


Uganda Open Mapping Program
Deliverable D140

Final Report

Prepared by:

- Fabio Giulio Tonolo (Ithaca)
- Rupert Allan (HOT)
- Tinah Mutabazi (Map Uganda)
- Hillary Musundi (MapUganda)
- Bernard Wright (GeoGecko)

Revised by:

- Chris Jung (World Bank)

Version: 1.0

Date: 27/09/2018

Approved: 04/10/2018

Table of content

Objective 2

Reference Documents 2

Background 3

Fine-tuned objectives 3

Final work-schedule 4

Task and deliverables 5

Project Management 5

Capacity development (training and workshops) 5

1st Workshop 5

2nd Workshop 5

Mapping 6

Target area 6

Remote Mapping 7

Field Mapping 8

UAV Mapping 9

Communication and Advocacy 12

Dedicated WebSite 12

Paper Map atlas 14

Conclusions 15

Objective

This final report, which constitutes a formal deliverable (D140) of the assignment, is aimed at summarising the activities carried out for the "Uganda Open Mapping" program, highlighting the main outcomes, assessing effectiveness of the project, and providing recommendations for future work.

Reference Documents

The content of this report is also based on the following documents, already available to the respective target audiences:

R1. Inception report (D130) - Issued on 12/03/2018

R2. 1st Workshop brief Report (D210) - Issued on 22/02/2018

R3. 2nd Workshop brief Report (D220) - Issued on 27/03/2018

R4. Capacity development at UBOS brief Report (D230) - Issued on 27/04/2018

R5. Statistics on tracing activities (D310) - On line (updated live)

R6. Statistics on field surveys activities (D320) - Issued on 28/09/2018

R7. Field Mapping plan - Issued on August 2018

R8. Website (D440) - On line

R9. Paper atlas (D440)

R10. Revised technical proposal - Issued on 10/10/2017

R11. Uganda Open Mapping Program - Terms of Reference (ToR) - Issued in August 2017

Background

As stated in the ToR (R6) of the Uganda Open Mapping initiative, the World Bank is supporting the Government of Uganda to increase resilience against droughts and food insecurity through a Disaster Risk Financing (DRF) program. The World Bank is also supporting the Kampala Capital City Authority on a range of disaster risk management technical assistance programs. One goal of these programs is to improve access to baseline data and risk related information to quicken the decision making process.

This goal is also reflected by the following documentation drafted by Republic of Uganda Ministries:

1. National Free And Open Source Software Policy (draft May 2016)
2. National Open Data Policy (draft May 2017)
3. UG's Spatial Data Infrastructure Policy (draft Feb 2018)

By creating up-to-date, open and detailed maps, it will be possible to exactly identify areas and households affected, monitor progress and impact of public work projects, and enable communities to understand their surrounding environment for improved decision making and increased resilience. Through OpenDRI projects, open and collaborative data collection is a core part of this approach, heavily leveraging the OpenStreetMap (OSM) open data platform.

Fine-tuned objectives

As stated in the Inception Report (R1), the original objective of the assignment was to develop capacity amongst technical staff in the Government of Uganda (GoU) and members of local communities in using the OSM platform and tools for mapping regions exposed to drought risk in Uganda (and more in general in their everyday work), with a focus on the Karamoja district. Nevertheless, one of the main outcomes of the Kick-off meeting held in Kampala at UBOS premises on 6/11/2017 was that the World Bank and the Office of the Prime Minister (OPM) were discussing DRM priorities with the goal to identify disaster prone areas for starting mapping activities, suggesting a shift of interest from Karamoja region to Kampala.

At the same time, the Uganda Bureau of Statistics (UBOS) confirmed the need for receiving customised capacity development on collaborative data conflations to process UBOS data to conform to OSM data as well as to exploit OSM tools to acquire/update new data. UBOS is specifically interested in the import/update of health/education facilities and Enumeration Area boundaries (for census purposes).

Additionally, the Kampala Capital City Authority (KCCA) was identified as the counterpart in charge for guiding the selection of the areas of Kampala to be mapped in the framework of the Open Mapping for disaster resilience program. More specifically, KCCA provided inputs - including attributes to be mapped - on the basis of the ”Multi Hazard Risk and Vulnerability profile for Kampala City” and the detailed flood risk mapping available in the Kampala Drainage Master Plan 2016. It was also agreed that KCCA will be the main beneficiary of the 2nd workshop and on-site training activities.

According to the the above mentioned outcomes, the work-schedule described in the technical proposal was revised with the goal to focus on the activities related to the Workshop and capacity building tasks and to prioritise the discussion with the governmental stakeholders to identify the target areas, which turned out to be a blocking issue for the field and UAV mapping tasks. Awaiting a formal approval on the final target area to be surveyed, the original 6-month work schedule (November 2017 - April 2018) was revised and most of the Mapping task were postponed for several months (until September 2018).

Final work-schedule

The details of the revised work-schedule are provided in the next table.

N°	Activity	Completed on
T100	Project management	
T110	Kick-off meeting	*Nov 2017*
T120	Ad-hoc meetings	*Sept 2018*
T130	Final report preparation	*Sept 2018*
	Deliverable D130: inception report	*March 2018*
	Deliverable D140: final report	*Sept 2018*
T200	Capacity development	
T210	One (1) two-days workshop in Kampala at UBOS	*Jan 2018*
T220	One (1)two-days workshop in Kampala at KCCA	*March 2018*
T230	On-site training, advice and support at UBOS' Geo-information Services Department	*April 2018*
	Deliverable D210: brief report on 1 two-days workshop in Kampala	*Feb 2018*
	Deliverable D220: brief report on 2 two-days workshops in Kampala at KCCA	*April 2018*
	Deliverable D230: brief report on on-site training at UBOS	*April 2018*
T300	Mapping	
T310.a	Discuss with WB/GoU priority areas (districts)	*Aug 2018*
T310.b	*Organize online campaigns and mapathons*	*March 2018*
T320	Field surveys (including training) and data collection	*Sept 2018*
T330	Aerial surveys with UAVs	*Sept 2018*
	Deliverable D310: statistics on tracing activities	*Sept 2018*
	Deliverable D320: statistics on field survey activities	*Sept 2018*
	Deliverable D330: orthoimagery upload in OpenAerialMap	*Sept 2018*
T400	Communication and advocacy	
T410	Local outreach	*Sept 2018*
T420	Engage the international OSM community and other online volunteering organizations	*Sept 2018*
T430	Publish two blog posts on the OpenDRI website	*Sept 2018 (1st blog posted, 2nd queued)*[1]

[1] *The 2nd blog post will be published in early October 2018, focusing on the UAV mapping tasks*

T440	Develop a dedicated Website	*June 2018*
	Deliverable D440: Website live	*August 2018*
T450	Create A3-printed maps of projects areas	*September 2018 (draft digital version)*
	Deliverable D450: paper atlas	*Early October 2018*

Task and deliverables

Project Management

The Project Management was assigned to ITHACA and was carried out remotely from ITHACA premises in Torino, Italy.

To ensure an effective interaction and coordination among the project partners (located in Kampala, Uganda) and the World Bank, an ad-hoc Google Group was created and exploited as main communication gateway and information repository. E-mails and Skype calls have been exploited for specific communication purposes (minutes of Skype calls are available on the aforementioned Google Group).

The Project Manager coordinated the contribution from the relevant partners for the drafting of each deliverable, taking care of their review and finalization up to the final approval from the World Bank.

Capacity development (training and workshops)

According to the revised work-schedule, two workshops were organised and held in Kampala, targeting two of the main stakeholders involved in the project, namely UBOS and KCCA.

1st Workshop

UBOS, 29-30 January 2018, UBOS Statistics House, Kampala

The two day workshop was mainly aimed at training UBOS staff (**14 attendees in total**) on the use of OSM tools to support the activities carried out by the Geoinformation Services Unit. The final goal was to increase efficiency and integrate open mapping tools in planning and executing the Uganda National Census planned for the year 2020, enabling a streamlined collaboration among line ministries and partners. The training was well received and effective in terms of introducing attendees to OpenStreetMap tools which covered remote mapping, field survey/data collection and data conflation/import workflows. The successful execution of the workshop was facilitated by the pre training meetings and discussions with the UBOS team which helped to shape the workshop agenda based on the needs of the participants. The sessions were a combination of discussions, presentations and hands-on tasks.

Details, workshop agenda and attendee list are available in D210 (R2)

2nd Workshop

KCCA, 19-20 March 2018, City Hall, Kampala

The primary target audience were GoU officers (**32 attendees in total**) from the disaster risk management and GIS departments at Kampala Capital City Authority and the Office of the Prime Minister; additional

representation from Ministry of Information and Communication Technology, Ministry of Lands, Housing and Urban Development, and the National Planning Authority made a great audience to create awareness of the mapping tools and to make the disaster risk management agenda relevant. 26 GoU officers were trained on OpenStreetMap tools and data conflation/import and export workflows. The sessions were a combination of discussions, presentations and hands-on tasks. Training materials were printed for future reference and to facilitate the attendees.

Details, workshop agenda and attendee list are available in D220 (R3)

In addition to the two aforementioned workshops, tailored on-site training sessions were held at UBOS in the period February-April 2018. The objective to build capacity at UBOS in terms of geospatial data management in OSM was achieved by carrying out (under the supervision of MapUganda and HOT and in coordination with UBOS) hands-on-data training on the following topics:

- complete the HOT Task Manager No. 3374 (Educational Facilities Buildings and Road Network Mapping).
- mass geo-reference Health Facilities data-sets (Tools: JOSM, Overpass) with a focus on geo-misplaced school data.
- create an import workflow on the OSM Wiki page.
- implement the 'Import of Health/Educational Facilities to OSM' process.
- exploit potential additional tools like Map Campaigner and Map Roulette.
- field data cleanup potential of OSM tools.
- potential Tools: ODK, OMK, POSM Combination of OSMAnd, ODK, JOSM, etc.

The details of each training session are available in D230 (R4).

Lastly, a 2-day training was carried out on 5-6 September 2018 targeting the members of the field mapping teams, including representatives from stakeholders (KCCA, OPM and UBOS), YouthMappers, community mappers and community leaders. The training was aimed at providing/harmonising the skills required to acquire data in the field through OSM tools (e.g. ODK Collect and OpenMapKit) as well the details of the information to be collected (drainage, POIs, roads, buildings).

Details are available in D320 (R5).

Mapping

Mapping activities (remote, field and UAV) were initially postponed, waiting for a final agreement between the World Bank and the GoU on the target areas.

Target area

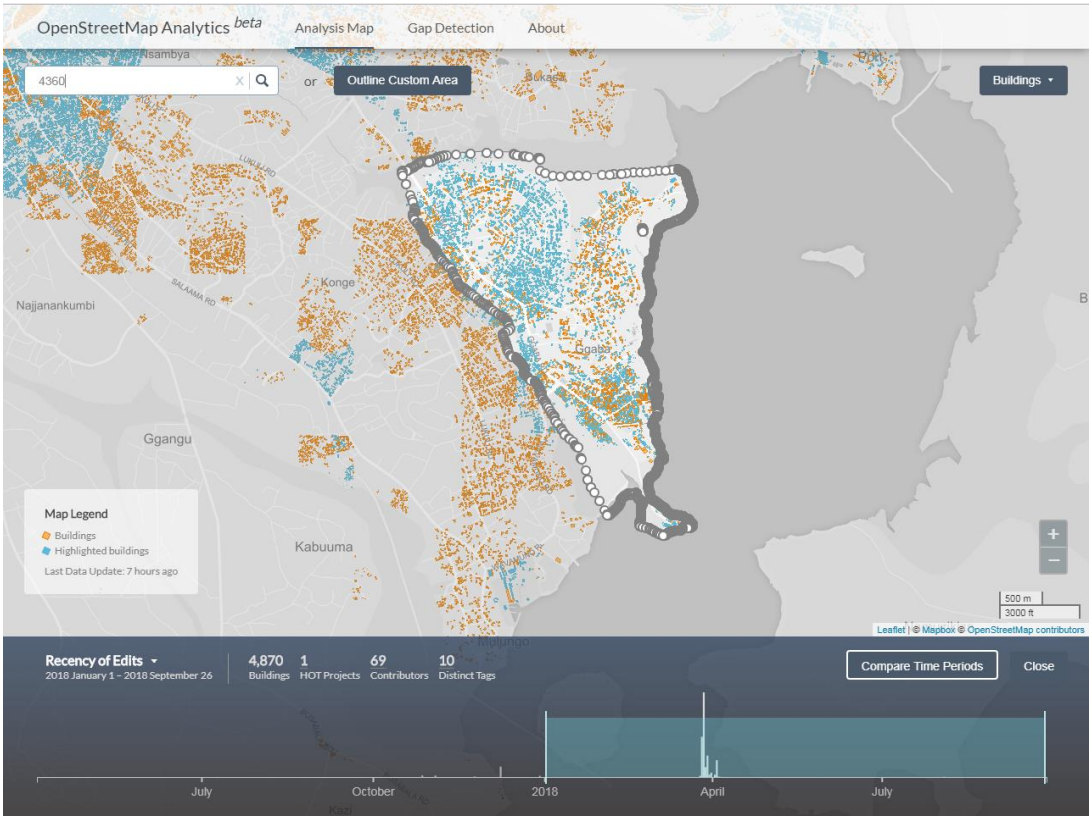
It was eventually agreed, thanks to the strict cooperation with KCCA, to focus on the Lake Victoria waterfront area (Ggaba parish).

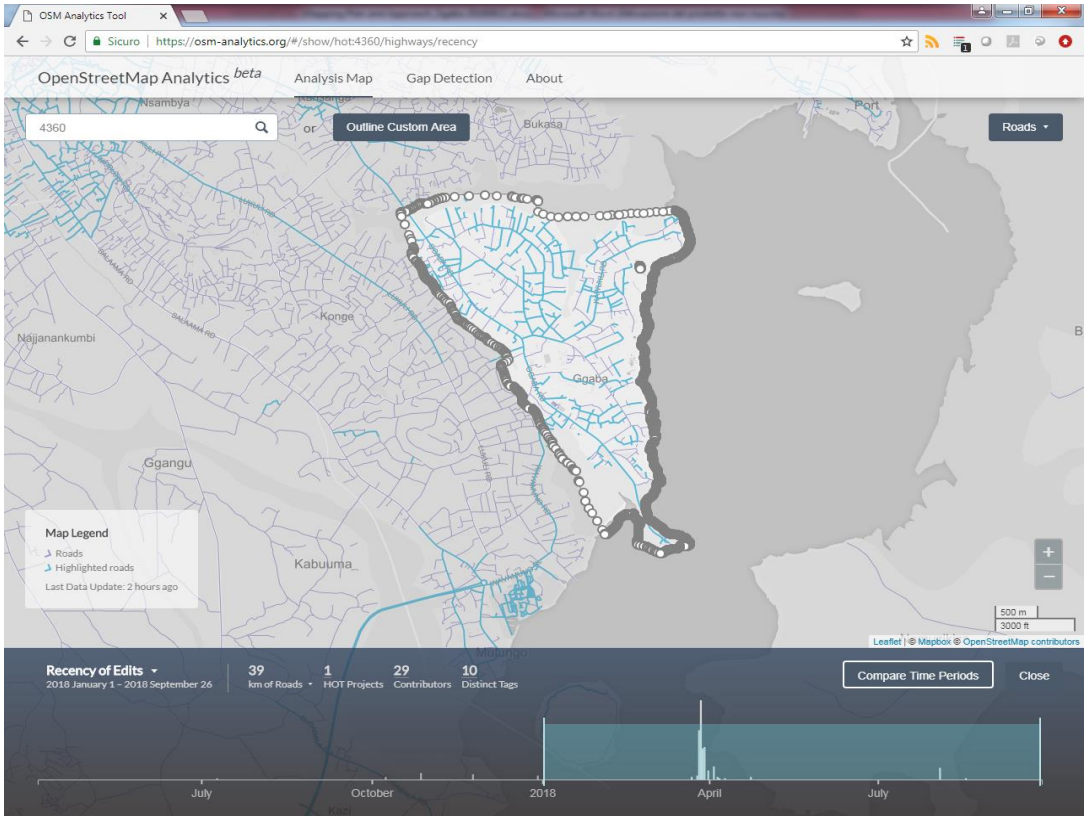
The criteria for selecting these areas for field survey was to address the high level of risk caused by flooding as a result of heavy rainfall and the rising water levels in Lake Victoria, the poor drainage systems, low standards of living and lack of access to services.

Remote Mapping

A remote mapping task (https://tasks.hotosm.org/project/4360) was set-up and completed to digitize buildings and roads in OpenStreetMap using available satellite imagery (Esri World Imagery was the most updated being dated February 2017). The whole of Ggaba parish (~6.6 km^2) was remotely mapped thanks to the effort of remote volunteers (including Youthmappers in Uganda and the global OSM community).

As shown in the next Figures, 4,870 buildings features and 39 km of Road network were edited in the project timeframe.





Of course it is expected (and it is encouraged) that the availability of updated UAV orthoimagery with a very high level of detail (spatial resolution of 0.03 m) will enable additional remote mapping tasks aimed at completing, updating and refining the available OSM features.

Field Mapping

The major focus of the field mapping activities in Ggaba was on the villages of Katoogo, Ggaba Water, and Ggaba Trading Center (~0.7 km^2 land plus 0.6 km^2 wetlands). In order to properly plan and schedule the field mapping activities, a detailed analysis of the target area was carried out in advance. Based on the findings of the analysis, a detailed field mapping plan (R7) was prepared and shared with the World Bank and the involved stakeholders.

The actual field mapping started on 7 September 2018 and lasted for 8 days until 15th September 2018. It has to be highlighted that, despite the continuous postponement of the original schedule due to the need for a formal approval from KCCA, the stand-by field teams were readily available to start mapping as soon as the consortium received the green light to proceed.

The focus of the field mapping was on:

- Buildings
- POIs
- Drainage network, ditches, and culverts

Data cleaning activities were carried out by a dedicated team, in parallel and after the field mapping activities, to ensure the quality of the data uploaded on OSM. The main issues addressed during the data cleaning phase were: data duplication, multiple tags, data coregistration issues.

The details on the adopted data model and the statistics on the collected information are available in D320 (R6). For easy reference, the main statistics on the mapped information (aggregated at village level) is reported in the next table.

Village	Buildings	POIs	Drain_points	Drains	Ditches	Culverts
Katoogo	890	97	79	11	54	6
Ggaba Water	508	52	24	6	18	6
Ggaba Trading Center	383	55	77	46	11	17
Total	**1781**	**204**	**180**	**63**	**83**	**29**

As the field surveying proceeded faster than expected, the field teams decided to add a fourth adjacent village, Ggaba Mission. Data from this village has also been cleaned and uploaded to OSM.

To access the data uploaded on OSM after data cleaning, the following links can be exploited:

- Waterways: http://overpass-turbo.eu/s/Chj
- Culverts: http://overpass-turbo.eu/s/Chl
- Buildings and POIs: http://overpass-turbo.eu/s/Chz

UAV Mapping

The UAV surveys aimed to provide an updated orthoimagery at a very high level of detail (0.03 m) with coverage over the 3 villages of the Ggaba parish included in the field surveys. The Ggaba area consists of mixed construction types such as the National Water Treatment area, large and small commercial buildings, larger residential buildings, and slums among others. The main slum area in Ggaba is called Katoogo and is situated in the southwestern part of Ggaba next to the wetland that ends in Lake Victoria.

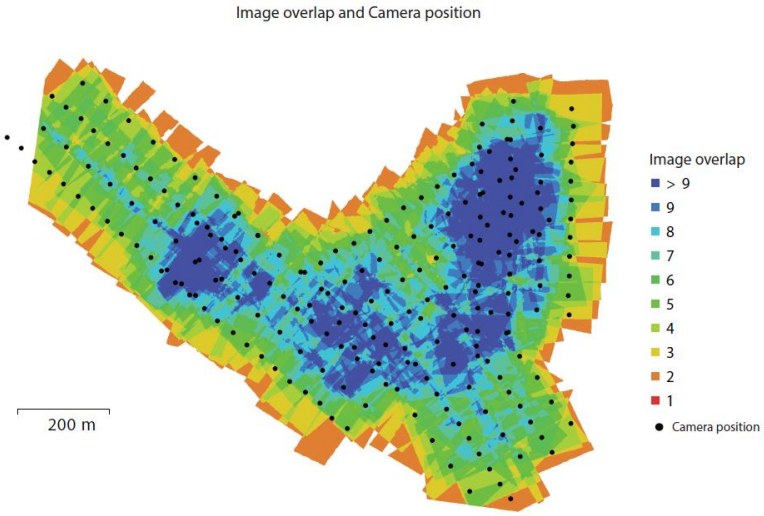
When trying to get the permissions for this flight, it was realized that Uganda currently does not have clear regulations on getting the permission to conduct a drone flight. It was also learned that currently importing drones into Uganda in banned. For these reasons, it is not completely clear who has the authority to give the final permission for the drone flight.

After various conversations with KCCA, permission was given from the office of KCCA Executive Director, who had been in contact with State House, to fly the drone over Ggaba.

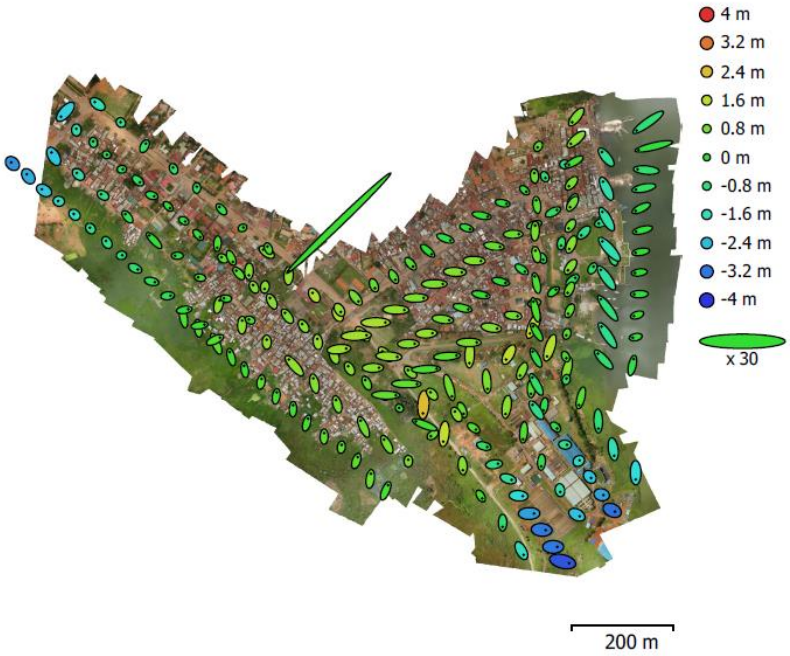
The UAV survey (planned with eMotion as flight planning software) was conducted from an open field within the National Water Treatment area and consisted of a total of five flights. The Ebee standard drone

was used for this survey. It is a lightweight fixed wing drone, with a Sony DSC-WX220 camera mounted on it. Due to the drone's light weight, it was deemed safe to use it especially in the urban context. The Ebee is also one of the easiest drones to pilot with easily adaptable hardware and software.

The survey - conducted within two days (19th and 20th September, 2018) - covered an area of 0.742 km² and was done at an altitude of 132 meters above ground. This resulted in a ground resolution of 3.34 centimeters per pixel. A total of 230 images were collected during the 5 flights with a certain overlap, enabling processing of the images and generation of 3D models and orthophotos. The location of each image and their overlap can be seen in figure below.



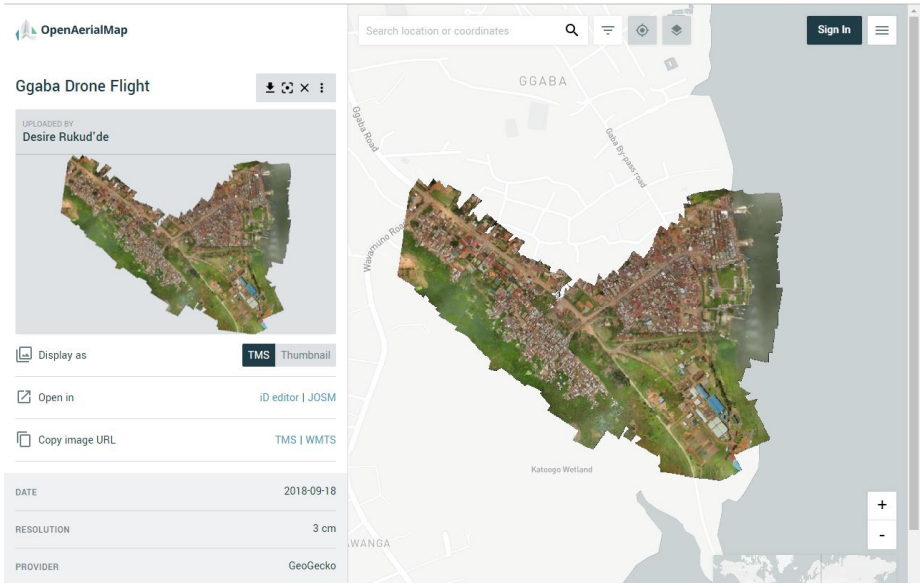
Agisoft Photoscan was used to process the acquired imagery. The following figure shows the camera locations and error estimates (Z error is represented by ellipse color. X,Y errors are represented by ellipse shape. Estimated camera locations are marked with a black dot).



Average camera location error is shown in the next table:

X error (m)	Y error (m)	Z error (m)	XY error (m)	Total error (m)
0.676479	0.645539	1.04866	0.935064	1.405

The produced orthoimagery was then uploaded on OpenAerialMap (see screenshot below).



The main challenges faced during the UAV surveys were:

- Accessibility of open sites: it wasn't possible to cover the full extent of Ggaba from the National Water site due to the visual line of sight requirement. An optimal open site in the northern part of

the area of interest was found but it has been difficulty getting access to it (private property). Since a negotiation with the land owner are still ongoing, the northern part of Ggaba area was not surveyed.

- Bird attacks: since Gaba is located on the shore of Lake Victoria and is also home to a wetland, it attracts a significant number of birds which are a challenge when flying UAVs.
- Weather: being close to the lake also creates challenges regarding wind. The wind in the Ggaba area was quite strong at some points in the day and when flying with a UAV as light as the Ebee, the wind becomes a significant limiting factor to a smooth flight.

Communication and Advocacy

The main focus of the communication and advocacy activities was on reaching out the local community and the relevant Governmental stakeholders. Local communities played an essential role in the remote mapping tasks and especially in the field mapping activities. Specifically, local leaders helped to sensitize on the non-political and practical nature of the project to avoid controversy/conflicts while selected community members supported YouthMapper student teams. Field data collection also involved stakeholders from government, i.e. OPM, UBOS, and KCCA.

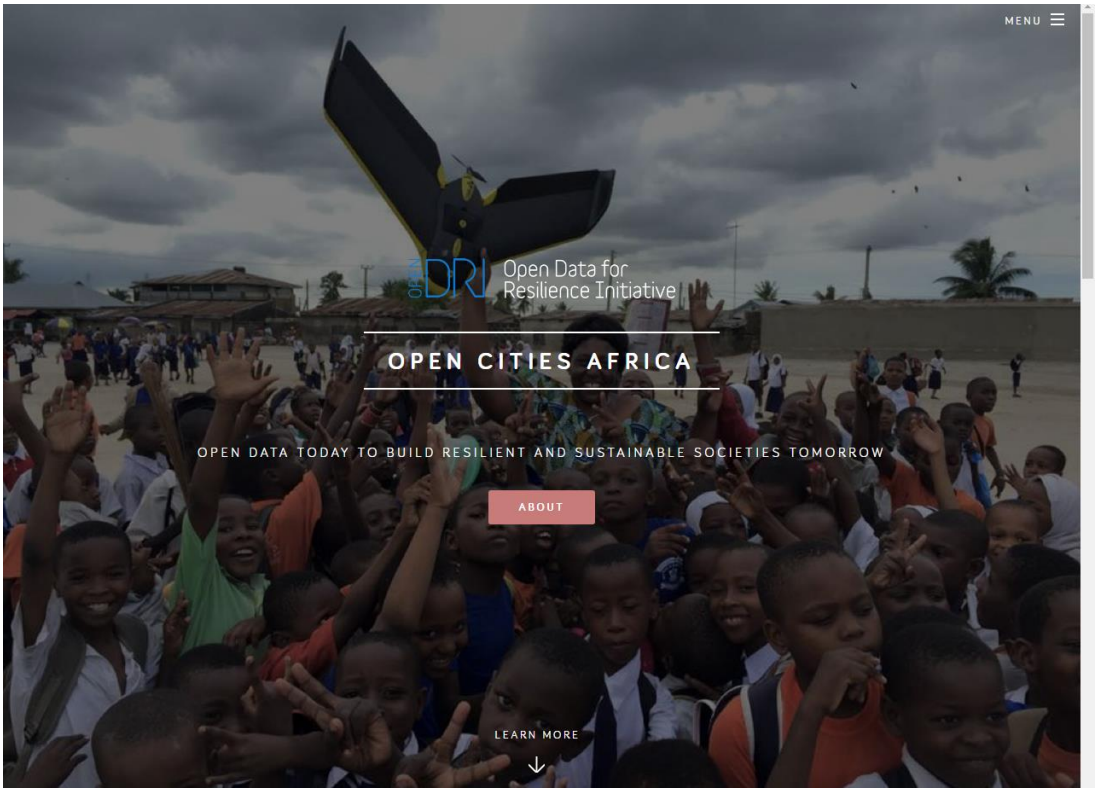
In addition to two blog posts published on the OpenDRI platform, two specific deliverables were produced to support the communication goals, i.e. a dedicated website and a paper map atlas.

Dedicated WebSite

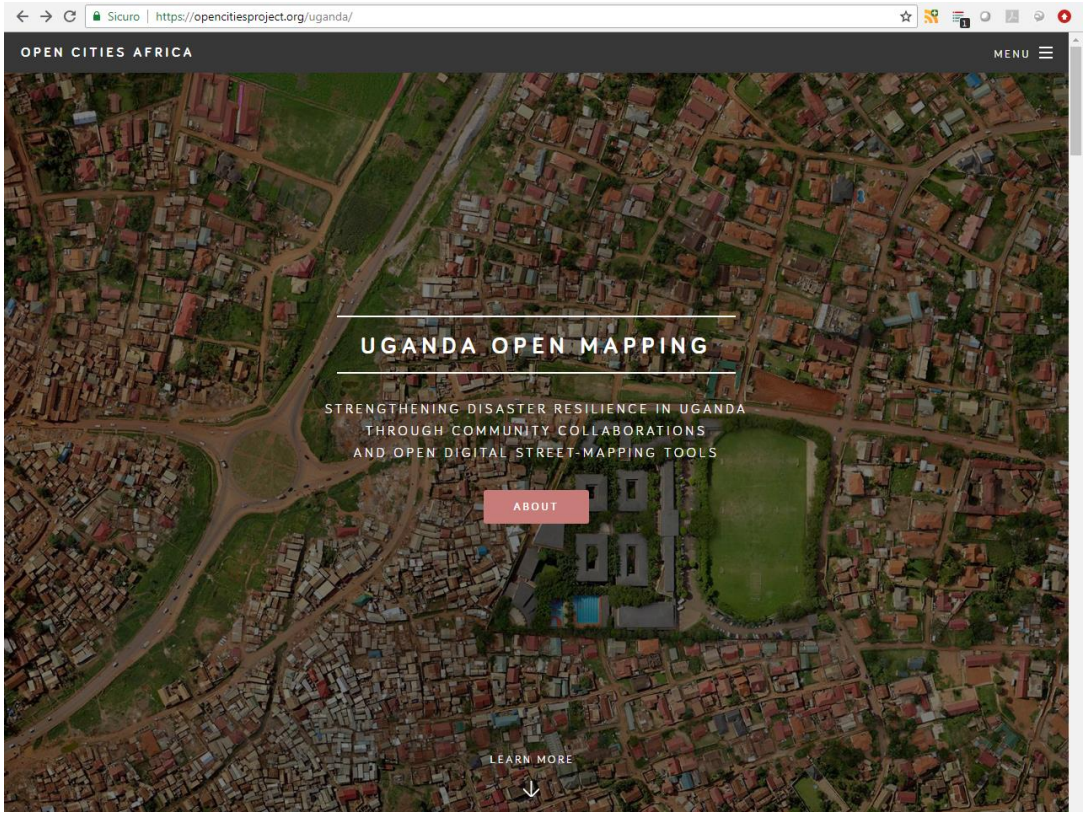
A dedicated website was designed and developed. After a preliminary draft release (including different styling options), that triggered a website design exploratory phase with the World Bank, a final draft was implemented. The concurrent World Bank activities related to the Open Cities Africa initiative led to a new proposal for the overall structure and hosting of the Uganda Open Mapping website.

It was therefore agreed, following a specific request from the World Bank, to nest the Uganda Open Mapping website under the umbrella of the Open Cities Africa initiative, adopting a consistent styling for all the cities involved in the initiative. Specifically, the following website structure was adopted:

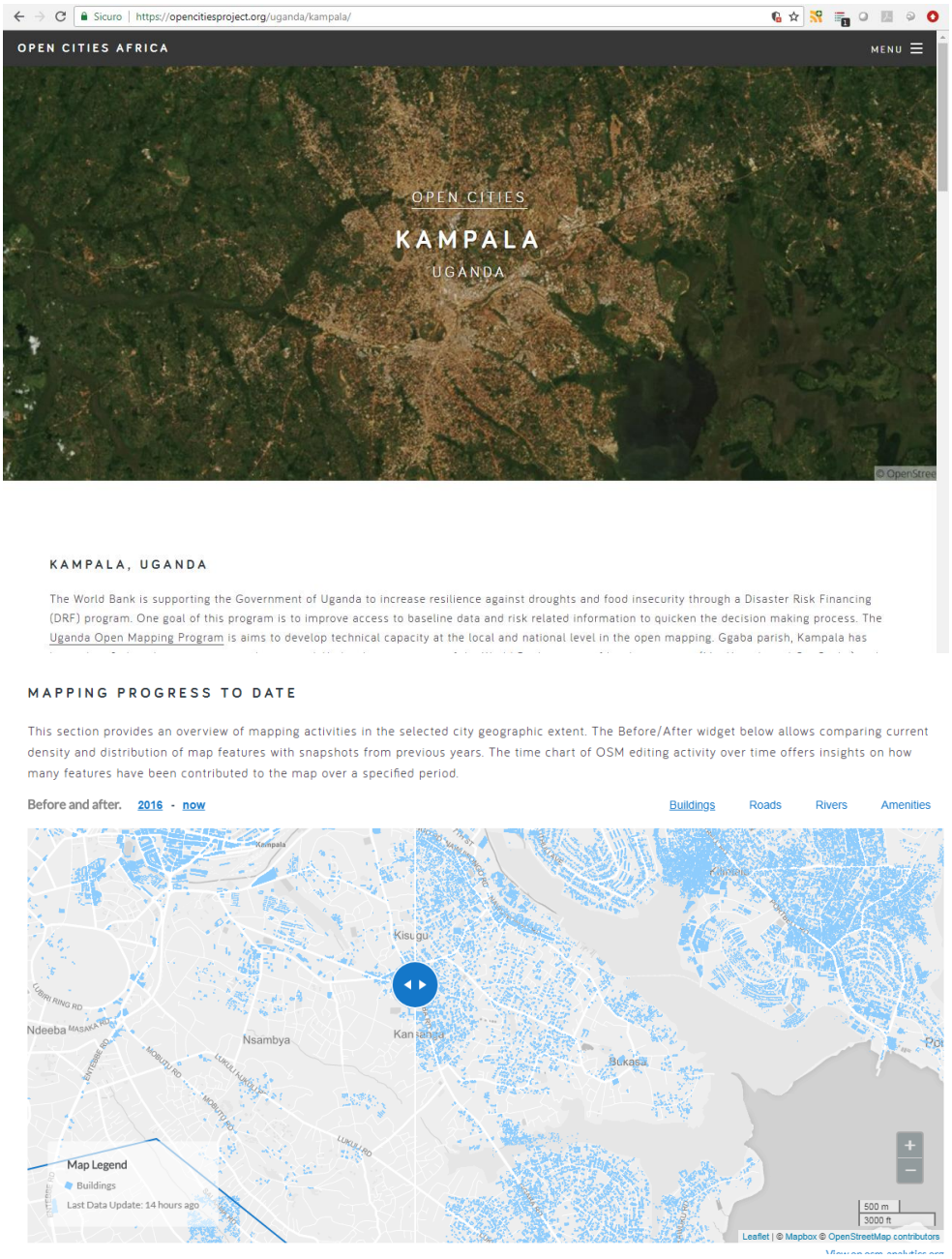
OpenCitiesAfrica: https://opencitiesproject.org/



UgandaOpenMapping: https://opencitiesproject.org/uganda/ (D440, R8)



Mapping progress: https://opencitiesproject.org/uganda/kampala/ (D310, R5)



The website was developed using the Jekyll framework and released as open source in a GItHub repository (https://github.com/GFDRR/opencities)

Paper Map atlas

An atlas covering sample areas was developed in digital format in order to show the mapping and analytical power of the data collected for developmental purposes. Map atlas sheets in A-3 format will be printed (50 copies) - as soon as the draft digital versions are finalised and agreed with the World Bank - and distributed through coordination mechanisms and local stakeholders, including KCCA, UBOS, and the Office of Prime Minister.

Conclusions

As it can be perceived by the activities and deliverable described in this report, it can be stated that Uganda Open Mapping project met the expected objectives and can be considered an effective and successful pilot.

Specifically, the following outcomes are considered good performance indicators:

- the operational involvement of Governmental agencies
- the engagement of local communities
- the capacitation of local communities in personal and professional use of OSM tools
- a significant increase of OSM features and related attribute information (coming from both remote and field mapping tasks)
- the active role of a synergistic consortium based in Kampala (and coordinated from Italy)
- the learning experience of MapUganda
- the decision (from KCCA) to address city dwellers resilience issues in Ggaba parish (usually sidelined with an assumption that rural population are underprivileged), allowing SDG goals 1, 10 and 11 to be partially fulfilled
- the involvement in the Open Cities Africa initiative

Nevertheless, some challenges impacted on the original work plan and schedule. The main issues were related to the cascading impact of the shift of the Governmental interest to a different target area. The choice of a different area specifically impacted on:

- the field team organisation (that originally planned to work mainly in Karamoja rather than in Kampala)
- the operational procedures for UAV flights, which are complicated in dense urban environment especially in terms of availability of take-off/landing places (together with the lack of clear regulations on getting the permission to conduct a UAV flight)
- the need to postpone all the mapping activities for several months, waiting for a formal confirmation of the new target area from the Government with an extrapolated impact on other project tasks (e.g. a second mapathon can be organised only when updated UAV orthoimagery is available)
- allocation and management of the personnel initially delegated to the project
- tight time constraints in carrying out the mapping activities in a reduced time-frame (less than 1 month)

Tailored solutions were discussed and agreed between the consortium and the World Bank, allowing all the tasks to be completed despite the encountered challenges. This was possible mainly thanks to the flexibility and commitment of the consortium partners.

Based on the lesson learnt and the aforementioned considerations, possible recommendations for future works are:

- advocacy for open mapping and outreach to local communities should be encouraged and supported, with the goal to ensure that a solid open mapping community of trained and skilled volunteers, professionals, and Governmental staff is already in place when new specific initiatives will kick-off, enabling a more responsive reaction. The capacity development activities should also cover the need to ensure that the received training can be sustained in the future.

- a flexible project timeline should be agreed with the donors to ensure that, in case of postponements out of the control of the World Bank or the consortium, the revised work schedule still allows the planned activities to be completed within a reasonable timeframe. Additionally, a re-evaluation of allocated budget should to be undertaken, to sustain the overhead cost related to the need to keep the team in stand-by
- existing budget in-use should be carefully and transparently diverted into training/alternative mapping events specifically tailored towards replication of the project, in order to prepare for 'going live' more effectively
- logistical/financial transparency between all collaborators at field-level should be coordinated externally in this context
- the implementation by Central KCCA of a 'Top-Down' house addressing plan, running concurrently with the Uganda Open Mapping fieldwork, could have had a negative impact. However, the measures taken (e.g. branding on jackets, 'Community-Survey' emphasis) allowed the two concurrent field activities to be clearly distinguished.