GIS support for the MSF Ebola response in Liberia, Guinea and Sierra Leone

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Case Study

MEDECINS SANS FRONTIERES

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Case Study

MSF Section	MSF-OCG
Title	GIS support for the MSF Ebola response in Liberia, Guinea and Sierra Leone
Owner & Commissioner	GIS Unit Logistics Department Médecins Sans Frontières Operational Center Geneva
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Purpose	This case study aims to examine whether the GIS officers' missions, as part of the 2014–2015 Ebola response, have succeeded in supporting the emergency response and furthering the strategic goals defined in the strategic paper "Development of the GIS in MSF-CH".
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ABBREVIATIONS

ETC	Ebola treatment centre
GIS	Geographic Information Systems
GPS	Global Positioning System
HOT	Humanitarian OpenStreetMap Team
MSF	Médecins Sans Frontières
MSF-CH	Médecins Sans Frontières Switzerland
NGO	Non-Governmental Organization
OCA	Operational Centre Amsterdam
OCB	Operational Centre Brussels
OCBA	Operational Centre Barcelona
OCG	Operational Centre Geneva
OCP	Operational Centre Paris
OSM	OpenStreetMap
VHF	Ebola viral haemorrhagic fever

EXECUTIVE SUMMARY

As part of the 2014–2015 Ebola response operation in Guinea, Liberia and Sierra Leone, Médecins Sans Frontières Switzerland (MSF-CH) started to systematically deploy dedicated Geographic Information Systems (GIS) officers to the field.

Primarily mandated to work in close collaboration with the epidemiologists, the GIS officers were charged with producing general overview maps, as well as topical maps that supported different aspects of the operation.

Both field and headquarters staff interviewed for this case study stressed that having dedicated GIS officers in the field was a major asset that had a significant positive impact on the operation. GIS support helped programme staff perform their tasks faster and target their activities more precisely and with fewer resources.

In total, the GIS officers produced more than 800 maps and related information products during 16 missions that took place between March 2014 and May 2015.

The following outputs were frequently mentioned as being the most useful:

- **Base maps**

  Significant parts of the affected countries were very poorly mapped or had previously not been mapped at all. GIS officers, with the support of local staff and the virtual OpenStreetMap community, quickly produced maps that showed roads, buildings and other infrastructure. These base maps were not only useful for MSF, but were also helpful in building relationships with other humanitarian actors and representatives of the local governments.

- **Identification of village, community and street names**

  GIS officers produced databases and maps with both the official and the colloquial names of villages, communities and streets in the areas of intervention. This helped staff to clarify quickly where patients had come from, which thereby enabled MSF to reach people in these locations more quickly.

- **Visualizations**

  Weekly updated maps of confirmed and suspected Ebola cases helped translate the progression of the epidemic from technical data into an easy-to-grasp map. As a result, staff at all levels had a better understanding of the emergency.

The interviews also highlighted the fact that most MSF staff knew very little about GIS prior to their deployment. Working alongside the GIS officers gradually changed that, and programme staff who have worked with GIS officers are now more likely to actively request GIS support. All interviewees emphasized that having the GIS officers in the field was essential for this learning process to occur.

Given the universally positive feedback on the role of the GIS officers, it is recommended that headquarters make GIS officers available to field offices on a more regular basis, particularly during epidemics.

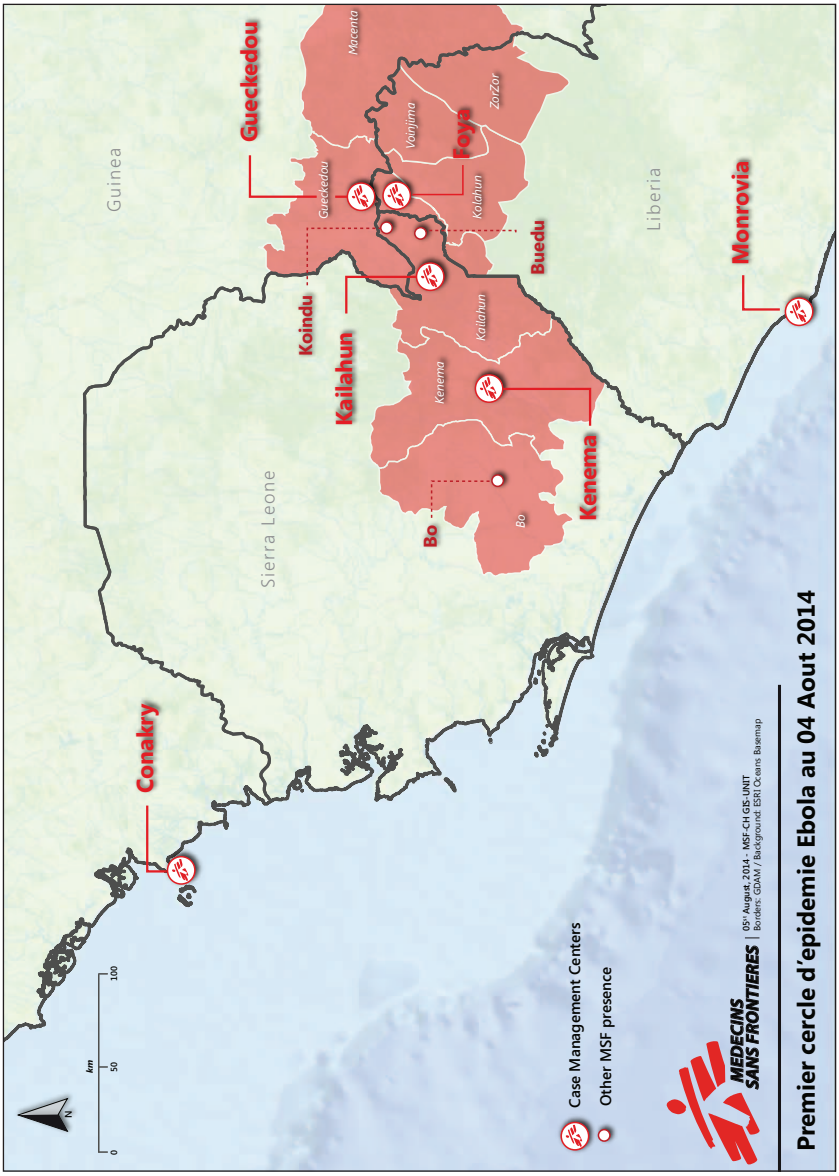

Figure 1: Situation Map of MSF activities for Communication purpose, August 2014.

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1. INTRODUCTION

1.1 BACKGROUND

In March 2014, Ebola viral haemorrhagic fever (VHF) broke out in southern Guinea. In the following months, the disease spread through parts of Guinea and most of Liberia and Sierra Leone. Médecins Sans Frontières (MSF) quickly deployed teams to assist with the response. In total, MSF employed more than 4,000 national staff from the affected countries and 1,300 international staff.

As part of this response, MSF Switzerland (MSF-CH) deployed nine dedicated Geographic Information Systems (GIS) officers for a total of 16 missions to the three countries. As the response progressed, this GIS capacity, which was provided by and initially supported the Operational Centre Geneva (OCG), turned into an intersectional resource that was also used by the Operational Centre Amsterdam (OCA) and the Operational Centre Brussels (OCB), as well as, to a lesser degree, by the Operational Centre Barcelona (OCBA) and the Operational Centre Paris (OCP).

While MSF staff have been using maps and GIS technology for many years, the use of dedicated GIS staff in the field was still very uncommon until late 2014.

The decision to send dedicated GIS officers to the affected countries was informed by a study on the use of GIS within MSF[1], which had identified epidemiology as "the domain where GIS can bring the most positive evolution"[2]. It was, furthermore, based on the GIS Strategy for MSF-CH[3] (see also 3. Strategic Objectives).

This case study aims to examine whether the GIS officers' missions to Guinea, Liberia and Sierra Leone have succeeded in supporting the emergency response and furthering the strategic goals defined in the GIS Strategy. The findings of this case study are based on oral and written interviews with 20 MSF team members and two external partners who were either deployed as part of the Ebola response themselves or at headquarters; it is also based on the end-of-mission reports of five GIS officers.

1 "State of art and opportunities using Geographic Information Systems in MSF" (2013) – referred to as "GIS Study" in this document
2 GIS Study, p.34
3 "Development of the Geographic Information System in MSF-CH" (2014) – referred to as "GIS Strategy" in this document

This case study is an update of the first case study, written in July 2014[4]. Where the first study looked only at the first deployment of a GIS officer to the field in Guéckédou, Guinea, this document summarizes the experiences and lessons learnt from all deployments that were part of the Ebola response, including the first mission.

Geographic Information Systems (GIS)

The term GIS in this case study encompasses any use of geographical information, or maps, ranging from the basic use of maps in the field to the use of Global Positioning Systems (GPS), remote sensing (satellite imagery), and all kinds of geo-referenced information (locations of patients, particular infrastructures, etc).

(See "3. Typology of GIS Applications", GIS Study)

1.2 MSF-CH GIS UNIT

Analysing GIS data and producing detailed, topical maps is a technical skill that was not readily available within MSF until 2014. To explore the use of GIS and to build capacity within the organization, MSF-CH signed a framework agreement with the French NGO CartONG in late 2013. In addition to building and maintaining technical infrastructure for MSF-CH, this agreement includes remote mapping support, as well as the provision of staff embedded in MSF field missions.

As such, the members of the MSF GIS unit wear two hats: on the one hand they are part of the internal MSF-CH structure and, on the other hand, they are employees of an external service provider[5]. While at the beginning of the response this dual identity seems to have caused some uncertainty regarding the GIS officers' status within the team, interviewees indicated that, as time progressed, GIS officers were seen as fully integrated MSF team members. They also indicated they had no reservations about sharing sensitive data with the GIS officers where this was necessary for their work.

4 "GIS Support for the MSF Ebola response in Guinea in 2014", OCG, July 2014. Available at http://reliefweb.int/report/world/gis-support-msf-ebola-response-guinea-2014-case-study

5 Note: This is about to change. As of 2016 GIS officers will become regular MSF staff.

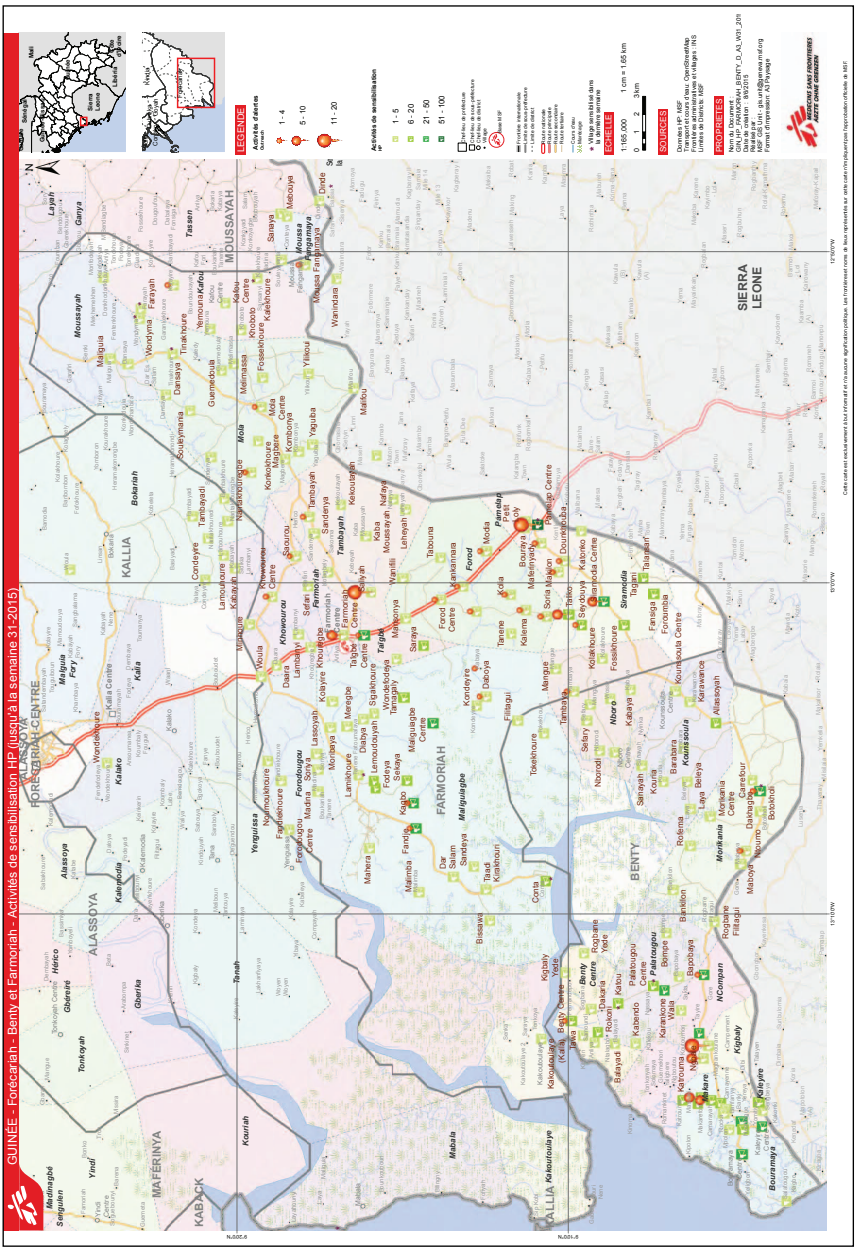

Figure 2: Map of Health Promotion activities done by MSF team in Benty and Farmoriah District in Guinea, August 2015. It supports MSF operations to monitor and foresee activities.


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2. GIS SUPPORT FOR THE EBOLA RESPONSE

As part of the MSF Ebola response, 16 GIS officers were deployed between the middle of March 2014 and the end of May 2015. At the height of the epidemic, five GIS officers worked in parallel in the three affected countries. During that time, the GIS officers produced more than 800 maps and related GIS products.

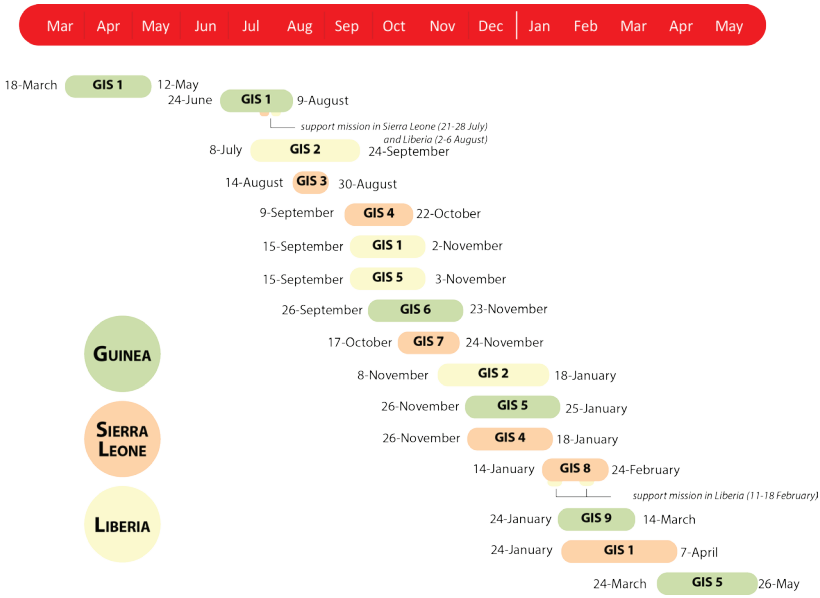


Figure 3: Timeline of deployments by country. At the height of the epidemic, up to five GIS officers were deployed at the same time. GIS 1-9 refers to the different GIS officers, some of whom were deployed multiple times.

2.1 INTERNAL AND EXTERNAL FACTORS

2.1.1 What is GIS?

All GIS officers and programme staff interviewed for this study concurred that there was very little awareness within MSF regarding how GIS officers can support programmes.

As a result, all GIS officers indicated that the majority of maps were produced based on their own initiative, while only a small number of maps were requested by the technical departments themselves. All interviewees ascribed this to the fact that MSF programme staff were unfamiliar with what a GIS officer could do and were, therefore, unable to request specific products.

However, all interviewees indicated that this changed as the mission progressed and as programme staff became more familiar with the GIS products. Over time, programme staff were submitting more and more concrete requests to the GIS officers, who were better able to anticipate the needs of the different departments.

The GIS officers felt that the overall knowledge of GIS improved during the Ebola response across sections. However, the high turnover of staff also meant that GIS officers were constantly required to educate new staff members about GIS. Many interviewees commented that being proactive and being able to explain GIS to staff who have very little time and who are very busy is one of the key soft skills of a GIS officer.

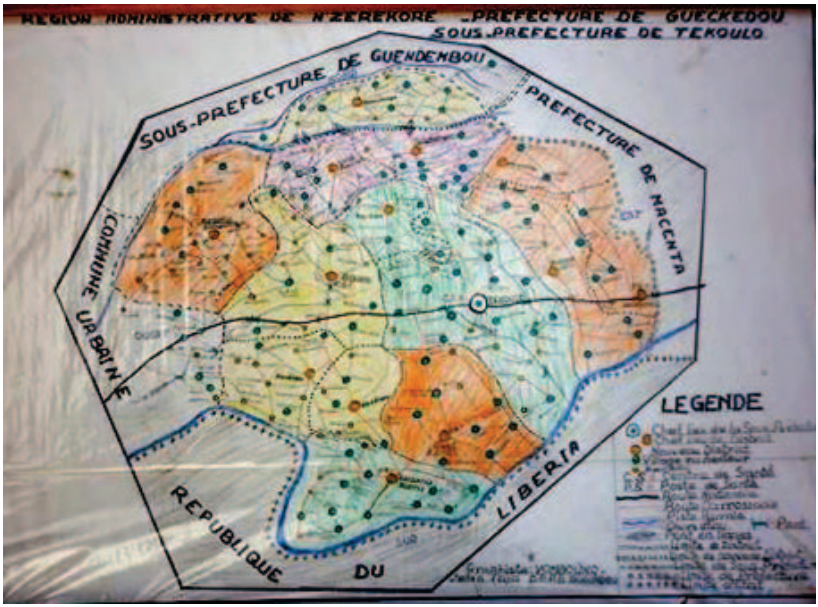
While some interviewees indicated that it would have been helpful to have been briefed on GIS before their deployment, most felt this would have been of limited use. The majority of interviewees felt that seeing GIS products in the field, and seeing how these products could address their concrete problems on a day-to-day basis, was what helped them understand the benefits.

All programme staff indicated that, for this learning process to occur, it was essential that the GIS officers were deployed to the field. Having remote GIS support was only seen as feasible in the later stages of a response, once the systems and products were well established and understood.

A senior MSF staff member based at headquarters added that some programme staff who had worked with GIS officers as part of the Ebola response were also requesting field-based GIS support for their next missions.

All the interviewees emphasized that the GIS officers were universally responsive to their needs. However, some indicated that physical proximity to distinct teams or sections had an impact in terms of the proactive production of maps, meaning that departments and/or sections where the GIS officer sat were getting a slightly enhanced or faster service.

Before



After

Figure 4: Maps of Guéckédou prefecture in Guinea before and at the end of the first GIS officer's mission

2.1.2 GIS as part of the hierarchy

During the first Ebola-related GIS mission to Guinea, the GIS officer was part of the epidemiological team. This decision was mainly based on the outcomes of an MSF study, which had identified epidemiology as "the domain where GIS can bring the most positive evolution"[6]. While epidemiology was one of the main users of GIS products throughout the response, the position in the hierarchy itself evolved over the course of the 16 missions. In July 2015, many interviewees felt the cross-cutting and interdepartmental nature of the GIS officers' work made it more appropriate for them to directly support coordination and field coordination, rather than being attached to a specific technical department. One interviewee suggested that GIS should be seen as a flexible support function that changes position depending on where the services are most needed.

It is worth noting that where staff voiced a preference for a specific department, it tended to be their own – with coordination being mentioned as the second preference. The fact that programme staff want GIS as close as possible to their own programmes can be seen as an endorsement of the utility of the function. However, the only coordinator interviewed for this case study felt that GIS should remain within a technical department.

2.1.3 Impact of ICT infrastructure

All GIS officers identified internet bandwidth as one of the limiting factors of their work.

While all GIS officers went to the field with the base maps that were available at the time of their deployment, downloading additional files was painfully slow at best. In one case, the GIS unit even resorted to giving a USB stick to an OCG staff member who was about to fly to the field, since this was the best way to transfer the data.

One interviewee indicated that MSF's new web-based e-mail system caused additional frustrations because the client would frequently time out during an upload, requiring the GIS officer to start the process again. This was the case in a very remote location, where MSF shared the internet connection of another NGO. Under these circumstances, being able to send and receive e-mails via an offline e-mail client could be helpful.

Another interviewee pointed out that it is essential for GIS officers to have all the necessary permissions and software to maintain their own machines, including for system recovery. Since GIS officers' computers and software requirements are different from the standardized MSF computers,

6 "State of art and opportunities using Geographic Information Systems in MSF" (2013) – referred to as "GIS Study" in this document, p.34

in-country IT staff can only be of limited assistance in the case of severe problems that require a complete system wipe.

- **Distribution of products**

  The ICT infrastructure also impacted how maps could be shared within the field teams, with the capital and with headquarters. While OCG launched an online map centre in July 2014, programme staff interviewed for this case study did not take advantage of this facility in the field. Even interviewees who were aware of the map centre and were comfortable using web-based platforms mentioned that they were not using the map centre. Browsing the web site and finding and downloading maps was considered too time-consuming, and staff felt it was easier to ask the GIS officer directly for a map. It is unclear whether a better internet connection would have changed this.

  Instead of the map centre, GIS officers relied on a mix of channels to distribute maps. These were: individual and team e-mails, individual printouts, folders and atlases of map collections, as well as wall-mounted maps. By putting maps on a wall at a central location, or sharing them with the whole team by e-mail, GIS officers were also able to increase knowledge about the type of products they were able to produce.

  On the other hand, staff at headquarters, other operational centres as well as some external partners relied on the map centre as a central repository for maps. Therefore, uploading maps to the map centre remains important in order to ensure the dissemination of the maps.

The maps shown in this document, as well as many other maps, can be accessed through the online map centre:
http://mapcentre.msf.org/en/

- **Mobile data collection**

  GPS coordinates were mainly recorded with the help of dedicated GPS devices. Android phones were used in some cases. However, this happened spontaneously rather than systematically. It is worth noting that these initiatives were not limited to members of the GIS unit. In one case, an epidemiologist received a donation of 40 smartphones and used these to collect data. In another case, a member of the OCA Manson Unit installed open-source software on the private phones of local staff to collect data[7]. Interviewees indicated that their experience with Android phones for mobile data collection was positive and suggested that MSF should explore this option further.

7 Gayton, Lochlainn, Theocharopoulos, Bockarie and Caleo: "Mobilisation of local people and technology in mapping for the Sierra Leone Ebola epidemic response". See Annex I.

2.2 GIS PRODUCTS

2.2.1 Global understanding of the situation

The 2014–2015 West Africa Ebola outbreak occurred in an area of the world that had been very poorly mapped.

In rural areas, this meant that many villages and roads didn't exist on any maps. In urban areas, including the capital cities, large parts of the cities were blank spots, with no available information about roads, street names, the number of houses, or the names of formal or informal subdivisions.

However, in an epidemic it is essential to be able to pinpoint where a patient comes from as quickly and as accurately as possible in order to identify the people they have been in contact with and to provide people living in that area with targeted health information.

Filling in these gaps and providing this information was one of the first tasks that GIS officers undertook in all locations across all three countries.

Base maps are maps showing a basic layer of information. Additional layers of information can then be added. Common examples of base maps include topographical maps, relief maps and road maps.

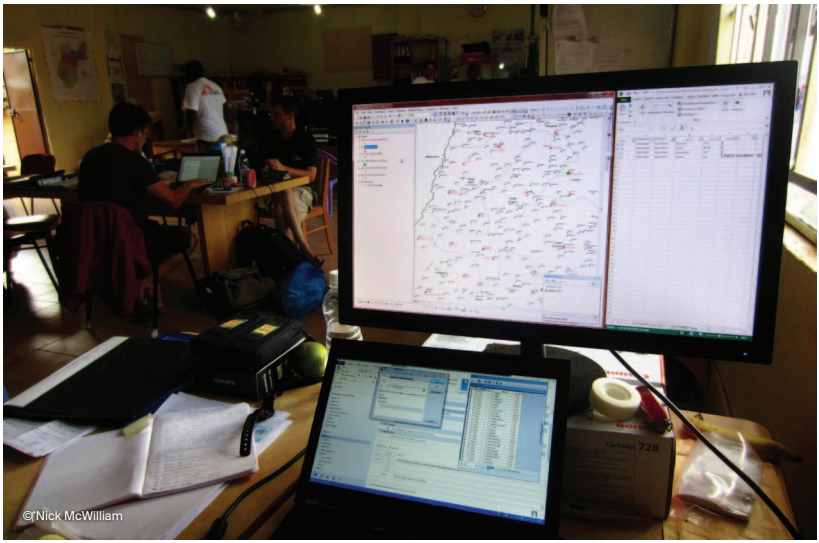


Figure 5: Identifying the names and locations of villages and communities was one of the first tasks that GIS officers undertook in all locations.

- **Rural areas: village names**

  One of the biggest challenges facing the team in all three countries was that both the name and the location of many villages were unknown. In addition, many villages had similar or identical names. For example, there are 14 villages called Bendou within the Guéckédou prefecture in Guinea. This was hugely problematic as the team had to rely heavily on patient interviews to decide where to intervene. Errors in identifying a location can lead to delays and wasted resources, and, in an environment where MSF vehicles are not welcome everywhere, unnecessary trips to the wrong location can expose staff to additional risks.

  The base maps produced by the GIS officers provided a solution to these issues. With the help of the maps and a database of all identified village names, the GIS officers were quickly able to identify the exact location of a village and whether the name existed more than once.

  Identifying village names was relatively resource-intensive since it had to be done on the ground. In many cases, local staff had to visit villages to confirm names and take GPS coordinates. Where possible, staff visiting an area for other reasons were asked to verify names, but, frequently, local staff had to be sent out in cars or on motorbikes to specifically carry out this task. The involvement of GIS officers at an early stage of the response is useful, since they can help define what data should be collected.

  All interviewees mentioned that being confident that they were sending their teams to the right location significantly improved their ability to target their activities effectively.

  One respondent also noted that, in other emergencies, programme staff had to try and identify the names and locations of villages themselves, for example, with the help of Google Earth. This frequently had to be done at night, after a long day carrying out regular duties. Having a dedicated GIS officer in the field had a threefold benefit: it increased the accuracy of the results, resulted in more user-friendly maps and saved time for programme staff.

Figure 6: Local staff members were essential during all stages of the response.

- **Urban areas: local community and street names**

  Urban areas posed similar problems to rural areas, in that large parts were unmapped, and many location names were colloquial and used inconsistently.

- In Freetown, the capital of Sierra Leone, for example, the smallest official administrative division is a 'ward'. However, when admitted to an Ebola treatment centre (ETC), many patients referred to the 'sector' they were living in because this was how they commonly described their place of residence. Sectors are informal names for areas of the city that can be bigger or smaller than wards, and often follow different boundaries. Unfortunately, the health of many patients deteriorated so quickly that it was not always possible to elicit additional information from them.
- In the Liberian capital, Monrovia, the smallest official administrative unit is the 'community', but people commonly refer to their 'sub-community' when describing their place of residence. These sub-communities are frequently named after prominent local figures, such as Ali's Compound or Morris' Farm, and might change their name over time.
- Street names are also frequently colloquial rather than official and, while Market Street or Rue de l'Ecole are often sufficiently accurate in villages, multiple streets with common names like these exist in many urban areas.

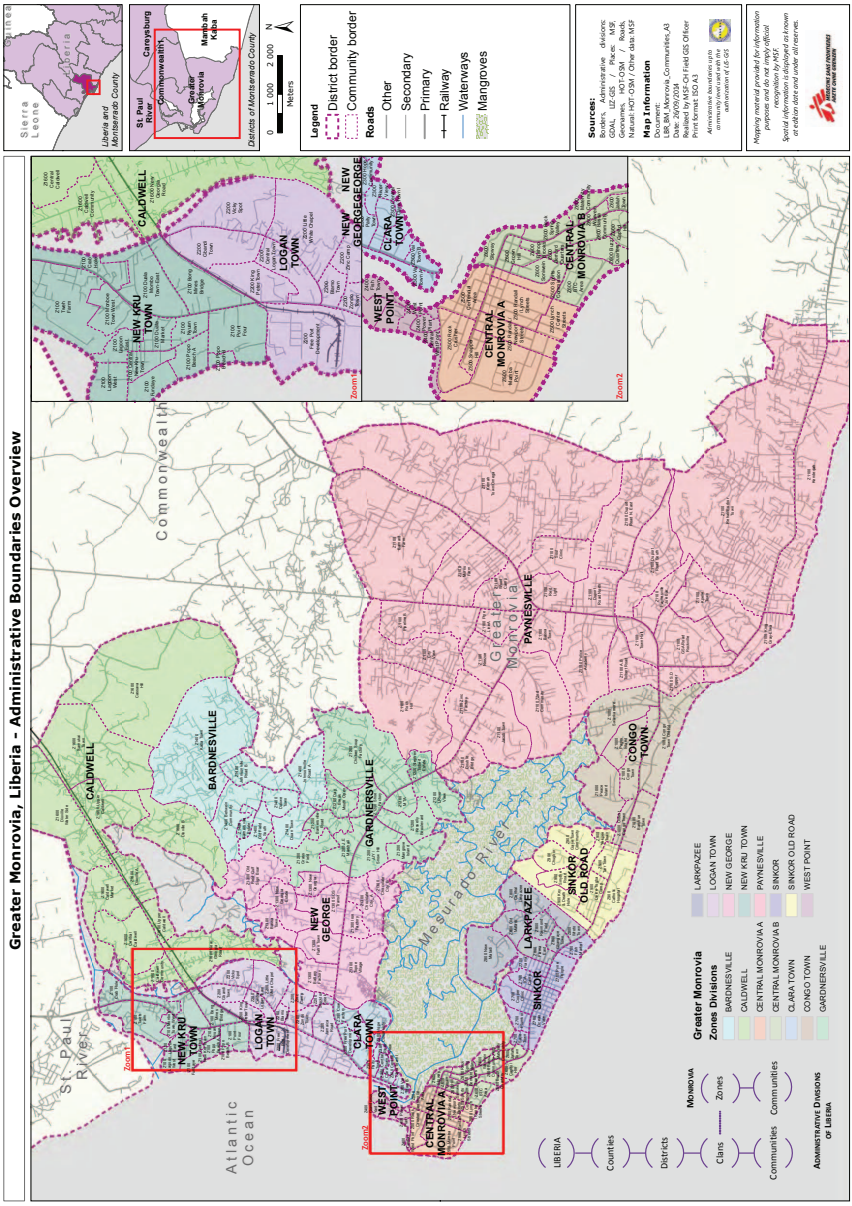


Figure 7: Many urban areas are only known by colloquial names that are subject to change. GIS officers mapped both the official and the unofficial names with the help of local staff. This helped to significantly reduce the time spent identifying the area a patient had originated from.

Most of these local and unofficial areas had previously never been mapped, which made identifying the exact location of a patient's home very challenging. In addition, some of these names had changed over the years and people living in a different part of the city might refer to the same location by a different name.

To address these issues, GIS officers produced base maps with the help of local staff that included both the official and the unofficial names. In all three countries, they were supported by the national statistics institute.

Data supplied in the end-of-mission report by one GIS officer suggests that clarifying the names of sub-communities and mapping them reduced the number of unknown addresses in the patient database by half.

- **Mapping villages, roads and buildings**

  In order to quickly get detailed maps of cities and major roads in the region, the GIS unit decided at the beginning of the response to crowdsource significant parts of this task.

  Thanks to the volunteers of the Humanitarian OpenStreetMap Team (HOT), satellite images were quickly turned into digital maps hosted on OpenStreetMap (OSM). The source of these images varied: in spring 2014, MSF-CH bought a first set of satellite images for their areas of operation and made these available to HOT. Later, other humanitarian organizations, the private sector and state actors contributed satellite imagery.

OpenStreetMap (OSM) – www.openstreetmap.org

OpenStreetMap is often referred to as the "Wikipedia of maps", as anybody can make changes to the maps online. OSM data is maintained by volunteers and released under an open-source licence. In many developing countries, OSM maps are more detailed than Google maps because Google has no commercial incentive to improve its maps in these countries.

Humanitarian OpenStreetMap Team (HOT) – hotosm.org

HOT is a group of OSM volunteers that acts as an interface between humanitarian organizations and the OSM volunteer network as a whole. Humanitarian organizations can send mapping requests to HOT, which then manages the volunteers responding to the request. This reduces the workload for the requesting organization. HOT also functions as first-level support for all technical questions, while the requesting organization has to be able to answer questions about the project itself.

As a result of the collaboration between the GIS unit and HOT, the first three priority cities were mapped in less than three days. Within five days, 244 volunteers had mapped more than 90,000 buildings.

In total, 3,300 volunteers added or edited 16 million objects, such as buildings, roads or land features, in support of the Ebola response over the course of a year (see Figures 8 and 9 for examples).

However, the data also shows that most of the contributions came from a very small number of dedicated editors: 10 million of the 16 million objects were contributed by 101 users.

In addition to the remote support provided by HOT, MSF staff collected GPS points and uploaded these to OSM. It was this combination of local and remote support that resulted in the rapid increase in the number of detailed maps; while the virtual volunteers were able to quickly trace roads and buildings on satellite images, local MSF staff added meaning to these outlines by identifying the function of traced structures (for example, school, hospital, market), or by adding the names of villages. In one field office, MSF staff collected additional information (such as the name and phone number of the village chief), which was used internally but not uploaded to OSM.
With a few exceptions, the GIS unit in Geneva functioned as an intermediary between the GIS officers in the field and HOT. This was considered appropriate by most interviewees. However, the HOT coordinator interviewed for this study indicated they would have preferred to have been more directly involved in the communication with the field so as to get more qualitative feedback about how the maps were actually being used in the field.

Many interviewees commented that they were “amazed” by the speed at which the area was mapped with the help of OSM volunteers. On their own, the GIS officers would not have been able to produce these base maps during their mission.

The base maps that the OSM volunteers helped to create also served as the foundation for many other maps, many of which could not have been produced without these base maps.

It is important to note that these base maps contained no sensitive or patient information. MSF teams could share them – digitally or on paper – with other humanitarian organizations and local authorities. This was greatly appreciated and many interviewees commented that being able to bring maps to a meeting helped build relationships and made it easier for MSF to obtain data from other actors.

Before

After

Figure 8: Before and after the Humanitarian OpenStreetMap Team activation - Guéckédou (Guinea).

Before

After

Figure 9:Before and after the Humanitarian OpenStreetMap Team activation - Freetown (Sierra Leone).

- **Collaboration with national statistics institutes**

  The GIS officers in all three countries sought to work closely with the national statistics institutes, which had information about administrative boundaries and village names on file. The interviewees described the collaboration as largely positive, but sometimes frustrating since the data was frequently incomplete, improperly formatted or badly maintained. In addition, in the case of Guinea, MSF was not allowed to share some of the data with other partners, such as OpenStreetMap, due to licensing issues. This limited the usefulness of the maps for the GIS officers.

  Collaboration with these national institutes also included ad hoc training and capacity building, which was universally appreciated. It also helped build relationships, which, in turn, made it easier for the MSF teams to request information or data.

2.2.2 Epidemiology

GIS officers worked closely with the epidemiologists in all deployments, and epidemiology was one of the departments that benefited the most from the added capacity. One interviewee emphasized that for this relationship to work smoothly, a clear separation of responsibilities was important. While the GIS officers assisted with defining what data should be collected and were responsible for producing GIS products, such as maps and other visualizations, the analysis and interpretation of these products was the responsibility of the epidemiologists.

- **Epidemiological overview maps**

  In all three countries, the GIS officer produced weekly updates of Ebola hotspots that showed both the number of new cases in the previous week, as well as the total number of cases since the beginning of the epidemic. A similar map showed new cases within the last seven and the last 21 days – the incubation period for VHF.

  These weekly, visual overviews were appreciated by all field and headquarters staff since they made data that was otherwise often displayed in tables more easily understandable. As one respondent put it: “That map translated the scientific into the operational.”

  As with the base maps, interviewees commented that having these maps and being able to share them with other actors helped them build relationships and obtain data from other actors. One interviewee also felt these maps gave MSF more credibility in meetings because the information looked more official when visualized on a professional-looking map.

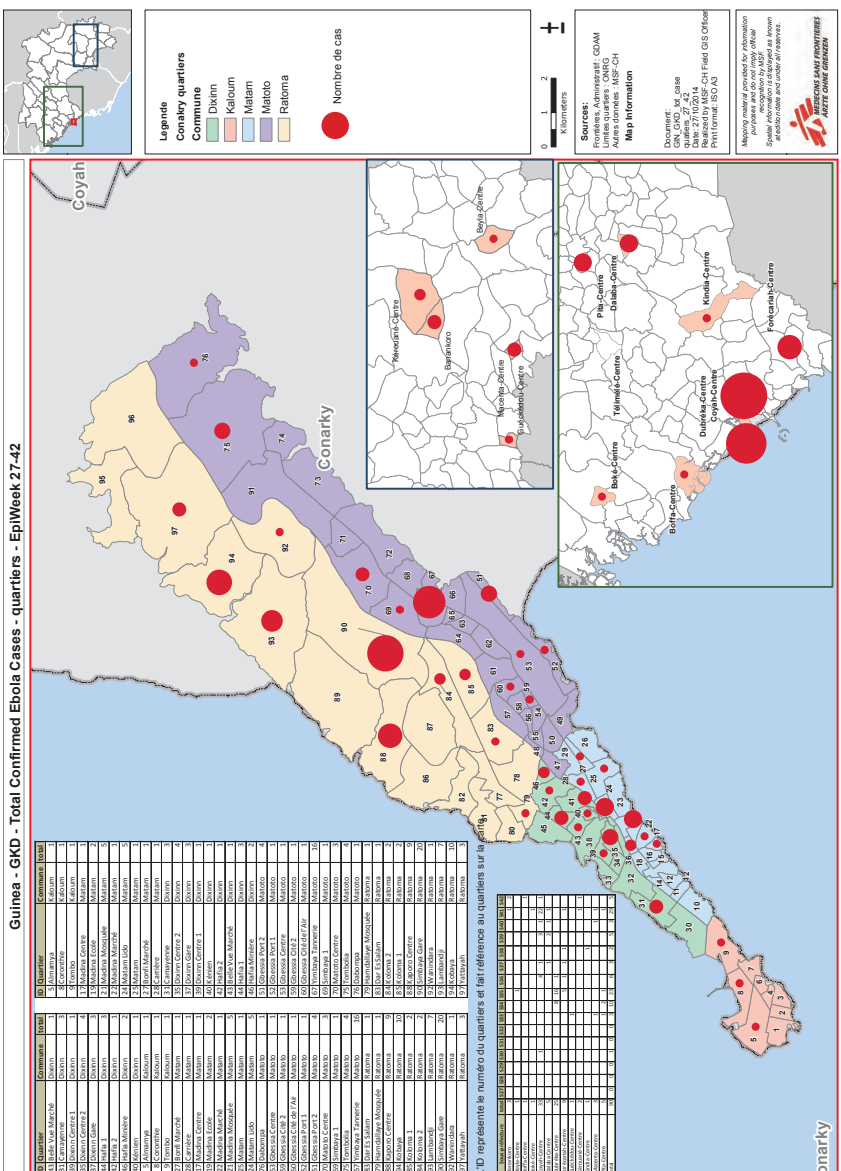


Figure 10: Regularly updated maps like these helped staff and external partners at all levels understand the situation better.

- **Line lists**

  The basis of many epidemiological maps produced by the GIS officers were 'line lists', which contained basic patient information, such as their place of residence. Matching this information with the list/database of known locations was the first step in visualizing new cases on maps.

  The fact that these line lists did not follow a common format between different MSF sections and offices – and that, in at least one location, their format changed over time – made the process of visualizing the data more laborious. In addition, other humanitarian actors used their own version of these lists. As a result, in at least one location, the line lists were so incompatible with each other that their data could not be merged, meaning that no comprehensive picture of the epidemic could be visualized.

  The early involvement of GIS officers in this process can help increase consistency and avoid duplication of work, since they can advise epidemiologists on what data should be collected and how it should be structured to facilitate the creation of GIS products.

- **Do-it-yourself maps**

  In one case, an epidemiologist asked the GIS officer for an Excel sheet with a custom macro that enabled programme staff to enter data and produce simple maps at district level themselves, without having to go through the GIS officer. While these maps were much more basic than those produced by the GIS officer, the epidemiologist felt this was sufficient to quickly gain an overview and that this was helpful in situations where a quick regional overview can inform the analysis.

- **Palm tree density**

  At the beginning of the emergency, the GIS unit requested a map that showed palm tree density close to the suspected point of the outbreak's origin. This helped the epidemiologists test their hypothesis that bats living in certain types of palm might have been the source, rather than bats living in caves. This map was created by Copernicus[8], an emergency mapping service provided by the European Commission with particularly strong analytical capacity. As an associated user, MSF was able to send a request to Copernicus, which completed the analysis within 24 hours based on existing satellite images.

8 See http://emergency.copernicus.eu/mapping/ems/what-copernicus

- **Geographic randomization**

  Two epidemiologists mentioned that the GIS officers helped them improve the scientific rigour of their epidemiological surveys by randomly selecting households on satellite images.

2.2.3 Reporting communication and advocacy

All interviewees commented positively on the way that maps can be used to translate data that exists in spreadsheets into something visual that can be understood more easily. This applies to both the geographic as well as the temporal dimensions of maps, when multiple maps can show changes over time.

The most useful products from a reporting and advocacy point of view were the weekly snapshots of new and total Ebola cases (see 2.2.2, 'Epidemiology'). Both field-based and headquarters-based staff remarked that having these maps helped them understand the situation better, and headquarters, in particular, appreciated that they provided them with a quick overview.

- **Quarantine advocacy map**

  In Sierra Leone, GIS staff produced maps with the help of the health promotion teams that showed the number of quarantined households in Freetown, together with information on whether the basic needs of these households were being met. These maps were used to advocate for the better provision of services, as well as for an end to the quarantines. While the latter was not achieved, some interviewees felt these maps were useful for putting pressure on the organizations responsible for providing essential services, and to illustrate why people were leaving the quarantine zones. Other interviewees felt this form of advocacy was not within MSF's remit, and that the resources used to produce these maps should have been used for other tasks.

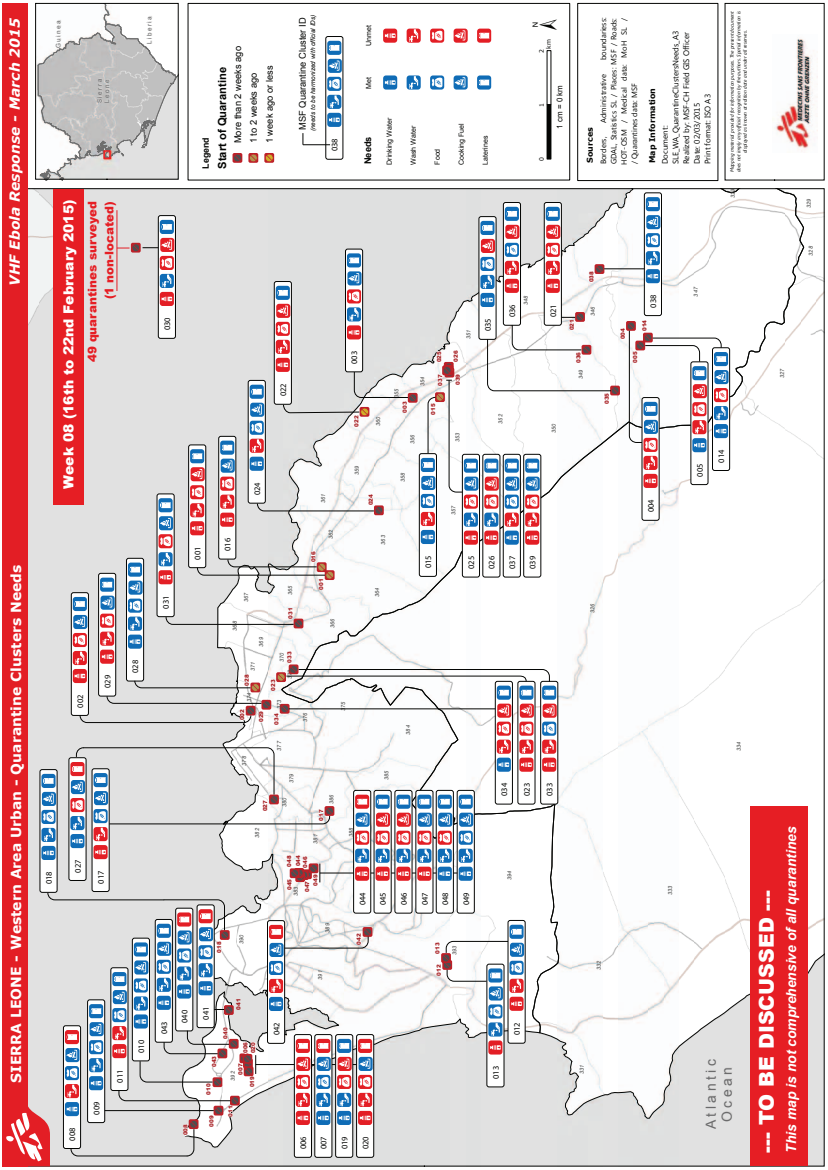


Figure 11: In Sierra Leone, GIS officers produced maps that showed unmet basic needs in quarantined areas.

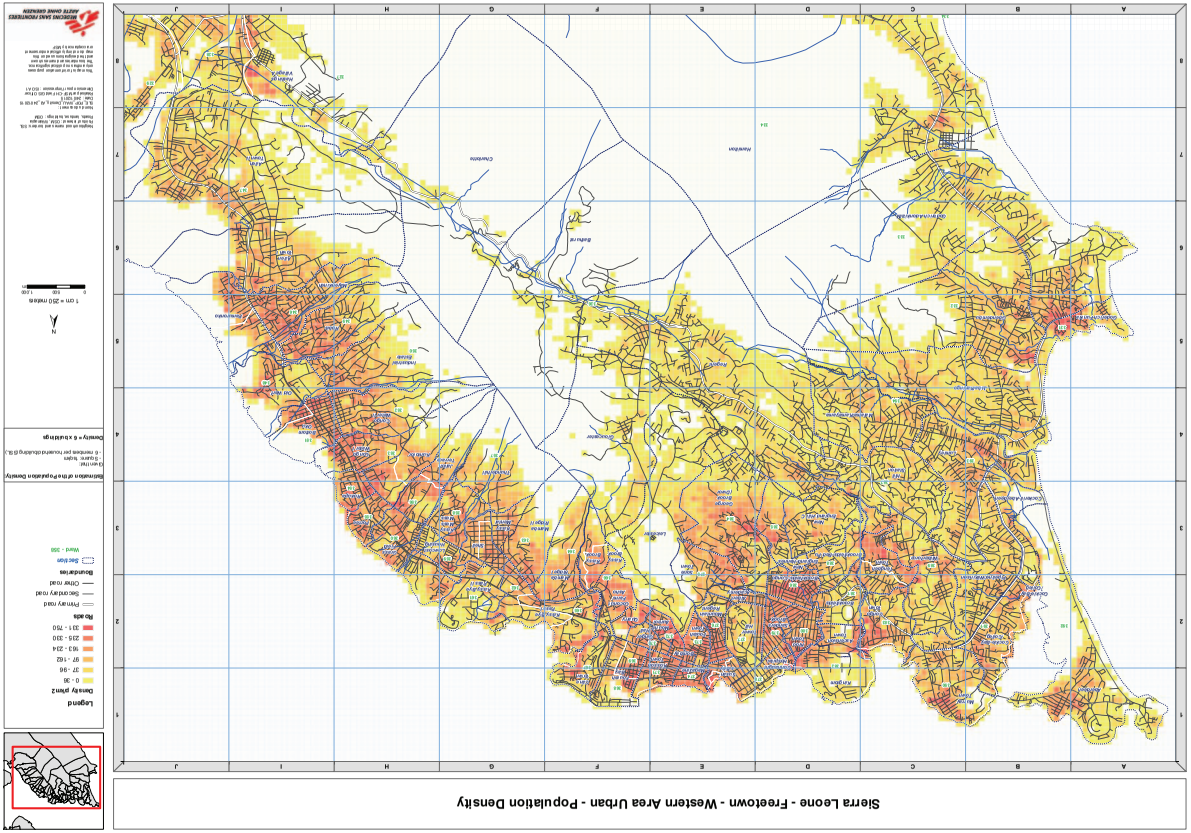


Figure 12: In Sierra Leone, GIS officers produced maps that showed unmet basic needs in quarantined areas.

2.2.4 Population count and movement

Since Ebola is spread from human to human and because people in the affected region are highly mobile, GIS could not be relied on to help predict where new cases might occur.

Nevertheless, one interviewee commented that, during the later stages of the response, knowing whether new hotspots had flared up in surrounding districts was helpful in anticipating new influxes of patients.

In addition, population density maps were useful in helping identify which areas should be prioritized for outreach and health promotion activities.

Community-level population density maps (see Figure 5) were produced based on the field team's knowledge of average family size and a count of buildings that had been mapped by the OSM volunteers. District-level population density maps were produced based on secondary data.
One epidemiologist offered a different point of view regarding the utility of the population density maps at a later stage of the response. He pointed out that, as time passed, many homes were empty and that estimates regarding population density should be informed by on-the-ground population counts as well as by the number of buildings.

2.2.5 Activity planning

Interviewees from all technical departments stressed that the dedicated mapping support provided by the GIS officers helped them perform their tasks more quickly and/or to improve the quality of their work.

One epidemiologist put it like this: "GIS can drastically and radically improve how we operate, and [can] open [up] new possibilities for what we can achieve."

Respondents were unanimous in their view that it was essential for the GIS officer to be in close proximity to the teams in the field in order to be able to provide support for concrete activities.

- **Logistics**

  The logistics department benefited from the GIS officer's activities through a wide range of products. The improved road maps, for example, kept the logisticians informed about who was working where, and allowed them to minimize the number of movements and cars required. In Guinea, this was also significant from a security point of view.

Some of the other maps that GIS officers produced for the logistics department included:

- Atlases with detailed maps of the areas of operation. Many of these atlases included a grid system and an index of known location names, so that villages could be easily located
- Distance maps, including road codes, estimated times and cost[9] of travel
- Infrastructure maps
- Maps for helicopter landing areas
- Ahead of the government-mandated lockdown in Sierra Leone, a GIS officer produced an internal map with addresses of staff to help plan a shuttle service to get them to work

Most of the maps produced for the logistics department were also of use to other departments.

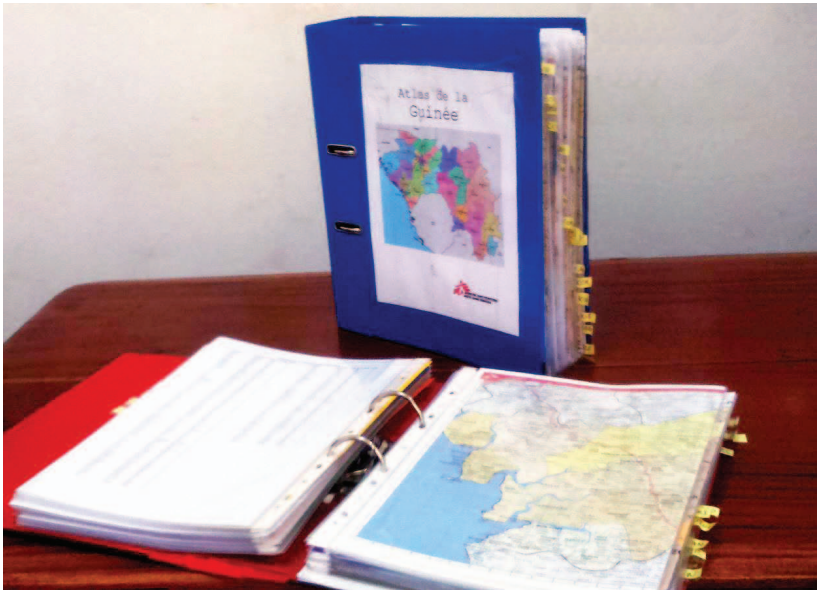


Figure 13: Atlas for Guinea.

- **Health promotion outreach**

  The health promoters interviewed for this case study were among the most ardent supporters of having a GIS officer in the field. Interviewees referred to the role of the GIS officer as "crucial" and "essential" in the case of an epidemic, and as very important in other

9 Produced for Freetown, where local staff were using public transport.

emergencies. Health promoters stressed that the presence of a GIS officer enabled them to become significantly faster and more efficient in their work. The field teams benefited primarily from two products:

- Up-to-date road maps that allowed team leaders to accurately plan travel times
- Maps showing VHF hotspots and population density. This helped decide which areas to prioritize for outreach activities
- Interviewees also indicated that health promotion teams felt very motivated by seeing their own work reflected on maps.

- **Coordination**

  The coordinators mainly benefited from maps that showed the locations of the different MSF activities. In strategy meetings, they also took advantage of the village localization in order to plan activities together with the heads of the technical departments. GIS officers were frequently present at the coordination and field coordination meetings to support the decision-making process.

- **Security**

  Following security incidents, GIS officers produced maps showing no-go areas as well as villages considered unsafe for MSF staff to enter. In one case, a GIS officer also created a confidential post-incident map to help analyse and report on the incident. In a number of locations, GIS officers also produced dedicated security maps that showed MSF assets and evacuation routes.

- **Medical**

  Of all the departments interviewed, the medical staff working in the Ebola Treatment Centres (ETCs) seemed to have benefited the least from the work of the GIS officer. Plans showing the location of buildings within the ETCs were normally created by the logistics department. Nevertheless, in two locations, a GIS officer also produced detailed interior floor plans of the isolation wards. Staff working in these locations found these plans helpful as it made it easier for them to plan trips into the isolation wards, where communication was very difficult because of the protective equipment. One interviewee also commented that having these floor plans helped ease the anxiety of new staff, since they could be shown more easily what to expect.

- **Building-level maps and stigma**

  As mentioned previously, many base maps available through the OSM collaboration were available at building-level granularity in urban areas. However, most interviewees indicated that they did not

require this level of detail for their work, and that this was probably the least relevant aspect of the maps for them. Similarly, one GIS officer commented that, for most of her work, the density of the road network was sufficient information.

At one point early in the response, a GIS officer produced a set of building-level maps to see whether they could help the water and sanitation teams identify more quickly those homes that needed to be disinfected. On these maps, the houses to be sprayed were clearly marked. However, after considering the amount of stigma that is attached to Ebola, it was deemed too risky to use these maps after this initial trial, due to concerns that they might get lost during field trips and end up in unauthorized hands.

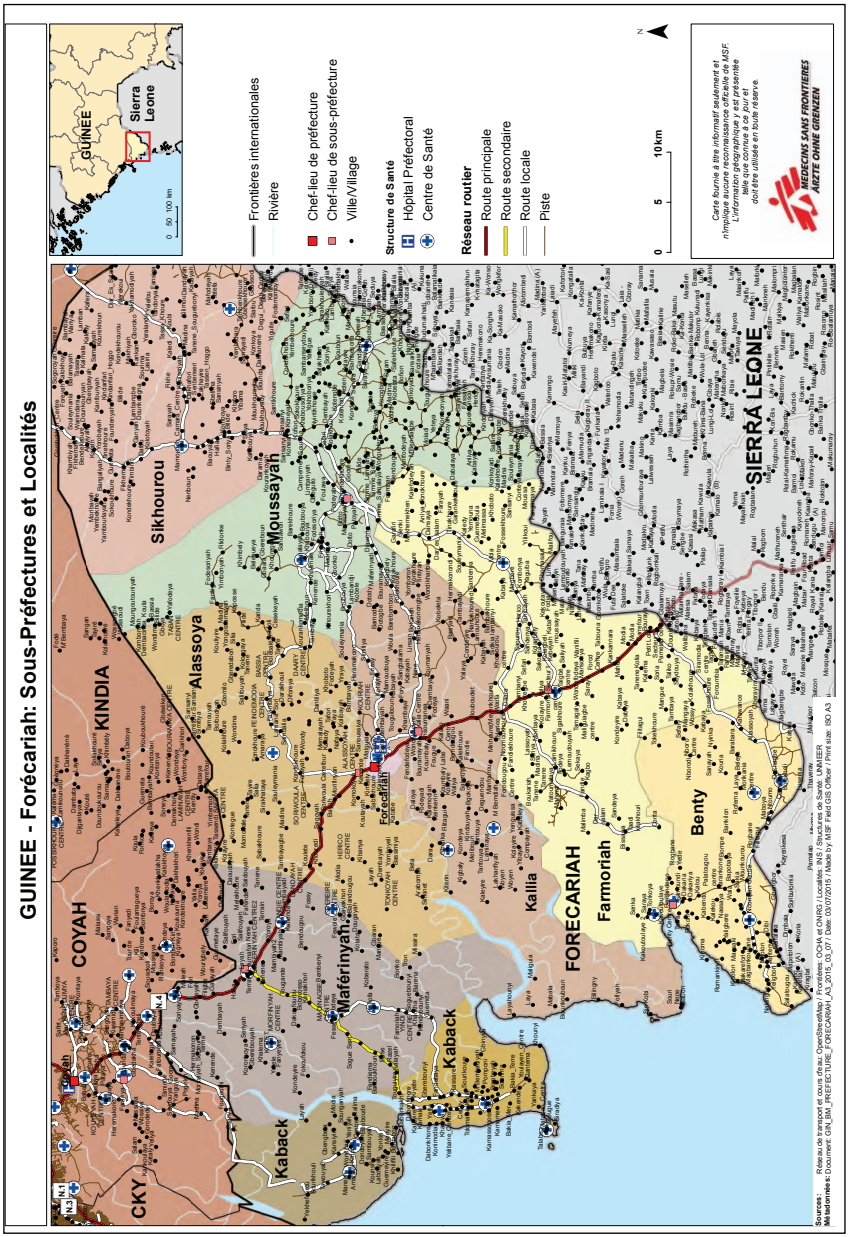


Figure 14: Base map of the Forécariah sub-prefecture in Guinea.

Figure 15: Map showing health promotion activities in Conakry, Guinea.

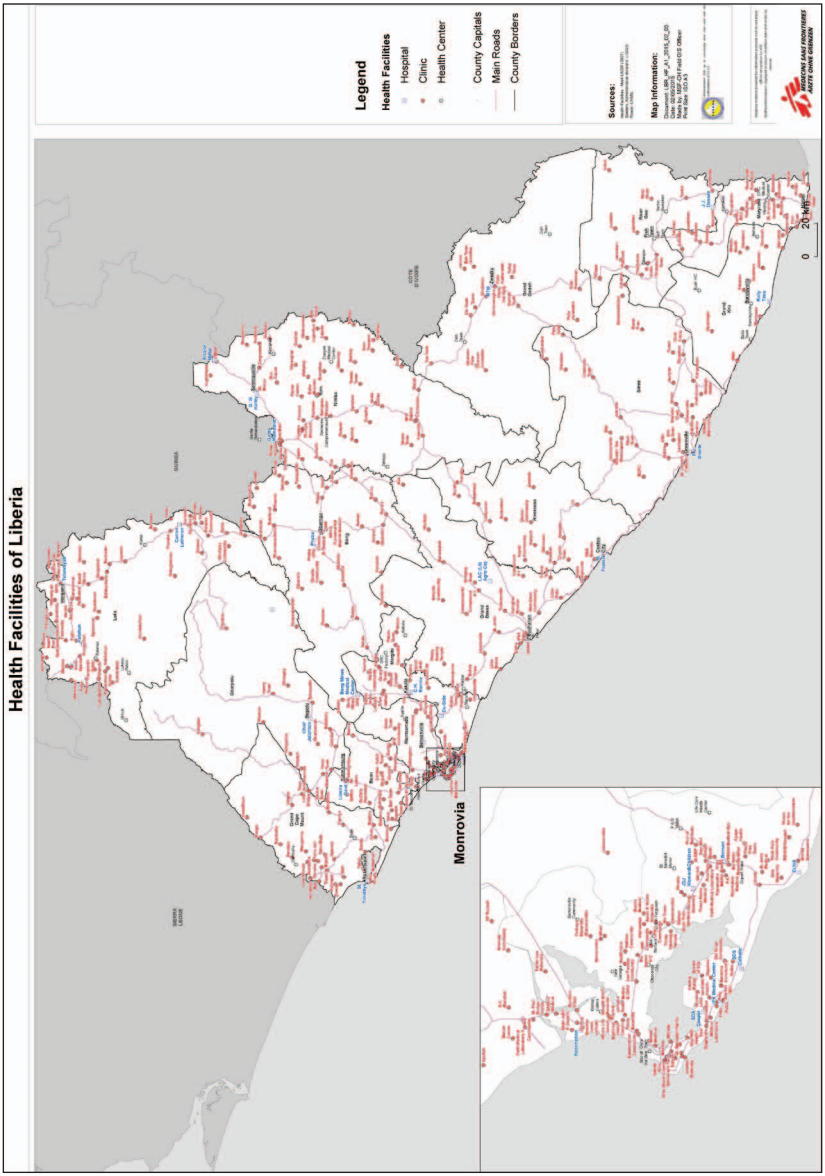


Figure 16: Map showing health facilities in Liberia.

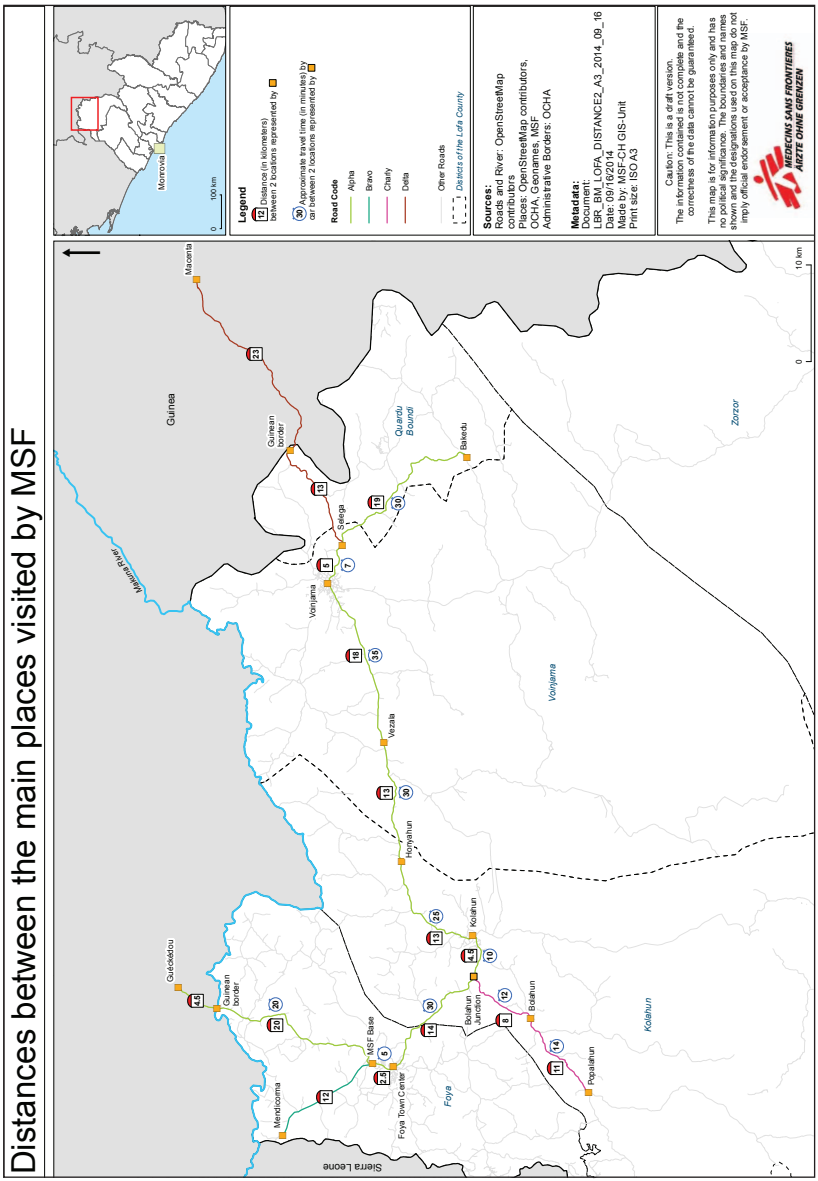


Figure 17: Map showing distances and approximate travel times in Lofa County, Liberia.

3. STRATEGIC OBJECTIVES

The decision to deploy dedicated GIS officers to the field was based on the GIS Strategy for MSF-CH, which defines four organization-wide strategic objectives.

- **Promote the use of maps and other GIS products in the organization**

  Prior to the Ebola response, most interviewees were unaware how a field-based GIS officer could effectively support them in the context of an evolving emergency response, in particular, during the outbreak of an epidemic. While all interviewees appreciated the importance of maps in general, most did not realize how quickly a field-based GIS officer could produce detailed, customized and topical maps that directly supported their work.

  MSF-CH should do more to educate staff about the range of GIS products and the type of support that the GIS unit and field-based GIS officers can provide. However, it was also clear that most respondents felt that seeing GIS in action in the field was what convinced them, and that a presentation at headquarters would have had far less impact.

  All field-based MSF staff emphasized that, in addition to his or her technical skills, it was also the GIS officer's personal communication skills and attitude that helped promote the use of GIS.

- **Consolidate existing GIS capacity in MSF**

  While the GIS unit is part of OCG, the GIS officers were deployed as an intersectional resource and worked closely with OCA, OCB, OCBA and OCP in the field, where relevant. In some cases, these sections also hosted the GIS officers. In addition, the Missing Maps Project, a joint project between MSF-UK, and the British and American Red Cross, contributed to the base maps through a mapathon, during which OSM volunteers traced satellite images.

- **Ensure good capacity to share information within MSF-CH and potentially across the organization**

  MSF-CH launched a password-protected online map centre in July 2014. However, interviewees based in the field were not taking advantage of this facility since they felt it was too time-consuming. Instead, interviewees preferred to receive maps by e-mail or on paper directly from the GIS officers.

On the other hand, staff at headquarters and other operational centres relied on the map centre as a central repository. Therefore, uploading maps to the map centre remains important to ensure the dissemination of maps across the organization.

- **Ensure participation and capacity building within the organization**

  All GIS officers had to proactively identify areas where they could add the most value. These were largely based on conversations with other MSF staff in the field, as well as their own experience. As staff became more familiar with GIS, they started to request specific products more often and became more involved in the design of GIS products.

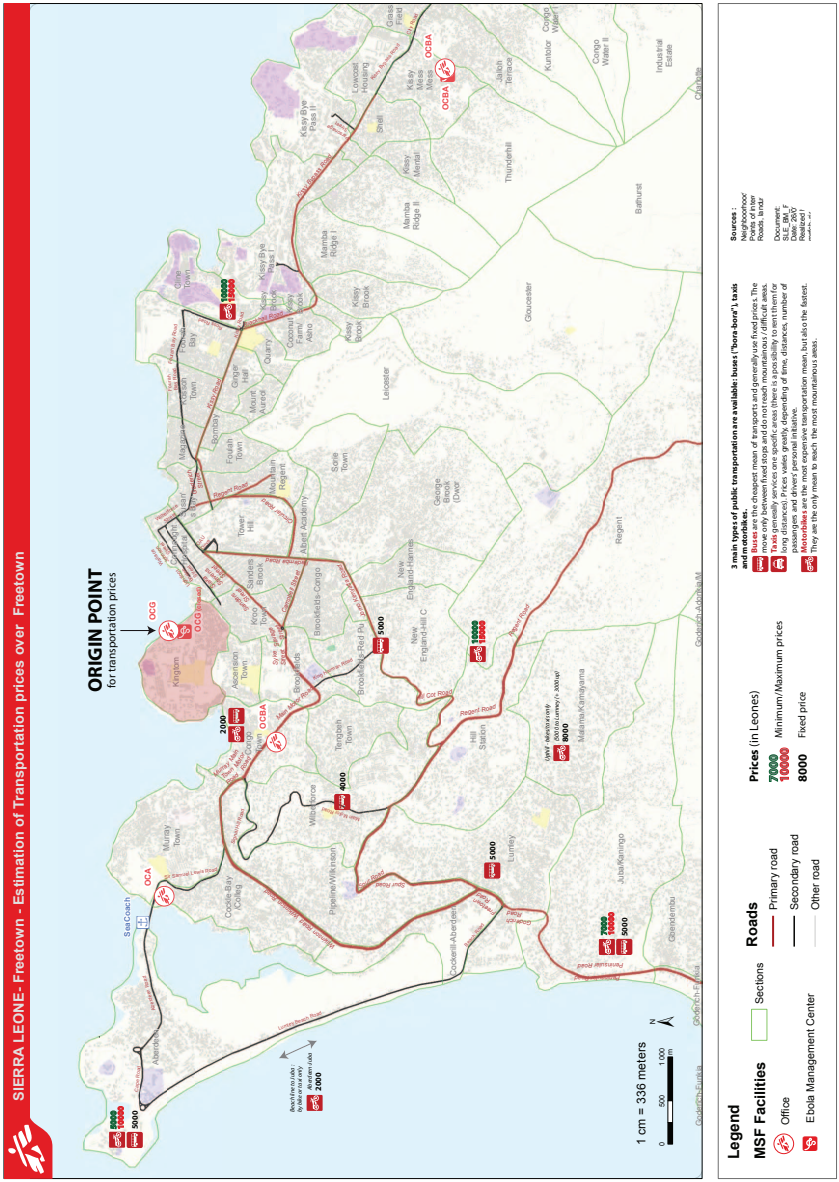


Figure 18: Estimation of transportation prices over Freetown. Such map helps finance and logisitic activities.

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4. CONCLUSION AND DISCUSSION

- All interviewees emphasized that the GIS officers were able to add significant value to the operation.
- Most programme staff stressed that having a GIS officer in the field was a significant time-saver, which enabled them to dedicate more time to their core competencies, and to improve or increase programme delivery.
- While GIS support can take place remotely, interviewees felt unanimously that having a GIS officer in the field, as part of the team, was essential to support concrete programme activities.
- The departments that benefited most from the GIS officers' presence were logistics, epidemiology and health promotion, as well as project and mission coordination.
- At the beginning of the response, the base maps and the localization of villages were universally regarded as the most useful outputs. As time progressed, epidemiological maps increased in importance.
- Beyond the general notion that maps are useful, there was very little awareness within MSF about what a GIS officer can do and how quickly new and topical maps can be produced. This lack of knowledge leads to the assumption that map production is complicated, and most staff would not have thought of requesting custom maps. Seeing the GIS officer in the field changed this perception. Collaboration between programme staff and GIS officers improved in all deployments as programme staff became more familiar with the work of the GIS officers.
- Some programme staff who have worked with GIS officers as part of the Ebola response have, in the meantime, started to request GIS capacity for other missions. This clearly shows that the value added by the GIS officers is appreciated.
- Considering that many MSF staff don't know how a GIS officer can support their work, it is essential for them to be self-starters, particularly during the first phase of an emergency where staff have little time to include someone else in their work. Until GIS is more widely known about within the organization, GIS field staff should be selected partly on their ability to make themselves useful, rather than expecting to be given tasks. This implies that mainly experienced GIS staff should be deployed during emergencies.
- The early involvement of GIS officers can help increase consistency and reduce the duplication of efforts, particularly during an epidemic.

Epidemiological tools, such as line list, can benefit significantly from the input of GIS officers as they can help define the data that should be collected.

- Good maps are valuable to all stakeholders in emergencies. By sharing high-quality maps, MSF teams were able to build relationships more quickly and more easily, and to generate goodwill with government officials and other humanitarian actors. In some cases, this also prompted other actors to be more open about their data. Similarly, capacity building and training, which the GIS officers provided to their national counterparts, were greatly appreciated and helped build relationships that facilitated the work of the GIS officers.


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5. RECOMMENDATIONS

General

- Headquarters should proactively deploy dedicated GIS staff to the field in contexts where direct contact with field operations adds significant value, such as where the close and timely monitoring of the spread of an epidemic is essential.
- Base maps of acceptable quality did not exist in the affected areas. Given the usefulness of having good base maps, MSF should identify current areas of operation where the organization expects to continue to work and try to produce base maps for these areas. The GIS unit, acting as a specialized front office, should seek support from initiatives such as the Missing Maps Project.
- Programme staff sometimes do not require the very high standard of maps that GIS officers produce. The GIS unit should explore whether Excel templates can be standardized so that programme staff can use them to produce their own geographic visualizations.
- MSF should continue to take advantage of crowdsourcing to create base maps. To facilitate this process, the GIS unit should continue to engage in a dialogue with the Humanitarian OpenStreetMap Team to better define expectations from both sides. Issues to be covered include the availability of GIS unit staff to answer questions and provide feedback, public communication and how to formally end the cooperation once the request has been fulfilled (deactivation).

Human resources

- People skills and a self-starter mentality are at least as important as the technical skills for the acceptance of GIS officers as part of the team. Until GIS is better understood by programme staff, GIS officers need to be advocates as much as service providers. Recruitment should take this into account.

Organizational

- Physical proximity increases information exchange, formal and informal communication, and teamwork. Where possible, GIS officers should share the space with the department that needs their services most. This can also mean that GIS officers rotate, depending on where they can add the most value during a given phase of the operation. This is independent of the question of line management.
- The GIS unit should increase awareness of its services during training

for field staff, either prior to deployment or when field staff come to headquarters for training and discussions.

Infrastructure

- MSF should explore further how Android phones can be used for mobile data collection, including the collection of GPS coordinates. The approach should consider two scenarios: one in which MSF provides smartphones, and the other where local staff already have smartphones.
- While internet access is not essential for all aspects of the GIS officer's work, many maps can only be produced with sufficient bandwidth. The lack of a good connection also means that remote support becomes difficult or even impossible. MSF should prioritize internet connectivity in locations where a GIS officer is being deployed.
- GIS officers should download all available map data before deploying since the internet connection may be too slow for large file transfers.
- Since GIS officers deploy with non-standard computers, they need to be equipped with recovery CDs that allow them to restore their systems, including specialized software and drivers.
- GIS officers should deploy with a dedicated A3 colour printer (as a minimum size) as well as ink cartridges. Before deploying, the GIS unit should evaluate whether A2 and A1 maps can be produced elsewhere in the country.

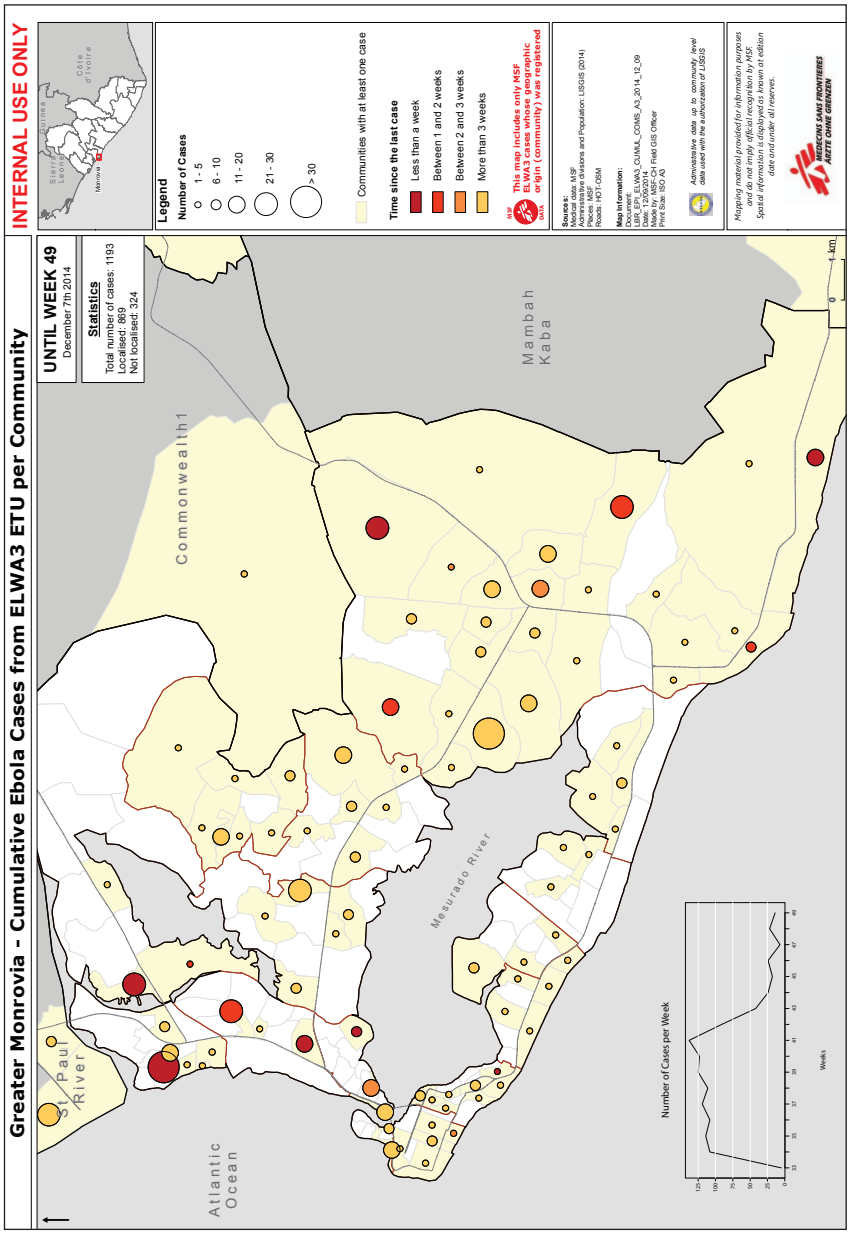

Figure 19: Epidemiological Map: Origins of cumulative Ebola cases registered in ELWA 3, Monrovia. This map will support MSF team to better understand the outbreak and plan their operations to focus and to prioritize zones of actions.

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ANNEX I
Mobilisation of local people and technology in mapping for the Sierra Leone Ebola epidemic response

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Grazia Caleo[1]
Laura Nic Lochlainn[2,3]
Georgios Theocharopoulos[2,3]
Stanley Bockarie[4]

Background

During the West Africa Ebola outbreak, the Ebola Management Centre (EMC) operated by MSF in Magburaka, Tonkilili district, Sierra Leone, required reliable geographical information to enable the tracing of contacts of Ebola cases. GPS-enabled smartphones, specifically, inexpensive devices running the open-source Android platform, have penetrated rural African markets. This implies a potential new opportunity to conduct sophisticated mapping and census data gathering using local volunteers and what is now effectively local technology. We describe a project to map and collect census data for the Tonkilili district using local workers with smartphones.

Project

A data collection team was recruited in Magburaka comprising 24 local workers, 12 of whom had motorbikes, and 12 others Android smartphones. After being provided with free, open-source survey software (OpenDataKit) to install on their phones and some basic training, they visited and recorded the GPS coordinates of villages. They interviewed each village leader or representative and recorded village name (and common variants), name/phone number of village leader and local health-care worker (HCW), population, number of households, and location of closest health facility. The methodology involved some advanced setup, including a local web-based aggregation platform. Users mastered the survey software in a few hours, and most were trained by their own recently-trained colleagues rather than by the external supervisor. Devices using Android, rather than Symbian or other operating systems, were used due to a reasonably high market penetration of Android and the availability of high-quality Android-compatible open-source software.

Outcomes/lessons learned

The speed of data collection was unprecedented: the team mapped 950 villages (the whole Tonkilili district, one of 13 in Sierra Leone) in 2 weeks. The data quality was reasonable; of those villages where data already existed, either from the 2010 census or prior OpenStreetMap contributions, less than 5% disagreed with the pre-existing names, suggesting that the data

1 Médecins Sans Frontières (MSF), Manson Unit, London, UK
2 European Programme for Intervention Epidemiology Training (EPIET), European Centre for Disease Prevention and Control (ECDC), Stockholm, Sweden
3 MSF, Amsterdam, Netherlands
4 MSF, Magburaka, Sierra Leone

collected were consistent. OpenStreetMap are using the validated data to update their maps. This comprehensive census exercise provided epidemiologists with the means of assigning Ebola cases to specific villages, determining at a sub-chiefdom level where the loci of transmission were occurring. The involvement of local community members using technology and devices they own and are familiar with allowed the implementation of a survey that would have required vastly greater resources using non-local devices.

Conclusions

A very modest investment can produce large-scale geographic and population data, using locally-appropriate technology in genuine partnership with local people.

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ANNEX II
List of interviewees

Name	Title	Interviewed for case study in	
		2014	2015
Annaud, Louise	Communications Officer, MSF-CH	X	
Audeoud, Jean-Guy	Field GIS Officer, GIS Unit	X	X
Bannick, Robert	GIS Expert, ACAPS		X
Beland, Pierre	Humanitarian OpenStreetMap Coordinator		X
Caleo, Grazia	Research Development Advisor, Manson Unit		X
Decroo, Tom	Program Officer, Luxembourg Operational Research Unit	X	
Greig, Jane	Epidemiologist, OCA/MSF-UK		X
De Laborderie, Sylvie	HQ and Field GIS Officer, GIS Unit	X	X
Lachat, Sarah	Communications Manager, MSF-CH	X	
Lugli, Mariano	Deputy Director of Operations, OCG	X	
MacWilliam, Nick	Field GIS Officer, GIS Unit		X
Martine, Leo	HQ GIS Officer, GIS Unit		X
Master, Pete	Missing Maps Project Coordinator, MSF-UK		X
Piguet, Pascal	Logistics Team Leader, OCG	X	
Pringle, John	Epidemiologist, OCBA		X
Sayah, Monia	Medical Team Leader/ Outreach, OCG		X
Soupart, Mathieu	Logistics Director, OCG	X	X
St Arnaud, Sarah	Field GIS Officer, GIS Unit		X
Sterk, Esther	Tropical Medicine Referent, OCG	X	
Tiffany, Amanda	Epidemiologist, Epicentre	X	X
Van Herp, Michel	Epidemiologist, OCB	X	
Vernier, Pierre	Field GIS Officer, GIS Unit		X
Watson-Stryker, Ella	Health Promoter, OCG		X