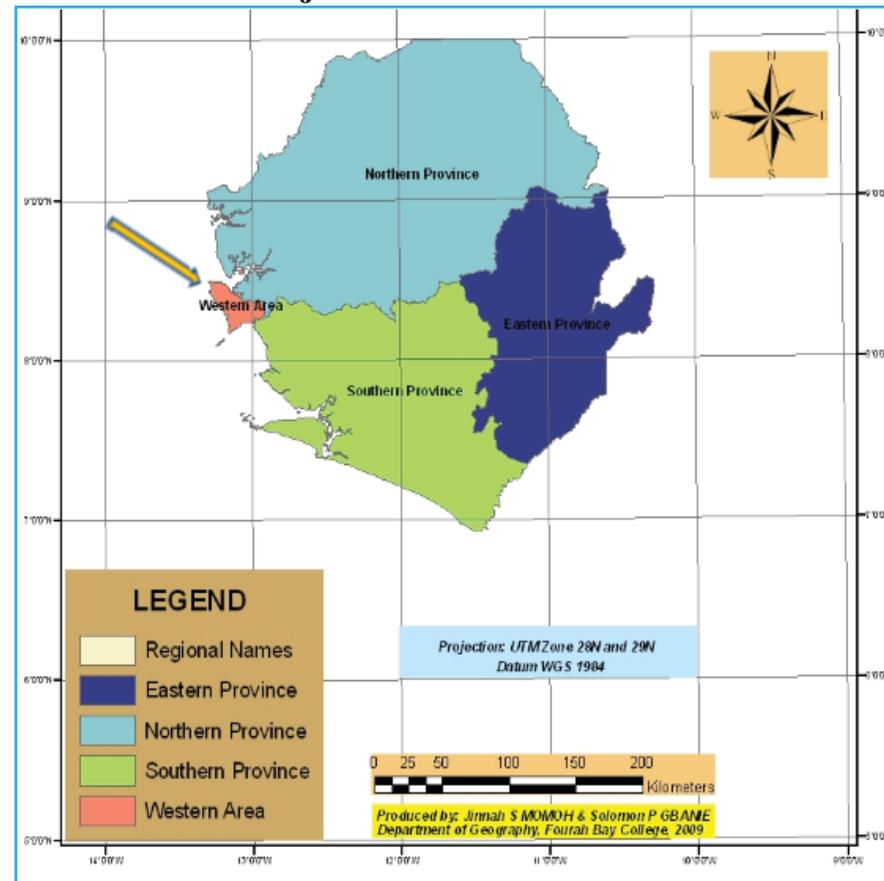


Figure 3: Map of Western Area Showing Western Rural and Western Urban

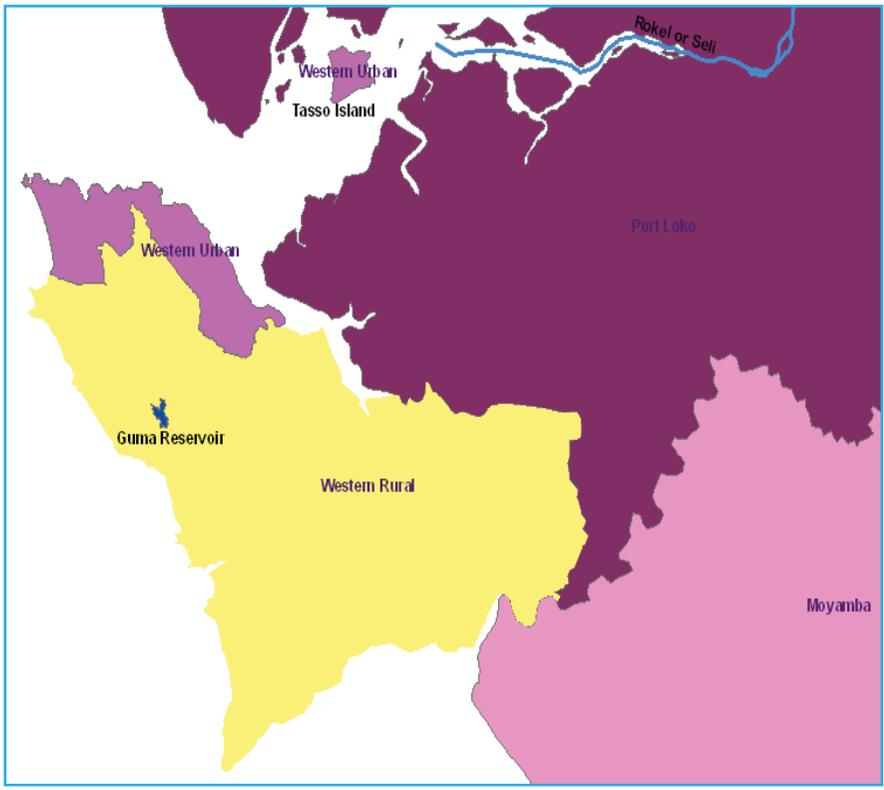


Figure 4: Map of UPA field sites in Freetown

