

# **Monrovia: From 1995 Block Mapping Survey to 2023 Digital Cadastre**

**Christopher BYREN, Sweden; Dr Mahmoud SOLOMON, Liberia; Frank PICHEL, United States**

**Key words:** Cadastre, Land Administration, Geographic Information, Spatial Planning, Digitization.

## **SUMMARY**

Lantmäteriet, the Swedish Mapping, Cadastral and Land Registration Authority, is implementing a Sweden funded bilateral project with the Liberia Land Authority in Liberia: 'Capacity Building for Inclusive Land Administration and Management Project in Liberia' (ILAMP).

In late 2022, an atlas was discovered, produced by the World Food Programme and UNFPA between 1994-1995, during a lull in the Liberian civil war. The atlas, found in a Liberia Land Authority office, is a hand-sketched block mapping survey of Monrovia and its environs – including the 3D strata given that apartments have also been captured along with all individual properties. Also discovered, in conjunction with the atlas are two directories of principal occupants, as well as commercial and private and public institutions that either own/owned or inhabited the properties at the time of mapping.

Given that Liberia is a country that lacks, or has lost due to the civil war, spatial information, registry data, and hardcopy maps - cadastral and otherwise - this discovery is significant. Lantmäteriet has scanned the atlas and accompanying directories and the objective is to subsequently digitize the atlas and following the linkage of data, create a digital cadastral map of Monrovia, anno 1995.

This will create a basis for further work related to the integration into a single digital record, including previously scanned records - creating a digital title deed solution and possibly leveraging Artificial Intelligence (AI) to geo-reference title deeds that lack coordinates.

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## **1. INTRODUCTION**

### **1.1. ILAMP overview**

ILAMP is a 5-year (2019-2023) capacity building project implemented by Lantmäteriet, the Swedish Mapping, Cadastral and Land Registration Authority. The Sweden funded bilateral project is in support of the Liberia Land Authority (LLA).

As the name implies, the focus is on building the capacity of the Authority via knowledge and skills transfer and training on key land governance functions including the latest survey methodologies, database administration and the workflow implemented to capture land parcels. The project's largest component is the organizational development of the Authority, where equipment, systems, skills, and spatial data have been lacking.

The LLA was established as an autonomous agency of the Government when the Liberia Land Authority Act was passed by the Legislature in 2016. The Act defines the LLA's primary mandate as the development of policies on a continuous basis and undertaking actions and implementing programs in support of land governance, including land administration and management.

### **1.2. Liberia's Land Information Challenge**

Years of conflict have left the historical legacy of land information in Liberia in tatters, and it is only in the last decade that the Government has been able to begin the process of rebuilding the land administration infrastructure. It should be noted however that even prior to the conflict the tradition of land documentation was weak and high accuracy spatial definition of property boundaries were limited to urban areas, at best.

Over the course of more than a decade of fighting in Liberia, many records were lost or destroyed. This is further complicated by the death of an estimated 250,000 people, and a refugee crisis which scattered two million people across the sub-region. Many of these refugees eventually returned home to find property occupied by others – with the resulting ownership disputes.

Years of conflict left the Departments of Lands, Survey and Cartography (DLSC) and the Centre for National Documentation, Records and Archives (CNDRA), the agencies historically responsible for verification, administration, and management of land information, in poor condition with limited technical and human resources.

It should also be noted that most of the land records that were held have little in the way of usable spatial definition of the property locations. In many locations, a legal textual description is all that is available, while others might include property dimensions. However, the defining property monuments may include natural features such as trees and creeks, that have long since shifted or no longer exist, or man-made monuments that have been lost to history. When survey diagrams are included, they generally contain only a compass bearing and distance between monuments, resulting in a well-defined polygon, but which is not tied to a specific location.



## 2. RE-EMERGENCE OF A MONROVIA ATLAS

In late 2022, an atlas was re-discovered, produced by the World Food Programme and UNFPA between 1994-1997, during a lull in the Liberian civil war. The full title is "1994-1995 Monrovia and its environs block mapping survey report - Maps of Monrovia Zones and Communities".

The atlas was found in an office at the Liberia Land Authority and is a hand-sketched block mapping survey of Monrovia and its environs - including the 3D strata given that apartments have also been captured along with all individual properties. Also discovered, in conjunction

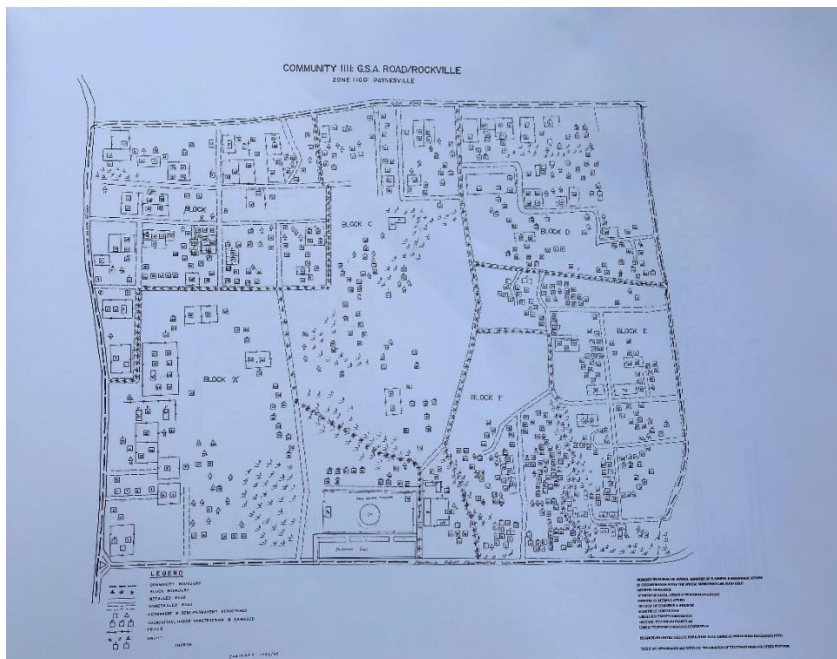
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with the atlas are two directories of principal occupants, commercial and private and public institutions that either own/owned or inhabited the properties at the time of mapping. The block mapping code implemented in the atlas links to the directories, associating the individual properties and apartments to the respective occupants - not necessarily owners - or institutions.

After discussions with the management at Liberia Land Authority the decision was made to scan the atlas and accompanying directories with the objective to subsequently digitize the volumes.



Scanning the atlas and directories in Liberia presented a challenge due to the unusual format of the material. The scanning was therefore done by experts at the National Archives (Riksarkivet) in Sweden. Riksarkivet possess both the expertise and the technology to be able to scan books without having to remove the pages from the volumes. This has been particularly important since the Liberia Land Authority are only aware of a handful of hardcopy versions in existence.

The printing was done in Lebanon in 1997 and the company that was contracted for the task is still operating in Monrovia. Through this company the ILAMP team managed to get a copy of the atlas and transport it – and the directories - to Sweden for the scanning.

The scan data of the atlas and the two accompanying directories have been delivered as a contiguous PDF and as single page TIFF files with the latter in 24-bit RGB with LZW-compression. The historical significance of this work cannot be underestimated. Now the atlas and directories are digitally preserved for the future - and more importantly, these hand-drawn maps could provide a digital cadastral map of Greater Monrovia that does not exist today

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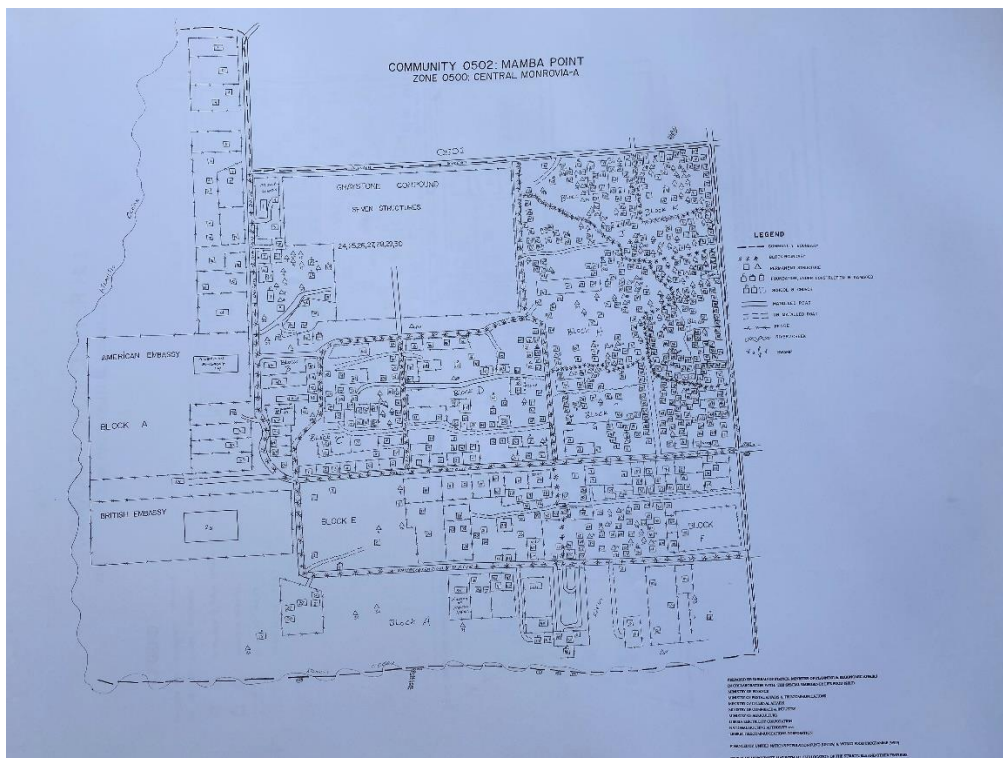
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### 3. RECOVERING AND INTEGRATING PREVIOUSLY SCANNED LAND RECORDS

The discovery of the Monrovia atlas and its value must be understood in its historical context. Following the war period land records were scattered across the Ministry of Foreign Affairs (MoFA) at the Executive Mansion and the Department of Lands, Surveys and Cartography, as well as CNDRA. The records were poorly indexed, existent only in paper form, and stored in damp rooms without climate control. Records were known to have been lost or misplaced regularly. The Government of Liberia, recognizing that the existing paper land records were at risk of loss and destruction, noted that they should be organized, digitized, and secured to prevent further loss.

CNDRA was identified as the natural and legal custodian of the land records, and with the support of USAID, the Land Policy and Institutional Support Project (LPIS) assisted the government of Liberia over the course of 2009-2012 in rebuilding capacity within CNDRA. Tasks included, amongst other things, digitizing the existing land records and rehabilitating the Deeds Registry System.

Over the course of 15 months from September 2011 – December 2012 staff members scanned and indexed more 10,000 documents and 20,000 pages into Open Title software from International Land Systems (ILS). Ultimately, the software was used until 2017 when a combination of factors led to a reversion to a paper-based process.



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## **4. LAYING the foundation for an INTEGRATED LAND INFORMATION SYSTEM**

### **4.1. Digitizing Paper Records**

Even though Open Title was a digital deeds registry, as a document management solution it did not cater for the ability to georeference title deeds as the survey diagrams lacked coordinates. Additionally, the scanning and indexing work done has to a certain extent sadly been lost due to the obsolescence of the system in 2017. The work now being done is intended to lay the foundation of a fit-for-purpose Integrated Land Information System.

Now that the Monrovia atlas and two directories have been scanned, the plan is to digitize or vectorize the map data – property boundaries, structures, and features. Once the map data is digitized, an attempt will be made to link the occupant information from the directories, utilizing Optical Character Recognition (OCR) to the structures/properties via the block mapping coding. Linking the principal occupants as attribute data to the properties should enable us to deliver an anno 1995 digital parcel fabric of Monrovia.

### **4.2. Linking Database Records to Title Deed Images**

In parallel to the scanning and digitization of the Monrovia atlas work has been ongoing resurrecting the now obsolete Open Title digital title deed solution. Being fortunate enough to be able to source the original Open Title database, work is ongoing to re-establish the links between the database records and available digital title deeds in an alternative environment. Some of the original data has probably been lost due to a server crash but attempts are being made to extract data from the three (3) original rack-mounted drives from CNDRA.

### **4.3. Connecting Title Deeds to Land Parcels**

Once the digitized cadastral maps including principal occupant attribute data is finalized, and the linkage of original database records to existing title deeds is completed as far as can be achieved, opportunity exists to extend this process.

The intention is to then cross-reference the names of the occupants of the properties against the names of title deed holders from the recovered data in what was Open Title, and in some instances be able to connect title deeds to properties. Obviously, being able to localize the available title deeds is entirely dependent upon the occupant at the time also being the legal titled owner of the property. Additionally, this by no means depicts the current reality of property ownership but is a version of the reality at that time.

Nevertheless, given the challenge that historical title deeds are not geo-referenced, this may contribute towards localizing and connecting title deeds to properties.

## 5. CONCLUSION

### 5.1. Initial Results

The initial results from the scanning process are extremely good, in that the images are high-quality, they follow the same structure and have consistent page placement, which should allow for successful OCR.

The digitization process is yet to commence, but initial comparison of the scanned map data against aerial imagery indicates a relatively accurate correlation between the hand-drawn maps and today's reality. This indicates a good level of scale accuracy from the hand-drawing that will be further tested by surveying and comparing against key features and ground control points.

So far, a linkage has been made between 35% of the records in the original Open Title database and the scanned title deed images. There also remain approximately 39,000 scanned documents not currently registered in the database.

In reconstituting the digital title deed solution, integration with a GIS now also provides the ability to capture the geometry of new registered properties, which are now being surveyed with co-ordinates.

### 5.2. Next Step – Using Artificial Intelligence

Can AI form part of the solution in solving the puzzle of geo-referencing title deeds? This is something that will be explored going forward and an initial feasibility analysis is underway.

Historical title deeds lack spatial definition i.e. survey diagrams only including a compass bearing and distance between boundary markers, but the diagrams may contain physical features such as roads, walls, adjacent buildings etc.

AI might be leveraged to interpret these features and assist in the geo-referencing of title deeds, but this has not yet been tested and established.

## BIOGRAPHICAL NOTES

Christopher Byren is the ILAMP Project Manager resident in Liberia since 2020. Christopher is a Technical Land Surveyor with over 30-years' experience in the geospatial industry. He has previously held management positions at Esri South Africa, Leica Geosystems and Swedesurvey and has been registered as a Professional Geo-Information Science Practitioner (PrGIScP) with the SAGC (South African Geomatics Council).

Mahmoud Solomon is an ECOWAS Fellow with a PhD in Surveying and Geoinformatics from the University of Lagos, Nigeria. Dr Solomon serves as Assistant Director, Survey and Mapping at the Liberia Land Authority. He offers post graduate courses in GIS, Remote

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Sensing and Climate Change at the University of Liberia in the Department of Climate Change and Environmental Science. He formally served the Ministry of Lands, Mines and Energy in the capacity of GIS Consultant and possesses several certifications in Information Technology.

Frank Pichel is the Partner for Global Field Operations at PLACE, a non-profit mapping data trust that makes spatial data more affordable for decision makers who need the information to improve their environments. As a land administration specialist, Frank has had the opportunity to work in Liberia in a variety of capacities over the past fifteen years. First as a contractor working to modernise land governance in Liberia, and subsequently as part of a bi-lateral organization designing land projects in Liberia, and finally as a land information specialist assisting with the documentation of community land rights for the LLA.

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