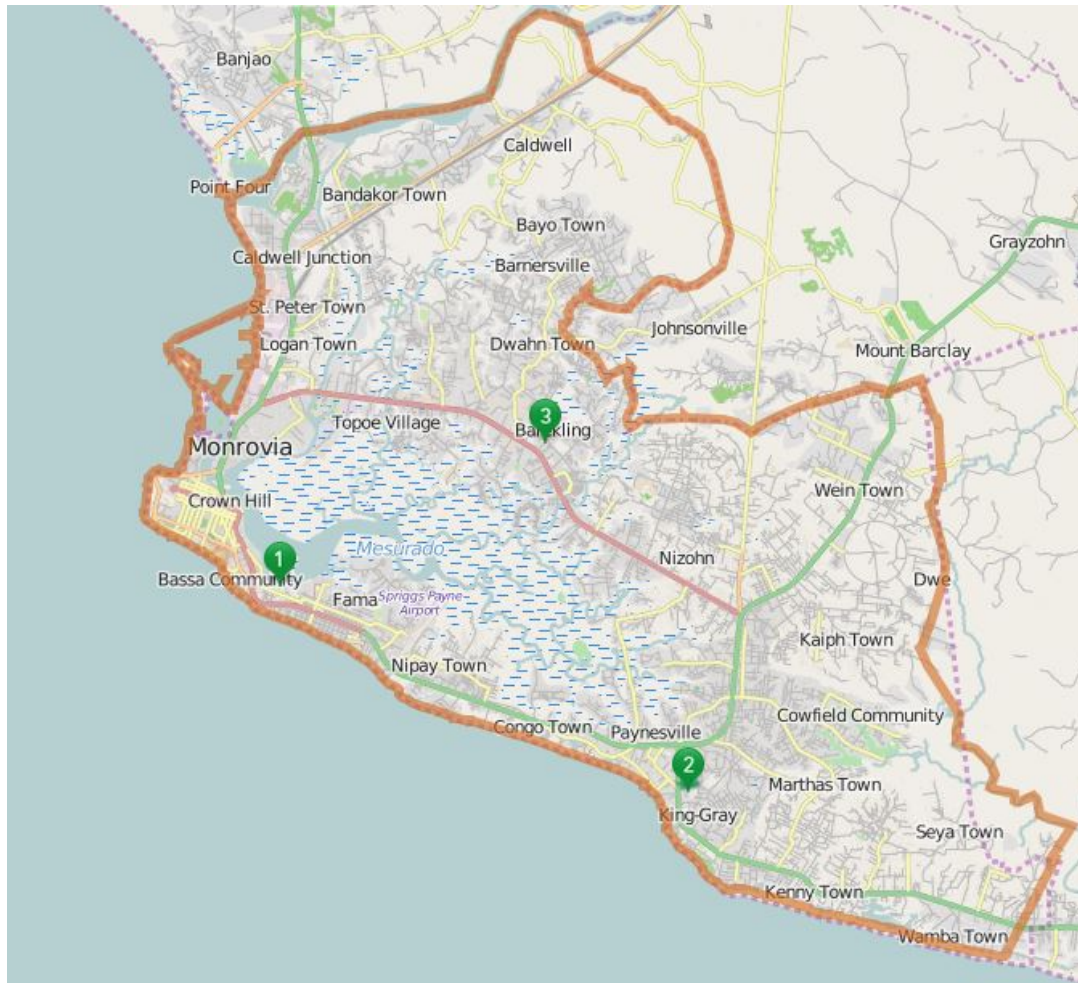

Locating an Ebola Treatment Center in Monrovia, Liberia



COURSERA: GEOSPATIAL INTELLIGENCE & THE GEOSPATIAL
REVOLUTION

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Introduction

This report will determine the best location to place an Ebola treatment center based on data available at this time. We will determine the accuracy of the data and using the method of disproving each hypothesis of a site being the best place, compare and assert which site is indeed the best suited.

Background

In a 26 September statement, the World Health Organization (WHO) said "The Ebola epidemic ravaging parts of West Africa is the most severe acute public health emergency seen in modern times." Where Guinea, Sierra Leone and Liberia being hit the hardest (presenting with 99.8% of known global cases) [1].

The WHO also reported on January 28th, 2015 that the response to the epidemic has shifted to a second phase; where the focus shifts from slowing transmission to ending the epidemic [2]. Since 13 January 2015, only two counties are dealing with new reported[3] incidents; Grand Cape Mount County and Montserrado County. The latter is where Monrovia is located, the former is a port county bordering Guinea's most heavily hit area (including the capital Conakry) to her north[4].

Though the tide of epidemic seems to be turning, all sources stress that getting it under control will still require a massive undertaking [2, 3]. Before the outbreak, Liberia only had 50 doctors[1], now with increasing infrastructure, the added treatment facility will help contain the outbreak, hopefully prevent new cases from spreading and caring for already infected individuals.

Analysis of Competing Hypotheses

We will evaluate the three hypotheses that each site is the ideal location for an Ebola treatment center. For now we will evaluate each center based on seven criteria, here we define these criteria and briefly explain how they will be assessed. ;

1. Is the clinic in an area known to have the Ebola disease present
We will look to both the trend of new cases, population density as it pertains to risk of contracting the disease and active cases.
2. Is the clinic in an area already being served by another clinic
If a clinic's area overlaps with another, there exists a risk of concentrating diseased individuals who are not being directly serviced. However this needs to be balanced with the possibility that an already-existing clinic could be over capacity and thus the resources could be very well spent, despite a clinic already being in place.
3. Is the clinic close to existing medical facilities
Though a specialized Ebola clinic is an asset, sometimes secondary and tertiary needs have to be addressed for patients. This could be elementary medical supplies such as beds or bandages, but also access to drugs and extra medical personnel.
4. Can the clinic serve a significant population
Similar to criteria 2, a clinic's location must be in tune with the local demand, but also cognizant of areas where demand could be higher.
5. Does the clinic have good access to transportation
Transport is necessary for two reasons, firstly supplies and personnel need to be able to access the clinic in a timely fashion. Second, sick individuals need to easily access the clinic as well. The shorter an infected individual needs to travel, the lower the risk of passing on the infection.

6. Will the clinic be located in a favorable physical environment.

This item is an amalgamation of criteria five's aspect of access, criteria seven's local security, and other necessary access (such as suitable burial sites for deceased patients).

7. Is the clinic a safe place for patients and staff.

Safety and security will be evaluated based on crime incidence and proximity to law enforcement centers. As well as any potential environmental aspects to consider, if any.

1 Site: Balli Island

The first proposed site for the clinic is Balli Island, a marshy island in the Mesurado river.



Figure 1: Photo facing east of the proposed site[5]

1.1 Disease Presence

From all available sources[1, 2, 6, 7] the Ebola disease is present in the area of site 1. JFK hospital is approximately 2 kilometers away to the east, and is a known Ebola treatment center. Also, the Monrovia Medical Unit (a treatment center exclusively for infected medical personnel) has been known to attract ill people seeking treatment[8]. Location here could alleviate some of this pressure, though it is hard to quantify how much of this pressure there will be left with the disease currently on the decline by the time this clinic is set up. People from outlying areas travel to JFK first to find care[9].

1.2 Proximate Ebola Clinics

Two Ebola clinics are located nearby, the JFK Memorial Medical Center is approximately a kilometer to the east southeast. This hospital is the premiere medical facility in the country and houses 75 beds for Ebola patients [1, 10]. The second nearby clinic is the aforementioned MMU, exclusively available to aide workers that have contracted the disease [11].

1.3 Proximate Medical Facilities

With the exception of the aforementioned medical centers catering to Ebola, there are two other nearby medical centers. The SDA Cooper hospital is located less than a kilometer to the east, however it has a history of closing for quarantine after suspected Ebola cases among its staff[12], these quarantines last around three weeks.

1.4 Population

Census numbers are hard to come by, but using an estimate from NASA's Socioeconomic Data and Applications Center (SEDAC)[13], we can see that Monrovia is a largely populated area, well over 1000 people per km^2 . To further complicate a population density analysis, we know that the outbreak has displaced people[2], making an accurate assessment impossible.

1.5 Transportation Access

Located approximately 100 meters off the Russell Avenue, the last 100m lack any meaningful road. Satellite imagery shows a township/slum in between the road and the proposed site's entrance. A number of ports are nearby for marine supply points, however they are only suitable for small craft [14].

1.6 Physical Environment

Palm Grove cemetery is located nearby, making for a likely suitable place to properly dispose of deceased patients without increasing the risk of transmission. However, safety concerns exist[14] about access to this cemetery, where former-combatants possibly loiter. Furthermore, the site is located in a marshy area that is almost certain to suffer partial to complete flooding during the rainy period (April-July) [15, 16]. The roads are probably difficult to traverse, with many potholes and poorly lit at night[14].

1.7 Security

This location is deemed relatively secure. This is based on the proximity to the Executive Palace, Temple of Justice, National Police Headquarters (1 kilometer to the west), Barclay (military) Training Center (2 kilometers west) and the single point of entrance makes checking who enters and leaves the area relatively easy. However, despite these instances in relative proximity, the streets outside the area as well as the Palm Grove cemetery are known to be unsafe areas[14]. UNMIL's presence (a United Nations led military and police force to ensure peace and stability in the region after the recent violence) has served to depress the crime-rate in areas, but as their build-down progresses, most sources agree the safety in the region will decrease[17, 18, 19, 14].

2 Site: SKD Stadium

The second proposed site is the Samuel Kanyon Doe sports complex. Home of the Liberian national soccer team. Recently renovated, it has room for 35000 spectators.



Figure 2: The main entrance to the SKD stadium.

2.1 Disease Presence

The disease is very likely present in the area surrounding the stadium [2, 1, 7]. However, likely only in a small amount since the MSF treatment center nearby (see below) only has 2 patients as of February 12th[9].

2.2 Proximate Ebola Clinics

The stadium is located approximately a kilometer north of the Doctors Without Borders ELWA (Eternal Love Winning Africa)-3 center, an Ebola clinic with 30 beds but only taking care of 2 patients[9]. It has recently begun downsizing its capacity in favor of a survivor's clinic, offering psychosocial support, health screening and primary healthcare to Ebola survivors. This strongly indicates a decreasing need for an Ebola treatment center in the region. ELWA-2 is just down the road, a mere 300m, focussed also on Ebola patients.

2.3 Proximate Medical Facilities

Along with the above mentioned ELWA-3 center and ELWA-2, the main ELWA hospital is located on the same area. Their services are likely more than capable of handling the areas medical needs.

2.4 Population

Situated in a relatively densely populated area, with residences all around[13], there is likely a significant populace to serve in a healthcare capacity, but likely not specifically related to Ebola.

2.5 Transportation Access

Viewing satellite images(ARCGIS and Google Maps), we can see the roads surrounding the stadium to be in relatively good condition. We also note a small airport to the north, however it is uncertain as to the state of its runway, capacity or availability. A small harbor is also located 2 kilometers to the south, passed the ELWA centers, however based on the satellite images, it is likely only suited to small fishing craft and thus of limited potential use.

2.6 Physical Environment

The stadium's physical location is likely ideal. The recent renovation[20] added roofs to the main section of the bleachers, which could provide some security from the elements for people or supplies. Since the stadium is built to handle large crowds, it could be used to handle large amounts of people needing aide in a confined environment.

2.7 Security

The area is easily sequestered and according to some sources, upon occupation guarded by private guards[14]. This suggests the area is quite easily secured, however due to its size would require a large force to do so effectively. A possible deal with some local UNMIL or trustworthy security forces would be a necessity. The stadium lights could help with the local stigma/reputation that dark areas are more crime-prone.

3 Site: Liberia Refining Company

The third site is located adjacent to the Liberia Refining Company (LRC).

3.1 Disease Presence

Similar to the previous areas, the area has infected individuals[2, 9]. The lack of public and proper sanitation in the area makes the likelihood of increased infection and prevalence of other diseases high.

3.2 Proximate Ebola Clinics

There are no proximate Ebola clinics.

3.3 Proximate Medical Facilities

There are a few medical facilities nearby, almost exclusively small outreach clinics, some (if not all) of which likely closed or temporarily quarantined [14, 9, 12].

3.4 Population

There is a significant population in the area that could be served by a nearby Ebola treatment center [13]. The location of the clinic near a main entryway to the city of Monrovia would allow it to also serve as a rapid response group near the outskirts of the city and also serve possible incoming patients from outlying areas.

3.5 Transportation Access

The area has moderate road access, with a paved road incoming from the north west and another road to the south off the main thoroughfare towards the refinery. There exists no available information outside commercial satellite imagery to determine the feasibility an easy of access via this southern route. This ease is also dependent on old satellite maps.

3.6 Physical Environment

From the limited available resources there seems to be an abundance of open ground to build a treatment facility, but security and access remain a concern. The poor infrastructure nearby in terms of water and sanitation[9, 12, 21] could increase the risk of secondary infection sources of not only Ebola, but also Malaria and other diseases prevalent in the area.

3.7 Security

The security of this site is closely related to the security of the refinery it would lie adjacent to. This needs to be estimated based on tertiary data such as consistent oil output and up to date satellite data. At present it is unreliable at best. The few available images also indicate no lighting in the area, so night time security will likely be an additional concern.

Hypothesis Matrix Results

	Site 1 is the best location	Site 2 is the best location	Site 3 is the best location	notes:
Condition 1	moderate	low	moderate-high	The estimates are based on the areas' (potential for) new infection and current patient load
Condition 2	moderate	low	high	here we define high as favorable in terms of our hypothesis, ie high means not being served by another clinic.
Condition 3	moderate	high	high	All areas have some medical clinics nearby, their availability is unknown, leading to low confidence in these results.
Condition 4	low*	moderate	high	We state site 1 has a low possibility since it is located in the business district, and relatively low residential areas nearby, however it is noted that it is closest to one of the highest risk areas in Monrovia: West Point [21]
Condition 5	low-moderate	high	low	though site 1 has no direct access, with some minor construction, access could be greatly increased
Condition 6	low	low	high	Here we deal with site 1's flooding problem and small serviceable population, site 2's excellent infrastructure but low need and site 3's high need, but local issues such as access and security.
Condition 7	high	moderate-high	low-moderate	Site 1 and 2 have decent to good security situation (if site 2 can arrange a large site's security), site 3's security remains dubious due to incomplete and unavailable information.

Conclusion and Evaluation

From above we can see that though site 2 is an ideal location, it would do the least good to the local populace. Site 1 and 3 have different advantages and challenges. It is the author's recommendation that if site 3 is deemed unsafe, another analysis is done with other possible locations. From the data gleaned here, a location in or near West Point, New Georgia or Bayo Town would be worth looking into. Another possible area to look into would be the province of

Lofa, it being the only province in the country that (as of the latest available public information on February 14th) is still dealing with newly infected cases. Within the parameters of this assignment, site 3 would be the best location (with the caveat of accessibility and safety being evaluated with proper data), otherwise/followed by an outreach center at site 1 to help the poorer areas situated to the north. Site 2 would be least suitable area due to an excess of available treatment options.

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