

Final Report

Accra City Project, Ghana



Humanitarian
OpenStreetMap
Team



OpenStreetMap
Ghana

Humanitarian OpenStreetMap Team, Mobile Web Ghana and OpenStreetMap
Ghana

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Abbreviations

AMA	Accra Metropolitan Assembly
AOI	Area of Interest
CSOs	Civil Society Organizations
GARID	Greater Accra Resilience and Integrated Development
GFDRR	Global Facility for Disaster Reduction and Recovery
GIS	Geographical Information System
GSS	Ghana Statistical Service
GHA	Ghana Highways Authority
HOT	Humanitarian OpenStreetMap Team
JOSM	Java OpenStreetMap editor
MMDAs	Metropolitan, Municipal and District Assemblies
MWG	Mobile Web Ghana
MOH	Ministry of Health
NADMO	National Disaster Management Organization
NGOs	Non Governmental Organizations
ODK	OpenDataKit
OMK	OpenMapKit
OSM	OpenStreetMap
OSM Ghana	OpenStreetMap Ghana
POI	Points of Interest
Sq km	Square Kilometres
WB	The World Bank

Executive Summary

In June 2018, the Open Cities Africa (Accra)¹ project commenced in Ghana. It is part of the Open Cities Africa project which seeks to make 11 selected cities in 10 African countries resilient to natural hazards like flooding. Open Cities Africa is part of the World Bank's Global Facility for Disaster Reduction and Recovery (GFDRR) and Open Data for Resilience Initiative (OpenDRI) program. OpenDRI over the past seven years has promoted and supported the use of open data to reduce vulnerability to natural hazards. The program has championed the advancement of OpenStreetMap (OSM) in government in disaster-prone areas in Africa and Asia.

The Open Cities Accra Project is being undertaken by three organizations namely, Humanitarian OpenStreetMap Team (HOT)², Mobile Web Ghana³ and OpenStreetMap Ghana⁴. The project is also being undertaken in the following 11 cities: Accra, Antananarivo, Brazzaville, Kampala, Kinshasa, Monrovia, Ngaoundéré, Pointe-Noire, Saint-Louis, Seychelles and Zanzibar City. In June 2018, delegates from these various cities convened at the Makerere University, Kampala for the official Open Cities Africa kick-off and training event.

This report summarizes the activities of the Open Cities Accra team since the project began in June 2018. The scope of this report is broader than the inception report as the project was extended. Initially, the project was expected to collect and curate geospatial data in all 4 focus areas of interest for this project and as shared by the Greater Accra Resilience and Integrated Development (GARID) project. These areas are Alajo, Akweteyman, Nima and Alogboshie. Per the requirements of the project, the team was expected to do both remote mapping and field data collection in only Alogboshie while doing only remote mapping in the other three areas, with the project ending in October 2018. However, in October 2018, the OCA Accra project was extended to accommodate field data collection in one additional area of focus. In consultation with the GARID project team comprising of representatives from the Word Bank Ghana office and the Ministry of Inner City and Zongo Development⁵, it was decided that extended mapping activities be conducted in Akweteyman.

¹ <https://opencitiesproject.org/accra/>

² <https://www.hotosm.org/>

³ <https://mobilewebghana.org/>

⁴ <https://www.osmghana.org/>

⁵ <http://www.miczd.gov.gh/>

It is worth noting that prior to the commencement of field data collection in Akweteyman, geospatial data had been collected both remotely and from the field in Alogboshie. This data has already been made available on the OpenStreetMap platform. Data collected included details and building footprints, drainage networks, flood history, roads, waterways, waterpoints, solid waste, health facilities, educational facilities, and points of interest⁶⁷. The same data was collected in Akweteyman, except for building details.

The report also details our engagement with stakeholders of the project, remote mapping, field data collection, and activities leading to the product development and recommendations. The OCA team, based on the user research survey, decided to develop a web application and produce printed wall maps for various government and other stakeholders of this project. These data products have been developed using data collected from the field and it is expected that the different stakeholders will take data-driven decisions using these products in their disaster risk management work.

⁶ <https://docs.google.com/document/d/11EfMTVLkDftSKx1oh3eUCGX-OtzbbGCjQeQGkjajsxA/edit?usp=sharing>

⁷ https://docs.google.com/document/d/1t6V_NSmNmy3ixWVTY-p_tp70kBIFcZI8-9fiK7p38NQ/edit?usp=sharing

PART 1: Project Overview

1.0: Background

Open Cities Africa

As urban populations grow and their vulnerability increases, managing urban growth in a way that fosters cities' resilience to natural hazards and the impacts of climate change becomes an ever-greater challenge that requires detailed, up-to-date geographic data of the built environment.

Addressing this challenge requires innovative, open, and dynamic data collection and mapping processes that support management of urban growth and disaster risk. 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 can help translate data into meaningful action.

Building on the success of the Open Cities project in South Asia, the global Open Data for Resilience Initiative, and GFDRR's Code for Resilience, Open Cities Africa was carried out in 11 cities in Sub-Saharan Africa, 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 aligned with GFDRR's Resilient Cities Program⁸ and 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 the selected cities. Following a competitive application process, a small team in each city received funding, targeted training, technical support, and mentorship to achieve 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.

⁸ <https://www.gfdrr.org/en/resilient-cities>

Accra, Ghana

Accra is the capital of Ghana, covering an area of 225.67 km² (87.13 sq mi) with a current population projection of about 2.4 million⁹ people. Approximately 56% of the population are under the age of 24. Data also shows that about 45% of Accra's residents are immigrants that originally lived in other African countries¹⁰. It is organized into 10 local government districts, 9 municipal districts and the Accra Metropolitan District, which is the only district within the capital to be granted city status. The city is saddled with problems such as overpopulation, traffic jams, solid and liquid waste problems, unplanned development, and flooding. In June 2018, the government invested two hundred million Ghana Cedis (GHS 200m) to de-silting major drains such as the Odaw and Korle lagoons, the Nima drains, the South Kaneshie drain, the Sakura drain, Kaneshie First light, and Odorkor drains, among others, that flood during the rainy season in Ghana¹¹. With more than 10 people killed in Accra during the rainy season in 2018¹², flooding is one of the major challenges confronting the inhabitants in Accra.

Project Approach

Phase One: Assess

During this phase teams established the availability and condition of existing data, relevant to the problem statement outlined for the city. Teams also finalized the project study area and the data to collect. They also identified project partners and stakeholders to ensure that efforts were a participatory process. All the findings during this phase, as well as a detailed data capture strategy were presented in the Project Inception Report.

Phase Two: Map

In this second phase, teams implemented the findings and data capture strategy developed in the first phase to address critical data gaps relevant to their specific Problem Statements.

⁹ <http://worldpopulationreview.com/countries/ghana-population/>

¹⁰ <http://worldpopulationreview.com/world-cities/accra-population/>

¹¹

<https://www.myjoyonline.com/news/2018/June-21st/accra-floods-govt-commits-ghs200m-to-projects-says-deputy-minister.php>

¹² <https://www.pulse.com.gh/news/local/10-dead-after-heavy-rainfall-on-monday-id8524515.html>

Phase 3: Design

In this third phase of the project, teams used the data collected in the Map Phase to design the prototype of a tool or product to communicate the data to their stakeholders to support decision-making. Prototypes could vary widely depending on city context, but could include a database and visualization tool, an atlas, a map series, or a mobile application.

1.1 Problem Statement

The Open Cities Accra Project sought to make Alogboshie and its environs resilient to natural disasters, especially flooding. The project involved the remote mapping of Alogboshie, Akweteyman and Alajo. These are areas of focus in a larger resilience project, GARID, and are all located along the Odaw River which is prone to floods. Alogboshie is a community that is plagued by perennial flooding, its indigenes and those in neighboring communities are mostly affected by this. The area is usually flooded in the months of June and July because the rainy season is at its peak then. The effect of the flood on human life in the community is huge. Often after floods, some indigenes of the community are displaced due to the loss of property. Also, this community being a slum makes it prone to disease outbreaks because of the poor planning of physical structures there. Lives are being lost yearly, properties are being destroyed, and diseases are spreading rapidly.

The Solution

Open Cities Accra worked to address these problems by providing a detailed and accurate map of the area and capacity building for the various stakeholders in the government institutions. These stakeholders include the Accra Metropolitan Assembly, Ghana Statistical Services, Metropolitan and Municipal District Assemblies, Ministry of Inner Cities Development and Zongos, National Disaster Management Organization etc. The Alogboshie community will benefit from this project as the results will help in planning the area and also inform disaster relief agencies in determining the number of relief services they need to send there. Government agencies like the Accra Metropolitan Assembly, National Disaster Management Organization and the various Municipal and Metropolitan Assemblies stand to benefit as their work becomes a lot easier with the maps that were produced as a result of the project. This will help them make data-driven decisions which have the tendency to affect the lives of indigenes more positively. To ensure these benefits, we provided training to staff members of these institutions allowing for the continuity of the mapping practice we have introduced them to.

The Approach

The approach adopted in this project included remote mapping, field data collection and data validation. Remote mapping was conducted to generate roads and building footprints of the AOI from drone image. Field data collection was conducted to collect additional detail on buildings (such as number of levels, building type, materials) roads, waterways, drains and their conditions were collected based on the data model developed with the project stakeholders. OpenMapKit, OpenDataKit and Mapillary was used in collecting the data. For the past almost one year, the team, assisted by volunteer-mappers, worked in these communities collecting, cleaning and curating geospatial data. The data was shared with the stakeholders in formats that they can use and training was provided to reuse the data to make their work more effective. In the end, the use of the data collected during this project will help the stakeholders take data-driven decisions to help prevent or reduce flooding in Alogboshie and its environs.

To ensure the data collected will be helpful to the disaster risk management work of stakeholders, including a number of government ministries and agencies, and some international organizations, Capacity building and community engagement was an integral aspect of this project. Our goal was to build the capacity of the stakeholders and community members to be able to collect their own data and contribute to the OpenStreetMap platform. This will ensure the availability of free and accessible accurate geospatial data which can be very useful in the fight against natural hazards like flooding in other areas.

PART 2: Data Collection Process

2.1 Area of Interest

Accra is the largest and the most populated city in Ghana. According to the 2010 Population and Housing Census, the total population of the city was 1,665,086¹³. The population growth rate in the Greater Accra Region is 3.1%¹⁴ which means as at 2018, the estimated population of the city was 2,036,889. Of the entire population of the people living in Accra, 60%¹⁵ live along the Odaw River Basin. The Odaw River Basin is known to be a flood prone area and considering the number of people who live there, the city stands to lose a huge percentage of its vital human resource and property if flooding in this area is not dealt with.

The OCA Accra areas of interest were the low-income or informal communities of Nima, Alajo, Akweteyman and Alogboshie which are known to be the main sources of waste entering into the Odaw river. These communities are the area of focus for Sub-component 2.1. Community-level solid waste management in Odaw Drainage Basin of the larger GARID project. The total beneficiary population for these communities is estimated to be about 300,000 inhabitants.

¹³ <https://ama.gov.gh/theassembly.php>

¹⁴ <http://www2.statsghana.gov.gh/nada/index.php/catalog/51>

¹⁵

<http://documents.worldbank.org/curated/en/887301539624730401/pdf/Concept-Project-Information-Dокумент-Integrated-Safeguards-Data-Sheet-Greater-Accra-Climate-Resilient-and-Integrated-Development-Project-P164330.pdf>

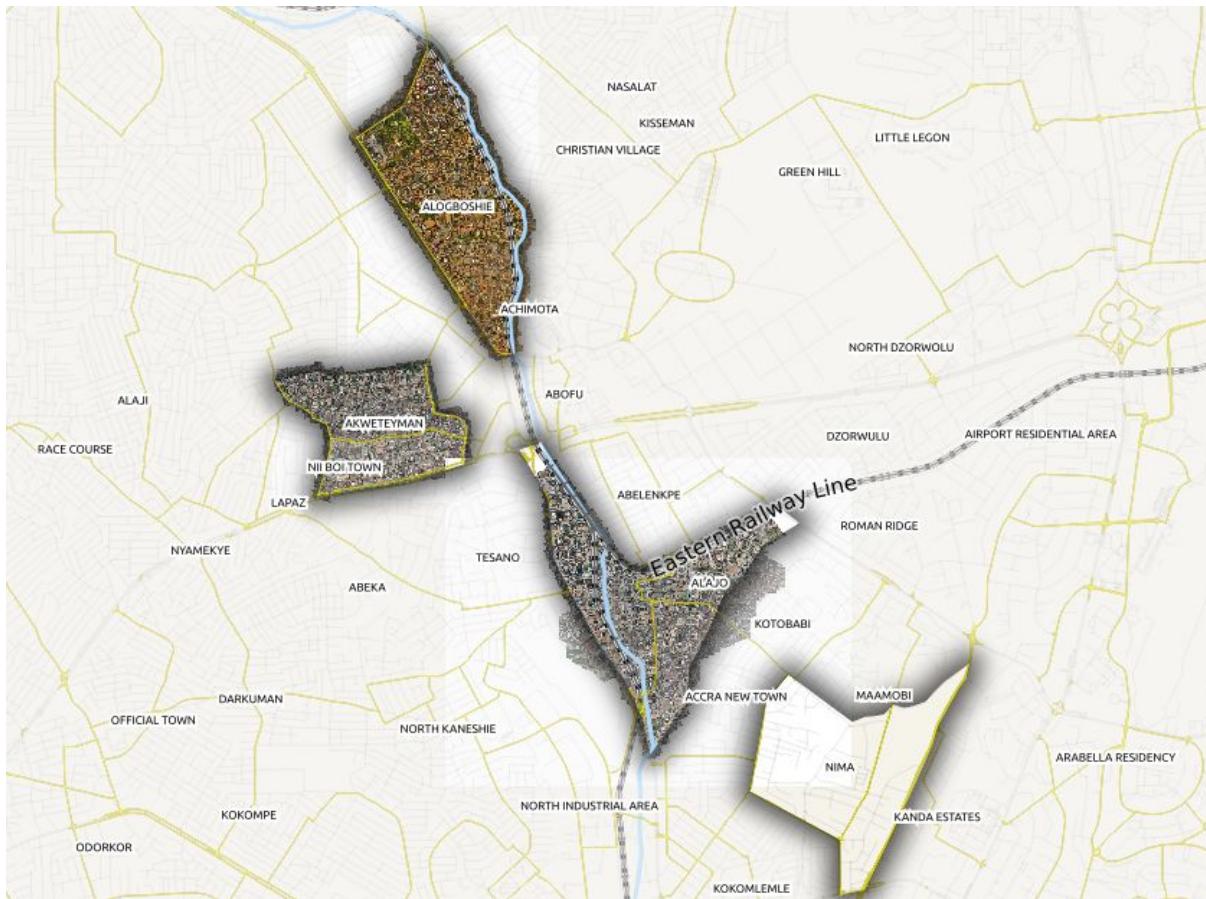


Fig 1 - Open Cities Accra project areas of interest

2.2 Field Data Collection

Data collection, both remotely and from the field, was very essential to the achievement of the goals of this project as a major goal of the OCA project is the collection and creation of up-to-date, high quality, accessible data to better understand natural hazard risk and support data-driven decision-making for the City.



Fig 2 - Field data collection

From the beginning of the project, steps were taken to ensure that we had a series of seamless data collection exercises. Such activities are listed below:

- **UAV imagery capture:** At the start of the project, the OCA team conducted an assessment of available satellite images of the areas of interest. We realized that the quality of images were poor (even for Bing and ESRI Satellite images) making it difficult for remote mapping, however we went on to set up an initial task on the HOT Tasking manager for Alogboshie with Bing. Bing was chosen because it had the best alignment with existing data and GPS traces available. Concurrently we worked on getting the UAV imagery of the communities for the actual remote mapping and field data collection process. Ultimately, we had a local contractor capture aerial images of Alogboshie. The drone image was used to set up a new task on the HOT Tasking Manager. Experienced and guided mappers used the Replace Geometry function in JOSM to align and map new structures preventing massive deletion and keeping object history in OSM. Later, we took the images of Akweteyman and Alajo as well which were used to set up new mapping tasks. Nima presented a challenge to us in aerial imagery capture. Since the President of Ghana

is a resident there, the community is regarded as a high security zone. Therefore drone imagery cannot be taken there without special permission granted us.

Bing Imagery	Drone Imagery
	
Akweteyman	
	
Alajo	
	
Alogboshie	

Fig 3 - UAV / Drone images captured

- **Recruitment of Mappers:** Before the field data collection in Alogboshie, we posted an application form on social media inviting all who were interested to volunteer as mappers to apply and come for an interview on a later date. The application form was filled by 96 people and we invited them for an interview. Our target number of mappers was 30, hence we had to screen the applicants. We did this based on qualification, experience and gender criteria. Gender integration was a prominent component of this project therefore we made the conscious effort to involve female mappers in the data collection phase of the project. After getting the desired number of mappers we needed, we invited them to a one-week training program at Mobile Web Ghana.
- **Training of Mappers:** The volunteer mappers were taken through an intensive 5-day training in the following:
 - Mapping with OSM iD editor
 - Mapping with JOSM
 - Remote mapping with the HOT Tasking Manager
 - Introduction to street level imagery using Mapillary
 - Mobile tools
 - OpenDataKit
 - OpenMapKit
 - OsmAnd
 - MAPS.ME
 - Mapillary
 - Introduction to GIS and using QGIS

During the one-week training that the mappers had to undergo in preparation towards field data collection for Alogboshie, they were taught how to collect geospatial data in the field with free and open source software. During the training period, they were taken out on two occasions to test their skills and understanding of the mobile phone applications they were going to use to collect data. Also, they were assessed based on their ability to work together in teams.



Fig 4 - Training of volunteer mappers and field test mapping

Remote Mapping

Remote mapping of the areas of interest for the OCA project involved the tracing of building footprints and other visible infrastructure over a satellite or UAV image. This creates geodata that is accessible from the OpenStreetMap database accessible to all under the Open Data Commons Open Data Licence¹⁶.

The tasks for all the 4 focus areas were created on the HOT Tasking Manager¹⁷. Remote mapping was done in preparation for field data collection. Remote mapping was done largely by OSM community members in Ghana including OpenStreetMap Ghana and YouthMappers, with some participation from the global OSM community. After the training we had for the stakeholders, they also contributed to the OSM platform by mapping Alogboshie.

There was a mapathon organized at the World Bank, Washington DC, to map Alajo. In all 170 people participated in tracing building footprints and other geospatial layers of Alajo, a suburb of Ghana's capital city, Accra.

¹⁶ <https://www.openstreetmap.org/copyright>

¹⁷ <https://tasks.hotosm.org>



Fig 5 - Remote Mapping by mappers



Fig 6 - Mapathon at the World Bank Washington office¹⁸ to map Alajo

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<https://blogs.worldbank.org/opendata/mapping-sustainable-development-open-data-resilience-mapathon>

Field Mapping

During field mapping, mappers used OpenMapKit (OMK) and OpenDataKit (ODK) to collect buildings and other features' data. OsmAnd was used to locate sections assigned by mapping supervisor to various teams as well as to record GPS traces. They were also given measuring rods to measure the depth and width of drains.

Generally, we expected the mappers to go to the field, observe geospatial features and record details about them. However, a considerable aspect of their work in the field involved interacting with community members and asking questions. For example, the mappers were tasked to collect flood history data from the field. This data cannot be merely observed and recorded. They had to ask questions and politely solicit answers. Therefore, before they went into the field to work, they were taken through a session during the one-week training program on how to interact with community members. They were taught the exact things to say: introduce themselves, the project and then proceed to ask the vital questions. This was done to alleviate any suspicions and assumptions that community members might have about the mappers and their work in their community. Also, it would make it easier for community members to open up about the environmental problems they face.





Fig 7 - Field mapping with volunteer mappers





Fig 8 - Engagement with community members on the field

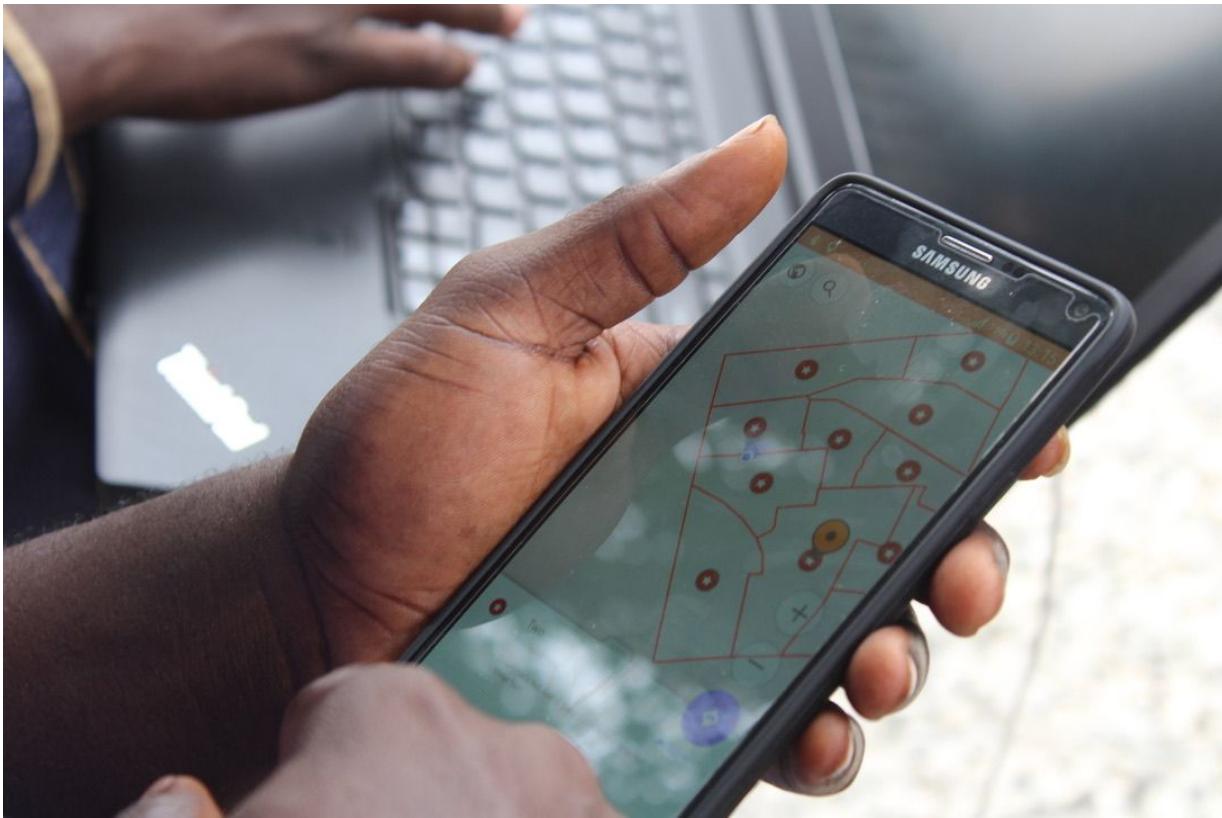
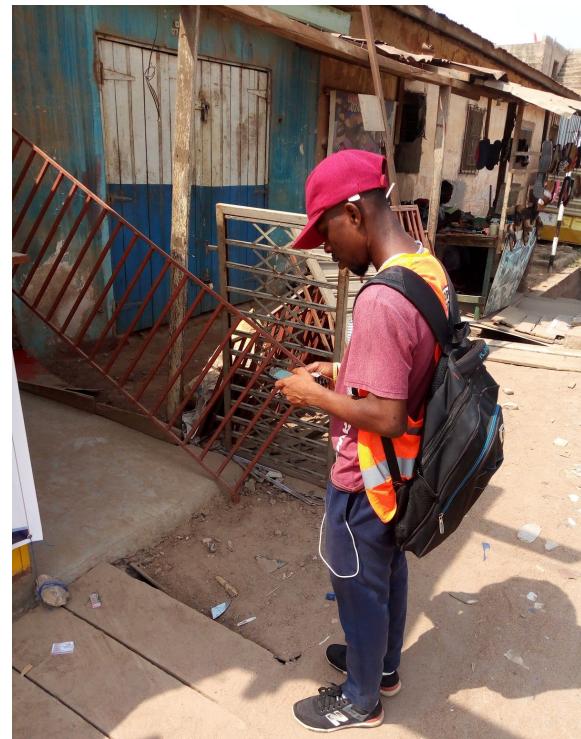


Fig 9 - Using OsmAnd to find task areas for the day by mappers in the field



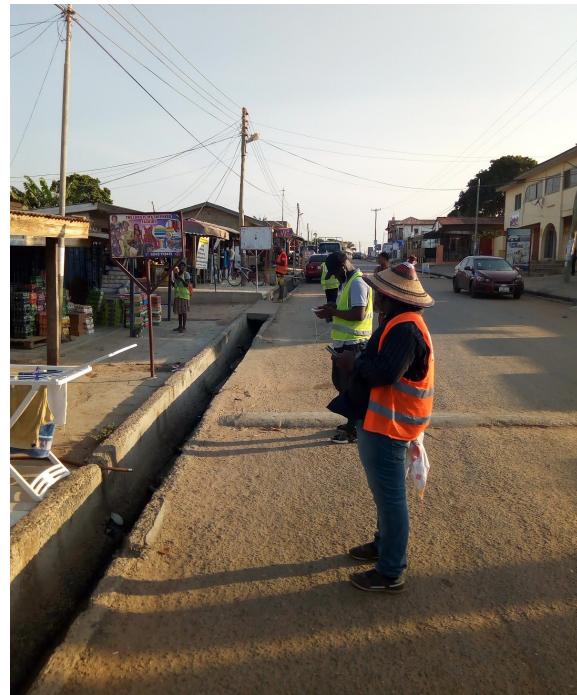


Fig 10 - Drain mapping on the field by volunteer mappers

Street-Level images

Street-level images offer detailed information from the horizontal point of view which aerial images doesn't offer. The OCA Accra team received a Garmin VIRB device which was generously leased to the team by Map Uganda¹⁹ for temporal use.

The images were uploaded to Mapillary, a crowdsourcing platform and community for the collection of street-level images by everyone across the globe which can be reused in projects such as OpenStreetMap.

Even though street-level images were not part of the initial plans of the project, the team pulled the limited resources together to collect street level images of all the four communities. As at the time of this report May 2019, street level images have been captured in Alogboshie²⁰ and some parts of Akweteyman.

These street-level images were further used in addition with field validation to ensure maximum level of data quality and integrity.

¹⁹ <https://mapuganda.org>

²⁰ <https://www.mapillary.com/map/im/cPcUZ6WJx0lw9VmCiGBpxA>

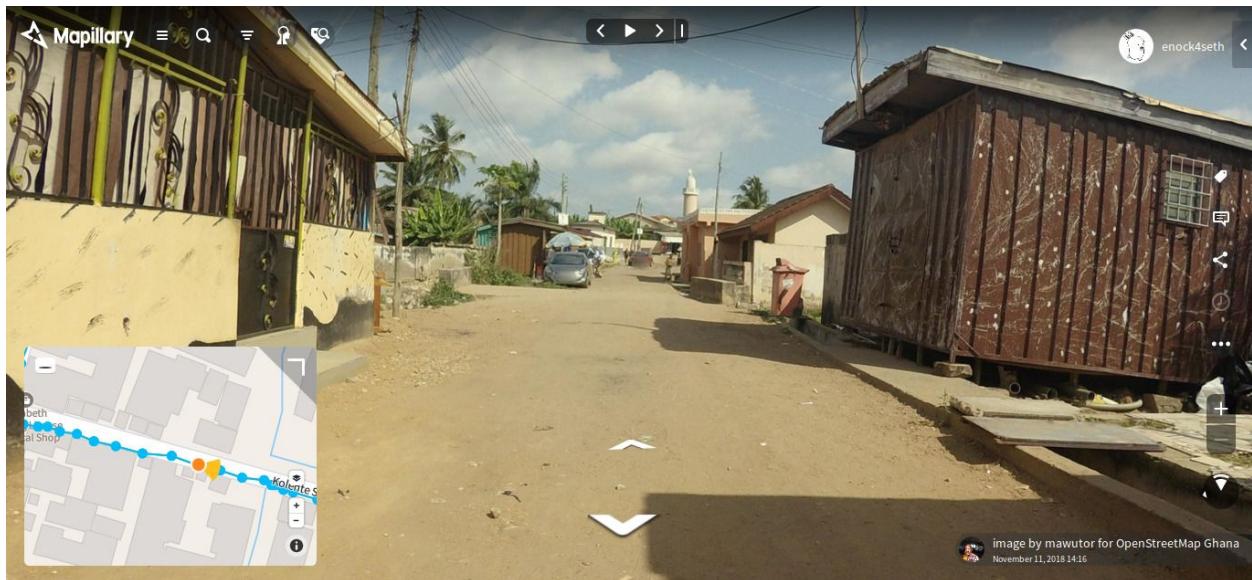


Fig 11 - Street-level image as uploaded to Mapillary

2.3: Data QA/QC

Data collected from the field were uploaded to a Portable OpenStreetMap (POSM)²¹ server at Mobile Web Ghana (our project office) for the entire period of field data collection in Alogboshie. Since POSM could not be powered in the field, mappers handed over phones to team leaders who then uploaded data to POSM on their behalf at the project office. During field data collection in Akweteyman, the team went into the field with POSM based on feedback from previous data collection and performed data uploads to POSM at the end of each data as instructed by the field supervisor at a suitable convergent point with a power source. The convergent points were mostly shops in the community. As of 19 February 2019, data quality for Alogboshie is strong with only minor tagging modifications needed. Map Campaigner, Osmose, OSMCha, and JOSM were used to assess the quality of data uploaded to OSM by the OCA Accra team by an independent team at for the Open Cities Africa project.²²

²¹ https://wiki.openstreetmap.org/wiki/Portable_OpenStreetMap

²² <https://docs.google.com/document/d/1HWlie7kZ9qse5Zlg1K-AYOZOOhRmHdEOC1jCkeq1pzWI/edit>

Data cleaning

The data cleaning team was made up of 7 mappers (5 males and 2 females). The data cleaners were trained as a group and supervised by a mapping supervisor, checking their individual data cleaning quality for prompt feedback. The training focused on advanced features and functionalities of the JOSM software that helped them in their work and improved efficiency. Some of these features included expert mode, filters, relations and plugins such as To-do list and Open Data. They were assigned portions of the data from the field downloaded from POSM and assigned by the mapping supervisor / technical lead. Google Drive was used as central storage and for dissemination of raw data to be cleaned and Google Sheets was used to track progress and status of assigned data before final approval for upload to OpenStreetMap. This made it possible for us to work both in-person and remotely. Telegram²³ was used by the data cleaning team to communicate and share screenshots of issues and problems encountered for best solutions either from supervisors or peers. Telegram was used because of the flexibility to use it as a stand alone application and seamless sharing of files. Issues that need data collectors to clarify are also forwarded to the data collectors or team leaders for further clarifications when required.

Data Cleaning Process

- A **raw** data file is assigned
- A **final** version cleaned and validated is uploaded
- Supervisor **reviews** the **final** data and authorises upload to OpenStreetMap

Tools used:

- JOSM
- QGIS
- LibreOffice Calc
- OpenRefine
- Google Docs

Observations during data cleaning

During data cleaning, the following observations were made:

- Misspelled Street names
- Building roof materials collected as wood
- Multiple house numbers and building names
- Same community name on dispersed buildings
- Unidentified street addresses added to buildings

²³ <https://telegram.org/>

Field validation

Field data validation was conducted after data was uploaded to OpenStreetMap. Vespucci mobile application was mostly used to check the validity of attributes collected in the field and saved as a .osm file on the phone or could also be uploaded directly to OSM. Street level images captured using Mapillary were as well used to validate data collected from the field.

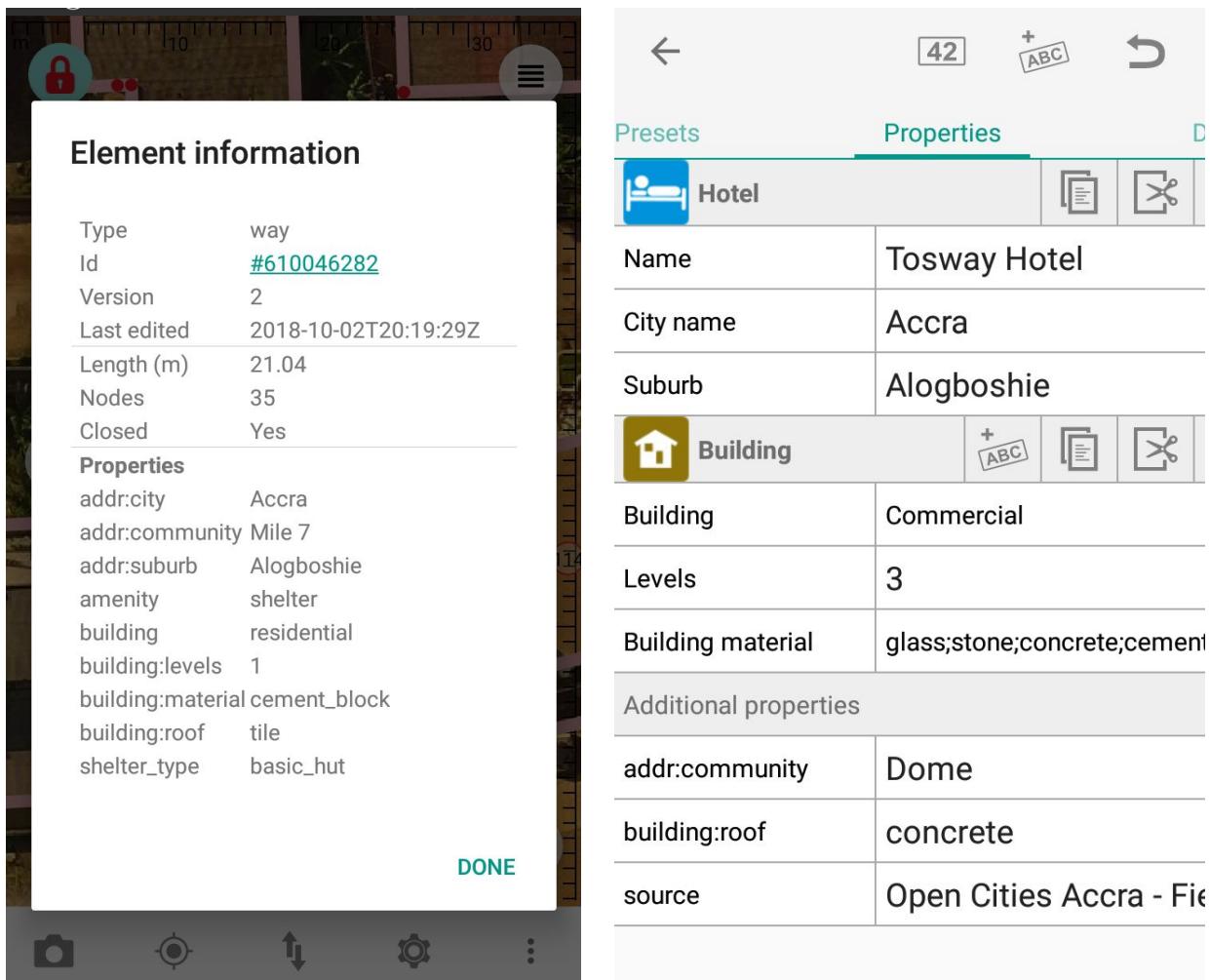


Fig 12 - Vespucci used to view building attributes during field validation

An Overpass query²⁴ was executed and exported saved as .osm file and opened in Vespucci for use in the field. Vespucci²⁵ was used because it was flexible and effective to

²⁴ <http://overpass-turbo.eu>

²⁵ <https://vespucci.io/>

modify and view object properties in the field. It functions much like JOSM, supporting most JOSM functions and presents. UAV imagery for study areas were used directly from OpenAerialMap as a TMS to avoid loading a larger .mbtile as in the case OpenMapKit which will be resource (RAM and CPU) intensive on the Android device and avoiding OMK crashes with .osm in megabytes. OsmAnd was also used for moving around and detecting streets that were not covered in the initial Mapillary capture exercise.

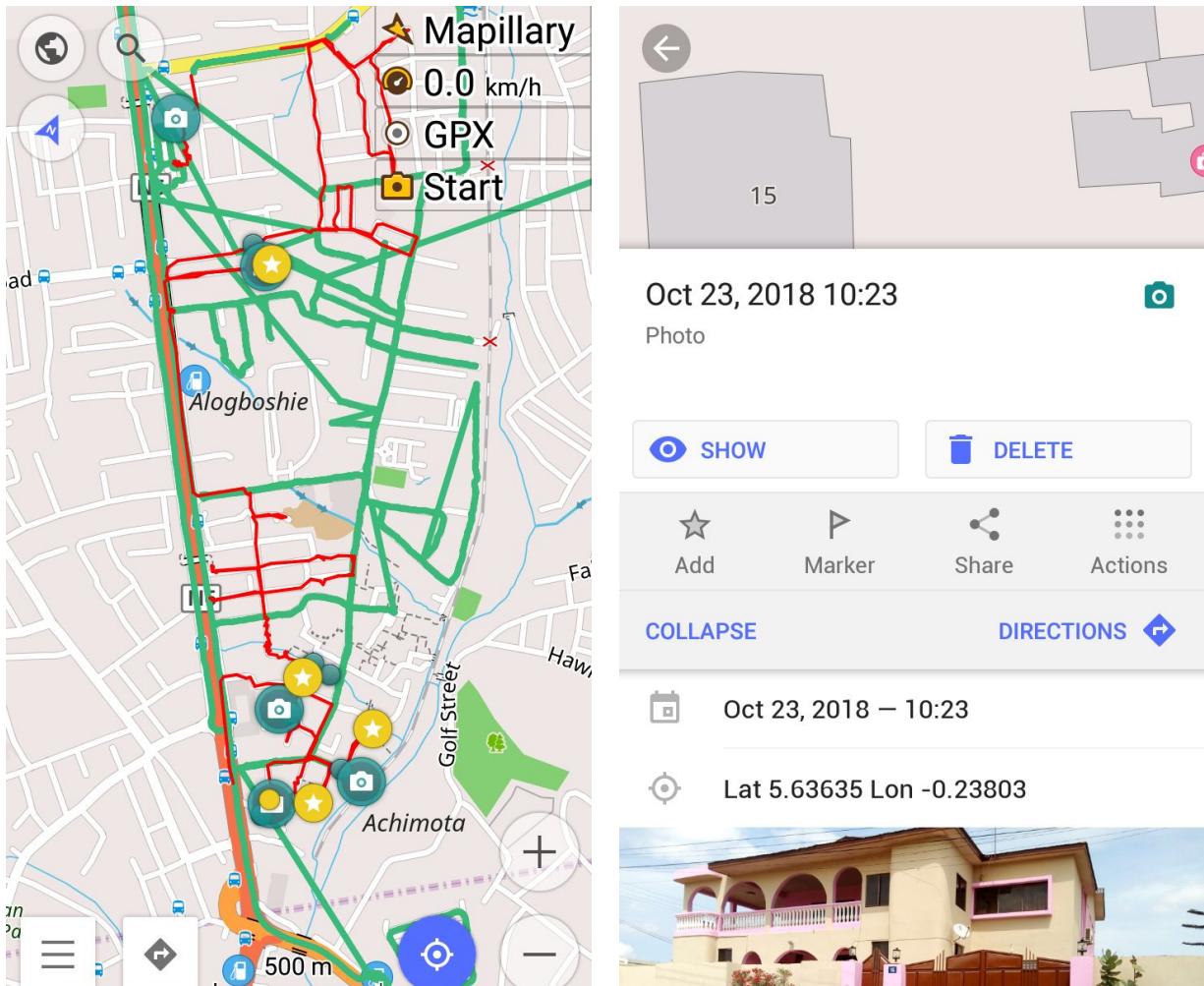


Fig 13 - OsmAnd for field validation and Mapillary images captured (Green dots)

Findings

1. Over one hundred features were randomly surveyed for validation from drains to buildings by observing and comparing attributes collected as mapped into OpenStreetMap.
2. Most buildings didn't have house numbers. There were a few buildings that had random house numbers, which were mapped during the field mapping exercise.
3. Not all streets had visible street sign or names.
4. We found out some footways were mapped as motorable ways which was either as a result of remote mapping using high resolution images or from outdated Bing imagery used for initial remote mapping in Alogboshie. These were corrected and updated in OSM.

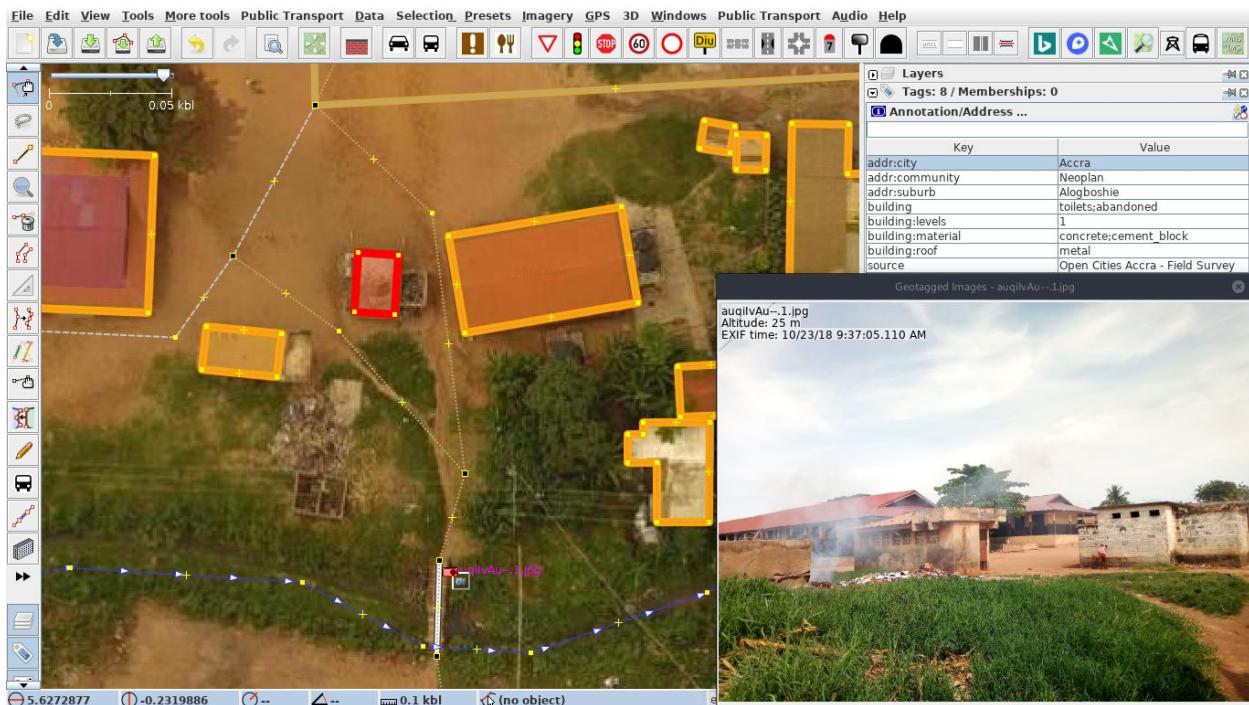


Fig 14 - Validating waste data with geotagged images from the field and JOSM

These measures were very effective ensuring that no major issues were identified by QA/QC tools such as OSM Analytics.

2.4: Geospatial Data Overview

The OCA Accra team collected data in the following categories with individual attributes as documented in section ‘2.2 Field Data Collection’ section, based on the data model developed by the project team and the project stakeholders.

The table below summarizes the extent of mapping and/or data collection in the various project areas of interest:

Layers / Communities	Alogboshie	Akweteyman	Alajo	Nima	# of features
Buildings	Field & Remote mapping	Remote mapping only	Remote mapping only	NA	Alogboshie: 7,373 Akweteyman: 6,733 Alajo: 10,386
Drain Segments	Field & Remote mapping	Field & Remote mapping	NA	NA	Alogboshie: 20.36 km Akweteyman: 19.85 km
Drain Points	Field & Remote mapping	Field & Remote mapping	NA	NA	Alogboshie: 812 Akweteyman: 1464
Health Facilities	Field & Remote mapping	Field & Remote mapping	NA	NA	Alogboshie: 4 Akweteyman: 10
Educational Facilities	Field & Remote mapping	Field & Remote mapping	NA	NA	Alogboshie: 14 Akweteyman: 32
Flood History	Field mapping	Field mapping	NA	NA	Alogboshie: 23 Akweteyman: 14
Solid Waste	Field mapping	Field mapping	NA	NA	Alogboshie: 51 Akweteyman: 26
Water Points	Field mapping	Field mapping	NA	NA	Alogboshie: 23 Akweteyman:
Financial Facilities	Field mapping	Field mapping	NA	NA	Alogboshie: 14 Akweteyman: 11
Roads and Paths	Field mapping	Field mapping	NA	NA	Alogboshie: 36.29 km Akweteyman: 29.29 km

Below is an overview of some of the feature attributes collected and the related attribute completeness in Alogboshie community:

Features Mapped	Attributes	Total Features	Attribute unset count	% unset
01 Buildings		7,373		
	building		0	0.00%
	building:level		1040	14.11%
	building:material		985	13.36%
	building:roof		1087	14.74%
	name		7133	96.74%
	addr:housenumber		7165	97.18%
	addr:street		6209	84.21%
	addr:community		1507	20.44%
	Average % unset			42.60%
02 Education Facilities		14		
	addr:city			0.00%
	addr:community			0.00%
	addr:suburb			0.00%
	addr:street		12	85.71%
	name		2	14.29%
	amenity			0.00%
	operator			0.00%
	opening_hours			0.00%
	capacity			0.00%
	fee			0.00%
	phone			0.00%
	Average % unset			9.09%
03. Solid Waste		51		
	addr:city		0	0.00%
	addr:community		0	0.00%
	addr:suburb		0	0.00%
	addr:street		42	82.35%
	amenity		0	0.00%
	waste		21	41.18%
	toilets:disposal		29	56.86%
	toilets:handwashing		26	50.98%
	access		27	52.94%

	fee		16	31.37%
	name		46	90.20%
	operator		45	88.24%
	Average % unset			41.18%

04. Water Points 23

	addr:city		0	0.00%
	addr:community		1	4.35%
	addr:suburb		5	21.74%
	addr:street		22	95.65%
	amenity		0	0.00%
	man_made		2	8.70%
	natural		22	95.65%
	drinking_water		0	0.00%
	pump		2	8.70%
	operational_status		0	0.00%
	name		22	95.65%
	Average % unset			30.04%

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. These were tracked on a monthly basis from start to end of the project.

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	5.94	8.08 sq km Alogboshie: 2.23 Akweteyman : 1.43 Alajo: 2.28 Nima: 2.14	Remote mapping in OSM/QGIS / JOSM	Alogboshie: 2.23 sq km Akweteyman: 1.43 sq km Alajo: 2.28 (<i>Remoley mapped & validated</i>)
1.2	Number of geospatial layers developed relevant to the resilience problem identified	17	8	QGIS / JOSM	Alogboshie: Buildings, Drain Segments, Drain Points, Health Facilities, Educational Facilities, Financial Facilities, Flood History, Solid Waste, Water Points Akweteyman: Financial Facilities, Flood History, Drain Points, Drain Segment, Educational Facilities, Water Points, Solid Waste, House Number

1.3	Number of attributes collected relevant to the resilience problem identified	130	20	QGIS / JOSM	Buildings: 14 Drain Segments: 35 Drain Points: 8 Health Facilities: 12 Educational Facilities: 11 Financial Facilities: 9 Flood History: 11 Solid Waste: 14 Water Points: 11 House Number: 5
1.4	Number of government or other pre-existing datasets used relevant to the resilience problem identified	0	10	N/A	From all the layers requested, none was given to our team. AMA shared with us a document titled PARTICIPATORY SLUM UPGRADING AND PREVENTION dated October 2011
1.5	Data collection has taken into account gender vulnerabilities	Data collection took into consideration the gender vulnerability by mapping materials and building types around the market area in Alogboshie			

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	258	100	Workshop attendance report	- 5-days mappers training: 30 - 2-days mappers training: 18 - 1-day stakeholders training: 23 - re:publica Accra 19: 30 - Training at the university: 120 - Data Use and Products dissemination Workshops: 21 - Meeting with MICZD: 6 - Field Data Validation for Alogboshie: 10

2.2	2.2 Number of people trained to use data product	21	100	Attendance List	- Female: 7 - Male: 14
2.3	2.3 Number of people with improved understanding of the resilience problem identified based on data product	147	100	Attendance List	University of Ghana outreach: 120 - MICZD: 6 - Data use and products dissemination workshop: 21
2.4	2.4 Number of people who would use data product to inform their disaster risk management decisions	27	40	Attendance List, OSM downloads, Open Data downloads	- MICZD: 6 - Data use and products dissemination workshop: 21

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	7	Attendance List	- 5-days mappers training - 2-days mappers training - 1-day stakeholders training - Training at the University of Ghana - Maame Digital - re:publica Accra 19 - Field Data Cleaning training - Data Use and Products dissemination Workshop
3.2	3.2 Number of people trained	329	100	Attendance List and counts	- 5-days mappers training: 30 - 2-days mappers training: 19 - 1-day stakeholders training: 23 - Training at the University of Ghana: 120 - Maame Digital: 60

					- re:publica Accra 19: 30 - Field Data Cleaning Alogboshie: 6 - Field Data collection for Alogboshie:20 - Data Use and Products Dissemination Workshop: 21
3.3	3.3 Number of people participating in community mapping activities	46	30	Attendance List	Female: 19 Male: 27
3.4	3.4 Number of stakeholder groups consulted (in planning activities, product development, etc.)	30	7	Email, Letters, Phone call survey forms	- Ministry of Inner Cities and Zongos Development - Accra Metropolitan Assembly - Ghana Statistical Service - Survey and Mapping division, Lands Commission - University of Ghana YouthMappers and Department of Geography and Resource Development - CSOs/NGOs (Future Leaders Association and Wealthy Women) - Kwame Nkrumah University of Science and Technology Youth Mappers - University of Mines and Technology Youth Mappers - University of Cape Coast Youth Mappers - Local NGOs eg. Let's do it Ghana - United Nations Development Programme - Civil Society Organizations and Non-governmental Organizations (Future Leaders Association and Wealthy Women) - Local OSM community - Community members of study area - Assembly man of Alogboshie - Ayawaso East Municipal

					Assembly - Stevdok Ltd - Forestry Commission - Tema Metro Assembly - Lands Commission - Benso oil palm plantation limited - EMO geomatics consult - Private Lands , Teshie Nungua - GAF - La Nkwantanang - Madina Municipal Assembly - Hydrological Services Department - CHED, Bibiani - Presbyterian Health Service-Osu - KNUST - National Disaster Management Organisation (NADMO)
3.5	3.5 Number of women engaged in the design of community maps	11	10	Email, Letters and Phone calls	From interactions with women in the field and community women group leaders: Future Leaders Association - 1 Wealthy Women - 1 Community resident: 1 MICZD - 3 Other stakeholders - 5
3.6	3.6 Gender-differentiated vulnerabilities identified through Gender Analysis				In analysing the gender-differentiated vulnerabilities in Alogboshie, we realized the following: - Difference in economic activities undertaken by men and women (including paid and unpaid work). Men in such communities are often more economically independent than their female counterparts. Therefore in the aftermath of a disaster, when property is lost, women will not find it easy establishing themselves again economically. - Different skills and capacities for men and women. Ghanaians are socialized into believing that the role of a woman in the home is to take care of household chores, the men on the other hand have the liberty to explore their surroundings through physical activities such as plucking fruits, climbing the roof to fix antennas, among others. This fact causes men to gain physical advantage over their female counterparts. These skills acquired through the exploration of their surroundings make it easier for men to escape the dangers of disasters than women.

		<p>- Different levels of access to information in which the media is a major source of information in Ghana especially for the uneducated people; radio and TV, but from the communities visited, we observed that women, compared to men, have very limited access to such mediums thus making men more informed.</p>			
3.7	3.7 Number of barriers to women's participation in Open Cities Africa identified	3	3	Direct observation interview data and community engagement analysis records Survey of women	<ul style="list-style-type: none"> - Lack of education / experience - Socialization - Parental and spousal control
3.8	3.8 Number of barriers to women's participation in Open Cities Africa addressed	3	3	Activities and training attendance records	Capacity building, field data collection was based in teams, engaging and training 12 female mappers for field data collection
3.9	3.9 Exchanges and/or discussions with other City teams	We had exchanges with SOGEFI/OSM Cameroon. This discussion was focused on the methodologies we both employed in our projects and learned from best practices as witnessed by each country team. We also received a Garmin Virb X Camera from Map Uganda team which have been used to capture Street-level images in our Areas of Interest. Having HOT in common with Liberia team also inspired some of our map designs.			

3.2: Gender

The Open Cities Accra project actively integrated a gender component into every aspect of the project. As women are usually more affected than men in the aftermath of flooding and other natural disasters, it was our aim to include women in every activity of this project from project decision making to data collection.

The Impact of flooding on men and women

From our field visit to the Alogboshie community, various stakeholders confirmed that women are more affected by floods than men. These impacts are caused by factors

including the division of labor, differences in skills and capacities, and differences in access to information.

- **Division of labor between men and women (including paid and unpaid work)**

In slum areas like Alogboshie and its environs, women and men do not pursue the same career paths, or, work in the same industry. You will often find the men engaged in menial jobs such as masonry, carpentry, car mechanics, painting etc. Mostly you will find the women engaging in economic activities such as trading food items in kiosks or on table-tops, hawking etc. This fact alone presented to us an inequality in income levels as the job opportunities regarded as the pure reserve of men in such communities tend to pay more than that of the women. The money the women earn is used to support their home and children. Financial power plays a major role in making a community resilient to natural disasters, especially from the point of view of the community members.

- **Different social skills and capacities**

Socialization also plays a major role in the way community members react especially to disasters. In a flooding situation, survivors are often forced to take some critical decisions and actions to save their lives. During floods, survivors often climb up to the roof of their houses or even on trees to escape death. In most communities men and women are brought up differently. Men are at liberty to be adventurous and explore their surroundings, while their female counterparts are restricted to domestic activities such as cleaning, washing and cooking. Therefore, young boys engage in activities such as tree climbing to pluck fruits and even climbing their houses to fix TV antennas. When disaster hits, climbing up the roof or climbing up a tree presents no challenge to men in such communities. However women may not know how to climb up to tree tops and rooftops to save their own lives.

- **Different levels of access to information**

Access to information is also very important in preventing casualties and fatalities during flooding. In such areas, you will often find the men clustered around one radio set and listening to the news and announcements while the women go about their daily chores. The media is the major source of information to Ghanaians - especially the electronic media (radio and TV). For uneducated people, radio and TV are the best sources of information because there are media houses that broadcast news in all the local languages. Therefore to remain informed in such a setting, one has to make it a daily practice to listen to the radio for news and announcements. Information we got from our visit to the area suggests that the women do not listen to the radio regularly. This is a serious problem for anyone who is living in a flood prone area. This means that men in such communities will be more informed about weather changes and weather news than women are. Once

again, this makes the women more vulnerable to natural disasters than the men because men have more access to information.

During the implementation of OCA Accra activities, we worked with two categories of women's groups in Alogboshie:

Women in Religious Associations: When the OCA team visited Alogboshie, we were able to interact with some women who belonged to Religious Associations, - specifically Women's Fellowship Groups in churches. This is a group that is found in most churches in Ghana, comprising the women in the church. The aim of these groups is to deal specifically with issues that affect women exclusively. One of the women we interacted with told us that she belonged to one of such groups in her church and that was the only group she belonged to. She also informed us about other associations that existed in the community like the 'Agbadza group': a cultural dance group. The associations in the community make it easy for one to reach a collection of women and also disseminate information to them.

Market Women Associations: Most women in Alogboshie are petty traders, market women and small and medium size business owners. Reaching out to these associations helped us to understand the key issues that their members face when natural disasters such as floods occur. During one of our visits to the area we spoke with one organization that functions as an association for market women called 'Future Leaders Association'. We also spoke with a representative of 'Wealthy Women', an organization that offers material help to market women when they are in distress.

Insights gathered from the women's groups on the impact of flooding on men and women

1. When disaster such as flooding occurs, women and children suffer most. Economically, women have to stay at home and make sure that the aftermath of the flood is cleared before she can go to the market. Women have to clean the house, look after the children if they are not able to go to school due to flooding. In some cases, women lose all their goods and have to go for loans to buy new sets of goods to trade in. Men on the other hand, will go to work (business as usual).
2. We spoke to a representative of an organization called Wealthy Women which provides financial services to women who have been hit by flooding and other misfortunes/disasters. She mentioned that the shed in the market are themselves affected by the rain and that makes the situation more difficult for women. In such cases, they provide financial help and also donate clothes and other needs to the affected women.

3. We also contacted a representative from an association for market women called Future Leaders Association. Their activities are to help the market women in times of distress like flooding. He mentioned that after the floods, the women lose a lot of their goods, so it is their duty to help organize some meetups with resource persons to help educate the women, encourage them in their times of distress and also offer some material support for them. He also mentioned that city authorities have asked all traders and squatters who are located within 50 meters on either side of the railway to relocate their structures. This he mentioned has affected a number of market women who are in the association.

Identifying and Addressing Barriers to Women's Participation

Three barriers to women participation identified in executing Open Cities Accra:

1. **Lack of education / experience:** You will often find that the average man is more educated than the average woman in Ghana. According to *Women and Men in Ghana*²⁶ by the Ghana Statistical Service, in the year 2014, 78.3% of men were found to be educated while 65.3% of women were recorded as educated. This makes it clear that there is inequality in the entire country so far as gender literacy is concerned. This data reflects a nationwide phenomenon. The percentages may drastically fall for women and rise for men in slum areas such as Alogboshie. Illiteracy presents a difficult challenge for us in our bid to integrate women in the project - especially women from the communities we worked in. The situation is no different in terms of their level of knowledge of technological devices. Therefore, it made it a daunting task for us to execute. However we remained poised to achieve our goal of integrating women into the project.
2. **Socialization:** Women and men are brought up differently. This means that their confidence levels vary. It also means that mentally some barriers might have been put in place by their upbringing that will prevent them from pursuing certain career paths or projects. Because women are often restricted to domestic chores and duties, you will mostly find that they have little or no interest in knowing how technological devices either operate or are operated. This alone places them several years behind their male counterparts who are often encouraged to play with appliances thereby increasing their interest in technology.
3. **Parental and spousal control:** In the Ghanaian culture, women are often placed under strict supervision and control. So you will find out that most young ladies have curfews while their brothers and male friends have freedom of movement. This is sometimes done with the right intentions to prevent teenage pregnancy and safety. However, this robs young ladies of a sense of adventure, personal initiative and drive to do something to cause a change in their locality. For some who are married, it will take the permission of their husbands for them to join and participate in activities connected to projects like this one. So if their husbands do not permit them, then they cannot be a part of this project - especially during the data collection exercise in the field.

The OCA team paid particular attention to the needs of women in the community and how they are affected by flooding and other natural hazards not only because gender integration is an important component of the project. But we came to the realization that

²⁶ <http://webdeploy.statsghana.gov.gh/docfiles/publications/W&M%202014.pdf>

since women constitute a huge percentage of people vulnerable to flooding, then their experiences and needs must be taken seriously. In addressing the problem of spousal/parental control in the participation of women in this project, we let the female mappers lead most of our interaction with the women in the community. This action helped in making the women more at ease to share their stories with us. Secondly, it portrays the image of women's participation in an activity such as mapping and data collection which might have been regarded as the pure reserve of men. Also, one of the female mappers actually lives at Dome which is near Alogboshie - which means she was trained by the OCA team to be able to collect data using the various tools we took them through during the training session. During the mapping and data collection, the mappers collected data on the sheds that the women hide their wares when it starts raining. Data on all temporary structures was not collected, however, we collected data on the permanent structures that

3.3: Stakeholder and Community Engagement

Stakeholder engagement was integral to the achievement of the goals of the Open Cities Accra Project. For our work to have a direct impact on people living in the areas of interest, we had to involve the various government institutions that are already working in that space. The results of our work will help these stakeholders in their decision-making process and interventions to help curb the occurrence of flooding in the target communities. It was also very important for us to engage with community members because they are the direct beneficiaries, making them key stakeholders of the project. We needed their perspective on the project and how best we could work to solve the problems that arise in the communities as a result of natural hazards. We also involved community members in the field data collection so as to teach them how to contribute to the OSM platform even after the project is over.



Fig 15 - Open Cities Accra project team engages major stakeholders of the project

In July 2018, the OCA team sent out invitations to a number of government institutions whose work relates to Disaster Risk Management (DRM). We invited them over to Mobile Web Ghana office for our first stakeholder engagement and training event. The purpose of this stakeholder engagement was to introduce them to the OCA Accra project, teach them how to contribute to the OSM platform and also do a data assessment of all the institutions represented at the event. We had in attendance representatives of the Accra Metropolitan Assembly²⁷, Land Use and Spatial Planning Authority²⁸, Forestry Commission²⁹ among others. These representatives of various government agencies were taken through lessons on how to contribute to OpenStreetMap using iD and JOSM editors. After the training session, the attendees expressed their profound gratitude to the OCA team for the lessons taught.

²⁷ <https://ama.gov.gh/theassembly.php>

²⁸ <http://www.luspa.gov.gh/>

²⁹ <http://www.fcghana.org/>

We held a data assessment of all the institutions represented at the event. Our quest was to find out what data they had available and also what data they would need us to collect from the field. Their data requirements would then feed into our data model for the field data collection.



Fig 16 - Open Cities Accra Project team meets with the Ministry of Inner City and Zongo Development

We were in constant consultation with the Ministry of Inner City and Zongo Development. The Ministry is responsible for community profiling for the component 3 of the GARID project. This made it necessary for us to involve them in our activities. At the initial stages of the project, we met with the Ministry team to update them about our field data collection at Alogboshie, our challenges and also the data products we were planning to develop.

We had a second meeting with the Ministry team on 26th November, 2018 to share with them the data model we were going to use for the data collection in Akweteyman. Some of the concerns raised at this meeting are listed below:

- Terminologies: The Ministry team primarily had a problem with the OSM attributes because they aren't consistent with the key and value pairs that are accepted widely by government institutions in Ghana. For example, 'highway' as an attribute is termed 'access' according to the ministry team. Also, 'drinking water' was deemed not adequate to describe water that can be used by community members, so they suggested the use of the term '*potable water*' instead because it captures the quality of water that makes it convenient to be used for other household purposes like bathing and not just drinking.

- The Ministry team mentioned that the OCA team needs to put the individual features in the data model into major thematic groupings. They mentioned that there are quite a number of facilities that serve the same purpose on a broader level but are at the same time different. For example, a football park and a nightclub can be put under the same thematic grouping which is recreational facilities.

We also engaged organizations such as the National Disaster Management Organization (NADMO)³⁰, Ghana Statistical Service (GSS)³¹ and the United Nations Development Program (UNDP)³², Survey and Mapping division of the Lands Commission and Ministry of Sanitation and Water Resources.

- **NADMO:** We met with NADMO to request access to available datasets, conduct a data gap analysis, and provide them with a letter of collaboration. They mentioned they have done extensive mapping of these communities and have some datasets to share.
- **Survey and Mapping division, Lands Commission :** This agency's mandate includes: direct and supervise the conduct of trigonometric, hydrographic and topographical surveys; survey, map and maintain the national territorial boundaries including maritime boundaries; and coordinate the production of photogrammetric surveys (i.e. aerial photography, orthophoto mapping). They mentioned they have toposheets and townsheets datasets related to the various communities we were working in. They usually sell the dataset to the public but were willing to work with us on partnership basis. But this partnership was never realized even though we have written to them officially as requested and followed up, there were no responses to date.
- **Ministry of Sanitation and Water Resources :** This ministry is also an implementing partner of the GARID project hence the team there was happy to meet us. They mentioned that they would allocate a contact person for us to work with in terms of providing us information on data gaps, availability and also participating in stakeholders training.

³⁰ <http://nadmo.gov.gh/>

³¹ <http://www.statsghana.gov.gh/>

³² <http://www.gh.undp.org/>

Available data access and use

After we had an engagement with some major stakeholders of the project, we came to the realization that data on physical infrastructure and flood history are generally not available and accessible to the general public. Also, we found out that some institutions have some level of data but not very up-to-date and they are not open. Institutions such as the Lands Commission and Land Use and Spatial Planning Authority have geospatial data available, however the data is not openly accessible. In some cases, they are given out at a fee. Ghana has an Open Data portal which is supposed to house a large percentage of government data. We visited the portal to find out if we could get some data that would be very useful to us in this project. The data on the Ghana Open Data portal³³ is quite outdated, also we couldn't find data on flooding and natural hazards.



The screenshot shows the Ghana Open Data Initiative website. The header features the logo 'Ghana Open Data Initiative' and a search bar. Below the header is a navigation menu with links: Home, Data (which is highlighted in green), Agency, Application, Developers, Aid Data Sites, WW Data Sites, and Contact Us. The main content area is titled 'Datasets' and displays a list of 15 datasets. On the left, there are three filter panels: 'Filter by tags' (Agriculture 6, Census 5, Foreign visits 2, Health 1, Nutrition 1), 'Filter by resources » format' (csv 14), and 'Filter by publisher' (MINISTRY OF FOOD AND AGRICULTURE (MOFA) 6). A search bar and sorting options ('Sort by Date changed', 'Order Desc', 'Apply', 'Reset') are also present. A specific dataset, 'Census Data-Household population', is highlighted with a brief description: 'The data information is about the household population by region, type of locality, sex, relations, deaths, heads and other information gathered in 2010 census.'

Fig 17 - Ghana Open Data Portal

³³ <http://data.gov.gh/>

The table below shows all stakeholders we were in direct contact with over the course of the project implementations (highlighted in yellow) and stakeholders that were added to the list during the course of the project (highlighted in blue).

1	Ministry of Inner Cities and Zongos Development
2	Accra Metropolitan Assembly
3	Ghana Statistical Service
4	Survey and Mapping division, Lands Commission
5	University of Ghana YouthMappers and Department of Geography and Resource Development
6	CSOs/NGOs (Future Leaders Association and Wealthy Women)
7	Kwame Nkrumah University of Science and Technology Youth Mappers
8	University of Mines and Technology Youth Mappers
9	University of Cape Coast Youth Mappers
10	Local NGOs eg. Let's do it Ghana
11	United Nations Development Programme
12	Civil Society Organizations and Non-governmental Organizations (Future Leaders Association and Wealthy Women)
13	Local OSM community
14	Community members of study area
15	Assembly man of Alogboshie
16	Ayawaso East Municipal Assembly
17	Stevdok Ltd
18	Forestry Commission
19	Tema Metro Assembly
20	Lands Commission
21	Benso oil palm plantation limited
22	EMO geomatics consult
23	Private Lands , Teshie Nungua
24	GAF
25	La Nkwantanang - Madina Municipal Assembly
26	Hydrological Services Department
27	CHED, Bibiani
28	Presbyterian Health Service-Osu
29	KNUST
30	National Disaster Management Organisation (NADMO)

3.4: Final Product

To better understand the needs of our stakeholders in relation to products that can be useful to them, we conducted a user research survey. The goal of the survey was to first assess the problems that the respondents face in their individual institutions with regard to accurate up-to-date geospatial data. We also needed to assess their level of proficiency with geospatial software and computers in general. Our stakeholders often make use of maps in their work hence we asked certain questions that could help us assess their map-reading skills as well.

All this information was necessary before a decision as to which data product to develop was determined. Our respondents and many others like them are going to be the main users of the OCA data product and this is why their input was sought before any actual development work started.

User Research Survey

One of the major goals of the Open Cities Accra project was to develop data products that will help policy makers to make data-driven decisions that will help the areas of focus become resilient to flooding and other natural hazards. To be able to develop products that are useful to organizations, government agencies and ministries, we had to do a user research survey before we could decide on which products to develop. The major stakeholders of this project are also regarded as the main users of the product that is why we dealt specifically with them and not ordinary people walking the streets of Accra.

Our user research survey started with the stakeholder engagement event we had in the early part of the project. We invited a number of government ministries to send their staff to come for the stakeholder engagement event. After the training, we had some time to do an assessment of the available data as well as the data gaps at such organizations. One thing was clear to us: most of these organizations made judicious use of geospatial data. Also, we visited a number of them during the early stages of the project and noticed most of them had pasted maps of sections of Accra (according to specific themes) on their walls. All of this information we gathered was later used to contribute to forming the basis of the data products we chose to develop for the Open Cities Accra Project.

Research Process/Methodology

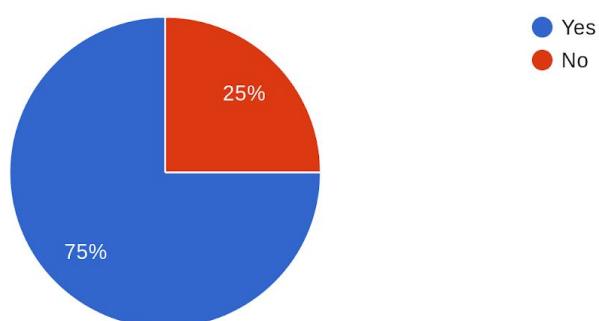
We did the user-research survey itself by sharing a form with representatives of the following institutions: Ministry of Zongo and Inner City Development, Lands Commission, Ayawaso East Municipal Assembly, Hydrological Services Department, National Disaster Management Organization, Stevdok Ltd, Forestry Commission, Tema Metropolitan Assembly, Benso Palm Oil Plantation Limited, EMO Geomatics Consult, Private Lands - Teshie Nungua, GAF, La Nkwantanang - Madina Municipal Assembly, CHED - Bibiani, Presbyterian Health Service-Osu, and KNUST. Through the survey, we were hoping to gather an understanding of the data gaps at these institutions, which tools they often use in geospatial data collection and analysis and how proficient they are in reading maps and their computer skills. The respondents mentioned the following tools JOSM, QGIS, ArcGIS, MAPS.ME, OsmAnd, Vespucci, OSMTracker, Mapillary, LUPMIS, Google Maps, AutoCAD, and ODK Collect. A majority of the respondents claimed that access to accurate geospatial data and the cumbersome process related to getting information in their institutions were the major problems they have to deal with in their work.

Research Results

From the survey findings, and our continued engagement with stakeholders, we came to the conclusion that the majority of the stakeholders needed accurate up-to-date geospatial data in their daily work. The greater portion of respondents stated that they had high ICT and map-reading skills. Based on this information, the Open Cities Accra project team decided to develop a digital platform and printed maps for the use of these agencies and ministries. Find below the results of the survey we did with some representatives of government institutions:

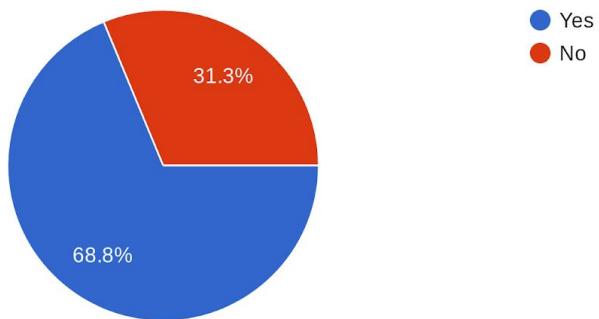
Do you collect or keep accurate and up-to-date (not earlier than June 2018) geospatial data at the institution you work for?

16 responses



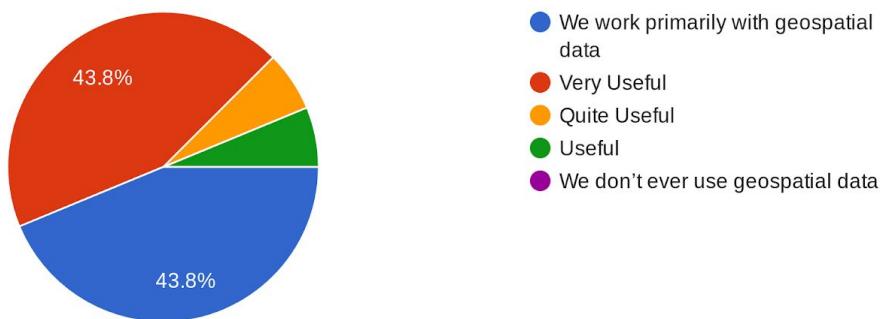
Do you keep accurate and up-to-date (not earlier than June 2018) printed maps at the institution you work for?

16 responses



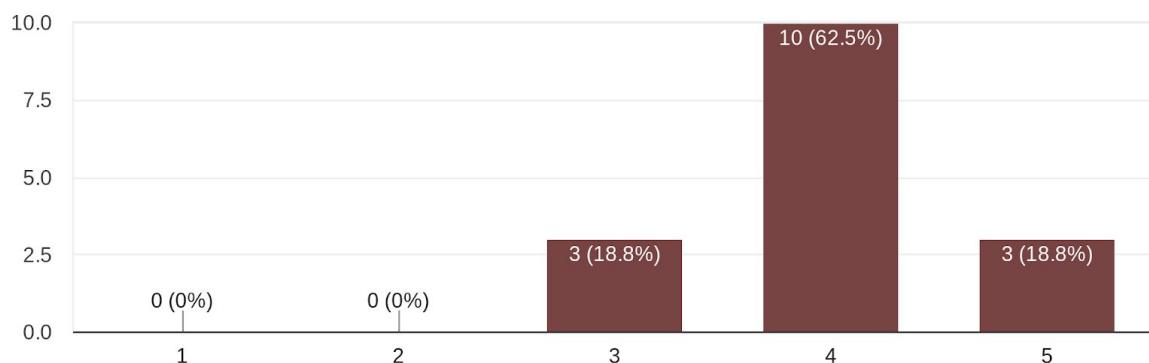
How useful is geospatial data to your work?

16 responses



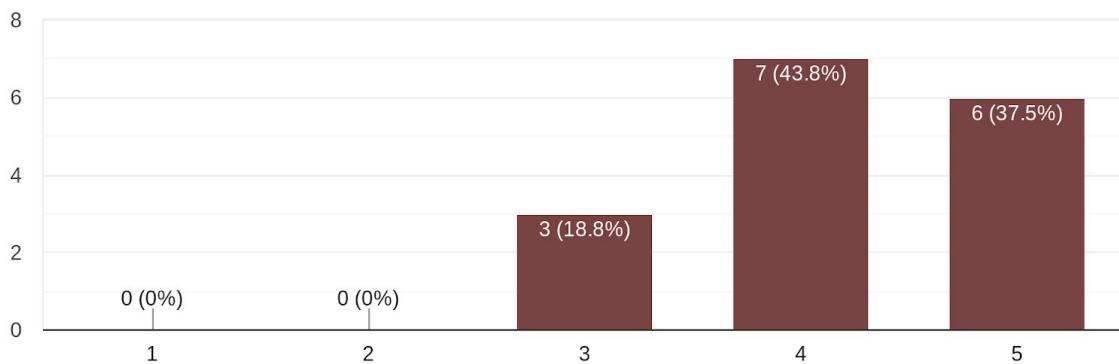
On a scale of 1 - 5 how will you rate your ICT skills?

16 responses



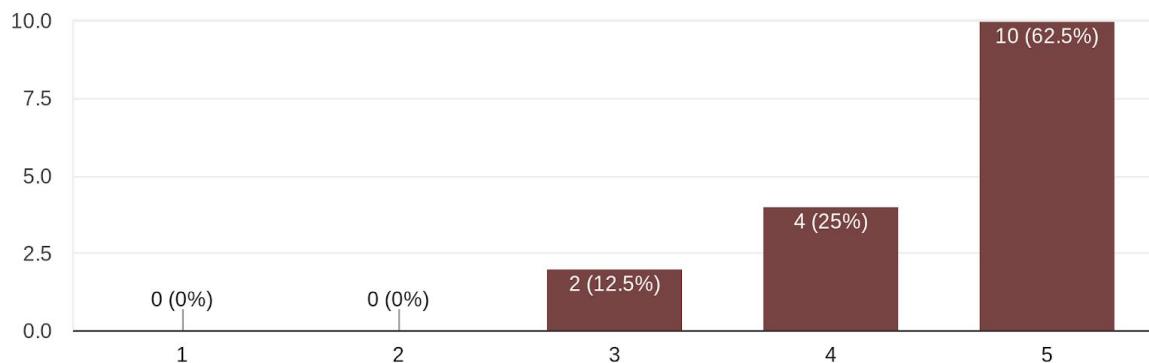
On a scale of 1 - 5 how will you rate your map-reading skills?

16 responses



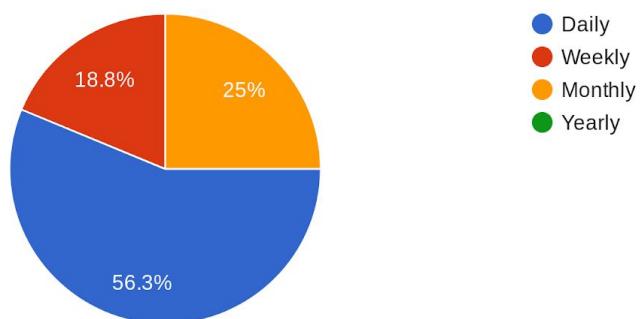
On a scale of 1 - 5 and in your opinion, how needful is a tool that provides geospatial data on specific areas in ...it comes to disaster risk management?

16 responses



How often do you think such a tool will be used in your institution?

16 responses



Product Development

Digital Platform

Based on the survey done with major stakeholders of the project, the Open Cities Accra project team deemed it fit to develop a software product³⁴ that will be of tremendous help to organizations and government agencies that work on disaster risk management projects.

The web application produced displays data in a given area of interest (Alogboshie, Akweteyman, Nima and Alajo). By clicking on a particular feature, details and attributes of that feature are displayed. For instance, if a building is selected, building material, roof material, name, building use and building levels, all associated to that building is displayed.

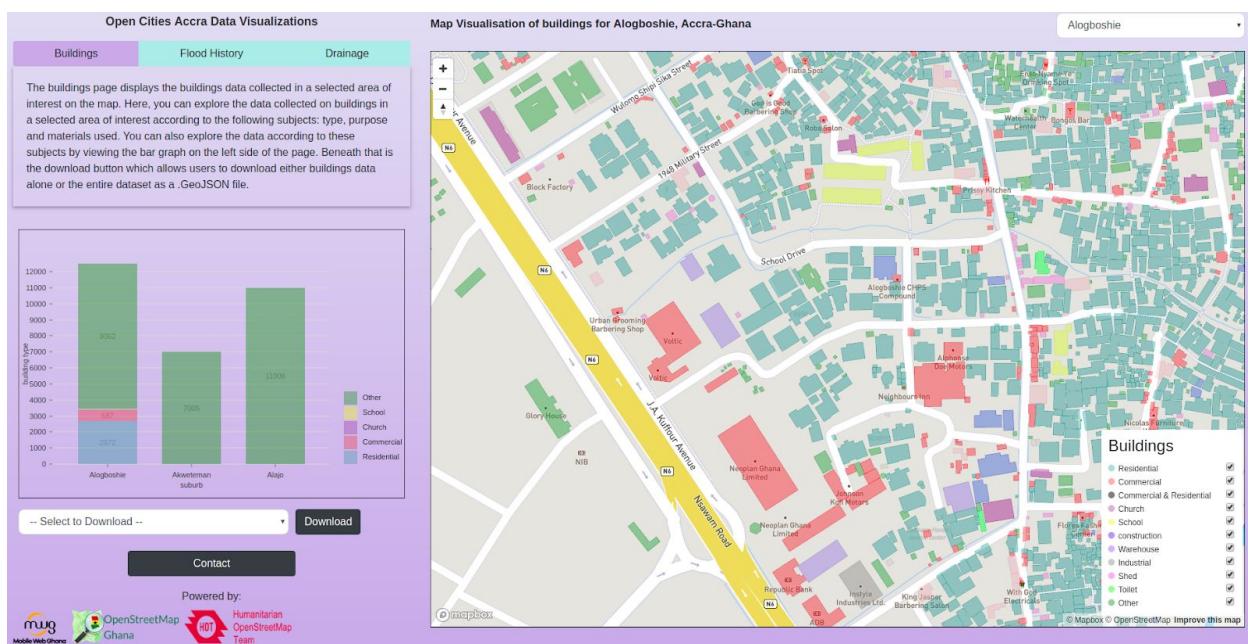


Fig 18 - Building visualization in Alogboshie

³⁴ <https://ocav1-app.herokuapp.com/>: This is the development link which will be moved to a live link later i.e opencitiesaccra.org

Wall Maps

Wall maps were designed using data from Open Cities Accra project in addition to existing OpenStreetMap data both remotely generated and collected in the field. These maps were produced for distribution to stakeholders to be used in decision making for these communities.

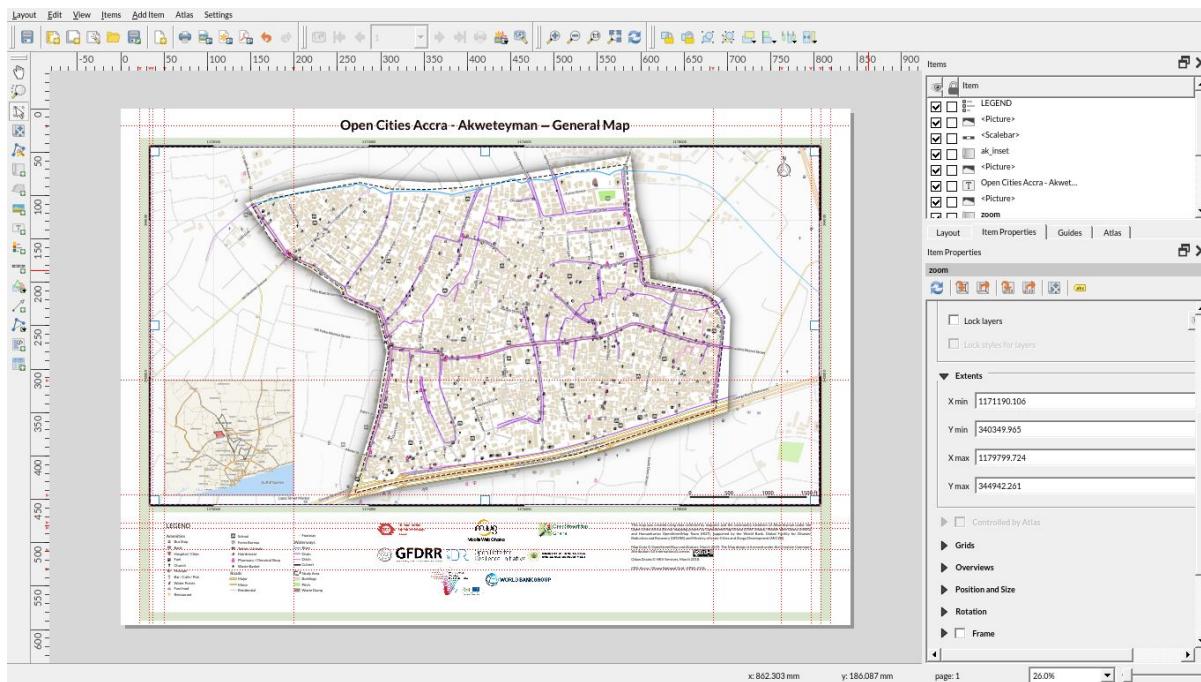


Fig 19 - Map preparation and production with QGIS

QGIS version 3.6 codenamed “Noosa”; a Free and Open Source Geographic Information System (GIS) was used to design maps. The maps were produced based on the following categories:

- General map
- Building map
- Based on building types
- Based on building materials
- Drainage and flood history map
- Maps of drone images captured



Fig 20 - An example of wall maps produced

Data Use and Products Dissemination Workshops

The main results of the Open Cities Accra Project are the data products and the geospatial data collected and made available for free on the OSM platform. For the results of the project to have the desired impact, it must be placed in the hands of all stakeholders who will use it in their work. Therefore, a data use and product exhibition workshop was organized on 26th March, 2019 to present the products and data to stakeholders and the general public.

We invited the major stakeholders of the project to MWG Offices to share with them the progress of the project and also the data products that were developed. After the product development survey we did prior to this stage of the project, the decision was taken to develop a web application and print out data products. At the event, we had the chance to interact with the stakeholders one more time, share our experience on the project with them and also present the products to them.



Fig 21 - Images from the Data Product Workshop

The participants were also taken through the web application the team developed. The software displays the data collected from the field and gives users the opportunity to explore the data. At the end of the event, we shared the printed maps with the participants and also engaged them further to find out how we can establish a relationship with them even after the project is done.

Feedback from participants

The feedback we received from the participants indicates that they were impressed by the data that was available to them as a result of the OCA Accra project, and are ready to use them in their work. Some of the feedback we received are enlisted below:

- According to one of the participants from the Land Uses and Spatial Planning Authority, there is no estimate of streets in the whole of Ghana. He pointed out that the data we have collected is essential to his department and in the

street-naming project being done by the government since the department so far relies extensively on OpenStreetMap street network .

- Another participant who represented the Ministry of Inner-Cities and Zongo Development mentioned that the data we have collected and made available in the maps and the web application will be useful in the GARID project and their work to upgrade slum areas and make them resilient to natural hazards.
- A participant from the Ayawaso East Municipal Assembly where Nima is located mentioned that the buildings and amenities would help the institution to track assets, which process would improve revenue mobilisation, and thus increasing internally generated funds in the assembly whilst making the communities resilient to natural disasters as well.

How would your relationship with the Open Cities team benefit your institution?

6 responses

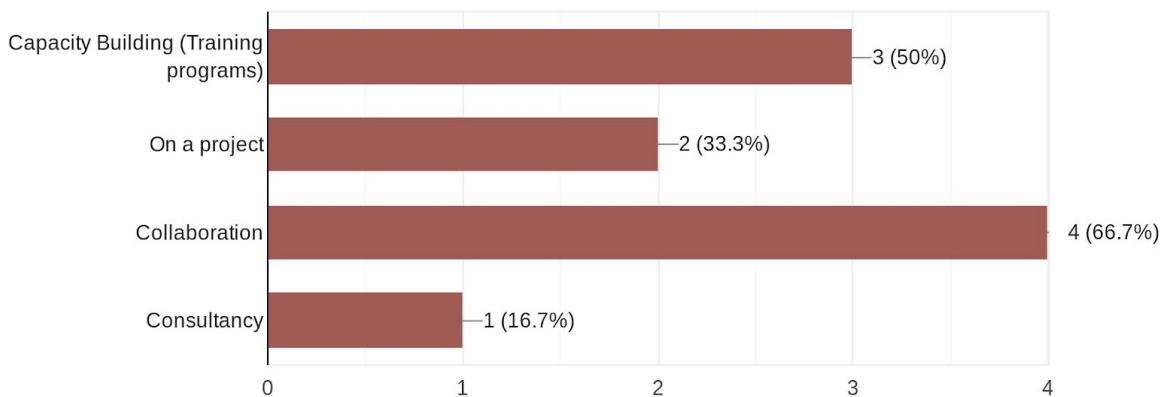


Fig 22 - Feedback from participants on their relationship with the OCA team

PART 4: The Open Cities Africa Experience

4.1: Challenges & Successes

The Open Cities Accra project team encountered a number of successes and challenges while implementing the project in Accra. In this section, we will share these experiences.

Challenges:

UAV image capture in Nima: Nima is one of the areas of focus for the Open Cities Accra project. Hence, just as was done for the other three communities, we sought to take the UAV image of Nima to facilitate the remote mapping process of the project. Assessment of the available satellite imagery revealed the imagery to be outdated and blurry. This would make remote-mapping a daunting task - hence, the decision to go with the UAV imagery. However, the challenge in taking the UAV image of Nima was that the residence of the president of Ghana is located in the community. This makes the community a high security zone, therefore we needed special clearance to be able to proceed to take the image. We tried working through a few of the government stakeholders of the project to no avail. We are in the process of getting the community photographed with a drone. This means Nima will be the last community to be mapped remotely.

Field Data Collection: Using smart phones for data collection was smooth but we had some drawbacks with drain segment and drain point features mapping as smartphones generally had limitations with GPS accuracy. With the help of high definition drone images, some of the points have been identified and aligned accordingly, though this delayed our drainage data upload to OpenStreetMap. The team also lost one smartphone during the drain data collection.

Access to the available data: After the OCA team outlined the major stakeholders of the project, the next thing was for us to identify which of them could give us access to the available data. Access to the available data would make our work easier and also ensure that we do not duplicate effort by collecting already existing information. However, we were not successful in this activity. Most of the institutions we contacted could not give us data, the data they gave us were not relevant to our project, or data was provided to us in formats that are not open.

Community Liaison: The Open Cities Accra project sought to involve community members in the project. From the beginning of the project, we went to the field to communicate with some of the community members and some groups especially for the gender integration process of the project. This was done to ensure that the project caters to the very needs of the community members and not merely provide a solution that would have been developed based on assumptions. However, we encountered a few problems with community entry. We needed a committee member of the community to help us enter those communities and communicate our activities to the people. Due to the lack of this, we had a few of the community members asking questions about the project. In Alogboshie, for example, prior to entry into the community, the government's task force had gone there to drive people away and demolish their structures that were within fifty meters from the railway line. Therefore, upon seeing our team of mappers, they assumed they were representing the government's task force. We were able to communicate with them that we were on a different mission. But we wouldn't have encountered this challenge if we had set up our community liaison effectively.

Successes

Capacity Building: Throughout the course of the project, we have been able to train over 50 mappers who had little or no knowledge of OpenStreetMap prior to being part of the project. Also, during the stakeholder engagement stage of the project, we trained about 30 staff members of government institutions in contributing to OSM. The essence of the capacity building component of the project is to ensure that as many people are introduced to the power of OpenStreetMap and learn how to contribute their quota to enhancing the platform. This feat gives us so much fulfilment knowing that we have grown the community of mappers in Ghana to a considerable extent. Some of the volunteer mappers have also gone on to become ardent and active contributors to OSM in Ghana - and this commendable.

Stakeholder Engagement: We were very pleased to be able to get the opportunity to engage some very notable government Ministries, Departments and Agencies during the project. Paramount amongst them is the Ministry of Inner City and Zongo Development. The ministry team offered exceptional help to the OCA team from the start to the end of the project. They were also helpful to us in the process of developing the data model we used in the areas of focus. The Accra Metropolitan Assembly was also very helpful to us during the stakeholder engagement stage of the project by way of sending in a huge number of representatives to all the training sessions we held for government institutions. It was at the stakeholder engagement events that we were able to get inputs from the many representatives of government institutions. We specially asked them about the final

products we intended to develop and their inputs were highly honoured and used during the development of the data products.

Usage of the OCA data: During the final product exhibition workshop and map distribution event, we were pleased to hear some of the representatives of government institutions inform us how useful the data we have made available for free on OSM will be to their daily work. The representative of LUSPA mentioned OpenStreetMap already plays an important role in their works and data we have collected will be very useful in the government of Ghana's street naming exercise that is currently ongoing. Another participant who represented the Ministry of Inner-Cities and Zongo Development mentioned that the data we have collected and made available in the maps and the web application, will be useful in the GARID project and their work to upgrade slum areas and making them resilient to natural hazards. Most of the representatives mentioned that we can be of help to them in the area of capacity building and collaboration on different projects also.

4.2: Lessons Learned

During the course of the project, the OCA Accra team had a number of lessons learned through working with various stakeholders and open mapping tools and processes. These include:

- Remote Mapping:

The OCA Accra team observed publicly imagery available to the OpenStreetMap community were very out of date. Hence drone imagery used for this was very useful and important to getting quality and good representation of information on the ground.

- Capacity building:

The team learned from trainings held preceding data collection and incorporated feedback from the test field data collections in the early stages of the project allowing for minimal issues from the field data collection. Also building upon this, issues identified from Alogbishie data collection were reiterated during the Akweteyman data collection to mappers and ensuring better data quality.

- Community Involvement:

We had little community involvement. Going forward we plan to have more members from the community taking part in the field mapping since this will reduce undesirable encounters with residents. In order to achieve this, a better community entry approach has been adopted in consultation with

major stakeholders, so that we can leverage on existing structures and hierarchy of command in the various communities. We plan to leverage the already existing community contacts from the Ministry of Inner Cities and Zongo Development going forward.

- Data Upload

We have identified a central point in the field where team briefing and data upload to POSM took place in Akweteyman building on lessons and feedback from Alogboshie. Better Still dedicated remote servers can be used. This will make it possible to upload on a daily basis to enable GIS and data cleaning teams to identify and find solutions to emerging challenges and data quality issues arising from the field in real time.

- Dialogue

In the field we learnt that dialogue has the power to dissolve doubts and calm tempers. As stated above in the challenges, on some occasions we had residents express a certain level of discomfort and doubt concerning the work our mappers were doing on the field. A soft response and peaceful dialogue yielded the desired results of easing the tension. On each occasion the mappers explained to the residents what the project was about. We took the mappers through a session on how to engage residents during the one-week training period. In the field, we saw how powerful dialogue was. This is a very important learning point that we will carry along moving forward.

4.3: Recommendations

The Open Cities Accra project has been a great learning experience for the team. We went into the field to study and interact with community members and some very prominent associations that operate in the communities in order to provide a solution that is tailored for the various communities. As such, we have learnt a lot from our interaction with such people that informed our work on this project. During our training with the volunteer mappers and engagement with stakeholders, we learnt some very vital lessons that would be beneficial to any organization that seeks to embark on a similar project. Based on these lessons, we have some recommendations to share, including:

- Relations between the city team and the government agencies would have been much easier if there was a focal and dedicated person at the institution who served as the first point of contact when the need arises.

- The online platform (TechChange) served as a good opportunity to learn and be informed about what the other city teams were doing in their various countries. However, it would be very useful if this aspect of the project could be emphasized and made compulsory for all. This will establish a very good working relationship amongst all the city teams and create opportunities for them to work together.
- The online product developed presents huge opportunities for geospatial data sharing in Accra and Ghana as well. We recommend that this product be taken up by the GARID project as a tool to share data collected throughout the GARID project activities. We further recommend that GARID partner ministries use this tool to disseminate datasets to the general public.

PART 5: Sustainability Plan

Donor funded projects often have a short life span, within which it is required to make a certain level of impact based on the goals set for the project. However, most of these projects are started with the aim of making sustainable impact transcending the funding period - with which the funding model is often at odds. The OCA Accra team is well aware of this fact and is willing to keep working to achieve the desired impact in making available up-to-date open data on OpenStreetMap in relation Disaster Risk Management (DRM) work in Accra. The benefits of this project are tremendous hence it will be more beneficial if the project is sustained beyond the months that it has been in existence. Below is a list of some of the benefits of the project that the OCA team believes if sustained can make a huge impact in the DRM work in slum areas of Accra and even beyond:

- **Accurate geospatial data:** Data collection was integral to the fulfilment of the goals of this project. Hence, it was the most intensive activity of this project. There were systems in place to ensure that the data collected was accurate and up-to-date so that it would be useful to policy makers and development partners of this nation. Hopefully, policy makers will make data-driven decisions based on the data we have collected to help curb the occurrences of natural hazards in the areas of interest and also reduce the effect these hazards on community members and the environment as a whole. This data was made available for free reuse and redistribution on the OpenStreetMap platform. This makes the data available to individuals who may need it to develop some very useful innovations.
- **Capacity building and stakeholder engagement:** One of the goals of the OCA Accra projects was to be able to create a community of people who are passionate about the frequent occurrence of flooding in Accra and are willing to use simple technological tools to solve the problems caused by flooding. Hence, we conducted a number of capacity building exercises for volunteer-mappers and government institutions. With the skills these individuals have acquired, they will be able to contribute to solving Accra's perennial flooding challenges.
- **The Greater Accra Resilience and Integrated Development (GARID) project:** The Open Cities Accra project is directly linked to a larger resilience project called the Greater Accra Resilience and Integrated Development (GARID) project. Both projects are funded by the World Bank. Therefore, the OCA team received support from the World Bank team in Ghana and the Ministry of Inner City and Zongo Development which are both implementing partners of the GARID project. The work the OCA team did was a direct input to the GARID project - a project that covers the entire Greater Accra Region.

- Strengthening of the community of humanitarian mappers and further growing the OpenStreetMap, GIS, Open Data and participatory mapping communities in Ghana. Also creating awareness through visualizations of data collected.

The team will continue to rely on the stakeholders of the project to be able to achieve the above-listed goals and make the desired impact. We need the help of, especially, government stakeholders whose work border on DRM. The following are some of such stakeholders:

1. Accra Metropolitan Assembly
2. Land Use and Spatial Planning Authority
3. Ministry of Inner City and Zongo Development
4. Community Members of Focus Areas
5. Youth Mappers in Ghana
6. National Disaster Management Organization (NADMO)

We are bound to encounter a few challenges in a quest to achieve the benefits of the project post-funding stage. These challenges can be put under the following sub-headings: financial challenges, social challenges, technical challenges and institutional challenges. Some of these challenges are:

Financial Challenges:

- Cost of venue for the training sessions we will hold to introduce people to OpenStreetMap and participatory mapping.
- Allowance for trainers and resource persons
- Cost of transportation for training sessions in government institutions
- Cost of data reuse and sensitization workshops
- Cost of doing outreach programs including logistics

Social Challenges:

- Getting DRM institutions, NGOs, CSOs, etc to participate
- Getting persons interested in conducting research and modeling
- Getting active and dedicated volunteers

Technical Challenges:

- Few highly experienced OpenStreetMap contributors and champions in Ghana
- Very low knowledge about OpenStreetMap, Free and Open Source Software for Geospatial tools
- Few highly experienced OpenStreetMap contributors and champions in Ghana

Institutional Challenges:

- Low level of participation by government counterparts / agencies
- Very low understanding of open data and open source ecosystem by some institutions
- Very low understanding of open data and the open source ecosystem

Actors:

Going forward the OCA team will remain at the helm of affairs so far as this project is concerned. Mobile Web Ghana, OSM Ghana and Humanitarian OpenStreetMap Team will remain implementing partners of the project. Indicating that the execution of the plan for the project is purely the responsibility of this team.

The other actors of this project who we have earlier classified as stakeholders are as follows:

1. Accra Metropolitan Assembly
2. Land Use and Spatial Planning Authority (LUSPA)
3. Ministry of Inner City and Zongo Development
4. Community Members of Focus Areas
5. National Disaster Management Organization (NADMO)
6. Youth Mappers in Ghana

In our engagement with members of staff of the following institutions, we came to the conclusion that what most of them lack is the technical know-how to collect geospatial data and make sense of them. Also, most of them do not have accurate and up-to-date geospatial data available to help them take data-driven decisions that are more impactful than decisions taken based on assumptions.

Sustainability Goals:

Several sustainability goals and related action points have been identified to further the work of OCA Accra. These have been discussed in detail in the sustainability worksheet³⁵ and are summarised below:

³⁵ https://docs.google.com/document/d/1eKBTC8DxkT9tia87vm_TtkHly4-YpqBPCS8q4LDSpKM/edit

Goal	Primary action points
#1. Facilitate the availability of accurate and up-to-date data that can be used to take data-driven decisions for disaster risk management work.	<ul style="list-style-type: none"> • Capacity building for government agencies, community members, and other project stakeholders. • Publicity for the OCA web application and data collected from the field. • Long term engagement with stakeholders/actors and relations with communities involved in open data, participatory mapping and disaster risk response.
#2. Long term engagement with stakeholders/actors and relations with communities involved in open data, participatory mapping and disaster risk response.	<ul style="list-style-type: none"> • Keeping stakeholders informed about the activities of the Open Cities Accra project team. • Engaging with actors, institutions and community members so the project team can provide technical support as and when possible. • Partnering with other organizations and start-ups working on disaster risk management and participatory mapping related projects.
#3. Increased institutional acceptance and use of OSM/open data leading to government, CSOs, NGOs and disaster risk management institutions integration of OSM in their workflow.	<ul style="list-style-type: none"> • Capacity building and training

Conclusion

The Open Cities Accra project has been largely successfully as the team was able to achieve the goals that were set before the commencement of the project. The experience we have had is one that has made us very much aware of the plight of members of the general public who live in communities that are prone to flooding and other natural hazards. It has also emphasized the importance of stakeholder engagement, community participation and the use of technology in solving some of the world's most pertinent problems. In all of this, we cannot undermine the importance of Open Data since one of the goals of the project is to make the data collected in all the areas of interest available online for free on the OSM platform.

Some of the most remarkable feats achieved during the project include:

- We were able to build the capacity of about 50 mappers and reached out to a total of 300 persons who were both students and stakeholders to make them aware of the importance of open, accessible and up-to-date geospatial data for disaster risk response, management and analysis.
- Throughout the project, we have been able to create and curate open data on buildings, drains, drainage points and economic activities,
- The Open Cities project team has been able to engage 10 government institutions and agencies including NADMO, MICZD, LUSPA, Forestry Commission, AMA/Headquarters, AEMA (Ayawaso East Municipal), etc.

It has been an amazing experience for all team members of the Open Cities Accra project. We have worked closely with the more experienced team from HOT who were always ready to give us technical support at all times. The GARID team in Accra, which is made up of representatives from the World Bank and the Ministry of Inner City and Zongo Development were also very helpful with their remarks and comments which helped us steer this project in the right direction. We are very grateful to the mappers and everyone we have interacted with in the course of this project and look forward to further collaborations and reuse of data collected in several fields.