

Final Report

Monrovia City Project, Liberia



Humanitarian
OpenStreetMap
Team



Humanitarian OpenStreetMap Team, iLab Liberia and OSM Liberia

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Abbreviations

AOI	Area of Interest
GFDRR	Global Facility for Disaster Reduction and Recovery
HOT	Humanitarian OpenStreetMap Team
LISGIS	Liberia Institute of Geo-Information Services
LNRCs	Liberia National Red Cross Society
LWSC	Liberia Water Sewer Corporation
MoGCSP	Ministry of Gender, Children & Social Protection
MoPW	Ministry of Public Works
NRMA	National Disaster Management Agency
OCA	Open Cities Africa
OpenDRI	Open Data for Resilience Initiative
OSM	OpenStreetMap
OSM Liberia	OpenStreetMap Liberia
JOSM	Java OpenStreetMap
ODK	OpenDataKit
OMK	OpenMapKit
UAV	Unmanned Aerial Vehicle
YOTAN	Youth in Technology and Arts Network

Executive Summary

This report provides an overview of the open mapping activities of the Open Cities Monrovia project led by Humanitarian OpenStreetMap Team¹ (HOT), iLab Liberia² and OSM Liberia³. Project activities were centered on addressing flooding and challenges relating to flooding through the provision of up-to-date data of Zone 300, the project area of interest.

Flooding in Monrovia is cyclical and occurs during the rainy season every year (April - October). The field mapping team collected data during the rainy season, making way for interventions to occur during the next dry season. The project used OpenStreetMap (OSM) and a suite of open mapping tools including Java OpenStreetMap Editor (JOSM), the HOT Tasking Manager, OpenMapKit (OMK), Open Data Kit (ODK), Mapillary, and QGIS, to collect, validate, map, analyze and share accurate datasets from our target communities. Data from the project has contributed to the open data ecosystem where it is being accessed for decision-making and repurposed for different initiatives. All data produced from this project's activities is openly available in OSM.

The project had the following objectives:

1. Create and/or collate and release open spatial data about the built environment, critical infrastructure, and natural hazards;
2. Develop targeted products and/or tools (e.g., visualization tools, atlas, map series, or mobile application) to assist key stakeholders to utilize risk information towards addressing natural disaster risk in the selected city;
3. Enhance the local capacity and institutional development necessary to support the design and implementation of evidence-driven urban resilience interventions; and
4. Promote peer mentorship and build regional networks across cities.

Since the project's inception, 6 trainings have been held, training 93 people in the use of mapping tools and techniques. Total area covered from mapping phases 1 and 2 is 1.11 square kilometers in Zone 300 of Monrovia City, encompassing four communities: Clara Town, River View, Struggle (Doe) and Hope. The data collection activities within our target communities resulted in mapping 4,126 buildings, 82 water points, 93 solid waste points, 86 economic activities, 32 education facilities, 24 health facilities, 76 drain lines, 33 drain points, and 234 flood history points.

¹ <https://www.hotosm.org/>

² <https://www.ilabliberia.org/>

³ <https://twitter.com/osmliberia>

PART 1: Project Overview

Introduction

Monrovia is the capital city of Liberia. Located along the Cape Mesurado peninsula, between the Atlantic Ocean and the Mesurado River, whose mouth forms a large natural harbor. The Saint Paul River lies directly north of the city and forms the northern boundary of Bushrod Island. These rivers open north of Monrovia's largest slum, West Point, home to approximately 75,000 residents and several other unplanned settlements. These unplanned settlements became densely populated during Liberia's 14 year-long civil war - a period where most rural dwellers relocated to the capital to seek employment, education, trading opportunities and security. A legacy of the war is a large population of homeless youth, either having been involved in the fighting or denied an education by it. In 2014, the city was also greatly affected by the Ebola outbreak that impacted several West African countries.

Monrovia is the country's largest administrative and commercial center with a population of over one million (2008 census), constituting 29% of Liberia's total population. Liberia's climate is primarily divided into two seasons - a wet and dry season. Monrovia has a tropical monsoon climate, with an average of 4,624 mm (182.0 in) of rain per year - making Monrovia the wettest capital city in the world.

Vulnerabilities in unplanned settlements in Liberia are numerous, ranging from mobility, health, education, sanitation and hygiene, lack of adequate economic activities for employment, waste management among others. Upon these pre-existing conditions, flooding is turning these communities into huge disaster hubs. These vulnerabilities can be addressed by collecting verifiable data that explore each of these challenges to help decision-makers and development partners to see the gap and true picture for interventions needed. Communities can use these data to generate resilience strategies to face disasters and to dictate their own development agenda at the local level. Success is often contingent on: local capacities and networks to maintain and utilize risk information, enabling policy environments to support effective data management and sharing, and targeted tools that help translate data into meaningful action.

Building on the work of GFDRR's Code for Resilience, Open Cities Africa is being carried out in selected Sub-Saharan African cities to engage local government, civil society, and the private sector to develop the information infrastructure necessary to meet 21st century urban resilience challenges. The project is aligned with GFDRR's Resilient Cities Program⁴ and

⁴ <https://www.gfdrr.org/en/resilient-cities>

implemented through a unique partnership between GFDRR and the World Bank, city governments, and a partner community comprised of regional scientific and technology organizations, development partners, and technology companies to support upcoming or ongoing World Bank-supported activities in select cities.

Problem statement

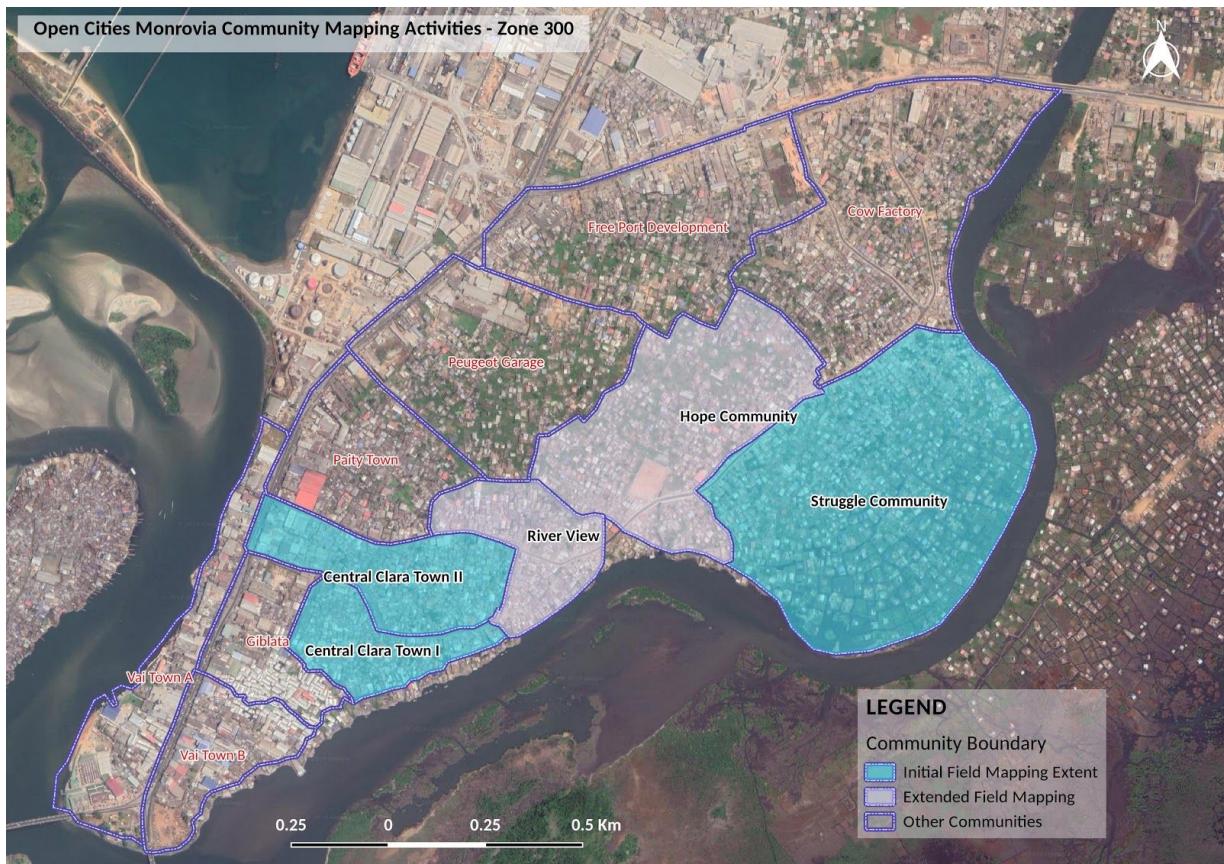
The city of Monrovia is a densely populated peninsular area surrounded by ocean and rivers with unplanned settlements that are prone to disasters. The Open Cities Monrovia project determined flooding as a priority for disaster resilience because it affects most communities (planned and unplanned). Flooding in Monrovia is cyclical, and occurs during the rainy season (April - October). We collected data during the rainy season, to capture accurate impacts of flooding and making way for interventions to occur during the dry season. Using Java OpenStreetMap Editor (JOSM), Open Data Kit (ODK), OpenMapKit (OMK), Mapillary, QGIS, among other tools, we collected, validated, mapped, analyzed and shared accurate datasets from our target communities.

The data is now contributing to the Open Data ecosystem where it can be accessed using a variety of tools. Flooding has affected the very fabric of Liberian society and therefore the final data products are benefiting everyone directly and indirectly, including government and development partners as well as members of target communities. We hope that this data will help stakeholders, communities and central government to repurpose and identify sustainable projects to tackle issues of flooding that will benefit not only the communities with whom we are working but several communities including coastal settlements across Liberia.

PART 2: Data Collection Process

2.1: Field Data Collection

OCA Monrovia's Area of Interest



The OCA Monrovia area of interest (AOI) was Zone 300, which is made up of the Bushrod Island and is home to some of the major slums (such as Slipway, Sonniwhein, and West Point) in Monrovia City. **Clara Town**, formerly known as Fanimba, was first occupied in the early 1970s, but due to a land dispute between the settlers and the Methodist Church who claimed the parcel of land at the time, the inhabitants had to flee. They later returned in large numbers in 1994 during the era of the civil war, during which time the swamp was increasingly dried up and the settlement now known as Clara Town grew into what it is today. Home to representatives from all 16 tribes of Liberia, Clara Town's total population during the last census stood at 54,400 residents.

River View is a sub-community within the Township of Clara Town, and is located on a stretch of land northeast of Clara Town and bordering Doe community.

Doe Community, a.k.a Struggle community, is located on Bushrod Island along Somalia Drive and was founded in 1984. This community remained a wetland up to the early 2000s, when it was populated by settlers drying up the swamp to make way for construction of makeshift structures. Today, the practice of drying up the swamp with garbage is the main method for earning a plot of land. This unplanned settlement is home to over 35,000 inhabitants, as of the 2008 population census, and its inhabitants represent 15 of the 16 tribes of Liberia. The **Hope Community** is one of the sub-communities of Doe community, and is located northwest of Doe community.

Available Data Access and Use

Before starting mapping activities, we searched for available data about the project AOI - Zone 300, and the project target communities - Clara Town, Doe, Hope and River View. LISGIS was the only key partner to share useful geospatial datasets that were used in identifying our target communities. Datasets received from LISGIS included community and zone boundaries, roads, waterways, education and health facilities. MCC and Liberia Water and Sewer Corporations alongside LISGIS focal persons were involved throughout the project implementation. The Monrovia City Corporation's Cheesemanburg Landfill and Urban Sanitation (CLUS) project team shared some datasets on waste management which unfortunately was outside of our project target communities.

We reached out the UN Habitat, Ministry of Public Works, and Ministry of Internal Affairs, but were unable to get data that could contribute to the project.

Based on data received, we worked alongside key stakeholders and target communities to understand their data needs and developed a [data model](#). A validation process was conducted by stakeholders on this data model which was used throughout our field data collection activities.

Remote Mapping

We conducted a series of remote mapping activities in each target community. Initially, our remote mapping efforts were stalled by low resolution and outdated imagery. Efforts were made to get more up-to-date imagery from US State Department's Humanitarian Information Unit (HIU) to incorporate into OpenStreetMap. Satellite imagery was as recent as May 2018, but unfortunately the resolution did not enable us to properly trace all building in our AOI.

We later engaged Youth in Technology and Arts Network (YOTAN), a civil society organisation (CSO), to capture UAV/drone imagery of target communities. Captured imagery was processed using OpenDroneMap⁵ and produced imagery that is now available on OpenAerialMap⁶. This updated, high resolution imagery was used to update the OSM basemap to effectively conduct field mapping activities. The remote mapping tasks were set up on the HOT Tasking Manager for better remote mapping quality control, coordination and to track level of efforts by our contributors. This was followed by a validation period before generating mapping files to be used on smartphones for field data collection.



Fig 1: Comparison of Bing (satellite) imagery and drone (UAV) imagery, both with zoom levels at 20m.

⁵ <https://www.opendronemap.org/>

⁶ <https://openaerialmap.org/>



Fig 2: UAV/drone aerial view of Struggle (Doe) Community

Prior to the remote mapping exercises, we held a half-day refresher training for our community of mappers (initially comprised of YouthMappers, OSM Community and iLab Liberia mapping party members), some of whom had prior experience with HOT remote mapping, while others had used Google MapMaker to map Monrovia and its surroundings. Our remote mapping activities engaged 41 users⁷ who made up to 6,765 contributions within a month.

Forms and Mobile Applications

The forms used as shown below within the mobile phone applications were designed by HOT following the agreed upon data model. As part of the project extension, each form was customized for the new communities that were added and the economic activity form was omitted from this exercise. The forms (and their purpose) used during the mapping phases of the project included:

- Buildings Form: to collect structural and use information (such as location, type, levels, material used, foundation height, etc.) on each building.
- Drain Point Form: to record points of interest that include blockage, pedestrian means of passage, and filters along a particular drainage.

⁷ <https://opencitiesproject.org/monrovia/>

- Drain Segment Form: to capture the length, depth and size of each of the drainages found within the target communities.
- Educational Facilities Form: to gather in-depth information on each school or sort of educational facilities found within the target communities such as number of students, opening hours, acceptance of fees, contacts, location, etc..
- Financial Facilities Form: to gather in-depth information on banks and other financial access points (i.e., Mobile Money, local money transfer) found within the target communities.
- Flood History Form: to gather flood history information about a particular building such as last flood experience, extent, impact, etc. in addition to the Monrovia Buildings Form.
- Health Facilities Form: to collect information on drug stores, pharmacies, clinics and hospitals if any within our target communities such as, name, location, bed count, operator, opening hours, specialty, etc.
- Water Points Form: to recognize and take down information on water pumps whether powered or manual and water wells regardless of their operational status such as location, name, operator, etc..
- Solid Waste Form: to identify and collect information (such as location, access, officiality and specifically for toilets, its means of disposal, toilets count, availability of handwashing resources, etc.) on dump sites, collective garbage and/or trash points, garbage bins/stations, public or private toilets/bathrooms regardless of their operational status.
- Economic Activities Form: This form was not relevant to the resilience problem the project was addressing. It was a request by project colleagues at the World Bank Liberia Office as a contribution to information gathering they needed about this part of the city. This form design was drawn out of conversations had during stakeholder meetings in which community leaders told us of the major economic activities as fishing, motorbike transport service, petty vendors, casual workers, nannies, sand mining and small businesses. This survey was conducted to get an in depth understanding as to whether there were other major economic activities not mentioned or what percentage of the target communities residents were directly involved with these activities.

To incorporate all of the above forms and carry out successful field mapping activities, we used the smartphone applications listed below:

- **Open Data Kit (ODK) Collect:** Was used by our well-trained field mappers to fill out the forms mentioned using smartphones during the field data collection.
- **Open Map Kit (OMK):** This was embedded into the ODK Collect application and used for collecting map data that was integrated with OpenStreetMap.

During the extension period in River View and Hope Communities, we did not collect data on economic activities since it was captured during mapping phase one and from community engagements and town hall meetings. It was established that residents of these clustered communities share similar economic activities and challenges.

Field Mapping

Before heading into field mapping activities, we analyzed the data from LISGIS, conducted stakeholder mapping and engagements, developed the data model, conducted remote mapping, designed XLS Forms based on the data model, and conducted a series of trainings in remote mapping as well as training in various mapping technologies and tools.

Equipment used for the project was provided by OSM Liberia comprising of 28 smartphones and 8 laptops through the NetHope Grant⁸. The laptops were used during training, remote mapping, mapathons and data cleaning while smartphones were used for training and field data collection.

By late July 2018, the project recruited field mappers from YouthMappers Chapters, OSM Liberia, iLab Liberia and the project target communities. As part of the recruitment, we tested the recruits using smartphones and remote mapping, to ensure they could read maps and add Points of Interest to a map. In mid-August 2018, we held a one week long training for 27 persons, 6 of whom were representatives from the project key stakeholders, in remote mapping and field data collection including drain data collection. Out of the 27 that attended the training, 20 (9 females, 11 males) were involved throughout the field mapping and data collection processes.

Prior to phase one field mapping, the 20 field mappers trained were divided into three teams for the ease of field activity coordination:

- **OMK team:** (10 persons) - responsible for the OpenMapKit (OMK) data collection using the buildings, educational facilities, financial institutions, health facilities, water point, solid waste, economic activities and flood history forms. This team was subdivided into five (5) teams of 2 persons each for better coordination in the field.
- **Drain team:** (6 persons) – responsible for drainage networks data collection. This team was also subdivided into 3 teams of 2 persons each for better coordination during field data collection.
- **Data cleaner team:** (4 persons) - responsible for the cleaning of all the data collected.

⁸ https://www.hotosm.org/updates/2018-04-19_nethope_device_challenge_april_update

During this project, we used an offline server (Portable OpenStreetMap - POSM) to store data collected from the field. This server was managed by the team supervisor after each working day who as well oversaw data cleaning processes. The data was downloaded from the server and divided into sections using JOSM and shared among data cleaners. Once cleaned, all data underwent validation and once all conflicts were resolved, uploaded to OSM where we conducted quality assurance and control.



Fig 3: Drain data collection



Fig 4: Remote mapping session

Field mapping for phase one mapping took place in September 2018 for both Doe and Clara Town communities; while the extension mapping activities for Hope and River View communities occurred during early December 2018. In September, a month which falls within the rainy season, our field mappers worked through flooded waters as several buildings being mapped were already covered at ankle-deep and some knee-deep floods, making it a challenge for our field mappers to work throughout these communities easily.



Fig 5: Field Mapper walks through a flooded community area to map facilities

2.2: Data QA/QC

Quality Assurance and Quality Control Process

The Quality Assurance and Quality Control process began with remote mapping to our data model, on to form designs and finally data cleaning and validation before uploading field data to OSM. The HOT Tasking Manager allowed us to carefully create tasks for remote mapping allowing each remote mapper to be assigned a unique task.

Open Cities Monrovia team designed a workflow for data cleaning which included the role and responsibility of each team member (data cleaners and supervisors). The workflow clearly defined the data cleaning procedures to ensure a better checking medium for quality data before uploading field collected data to OSM.

Our forms had required fields for specific questions that should not be skipped. These forms were loaded to our project phones each assigned to a field data collector by the phone's IMEI number for easy identification and early error tracking.

Data Cleaning and Data Cleaning Workflows

Field mapped data was post processed/cleaned by selected members of the field mapping team. These were supervised by the project Mapping Supervisor and supported by the HOT Technical Advisor. For all of our data cleaners, this was their first time to clean data for upload to OSM.

During data cleaning in mapping phase 1, the following observations were made and addressed in extension mapping phase:

- Overlapping or double buildings (Building inside building)
- Unconnected nodes without physical tags.
- Unnamed ways
- Way end node near other highways
- Incorrect feature tag(area wrongly tagged for building)
- Misspelling of features
- Waterways end without connection with another or the direction of the waterway is wrong
- Ways with the same position
- Missing tags
- Untagged ways (when the way is not tagged rightly)
- Specific highway type (when the highway type is not specified)
- Crossing building/highway (highway crossing through building)
- Duplicated ways
- Amenity inside amenity (amenity=toilets inside amenity =toilets)

We created two digital workflows, OMK data cleaning workflow⁹, and Drainage data cleaning workflow¹⁰. The OMK workflow was used to clean OMK data while the Drainage data workflow was used to clean drain points and drain segments datasets from ODK.

At the end of each workday, datasets from all phones assigned in the field were uploaded to our POSM server. This was managed by the team supervisor who downloads the data by forms the following day and assigned it to the data cleaners.

The workflow required data cleaners to merge data from the field with data in the OSM database using the JOSM editor. As part of the data cleaning, a data cleaner had to add/activate all required plugins to commence the data cleaning process in JOSM. Newly constructed buildings (polygons) data was collected as nodes, we had to copy the nodes attributes to a newly drawn polygon before deleting the node.

JOSM built-in tools or plugins activated to examine the quality assurance of the data during the

⁹ <https://goo.gl/Vt3tdE>

¹⁰ <https://goo.gl/C5SsA6>

data cleaning process were as follows:

1. Filter

- 'new OR modified' filter was used to show the separation between the field data imported to JOSM and data downloaded from OSM server within the specific area of interest. It also helped us to recognize missing buildings within AOI.

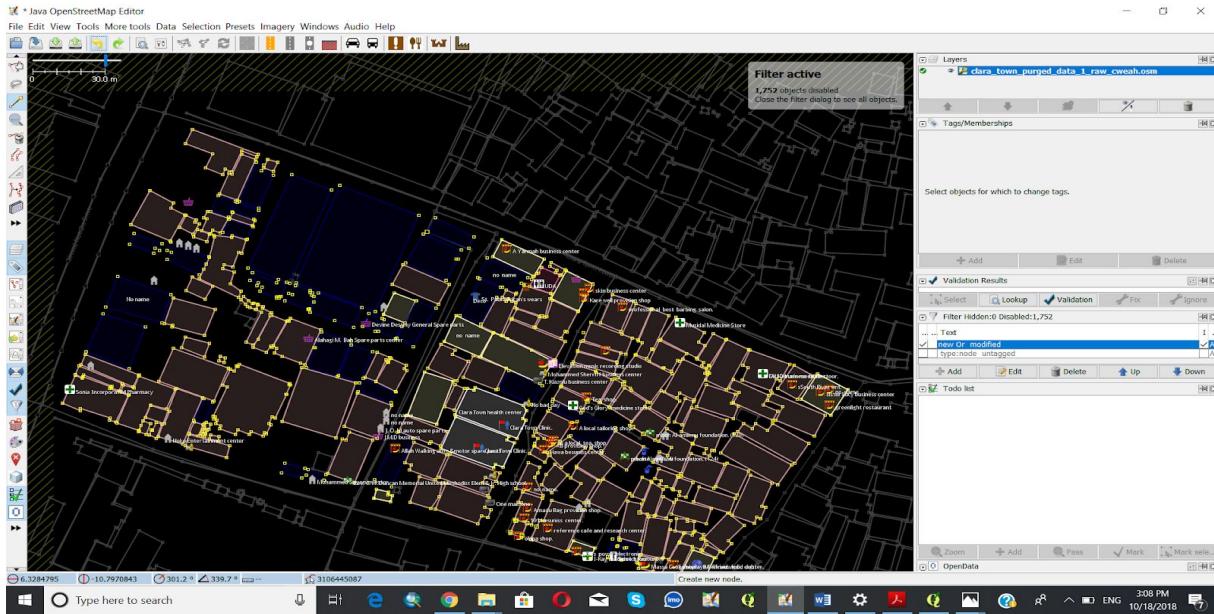


Fig 6: A screenshot showing the use of the 'new OR modified' filter

2. Todo List plugin - helped us to monitor the progress of the data cleaning and other necessary editing. Here, you begin by selecting a list of objects you need to clean and add them to the todo list. Once you have added objects to the todo list, you can either select one at a time and zoom to it and after examining the object for necessary edits, you can mark the object as finished to go to the next.

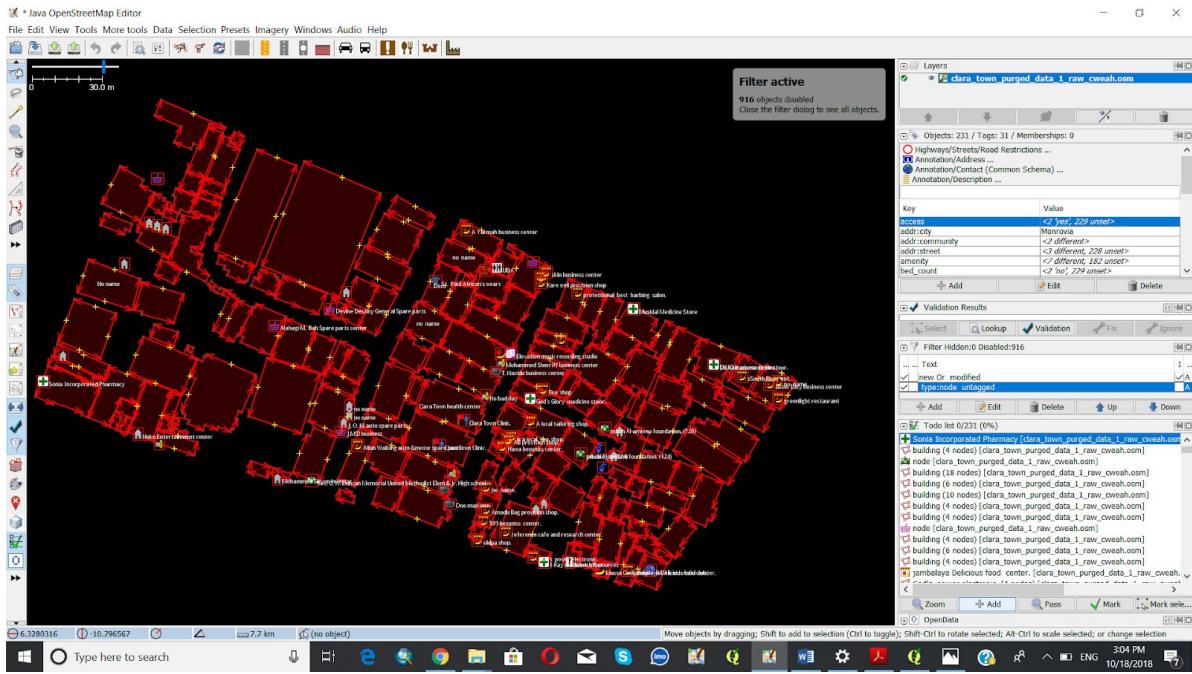


Fig 7: Data being highlighted and added to the 'Todo List' for one at a time check

3. Validation - used to correct any errors that are detected; and go through the warnings. When we run the JOSM validator while cleaning the data, it automatically checks the data for suspected mistakes and basic errors flagged to be fixed. Some of the errors fixed are as follows:

- Overlapping or double buildings (building inside building)
- Unnamed ways
- Incorrect feature tagging (area unnecessarily tagged for building)
- Untagged ways
- Unconnected nodes without physical tags

Once the error is fixed, run the Validation tool again and it will disappear from the list. Some of the issues are common with fairly easy fix while others will require careful attention for someone to go through to see whether the warning is important or not. However, sometimes a fix can cause other problems, which is why it's important to run validation many times.

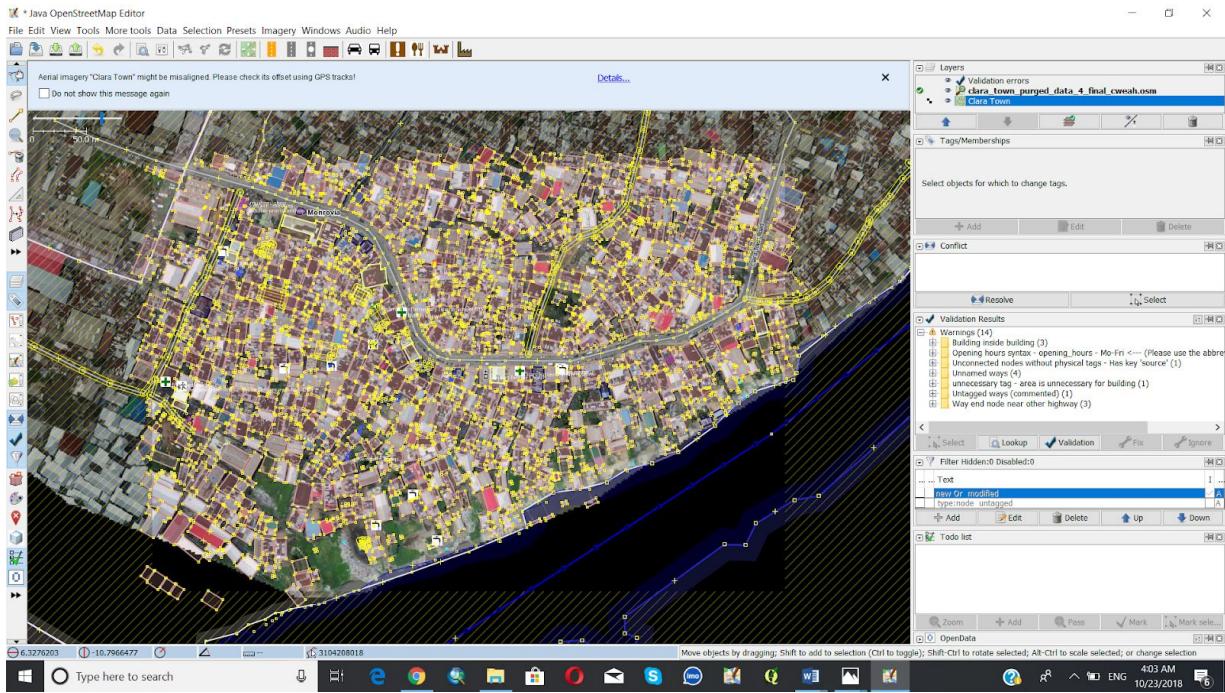


Fig 8: A screenshot displaying some errors and warnings for a 'Validation Results'

2.3: Geospatial Data Overview

Field Mapping Results

Field mapping activities were centered on the data model developed by the project team and the project stakeholders. Below is an overview of some of the feature attributes collected:

Buildings	Education Facilities	Health Facilities	Solid Waste	Water Points	Flood History
addr:city	addr:city	addr:city	addr:city	addr:city	location
addr:community	addr:community	addr:community	addr:community	addr:community	dwelling_type
addr:street	addr:street	addr:street	addr:street	addr:street	building_use
building	name	name	amenity	amenity	years_in_house
building:levels	amenity	amenity	waste	man_made	address
min_height	operator	emergency	toilets:disposal	natural	community
building:material	opening_hours	bed_count	toilets:handwashing	drinking_water	street
building:roof	capacity	dispensing	access	pump	landmark

amenity	fee	opening_hours	fee	operational_status	experienced_flood
shop	phone	operator	name	name	flood_history
office		operator_name	operator		flood_event
tourism		phone			flood_year
religion		description			flood_depth
name					flood_source
					flood_cause
					flood_effect
					moved_year
					comment

From field mapping activities, the following features were mapped in all target communities:

Community/ Mapped Features	Clara Town	Struggle (Doe)	Hope	River View	TOTALS
Buildings	1110	1754	1135	514	4513
Water Points	29	26	6	0	61
Health Facilities	12	4	0	0	16
Education Facilities	13	6	0	1	20
Financial Facilities	0	0	0	0	0
Solid Waste Points	6	26	1	27	60
Drainage Segment	67	9	1	1	78
Flood History Points	49	155	9	21	234

PART 3: Project Results

3.1: Monitoring and Evaluation

The project's monitoring and evaluation component centred on tracking the different indicators of the various themes of the project. These themes included **data collection and release**, **data product development**, and **capacity strengthening and institutional development**.

Theme 1: Data Collection and Release

The focus under this theme was to track the number of data layers collected and their associated attributes versus the amount of area mapped using a participatory approach.

Number	Indicator	Metric	Target	Data Source	Disaggregation
1.1	Amount of area mapped using a participatory approach, that has been validated		1.11 2.3906 sq km	Liberia Institute of Statistics and Geo-Information Services in OSM/ OSM Task Manager / JOSM	Field and Remote mapping of Clara Town, Doe , Hope and River View Communities
1.2	Number of geospatial layers developed relevant to the resilience problem identified		10	7 Data Module	01. Buildings 02. Drain Segments 03. Drain Points 04. Health Facilities 05. Educational Facilities 06. Financial Facilities 07. Flood History 08. Solid Waste 09. Water Points 10. Economic Activities

1.3	Number of attributes collected relevant to the resilience problem identified	135	74	Field Data collection	Buildings: 14 Drain Segments: 37 Drain Points: 7 Health Facilities: 13 Educational Facilities: 10 Financial Facilities Flood History: 19 Solid Waste: 11 Water Points: 10 Economic Activities: 6
1.4	Number of government or other pre-existing datasets used relevant to the resilience problem identified	2	8	Datasets received from LISGIS and UN Habitat	1 - Zone Boundaries 2 - Community Boundaries
1.5	Data collection has taken into account gender vulnerabilities	Women and children are the most vulnerable people during while flood, while it is true that men have to commute through flooded waters to find food and money to replace or repair parts of the damaged home due to the high rise in water level, but women have to sit home in the flooded waters to prepare food and cater to the kids in these unhygienic environs thereby causing both them and their children to often fall ill to diarrhea, cholera, malaria, and other waterborne diseases.			

Theme 2: Data Product Development

Under this theme, the project's focus was on tracking the number of people attending the various session organised during the life cycle of the project and how these would relate with the data product developed by the project.

Number	Indicator	Metric	Target	Data Source	Disaggregation
2.1	Number of people attending presentations who are made aware of the data product	297	50	Meeting with Stakeholders, trainings, Mapathons and product launch	Disaggregated by: sex, stakeholder group Female: 107 Male: 190 LISGIS, MoGCSP, NDMA, LNRCS, LWSC, MIA, Stella Maris Polytechnic, University of Liberia, MCC, CSOs, Students, Press, Target communities youth and leaderships

2.2	Number of people trained to use data product	69	60	Attendance sheet	Disaggregated by: sex, stakeholder group Female: 26 Male: 43 LISGIS, MoGCSP, NDMA, LNRCS, MIA, LWSC, MCC, CSOs, Press, Target communities leaderships
2.3	Number of people with improved understanding of the resilience problem identified based on data product	238	40	Attendance sheet	Disaggregated by: sex, stakeholder group Female: 107 Male: 190 LISGIS, MoGCSP, NDMA, LNRCS, LWSC, MIA, Stella Maris Polytechnic, University of Liberia, MCC, CSOs, Students, Press, Target communities youth and leaderships"
2.4	Number of people who would use data product to inform their disaster risk management decisions	110	25	A midterm/final surveys	Disaggregated by: sex, stakeholder group Female: 25 Male: 85 Government Stakeholder, target community leaderships, Press, Youth Mappers

Theme 3: Capacity Strengthening and Institutional Development

Theme 3 focused on tracking the number of events held together with the number of people attending these events and how in turn this strengthens stakeholders and other institutions in the city and nation at large. This theme as well tracked the numbers of barriers to women involvement in projects of this nature and how these were addressed by the project.

Number	Indicator	Metric	Target	Data Source	Disaggregation
3.1	Number of training events held		8	5	Attendance sheets Disaggregated by: Remote mappings - Target communities Remote mapping - Target communities with improved imagery Field Mappers training - Field Data collection/drain data collection/data cleaning Mapathons - (Remote mapping of Ganta & Kakata) Map Making - Using QGIS to develop data products Fresher training - OSM tools
3.2	Number of people trained		117	60	Training attendance roster Disaggregated by: Female: 35 Male: 82 Remote mappings - Target communities Remote mapping - Target communities with improved imagery Field Mappers training - Field Data collection/drain data collection/data cleaning Mapathons - (Remote mapping of Ganta & Kakata) Map Making - Using QGIS to develop data products Fresher training - OSM tools LWSC, MCC, LISGIS, Target communities youth
3.3	Number of people participating in community mapping activities		34	20	Community mapping activities sheet or data collection roster Disaggregated by: Female: 8 Male: 26 LWSC, Youth Mappers, iLab Liberia, OSM Liberia, Target communities youth

3.4	Number of stakeholder groups consulted (in planning activities, product development, etc.)	26	15	Stakeholder engagement, Letters, Phones calls, emails, survey	Disaggregated by: OCA stakeholders mapping, Project update, Stakeholders engagement, training, presentations, launch LISGIS, LWSC, MCC, LNRCS, University of Liberia, Starz College of Technology, Stella Maris Polytechnic, Target communities leadership, Youth Mappers, iLab Liberia, OSM Liberia, iCampus, Ministry of Internal Affairs, Ministry of Gender and Child Social Protection, YOTAN, World Bank, Women groups, Youth groups
3.5	Number of women engaged in the design of community maps	60	25	Women engagement activity	Prestige Women and girls organization, Action for Community Transformation, Womb 10/40, Progressive women, Blessed women
3.6	Gender-differentiated vulnerabilities identified through Gender Analysis	OCA Monrovia activities were designed to take into account gender integration, ensuring a balanced involvement of genders in project activities. The project also sought to understand how the different genders are affected by the problem the project was addressing and to identify any barriers to women participation projects of this nature. These are further discussed in section '3.2 Gender' below.			
3.7	Number of barriers to women's participation in Open Cities Africa identified	6	3	Direct observation interview data and community engagement analysis records Survey of women	Barriers that could hinder women participation for this project are: 1. The lack of technical skills, 2. Availability to implement the field work, 3. The perception that such field and technical works 4. Women stay at home to manage domestic issues 5. Parent choosing career for their girl child 6. Less interest the technical education Barriers that could hinder women participation for this

					project are: 1. Women are housewives and therefore should be at home to nurse children and cook 2. Technology is a man's thing 3. Women are not to do men's work, field data collection is a man's job 4. Women are expected to stay at home and take care of the kids 5. Parent choosing career for their girl child 6. Less interest the technical education
3.8	Number of barriers to women's participation in Open Cities Africa addressed	2	3	Activities and training attendance records	1. The lack of the technical skills 2. Availability to implement the field work
3.9	Exchanges and/or discussions with other City teams	The Monrovia team attended various training and summits. In Kampala, the team learn about OSM and HOT (Tasking Manager, OMK, JOSM, ODK, Field Papers) and Mapillary. In Dar es salaam, our team attended FOSS4G conference and HOT summit. In both events, we learned from peer projects and expects work and mapping tools. Our project lead represented us in Zanzibar where he along with other colleagues learn Mapbox webmap technologies and his team was able to produce a 3D map of St. Louis in Senegal.			

3.2: Gender

OCA Monrovia activities were designed to take into account gender integration, ensuring a balanced involvement of genders in project activities. The project also sought to understand how the different genders are affected by the problem the project was addressing and to identify any barriers to women participation projects of this nature.

Identify and Address Barriers to Women's Participation

Women in these target communities are mostly housewives. Their ability to perform regular chores like going to the market, fetching clean drinking water, cooking and disposing of waste at designated sites, are hindered by frequent flooding.

There are also several barriers preventing women from participating in projects like the Open Cities Africa, many of which are misconceptions, which we gathered through our engagements with the communities:

1. Women are housewives and therefore should be at home to nurse children and cook.
2. Technology is a man's thing.
3. Women are not to do men's work, field data collection is a man's job.
4. Women are expected to stay at home and take care of the kids.
5. Parent choosing career for their girl child.
6. Less interest in the technical education.

By involving women into the project trainings and deploying several of them in the field (working in their communities), several of these barriers were addressed.

Children are prone to diarrhea, cholera, malaria and other water-borne diseases and are often unable to get out of their homes to attend school or play outdoors, therefore the women are expected to stay at home to take care of the kids. Men, most of whom are informally employed and engaged in casual labor, are hindered mostly by mobility where the few footpaths, walkways or tertiary roads are flooded and they are compelled to travel through high rising waters to make ends meet for their families.

Through our engagement with women's groups in target communities, it was evident that women and children are most affected by flooding since they are home almost all the time. Women for instance are unable to make fire and prepare meals to feed the household when homes are flooded. Families often sleep in wet beds as the homes are flooded, in other instances, families become Internally Displaced People (IDPs) where they have to leave their homes and relocate to public buildings like schools or markets.

Because women in these target communities are mostly at home, they are by default the first responders to flooding and the accompanied damages. In the communities, women are not often given equal access to education and are usually expected to manage the home. Therefore, they do not have the same opportunities to acquire skills as men. Additionally, early marriage is common and young mothers often train their daughters in managing petty trading skills, cooking and caretaking for siblings rather than prioritizing formal education. Boys, on the other hand, are encouraged to go to school and accompany their fathers to casual labor jobs to increase the family's income.

Due to the lack of formal education amongst women, access to information is a huge challenge and they often rely on word-of-mouth news, locally produced films, and radio talk shows in

colloquial Liberian English. There exists other informal means through which these women get informed, but these means are specific to either their savings at the savings club meetings, market associations (business-related information) or social clubs; births, deaths, children graduations, and church or mosque announcements.

At the community level in general, the local leadership host meetings, known as palava hut meetings, to share information or have an announcer who goes about the community announcing upcoming important visits, events or convey general information about the community. This information is mostly community-related and not national news. Their male counterparts have additional outlets for information and engagement such as the intellectual centers, and more access to educational opportunities. Sometimes heads of household (men) are invited to emergency community meetings from which they are required to pass on the information to their households immediately.

To address these barriers and vulnerabilities, we incorporated several young women (11 overall) from the target communities into the project, trained the youth of the target communities (over 30 young people) in mapping technologies, and structured our data model to reflect and collect data to address issues of mobility, health, education, safe drinking water and waste disposal. Due to barriers such as lack of formal education, lack of technical skills, unavailability to work outside of their homes, and the perception that such field and technical work should be done by men, we could not recruit as many young women as we wanted. But through engagement activities and a general training for the youth of these target communities, girls and women were encouraged to get involved in future initiatives within their respective communities.

3.3: Stakeholder and Community Engagement

The Open Cities Monrovia project was designed to bring together a consortium of implementers and key stakeholders at the national and local/city level. Stakeholder engagement took into consideration key actors currently working in resilience activities and potential beneficiaries of the project. During the stakeholder mapping exercises, we engaged the following institutions:

- Liberia Institute of Statistics and Geo-Information Services (LISGIS)
- UN-Habitat
- National Disaster Management Agency
- Target Communities (Clara Town, Struggle (Doe) Community, Hope Community and River View Community)
- Monrovia City Corporation (Cheesemanburg Landfill and Urban Sanitation) project (MCC)

- Liberia Water and Sewer Corporation (LWSC)
- Ministry of Public Works
- Ministry of Gender, Child and Social Protection
- University of Liberia
- Stella Maris Polytechnic
- Starz College
- African Methodist Episcopal University
- BlueCrest University

Our stakeholder analysis categorized these stakeholders into levels of involvement in the project. During the project implementation, a few of our stakeholders roles changed from our initial analysis at the project inception and through the project implementation. Stakeholders roles range from Contributor to Beneficiary.

- i. **A Contributor** is a stakeholder who contributes directly to the project activities such as providing datasets or technical support.
- ii. **A Beneficiary** is a stakeholder who will use the data and developed data products for decision making.

There were shifts in roles during the project implementation, below are how these shifts occurred:

- Liberia Institute of Statistics and Geo-Information Services (LISGIS) - **High priority**. Remains our primary **contributor**.
- UN-Habitat - **High priority**. This entity changed from contributor to **beneficiary**.
- National Disaster Management Agency - **High priority**. This entity changed from contributor to **beneficiary**.
- YOTAN - **High priority**. This entity worked with us to capture aerial drone imagery of the target communities.
- Clara Town, River View, Hope and Doe Communities leadership and youth groups - **High priority**. These communities remained **contributors and beneficiaries** of the project.
- Monrovia City Corporation (Cheesemanburg Landfill and Urban Sanitation (CLUS) Project - World Bank Project) - **High priority** from being a beneficiary to a **contributor**.
- Liberia Water and Sewer Corporation - **Medium Priority** from being a beneficiary to a **contributor**.
- Ministry of Public Works - **Low priority**. This ministry remains a **beneficiary**.
- Ministry of Gender, Child and Social Protection - **Low priority**. This ministry remains a **beneficiary**.
- University of Liberia - **Low priority**. This university remains a **beneficiary**.
- Stella Maris Polytechnic - **Low priority**. Remains a **beneficiary**.
- Starz College - **Low priority**. This college remains a **beneficiary**

- African Methodist Episcopal University - **Low priority**. This university remains a **beneficiary**.
- United Methodist University - **Low priority**. This University remains a **beneficiary**.
- BlueCrest University - **Low priority**. This University remains a **beneficiary**.
- Civil Society organizations remain **low priority** and **beneficiaries**.

Beyond our engagements with target communities' leadership comprised of women, youth and elders, we recruited and incorporated residents into the project implementation activities. The project included three youths from each target community to serve on the field mapping teams, while these communities' youth leaders served as project ambassadors to their communities, coordinating engagements and other communications throughout project activities.

3.4: Final Product

Products User Research Survey

The OCA Monrovia project model was based on the idea that we must design products around people, rather than teaching people how to use products we single-handedly designed, that may not address their needs. To achieve this, we had to understand people, their behaviors, attitudes, needs, and goals.

Being a participatory and open mapping project, we were focused on getting the data back to the community and stakeholders in a format that would be usable for them all. This led us to conduct a user research survey amongst target communities, stakeholders and beneficiaries. Our creative approach to solving the problems of flood and other issues identified from the collected data started with the communities and therefore it should end with innovative solutions tailored to meet their needs.

The project has developed products (printed atlas and wall maps) using data collected from these communities to inform responders, government and local leadership on how to address issues identified as a result of flooding. It is expected that these products will help researchers, journalists, leaders, civil society organisations, and development partners as reference maps for decision-making.

Research Process/Methodology

In addition to our stakeholder meetings in which we discussed ways to present and share the data for easy access, we conducted a user research survey that helped us gather additional feedback and input from users (target communities, stakeholders and beneficiaries) across different spectrum of the communities on how we can appropriately present and share the

data. Hearing from them on the type of products to develop and how such products will be helpful to all stakeholders was paramount to the success of the project.

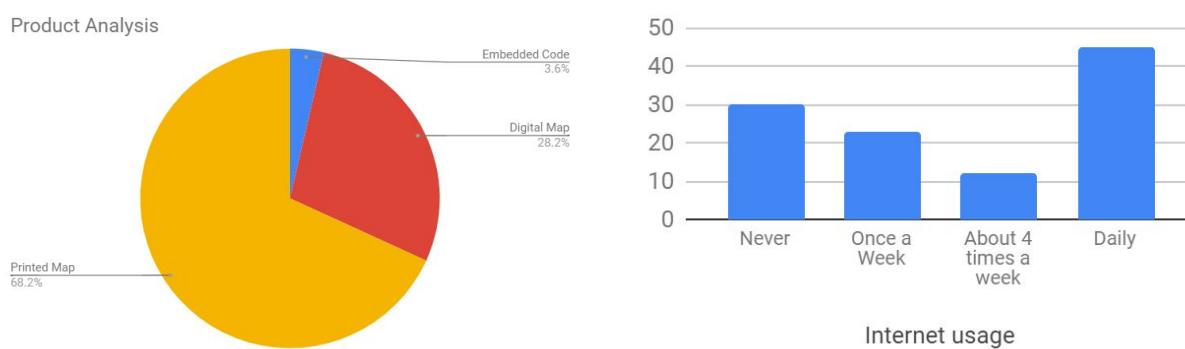
We conducted a user research survey with paper-based and digital forms in the target communities and amongst our stakeholders to reinforce our understanding of the needs of the beneficiaries for the development of data products that will work for everyone.

Research Results

We conducted the User Research survey¹¹ with residents of the target communities and other stakeholders. During the survey, we targeted reaching a diversity of demographics including gender, age groups, and various career participation. Our survey which was based on voluntary participation took into consideration the traditional paper-based approach and a Google form link was shared on social media. We received 110 respondents: 98% paper-based and 2% online. From data analysis, we found that 68.2% (Fig A) of total respondents prefer a printed map (atlas), followed by the digital map at 28.2% and Embedded code 3.6% (enumerators explained what embedded code was to each respondent). Considering the majority of our respondents are youth (Fig K) with 70.9%, daily internet usage (Fig B) dominates.

However, considering only 21.8% (Fig E) of respondents have used digital maps, a little over 75% (Fig. F) of overall respondents prefer the project to develop printed maps (atlas). When asked which of the three products will be most accessible to community residents, nearly 80% (Fig I) of respondents said “Printed Maps” while 70% believe printed maps will be used by most residents (Fig G).

Out of the total number of our survey respondents, 103 (Fig J) respondents have had flood experiences. Looking at the history of residents residing in these unplanned settlements, 25% have lived here all their lives while 40.9% (Fig L) have lived here between 1 to 10 years.



¹¹ <https://goo.gl/fvw1gG>

Fig A: Product Analysis

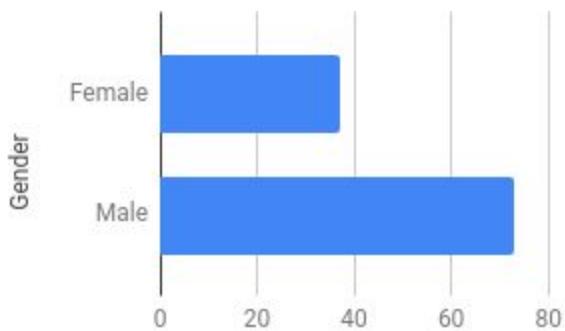


Fig B: Internet usage

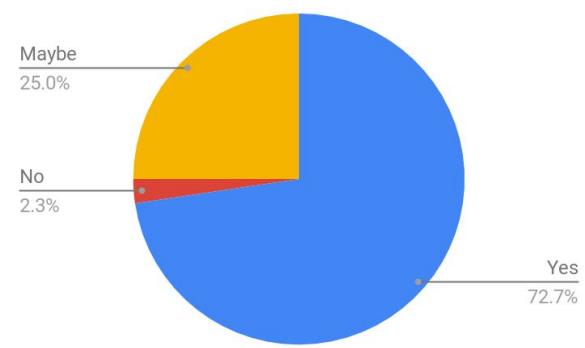


Fig C: Gender participation

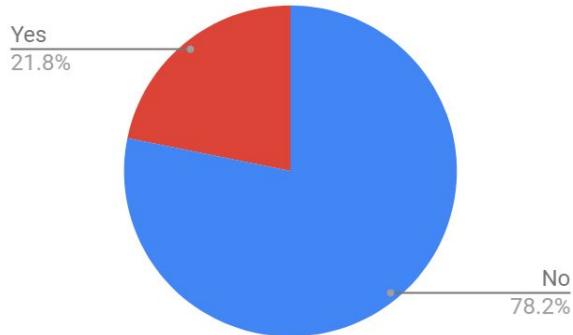


Fig D: Map will improve flood situation Participant

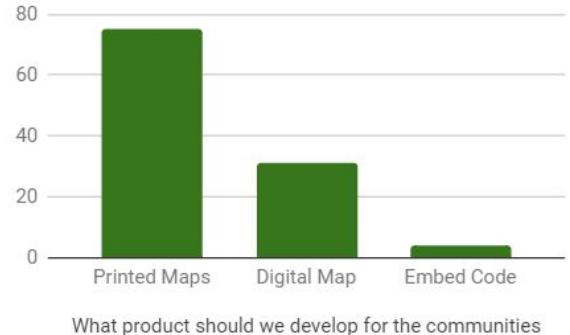


Fig E: Digital map users participation

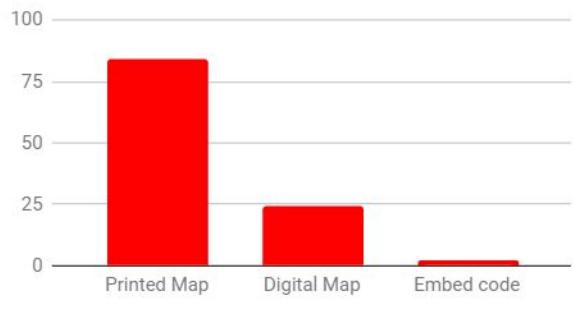


Fig F: Product development participation

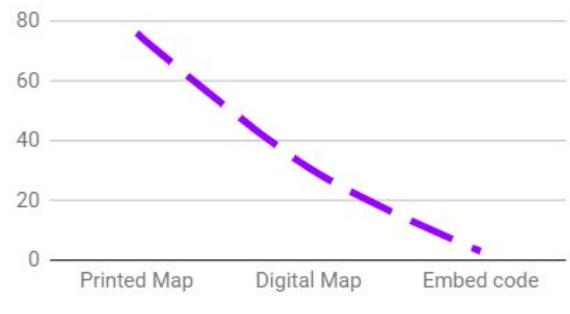


Fig G: Product adaptation participation

Fig H: Product accessibility participation

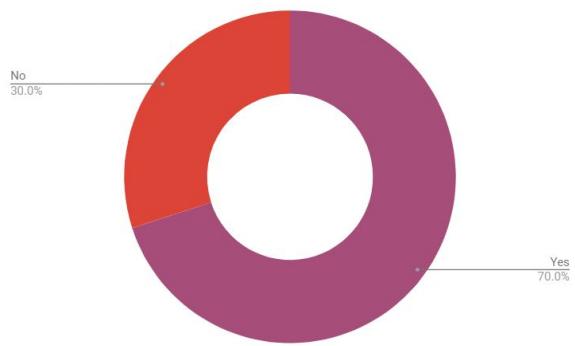


Fig I: Printed map usage participation

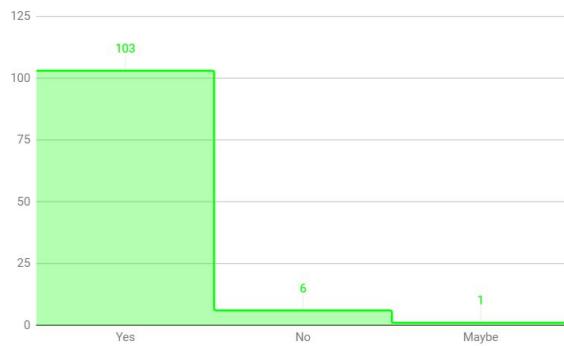


Fig J: Flood experience participation

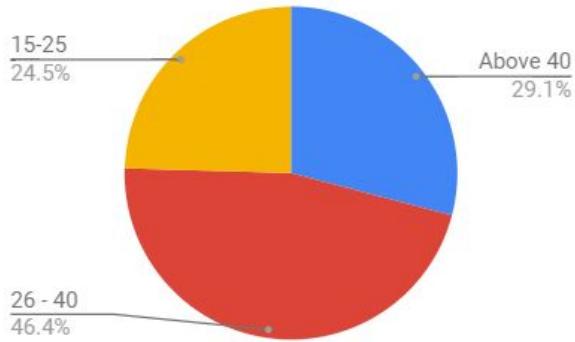


Fig K: Age range participation

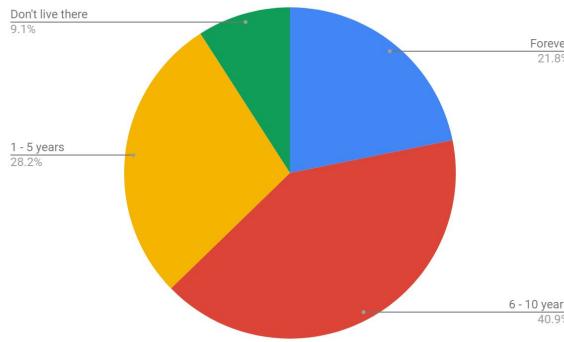


Fig L: Lived in target communities participation

Product Development

OCA Monrovia activities centred on addressing challenges related to flooding, which is affecting every fabric of the Liberian society and therefore the final products are designed to address and benefit all stakeholders (government, development partners and the citizenry) including target communities directly. We are optimistic that these data products that were developed through a User Centered Design approach will be useful in designing and developing flood resilience approaches while at the same time supporting central government decision-making by identifying sustainable projects through scalable models that are applicable to other affected communities that weren't included in this project.

Informed by the user research survey, we developed a wireframe of the products for stakeholders before going into development. From initial conversations, printed maps (in the form of atlas and wall maps) stood out as the most usable products that would benefit the communities. Our team has developed these products, which are to be distributed to all target communities and project stakeholders.

Printed Maps Atlas

The OCA Monrovia target communities atlas comprises of individual community maps with different themes of the data collected during field mapping. The atlas therefore comprises of four sections organised according to communities and with the same map theme for each community.

These map themes include:

- Drone Imagery
- Building Types or Use
- Building Materials
- Water Points Operational Status & Waste Points (Type)
- Water Points Type & Waste Collection Points (Type)
- Health & Education Facilities
- Drain Network (Drain & Ditches) and Recorded Flood History (Drain & Ditches)
- Aerial view of a community

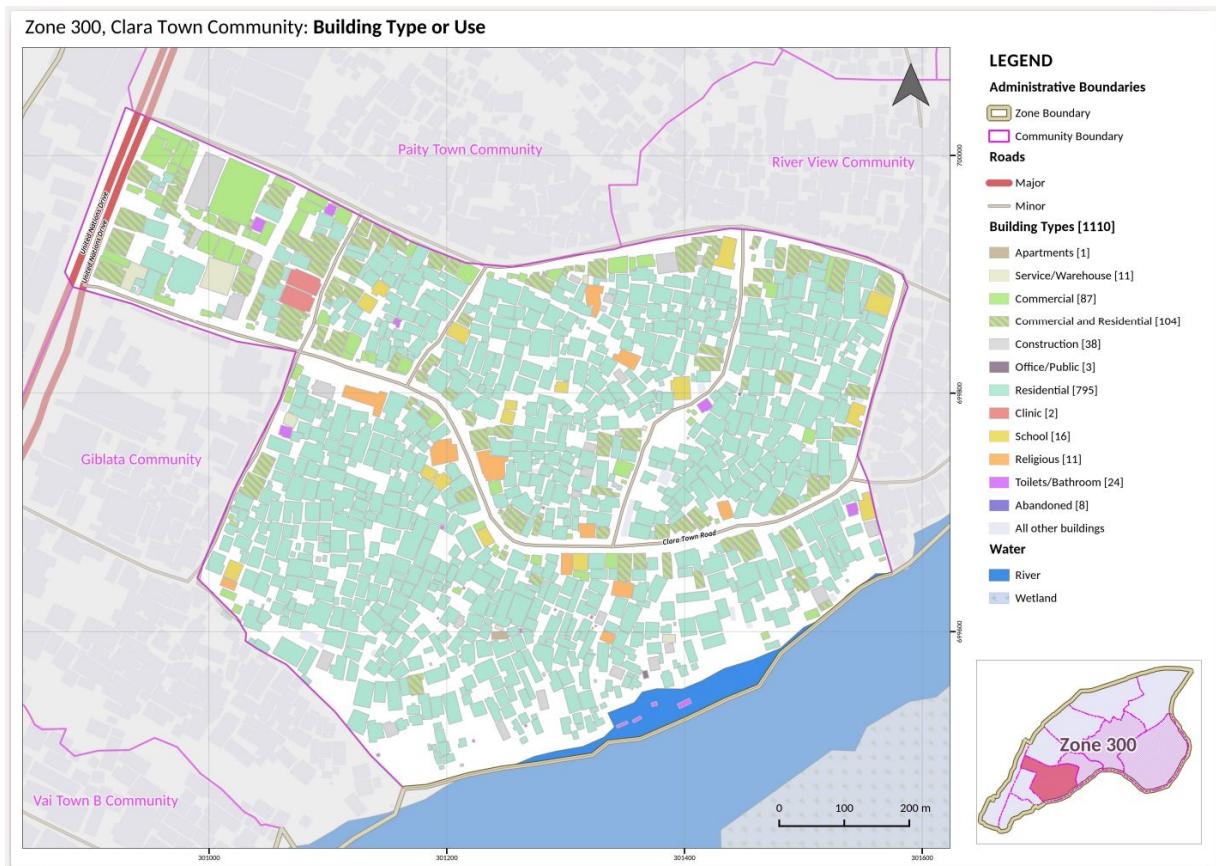


Fig 9: An example of atlas maps

Wall Maps

In as much as map atlases contain more maps showing the different classification of the data collected, only a few copied can be printed, which will be given to community leaders. Wall maps on the other hand are viewed as more applicable in terms of pinning them to notice boards of community and youth centres for the benefit of all community residents. These maps are printed on A1 size durable paper, and are expected to serve these communities for many years.

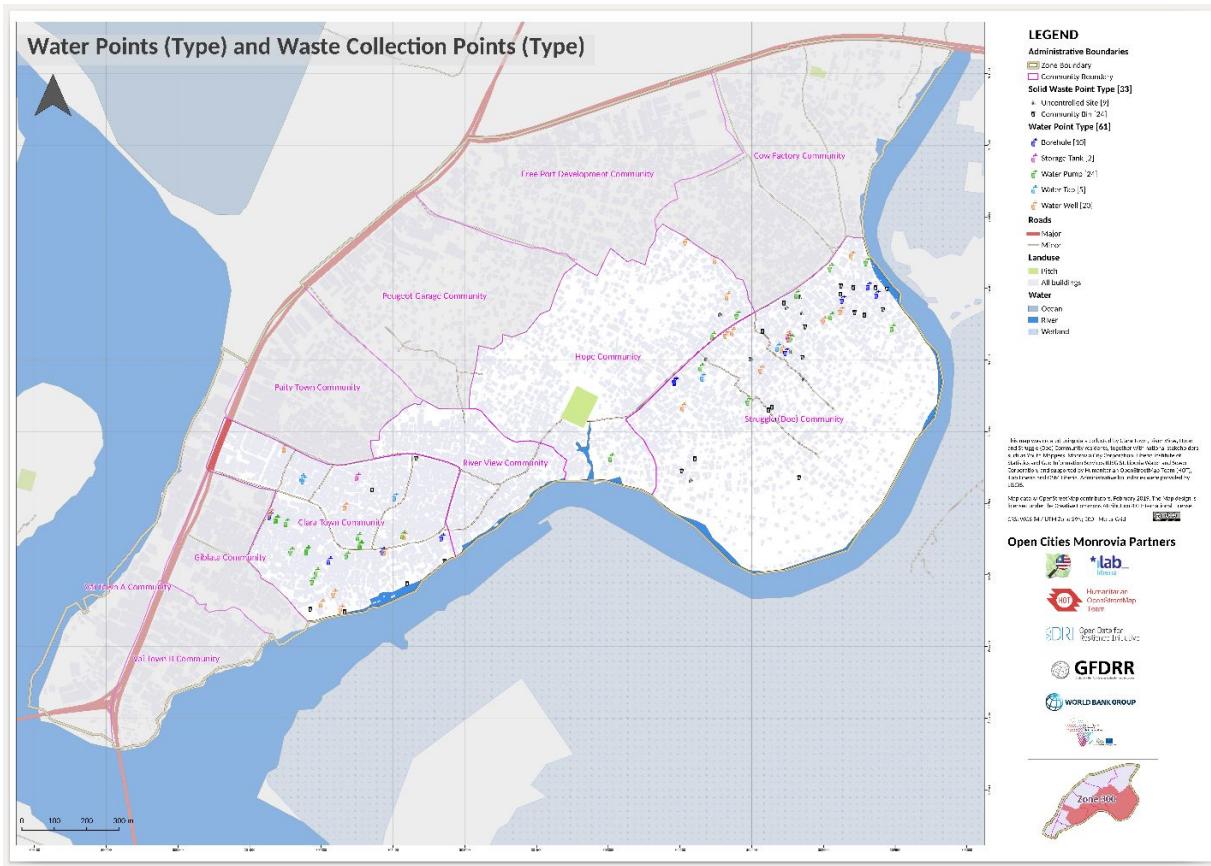


Fig 10: An example of wall maps

Data Use and Products Dissemination Workshops

We met with all target communities (including leadership, youth, women and physically challenged) groups in a Town Hall meeting format where we presented the products and taught the communities leadership in reading and explaining the results.

A general launch of the products took place on March 8th, 2019 for a larger audience of stakeholders including the National Disaster Management Agency, Liberia Water and Sewer Corporation, Monrovia City Corporation, Liberia Institute of Geo-Information Services, Ministry of Public Works, Ministry of Gender, Children & Social Protection, Ministry of Internal Affairs, Open Government Partnership Initiative, score of Universities, tech and community colleges, Civil Society Organizations and The World Bank Country office, Liberia National Red Cross Society, leadership of the project target communities and the media.



Fig 11: At a town hall meeting, getting products and data back to the community



Fig 12: Handing the products (Atlas & Wall Maps) over to the target communities



Fig 13: Products launch and dissemination to stakeholders meeting at iLab Liberia's office

PART 4: The Open Cities Africa Experience

4.1: Challenges & Successes

During the project implementation, we encountered the following **challenges**:

- Our key stakeholders were **government actors**, most of whom expressed huge interest from the onset during stakeholder engagement but soon found out they could not attend stakeholder meetings, visits to target communities, or learning opportunities like mapping technologies training and mapathons. Though several of them attended the project launch, it took a lot of follow up efforts for **continued participation in the project** activities. This was largely due to transition within government at the time, bureaucracy to obtain permission from senior management, limited budget for operations and or higher priorities on other government functions.
- A **political leadership struggle** at the level of the community saw us meeting and working with two different leaderships within Clara Town community who somewhat refused to work together. For instance, our initial stakeholder engagement exercises saw us working with the local Leadership of Clara Town, but upon hearing of the World Bank's visit to the community, the newly appointed Commissioner of Zone 300 (project AOI) took on the show of organizing the Town hall meeting leaving out the local leadership to an extend they weren't represented. As a follow up after the meeting, we had to make our position known that we had not switched focal persons but rather were working with everyone in the interest of the community. This leadership struggle remained a challenge to us as we had to communicate separately to each of these groups as they are not collaborating. For the "Getting data back to the community" exercise where we presented the finished products (Wall Maps and Atlases), the event was hosted at the offices of the local leadership. At that event the Commissioner did not attend, but sent a proxy.
- The **rainy season** posed a huge threat to our project implementation, both program and budget-wise. There was so much rain, with increased flooding in the communities, making it very challenging for field mappers to reach several buildings. The rains as well created a delay in field work, as field teams often waited until the rain ceases before they could pull out the smart phones to collect the data or travel between buildings.
- Due to **poor satellite imagery** for our project target areas, we had to spend a longer time on remote mapping activities. As a means to improve the imagery, we flew a drone over the target areas and generate updated imagery for better implementation of project activities.

Regarding **successes**, the project did an excellent job in stakeholder engagement as the awareness of the project amongst various stakeholders had a huge impact. Beyond the stakeholders:

- The Humanitarian OpenStreetmap Team (HOT) was able to train the local mapping community in using OSM tools effectively.
- Under the OCA project, the mapping community (iLab Liberia, OSM Liberia and YouthMappers) was able to form a collaboration that will see the Liberian mapping community grow, furthering community mapping activities and initiative in Liberia.
- We were able to break barriers that women are not capable of working on a technology project to this scale, through the involvement of 8 women out of 34 total field mappers who participated in the mapping activities. To achieve this, we kept re-echoing the value of women in tech, sharing stories of other females from our communities of mappers (Youth Mappers, OSM Liberia and iLab mapping parties attendees). The aspect of learning new skills also attracting school going girls as an opportunity to acquire new skills after getting an insight of the simplicity and broader job placement knowing technology offers.
- The project trained over 30 young people from the target communities in using the technologies used during the project. A skill that will take them a long way in seeking employment.
- The data products are giving the communities and leaderships including other stakeholders a much in-depth insight of the challenges these communities are faced regarding flooding.
- The training opportunities that our project team attended throughout the project was a huge boost not only to the project implementation, but the ability to learn and share what we learn from these events.
- The engagement from project funders and implementers was very relevant to the successful implementation of the project
- The Open Cities Africa online project platform, webinars and adequate resources were helpful throughout the project lifespan.

4.2: Lessons Learned

The implementation of the Open Cities Monrovia project accorded us a number of lessons that have set us strongly on a course of implementing Open Mapping projects in Liberia. These lessons are discussed here below:

- Communities are willing to work together and support projects that make their neighbourhoods better and more resilient. Throughout the course of the project, we

never had challenges or resistance working with communities. They indeed were always happy to receive us and guide us around their communities.

- Many stakeholders are more motivated if a project has direct gains and contributions to their core mandate or business case. Additionally, working directly with some of the staff from these organisations provides a more reliable way of having the stakeholders involved in the project.
- Open Mapping tools and methodologies are easy to learn and pose many career development opportunities to young people and students. Community leaders embraced these tools as well and were eager to further discover how these tools can be used in the execution of their leadership roles in these communities.
- Throughout the project, we awarded certificates to participants, a gesture that increased interest of mappers to participate in our mapping activities.
- Our field mappers felt more empowered and enthusiastic about the project because apart from financial compensation, they had the opportunity to learn new skills through trainings, mapathons and other resources during project implementation.
- The project target communities took ownership of the project because of the level of engagement, involvement and particularly the data products. During the product launch, the leadership in all four communities expressed the desire of working with us in the future as they admitted, if all projects were designed in this manner, their livelihood could have been far better.
- Coordination between HOT, iLab and the project team was very professional, collaborative and the level of support the local team got from HOT was overwhelming.
- The level of organization from the World Bank on the project from the project platform, to regional knowledge sharing opportunities, resources and webinars was very encouraging for cities project leaders.

However, we further learned, and note that;

- To get key government stakeholders commitment and full involvement into the future projects, it's important to include focal persons from these government into the budget. This important to incentivize them to take ownership of the projects.
- We will fully utilize the project techchange platform by ensuring we post more content on every relevant activity we carry out. This is something we didn't do to the maximum during this project.
- There was little or no direct engagement with other cities teams beyond the summits and workshops. For next projects, we will make sure we conduct at least one monthly call with different cities to share and learn from each other.
- Due to the rain, we lost several hours and days during field work. Moving forward, we will fully utilize weather reports to know which days that might not be conducive for field work, though it is the rainy season, but there are days when the rain is heavier.

- We need to take full advantage of the HOT webinars to learn more of their tools including new features and tools.

4.3: Recommendations

As an underdeveloped country, the challenges and effects of climate change have grave consequences for Liberia. It has become clear through the Open Cities Monrovia project, to project partners and communities alike, that there is a need for open geospatial data across sectors such as water management, energy/power, population control and migration, maritime, revenue collections, national risk management, cartography education and training, and more. During our community engagement session and field mapping activities, community residents kept asking: *"How will your project physically support our conditions?"*

It is recommended that HOT continues to support the young mapping community in Liberia to put more of the country on the map. We additionally recommend that more coastal cities such as Buchanan, Greenville and Harper be considered by the World Bank for community and open mapping activities going forward. This will foster preparedness, resilience and better recovery from any disasters they may face.

Economic activities in target communities

While data collection is useful for understanding the current conditions and challenges faced by these unplanned settlements, it is crucial that data collection and mapping are followed by initiatives that alleviate these challenges by directly supporting these communities. With this in mind, we carried out a survey to collect information on economic activities men, women and the youth are involved in our AOI.

Communities in our AOI are not only geographically adjacent to one another, but also share similar economic activities and challenges. Through mapping and community engagement, we learned that men, most of whom are high school dropouts, are largely engaged in casual work (loading and unloading goods at warehouses, ships and containers at Monrovia's Freeport) while others worked in small industries and stores (store-boys) handling various tasks.

Women, due to early marriages and lack of educational opportunity, are mostly housewives, petty-traders and nannies at private homes. A larger percentage of the youth are unemployed and have either dropped out of or not entered school; many are also former child soldiers. This segment is normally involved with casual work, such as illegal sand mining and gambling. A small percentage are school and college students.

Supporting these communities through sustainable economic activities will serve as an alternative means to improving their livelihood for both educated and uneducated inhabitants. Strategic support will also enable them take ownership of development activities, particularly involving flooding as the activities presented will help clear waterways, provide safe drinking water for households, and protect the riverside from garbage, toilets, illegal sand mining etc.

From the communities' perspective, vocational education and skills-building for women and youth will provide a pathway for self-improvement and earnings that will better care of their families. Through surveys and community meetings, our team identified that waterway boat transportation systems would create employment and generate funds that could contribute to restructuring drainage networks, establishing proper waste disposal sites, cleaning the river waterfront of garbage and makeshift toilets, paving the way for more recreational activities. The following are recommended economic activities identified in these communities:

- Water transportation systems: This will help not only the target communities but several other communities along the Stockton Creek, Du and Mersurado rivers, with between ten-to-twenty communities benefiting. Currently in Monrovia, there are only two main streets leading to the city center, and traffic congestion as well as fares are only increasing. Disrupting the city's limited public transportation options will bring about healthy competition, new jobs, and will ease transportation issues.
- Building public toilets: This will enable communities to clean up their existing drainage networks, which are currently being used as toilets by some community dwellers at night, clear waterfronts of makeshift private toilets structures thereby improving the communities cleanliness and reduce instances of waterborne illnesses. The toilets will not only improve hygienic conditions but can generate some income as community members pay small contributions to maintain these structures.
- Water kiosks/stations (polytanks constructed for safe drinking water): Cholera and diarrhea are common in these communities, especially amongst children, because of the lack of safe drinking water. At the moment there are some water stations, but they quickly run out of potable water and it takes days for them to be refilled. During this period, a lot of homes rely on rainwater captured from the roofs of their homes but, because a lot of these roofs are not clean, the resulting water is polluted. Wells are also primary water sources that become polluted during periods of coastal flooding.

It is further recommended that open mapping activities become a core part of Monrovia City Corporation and World Bank projects in Monrovia. This will ensure that open data is continually generated, updated and shared with the necessary stakeholders and communities.

PART 5: Sustainability Plan

The Open Cities Africa project brought about several opportunities that the Monrovia team looks towards sustaining as benefits to the mapping community in Liberia. The following are some of the benefits we are working towards providing through our sustainability module:

- The Open Cities Africa project was successful in bringing together different mapping groups in Liberia into a single network. This is now enabling us to learn together, have a central meetup point and coordinating on project activities.
- The Liberia Mapping community has found a home from where we can host mapathons, GIS training, and other related mapping meetups.
- There are resources from HOT, and other open mapping technologies courseware online, which will be used to conduct trainings, mapathons and awareness sessions.
- From the implementation of the Open Cities Africa project, the final data product is being viewed as a professional outcome of a mapping project. This has set our network in a suitable position to implement and support future mapping projects as a means to sustain our network.
- The network will make use of the OSM Liberia equipment (few laptops and smartphones) to begin conducting its sustainability initiatives while soliciting additional equipment as the network grows and as training and projects require.

We look forward to our network, partners and funders to support us in sustaining these benefits. As a community of mappers, we hope to keep growing the community through training, paid services and collaborative projects. With support from our stakeholders, community, local and international partners, we will continue to conduct capacity building across schools, communities, and cities; participate in national mapping projects.

The mapping community's new home is the [iCampus](#). We hope to use this open space for the short term (2019) for meetups, through iLab's arrangements though we will be required to pay rental fees for events and trainings as we pursue a for a long-term solution of a permanent office space within the iCampus which will required we rent an office to have privilege to the campus full facilities like training halls and meeting rooms at a discount. With the available resources and partnership from OSM Liberia, we will continue to revise and update these resources which will be used for training for a long time.

With our existing current stakeholders, Humanitarian Openstreetmap Team, World Bank, Monrovia City Corporation, Liberia Institute of Statistics and Geo-Information Services, National

Disaster Management Agency, Ministry of Internal Affairs- urban division, Liberia National Red Cross Society, Ministry of Public Works, Liberia Water and Sewer Corporation, other INGOs, Universities, Technical colleges, Civil Society actors and high schools in Liberia, we are optimistic we can work together in supporting nationwide mapping initiatives beyond the Open Cities Africa project.

Several of these stakeholders' (National Disaster Management Agency, Ministry of Internal Affairs - Urban Division, Liberia National Red Cross Society, Liberia Water and Sewer Corporation), work requires intensive mapping activities, but the lack of technical skills and budget to foster this major component of the operations had been stalling their efforts. As a community of mappers, we see these gaps as opportunities for sustainability in that we will reach out to form collaborations geared towards supporting this aspect of their work. We strongly recommend to donor partners, the World Bank, UNDP and USAID to encourage their partners to work with us in this regard.

All of these benefits and potential collaborations outlined in our sustainability module comes with financial, social, technical and institutional challenges that need to be addressed if this sustainability module will last. These are discussed below:

Financial

As a forming community of mappers network, we need financial support to get off the ground and through collaborations, grants, and partnership, we can in the near-future sustain our own operations moving forward. Areas for financial support are:

- An office space at the iCampus (with training facilities)
- Devices and equipment for training and mapathons
- Mobility to conduct mapping-related events (training + Mapathons) across the country
- Electricity, internet and stationery for office and field training
- A mini budget to run the affairs of the network

Technical

The technical aspect of our sustainability is as relevant as the financial. We will need to build the technical capacity of the community of mappers who in term will conduct a Trainer-of-Trainers for the rest of the network. Capacity building for the network needs to be extensive across different platforms and mapping technologies to include:

- GIS - Cartography
- OSM technologies
- ESRI technologies
- Bing Maps
- Mapbox
- CartoDB

- UAV Image capture and processing

These and other mapping tools will ensure the network has the capacity to support the different scopes of mapping work across partners and actors. The network will need equipment like laptops, cameras, drones, smartphones and online servers to support training and mapping activities. Ideally, scholarships opportunities to learn and attend national, regional and global mapping events will improve the capacity and build additional partnerships of the network.

Social

Socially mapping is not one of those career paths Liberians have ventured into, as such, our community of mappers will generate huge interest across the country and in the education sector. Cartography, map reading and other GIS mapping skills are still rare in Liberia. Increased effort by the mapping community to train more people is therefore a high priority. The inclusion of females in geospatial works is something we must continue to bring to the forefront as it is one of the barriers faced by women in Liberia. Most families, communities see technical works, in this case mapping to be more of a male career. As such, awareness is required and will have to go beyond emailing, social media to include SMS and in-person visits to schools and communities, especially to recruit females to learn, join and participate in the network activities.

We will need to conduct a lot of remote mapping events on campuses, communities and in other counties. This will require that we have the needed logistics on hand to facilitate these events outside of our official meetup space or office. To get stakeholders from different institutions to attend an event in huge numbers is always a challenge. Therefore, we will conduct some trainings at stakeholders facilities to ensure they are fully participating and will create an opportunity for in-depth partnership discussions.

Institutional

The Community of mappers will create an institutional structure to include a management team coordinators, trainers, communication and outreach teams and a liaison officer on a volunteering basis. As the network evolved and sustainability becomes eminent, we will form a more organized and permanent body to run the daily operations of the network and its activities. We will form mapping ambassadors across all 15 counties of Liberia who will coordinate the affairs of the network at the county level.

Conclusion

Open Cities Monrovia's activities have been successful and the project's objectives reached. From remote mapping, to trainings, to field mapping, then data cleaning, and map production, the OCA team provided vital skills to community residents in Zone 300, and generated useful, never-before-collected data. All datasets collected will support civil society advocates and service delivery by city leadership as well as the central government.

Using a participatory approach, we mapped a total of 1.11 sq. kilometers of Area of Interest, developed 19 geospatial data layers and collected 250 attributes relevant to our problem statement. We received 3 pre-existing datasets from government stakeholders, 2 of which were relevant to the AoI. The project conducted 9 training sessions, 7 for project staff, 1 for target community youth and 1 for stakeholders and the general public with over 115 persons benefiting. Up to 42 groups of stakeholders were engaged, while few them contributed directly to the project, the majority are beneficiaries. From the 42 stakeholder groups, 7 were women groups residing in the project four target communities.

In our stakeholder engagement, we identified 3 barriers faced by women:

1. Women are housewives and therefore should be at home to nurse children and cook
2. Technology is a man's thing
3. Women are not to do men's work, field data collection is a man's job
4. Women are expected to stay at home and take care of the kids
5. Parent choosing career for their girl child
6. Less interest in technical education

The project however, was able to address 2 of these barriers by training and including up to 8 women as members of our 20 field mappers.

The User Research Survey and User Centered Design approaches used during the product design phase generated much interest and awareness amongst stakeholders as evidenced from the two town hall meetings and stakeholders gathering at the products presentations. We had 297 persons attending presentations who are made aware of the data products, of this number, up to 69 persons were trained to use data products. Overall, we have approximately 270 people with improved understanding of the flooding resilience problem identified from reading the data products. We can argue that up to 220 persons would use the data products to inform their disaster risk management decisions.

The collaboration between iLab Liberia and OSM Liberia has strengthened not only their mapping skills but also the mapping communities they have trained and cultivated, ensuring that more skilled mappers than ever before are ready and willing to continue contributing to Liberia's mapping initiatives.

In an effort to merge our efforts, we have recently applied for the HOT microgrant for 2019. This grant if awarded, will ensure we host regular mapping activities (training and mapathons) to building this community and extend to high schools and the physically disabled community.

During the project products launch for Stakeholders, Ministry and Internal Affairs and the Liberia Institute for Statistics and Geo-Information services expressed interest in working with us on future projects. We are planning to meet with the senior leadership of these institutions and work out Memorandum of Understanding (MOU) to support our collaboration.