

**CDC Ebola Response Oral History Project**

The Reminiscences of

R. Ryan Lash

David J. Sencer CDC Museum

Centers for Disease Control and Prevention

2018

R. Ryan Lash

Interviewed by Samuel Robson  
August 8<sup>th</sup>, 2018  
Atlanta, Georgia  
Interview 1 of 1

CDC Ebola Response Oral History Project

Q: This is Sam Robson here with Dr. Ryan Lash. It is August 29<sup>th</sup>, 2018. We're sitting here in the audio recording studio at CDC's [United States Centers for Disease Control and Prevention] Roybal Campus in Atlanta, Georgia, and I get to interview Dr. Lash today about his part in CDC's response to the Ebola outbreak that happened in West Africa, 2014-2016. Thank you so much, Dr. Lash, for joining me for this. It's a privilege to have you here.

Lash: Thank you, Sam. It's an honor to be asked to share my story.

Q: Of course. To start off, would you mind saying the phrase, "my name is," and then stating your full name?

Lash: My name is Robert Ryan Lash. My mother's been complicating my life since birth with that decision. I've always been known as Ryan Lash.

Q: Can you tell me what your current position is with CDC?

Lash: My current position is in the Division of Global Migration and Quarantine, the Travelers' Health Branch, and I am on the Disease Classification and Recommendation Team.

Q: We will get into that a little bit more a little bit later. That's super interesting. [laughs]  
If you were to summarize to someone in a few sentences what your part was in responding to that Ebola epidemic, what would you say?

Lash: I would say that I was asked to deploy to Sierra Leone, to Freetown, in the fall of 2014 as the outbreak was continuing to expand and get worse, specifically to provide mapping and GIS support. I had a close friend who had deployed prior to my deployment, and he had specifically name-requested [me], that he thought my skill set was unique and desirable and that I could help contribute to the response.

Q: Thank you. We're going to back up, and if it's okay, maybe we do twenty or thirty minutes of life review and learn what put you in the position that you could come out and help with CDC's response. And feel free to—what's the word I'm looking for? Extrapolate?

Lash: Expound?

Q: Expound, that's better. One of these E-X words.

Lash: What part would you like me to—

Q: So! The very beginning. What's your birthday?

Lash: My birthday is December 2<sup>nd</sup>, 1981. I was born in Birmingham, Alabama, though I don't identify much with the southeastern United States heritage. My family moved a few months after I was born in Birmingham to Kansas City, to the suburbs of Kansas City, and so I grew up and went to school there. I come from a family of four kids, and my father is a doctor and my mom is a nurse. I certainly didn't imagine that I would have the opportunity for a career in public health and be working at CDC as I am now, but reflecting on being in a medical household, we learned all the proper anatomical terms from an early age, etcetera. Public schools all through early childhood, and then ended up at the University of Kansas, where I eventually settled on a geography degree, which I found that it really suited my personality and things that I'd been interested in my whole life as far as maps and landscapes and thinking about where things are located, how place impacts the types of resources and decisions that people make. I really identified, since learning about that academic subject, as a geographer.

Q: Can you trace that interest back a little bit? Because that sounds fascinating and not something that every kid grows up with.

Lash: Yeah, I agree. I certainly never grew up having any awareness that you could have a career as a geographer and that that would be a profession, or even that there was an

area of subject. I remember a geography bee in elementary school, I think I did pretty good at that. We talk about in geography—geographers suggest that people might have innate geographical tendencies if you prefer the window seat on an airplane, for example. If you like staring out the window and looking at what's there and thinking about what's there. My grandparents were farmers in Kansas, and I often think about the time spent observing the environment and thinking about relationships of weather and climate and where a particular species are. And as my career has grown, how that impacts the types of access to resources and health inequities or inequalities that people now face. I think a lot of that ties to geography. Eventually, in my undergraduate studies, I was exposed to the story of John Snow and his very famous cholera map, and so that got me obviously more excited. Also, interestingly enough, cycling was something that I took up, bicycling in college. The experience of riding a bike made me aware of geography in new and really interesting ways that I hadn't ever thought of. You become very aware of which direction the wind is coming from, what the easiest ways to get on certain roads are, traffic patterns so you're avoiding busy streets, where the big hills are when you're tired so that you can take the easiest path home. Also in Kansas, there's really interesting aspects of the way that the land is divided and how you can mark and measure distances. For example, the township and range system that the western United States is laid out on is based on square miles, so it's easy to estimate how far you've gone or how long it's going to take to get back home simply by knowing that the next gravel road is going to be another mile past, etcetera. So all of those things were things I learned a greater appreciation of during my undergraduate studies in geography. I actually was encouraged to take a geography class by friends of mine who were cyclists as well. I do feel like geography taps into

some of my innate qualities and interests, and so I feel fortunate to be able to continue to pursue that. Although in my experiences here at CDC, I find a lot of people aren't familiar with geography. They don't realize that it's an academic discipline, that there are courses, there's even a small subfield known as medical geography that I've studied briefly. It just doesn't have the recognition within the American public health system that I have sought and now seek with a career in public health.

Q: Were there some classes that really called you, that really impacted you when you look back?

Lash: Yeah. Geography departments often incorporate lots of other academic disciplines, so within the geography department at the University of Kansas, we had people who had interest in soils and geomorphology, so they're kind of geologists. In other academic settings, they could be in a different department. Similarly, I was supervised by an African human geographer. There are separate African studies programs and he was affiliated faculty there, so we're talking about the geography of Africa, whether there's anything unique about a continent like that. Questions that historians have also asked, and economists have been interested, obviously, in many of the countries there for socioeconomic development and things like that. There's great diversity I've found in geography. You really can take a geographic lens and apply it to lots of different disciplines. And one of the primary ways they do that is thinking about organizing information and facts spatially, on a map. Occasionally, geographers will use the pitch that spatial is special, and by that they mean basically when you start to think about

organization information geographically, you oftentimes may be surprised by the highs and lows of the information you're finding, but you also want to pay attention to the gaps: where is it that we don't have information, what is it we're not seeing, how come we don't know about what's between here and there, etcetera. Those types of questions still obviously apply to a lot of public health work, and that's what I hope to continue with my career in doing.

I was exposed to a lot of that early on in undergraduate geography. Nowadays with computer technology, the ability to make maps on computers and collect and store information geographically has greatly been revolutionized. As an undergraduate, we didn't have Google Earth. That didn't exist before then. Smartphones didn't exist, and so GPS [Global Positioning System] has become more ubiquitous and has also introduced lots of new opportunities for geography. That area of geography is called geographic information science, or GI science. Before that, it was also known as GIS, geographic information systems. Those are the terminologies I frequently use now to describe my skill set.

I've been interested in how to make a really good map, a map that tells a story, a map that displays information and communicates information in an authoritative and objective way. There's studies on the history of maps and discussions about maps being misleading at times, either purposefully or naively, simply because people didn't appreciate the way the information was being perceived on maps. There's a famous title called *How to Lie*

*With Maps* that often attracts a lot of attention. So, I am excited. I see it as a powerful and meaningful tool and hope to continue to advance its use in public health.

With my master's studies, I kind of continued in that vein. I describe my undergraduate years as focusing on geography techniques, on this cartography, on GIS. Also, remote sensing. That's the use of satellites and aerial photography for capturing geographic information. During my master's studies, I found a biology professor named Dr. Town [A. Townsend] Peterson, who was very influential. He hired me at the start of my graduate studies because in biology, they were starting to use these GIS skills as a way to map species distributions. If you think about where lions are, is an example Town often uses. Lions currently exist in Africa, but you can describe in geographic terms what lions need to survive and why lions only live in Africa at the moment. But if you think about the spread of diseases or the spread of species, there's a lot of analogies that can be made because oftentimes, lions live in Africa because they can't swim across an ocean and get to the Great Plains of the United States. But if they were ever introduced in the Great Plains of the United States, it's possible that lions could live in Kansas if they could get through the harsh winters. Maybe tigers. Pick your large carnivores. And I think actually we used to have mountain lions in Kansas. I think they might be returning a bit. But so Town was interested in using these new technologies of GIS to basically map and model where species are and where they might be, or where they might be if climate conditions were different or if they were introduced. Back to the lion example, we could look and find that the environmental conditions for where lions currently live in Africa can actually be found in certain parts of the United States, and so the argument is that lions

could live in the United States except they just haven't been introduced yet. Again, the modern example of this in terms of public health, I got the experience while working with Town to learn about these other examples. Monkeypox is one that happened recently while I was in school. Monkeypox is a disease, a poxvirus disease, studied here at CDC, and it is endemic to central and western Africa. In 2003, it appeared in the United States surprisingly and appeared in prairie dogs. Pet prairie dogs had become infected with monkeypox and were biting people occasionally, because they're not necessarily great pets. Occasionally, if these infected prairie dogs bit somebody, they were able to get monkeypox as well. I don't believe there were any fatalities from monkeypox, although it can be a fatal disease. The work that CDC did along with state and local public health agencies eventually identified that monkeypox arrived in the United States because exotic African rodents were infected with monkeypox and they had been imported into the United States as part of the animal pet trade, and those rodents came into contact with the prairie dogs and that's how monkeypox arrived in the United States. Some of those exotic animal species have been released into the wild in the US, and so you can still find in a few remote parts of Florida where those exotic African rodents are now able to live and persist. It doesn't appear that they have monkeypox. It seems like that outbreak is under control. But nonetheless that, as a graduate student, was a really exciting story to learn about and to think about these ecological theories and how they can be applied.

During my master's studies with Town, I was obviously learning these skill sets, and he had ongoing collaborations with CDC collaborators in the poxvirus program at the time. I was fortunate to meet those folks and inquire about opportunities to apply my GIS skills

to study poxviruses, and was fortunate after I finished my master's thesis to come to Atlanta and begin working on the poxvirus team, and that was in the fall of 2007. I did that work for two years before realizing that a PhD would be a valuable credential to have for the types of CDC jobs and positions I hoped to have in the future, so I decided to seek out a PhD program in geography, settle on the University of Georgia close by, conveniently, and started my PhD in the fall of 2009.

Q: Can you tell me about those first two years in a little bit more detail, here at CDC for poxvirus?

Lash: Yes. I was invited to come and work on the poxvirus ecology team. There was a mammologist named Dr. Darin [S.] Carroll [note: director of CDC's Occupational Health and Safety Office] who is still here at CDC, and Darin was one of the primary points of contacts that I had met, and he was familiar with these GIS applications that Town Peterson was doing. They had published some articles already, using that to look at filovirus. In fact, Ebola and Marburg, my very first scientific publication, was about the use of GIS models, ecological niche models to modeling where Ebola was likely to occur. We used those maps to try to make inferences about what types of animal species were the reservoirs for Ebola and Marburg, which is an important personal anecdote because to have my first scientific publications be about Ebola and Marburg obviously led to a lot of excitement and enthusiasm when the opportunity to deploy for the West African outbreak came up.

But going back to the poxvirus group, we basically were using these methods to try to identify, from where human cases of monkeypox had occurred in Africa, to extrapolate from those limited surveillance data to other locations where monkeypox might be occurring. So we could think of new surveillance studies, new efforts at trying to identify—like Ebola and Marburg, the animal reservoir for monkeypox was not well known what species it was. At the time, there wasn't strong evidence about where monkeypox existed within the animal communities, and obviously that's really important information to know when you are wanting to try to prevent human disease. So that was the work that we were doing on the disease ecology team. Actually, one of the things that was exciting and influential about my career from that work was that the monkeypox virus was discovered as smallpox was being eradicated, and so when I arrived and we were trying to make these more detailed maps, I was given access to the case records of the monkeypox cases. As I was looking at those case records, I was learning this history of monkeypox investigations and realizing that it was actually tied to smallpox eradication very closely. The reason that is, is because in the Democratic Republic of Congo, they believed that they had eradicated smallpox, and yet an outbreak occurred of a new poxvirus and it looked identical to smallpox. Monkeypox was first believed to—in humans, they thought it was maybe smallpox, and so they came back and CDC researchers helped, were heavily involved in those investigations, and through that research, eventually identified that it was not smallpox but instead a related poxvirus that was infecting people there. These monkeypox case investigation forms that I was able to look at here at CDC were on the old smallpox eradication documents. My work then was a process of transcribing the locations information that obviously was captured before

GPS existed, and so in these remote African locations, they were doing contact tracing and case investigation, just like we ended up doing in the Ebola outbreak, to investigate monkeypox. These forms would record the names of individuals, they would try to capture the geographic information asking people where they lived. They would try to record that in as much detail as possible. And what I was doing when I arrived in 2007 was going back and looking at those old records, trying to interpret those place names and find them on maps. As precisely as possible, to record those locations in our GIS system using latitude and longitude coordinates so that that information could be used to build these predictive models that we were studying and hoping to refine.

Q: Can you tell me about some of the challenges that you found in that work in translating the info from a case investigation form to where exactly is this, what is the place name, that kind of thing.

Lash: It's a relatively straightforward process, but as a geographer, I think I brought some unique skills to that process. While I was a master's student, I got interested in the history of maps and public health maps, specifically malaria maps. I spent time in map libraries. They're not libraries that most people are familiar with or have spent much time in, but just like regular libraries, map libraries are collecting and archiving historical maps. When I got here to Atlanta and was posed with this question of trying to find a particular village name in Africa, and at the time in 2007 I would use Google Earth and use Google Maps, and these computers were failing. The best available databases that I had access to at the time couldn't help me find where that village was. I decided to go seek out a map

library to see if maybe there were historical maps that could help with that process. My experience in doing that was informed by actually, again, work we'd done with filoviruses where there was a historic Marburg case that was investigated in Zimbabwe. The meetings we had with our CDC colleagues doing work on the filoviruses, we found that the cases were in travelers and the travelers had traveled around an abroad tour of different locations. The epidemiologists had focused their investigation of this Marburg case on locations where the travelers said they'd been bit by spiders. They thought, I got a nasty spider bite, and look, it swelled and it got infected and then I eventually got sick with these other symptoms, so it had to have been that spider that bit me. That was the theory of the day, and they went back and collected all sorts of spiders, etcetera. In the 2000s we're looking at this and going, we really don't know of any evidence to date that Ebola and Marburg are spread by spiders. But we also noticed that anecdotally, these travelers had reported visiting caves. There wasn't much written in the epidemiologic reports at the time, other than to say when we asked the travelers where they went and they listed off their itinerary, they mentioned visiting a location called Sinoia Caves. In the 2000s, as we're looking at this and trying to think, where else might these people have encountered what we thought were the potential reservoirs, thinking about bats or rodents, we focused on these Sinoia Caves that showed up on the map about the case reports, but nobody had really made that connection. We were able with our modeling to build a model of where other Marburg outbreaks were and what were the ecological conditions for Marburg, and now we know that bats are very important reservoirs. Our model was able to help identify other cave locations, and sure enough, one of those cave locations coincided with the Sinoia Caves. From that, we were able to suggest that maybe

these initial cases of Marburg were instead tied to being exposed in caves where they might have been exposed to bats, and that might've been where they acquired the infection, instead of the suggestion of spiders or other arthropods and insects.

That work I'd done during my master's studies, so when I came to CDC and I'm again trying to look for these foreign African village names—oh, what I left out was when we were looking to try to locate Sinoia Caves at the University of Kansas, I went to our map library there and found historical maps of Sinoia Caves, so we were able to find them in detail. They existed in historical maps, but in our process of digitizing maps of the world, as our technology is now enabling us to do in the last fifteen to twenty years, that historical information hadn't been captured yet on those digital archives, and so that's why Google Earth wasn't able to answer my question at the time, and also why with poxviruses, again, African village names, Google Earth wasn't giving me the correct location. Or occasionally, it's a common problem in this process of taking a place name and trying to find its location on the map, there might be more than one location with that same place name. In the United States, the example I always use is Springfield. You think of how many different states have a city named Springfield in them. When you are thinking about how to record geographic information on a piece of paper and writing it out as place names, oftentimes, you need a hierarchy of place names, and so this is what public health practitioners have known and they have done for a long time. But in the poxvirus research, I wanted to try to confirm that the village name I was looking for and its location that I was identifying was consistent not only in spelling with the village name, but also I would often have a district name. I'd want to make certain that that was

the right village within the right district so that I could be more confident and more precise in my work.

During the poxvirus work and trying to make these more detailed maps of historic poxvirus cases, I went to the University of Georgia's map library and scanned all of the historical maps for Democratic Republic of Congo that I could find. Those ended up being incredibly valuable in this process of—I describe it as transforming. I couldn't improve the accuracy of the written records that had been maintained during the case investigations. Those people did their job really well. But the problem we were faced with today is that we wanted to be able, in a computerized mapping format, to be able to look at those locations. Obviously, with place names alone, I wasn't able to identify the latitude and longitude, the specific coordinates on a map of where those villages were. That's why we had to do this exhaustive historical process of combing through old maps and the old records and trying to match them up, and that was work we could only do because we were here at CDC and had access to the historical records and the original case forms. We had microfilm records of that, it was awesome.

Q: That makes sense for why being here at CDC gave you access. I'm amazed you were able to find such relevant maps just in the middle of Kansas and Georgia.

Lash: The explanation for that is that the United States military had been actively trying to map the world long before Google Earth had tried to do that. The United States isn't the only superpower that did that. The Soviet Union also was heavily involved. At the

time, for military purposes, they had been making detailed maps of nearly every place in the world. From the defense and military perspective, one of the things that was concerning to them was that once those maps were printed, if they stored them all in one map library in the United States, that one map library would be very vulnerable, and that type of logic actually, a sad anecdote about that was that on September 11<sup>th</sup> when the World Trade Center fell down, the World Trade Centers had housed the City of New York's GIS resources. A contemporary example of, if you have important geographic information and you store it in only one physical geographic location, it could be very vulnerable. This problem had been thought about and considered nationally by the defense and intelligence communities, so they created a program where they were printing duplicate copies of maps and distributing them, and they were distributing them out to university map libraries. A number of universities across the country have very robust and very valuable map collections, and so the Defense Department, as they produced these maps, would send duplicates out to those different locations as a way of preparing ourselves and strengthening our defenses so that if geographic maps were ever needed, they could be accessed and maintained in safe keeping. So the University of Kansas happened to have copies of some of those maps. But one of the things to prevent the complete set of those maps from falling into the wrong hands or being used for nefarious purposes, the Defense Department I believe had kind of randomized which maps they sent in different locations. To my knowledge, the way that program was historically managed, there wasn't one complete set. Since then, those maps are now declassified and are available for the public and scholars to research, and that's what I was doing. I was working from these declassified paper maps of Africa, both from the

University of Kansas map library and the University of Georgia map library, to do this historical poxvirus research.

Q: Thank you for that explanation, that was thorough! That is really neat. I had no idea the Defense Department was doing stuff like that.

Lash: Yeah, happy to share. Those are the sorts of interesting geographic factoids that I've acquired over the years, and happy to think that they may be useful to others moving on.

Q: So two years in poxvirus until 2009. What did you do then?

Lash: I was accepted into the PhD program at the University of Georgia, and I started that PhD with the intent that I wanted to learn more about GIS technologies. As I mentioned before, when I was an undergrad [undergraduate student], Google Earth didn't exist or it had just come out. We had like one computer with Google Earth installed, and I remember it was in a hallway, and I would stand there in the hallway and zoom in on my house in Kansas and explore other areas, etcetera. By 2009, that technology had continued to evolve and become more ubiquitous, etcetera, and I hadn't learned enough during my undergraduate and masters to be able to apply that technology to the public health applications that I was observing and opportunities I was observing in the two years I'd spent here at CDC. So I went back to UGA [University of Georgia] and said I want to learn more about these technologies, I think it's really valuable to my public

health work. I focused in on that. I took some classes in other areas that I didn't have previous experience, classes in ecology, took a class in the veterinary school on how to trap animals, how to trap raccoons and anesthetize them and whatnot. I was really excited about the prospects of a career at CDC using GIS. There is, and was before I arrived, already an active community of people using GIS and mapping technology in public health work, but those skills and that technology to this day remains unevenly distributed throughout the agency. There are some groups who've—either because there's really good surveillance data, very detailed, that was collected maybe with GPS devices—those groups may have started using GIS early on, and for years have been investing in that as an important public health tool and as public health infrastructure. Other groups though haven't yet for various reasons.

Q: What would some of those be?

Lash: Some of the earliest examples for infectious diseases of GIS use that I was familiar with from my research were in malaria. In Kenya, the CDC offices in Kenya have been experimenting with using GPS to collect the household locations of malaria cases for where they were trying to deliver mosquito-proof bed nets and things like that. Also in environmental health here at CDC, there's a group in ATSDR [Agency for Toxic Substances and Disease Registry] called GRASP, [Geospatial] Research, Analysis, and Services Program. They had existed prior to my arrival, and they continue to be a really valuable mapping resource. But what I found was that in the poxvirus group, it was also really a fertile group for GIS research. Already they had hired an Emory [University]

MPH [master of public health] student who had done some GIS mapping and modeling, and so when I was hired onto the ecology team, I was building off of some of the data and resources that she had worked on, and also beginning to pursue the research there, again, modeled after what I had learned from Town Peterson about ways in which we could, for ecology purposes, use the maps to model species distributions. That skill set though was one that other researchers, other ecologists at CDC had been interested in. So after my first year of my PhD program, I was invited to apply for a summer internship program at CDC in the Rickettsial Zoonoses Branch. The Rickettsial Zoonoses Branch, they study obviously the rickettsial bacterial organism, and *Rickettsia* are transmitted typically by vectors, ticks, mites, and lice. There, we were trying to again use the same approach of looking at historic human cases of rickettsial diseases to build these types of models that might help us understand where disease risk was, where vectors were, etcetera. I did that for a summer, went back to UGA. It was a valuable experience and my supervisor then, Dr. William [L.] Nicholson in the rickettsial group, he was excited about this area of research and so he was able to create an ORISE position for me, an Oak Ridge Institute for Science Education fellowship. Beginning in my fourth semester of my PhD, I moved back to Atlanta and was working part-time in the rickettsial group and still trying to finish my coursework and my classes for my PhD.

Once I got back to CDC, I got distracted by lots of other things, and my PhD progress slowed a lot, but that's only because the types of research opportunities that I was being offered with my skill set continued to grow and expand and I was really excited about the opportunity to be a geographer here at CDC and contribute uniquely. So in the Rickettsial

Zoonoses Branch, I ended up spending about three years there and was making slow progress on my PhD. Fortunately, my PhD committee was supportive of my opportunity and work experience at CDC, so they didn't give me too much trouble about the slow progress. I did get to participate in the field investigation of Heartland virus, a new tickborne disease that was discovered here in the United States. For two summers, while working for Dr. Nicholson, we were traveling out to Missouri and collecting ticks and using my skills of how to trap raccoons and anesthetize them and collecting blood specimens. Through that work, we were able to help collect the specimens in the field that would conclusively show that this new Heartland virus, which had only been identified in two human patients originally, was in fact also found in ticks and that these two patients who had reported being bitten by ticks before but didn't know if that's how they got infected with Heartland virus, our fieldwork showed that in fact that could've been what had happened. That was really exciting public health research to be a part of.

I enjoyed that work, but I was offered an FTE [full-time equivalent staff] position in the Travelers' Health Branch here at CDC. The Travelers' Health Branch, on the communications team, they are responsible for making the CDC Yellow Book, a really valuable and popular publication that CDC's been making for decades now. They had been making an increasing number of maps for that publication, and they needed somebody who could come in and help continue to make those maps and improve on those maps. That opportunity was actually really important for Ebola, and I'll get to that in a second. So I started that job, I got married in the spring of 2014, I started the job a few weeks after my wife and I got married, and by the end of that year I was in Sierra

Leone working on the Ebola outbreak. I think March was when I started in the Travelers' Health Branch, and was working on the Yellow Book. That would've been the 2016 edition. We work about two years ahead of time on each edition. I had been working with a colleague, Dr. [C. Virginia] Ginny Lee, and she and I were responsible for making the maps for the Yellow Book, and we've been doing that.

In July, I started to hear rumors a little bit about the Ebola outbreak, the reported cases, and obviously because of my historical work on filoviruses and the personal connections I had developed with friends in the Viral Special Pathogens Branch, I was very interested in trying to stay abreast. Also, there was new GIS technology that was becoming more readily available and more popular. Specifically, a volunteer mapping project called OpenStreetMap became increasingly important. Outside of CDC's response to those initial cases of Ebola and Guinea in 2014, Doctors Without Borders or Médecins Sans Frontières, MSF, had also been responding. MSF had GIS people who were also trying to use maps and the latest technology to support the field response. What MSF ended up coordinating and doing was they were coordinating with the OpenStreetMap community, and the OpenStreetMap community is a volunteer technical community. It's all volunteers, and the mission of OpenStreetMap is to create a freely available global map of the world. It's kind of like taking Google Maps and mashing it up with Wikipedia. These volunteers, like editors to Wikipedia, can come in and they can upload GPS data for where roads are anywhere in the world, and then increasingly common, also using satellite imagery. Anybody with an internet connection and a web browser can connect to the OpenStreetMap portal, and they can begin helping to digitize maps and infrastructure

on the ground. That's what MSF had done that was really innovative in 2014, and I had been paying attention to that because I found it to be exciting and a novel application. I was working on the Yellow Books, the Ebola outbreak was going on, I had other friends in this OpenStreetMap community outside of CDC, so occasionally I was getting personal emails saying, hey, what do you know about what's going on there? And similarly independent of that, the MSF people were coordinating with the OpenStreetMap volunteers and another specific group of OpenStreetMap volunteers called the Humanitarian OpenStreetMap Team, or HOT. What they accomplished was in the remote villages in Guinea—I think it was Forécariah Province—they mapped in great detail very quickly the roads and houses of these villages where the outbreak was occurring. As volunteers are making these maps from satellite imagery, the data is able to be downloaded by anybody else in the world. Within hours, probably more likely within a day or two, MSF contractors in Guinea were downloading this brand new OpenStreetMap data so that they could make the most detailed maps of the outbreak to support the case investigation and case finding. All of that was happening, and I was very excited by that work. But my job responsibility was to continue to make the Yellow Book maps because that had a deadline of October 1<sup>st</sup>, and my supervisor said we couldn't be delayed.

I was still finding a little extra free time though in the process of making the Yellow Book maps, like I said, to stay abreast. I actually helped provide a few training classes because OpenStreetMap, particularly editing data and contributing data in OpenStreetMap, was something that few people at CDC knew about. I organized a little

lunch-and-learn workshop through CDC's Geography and Geospatial Science Working Group, or GeoSWG. I talked generally about what these new GIS tools were and how they might be useful. I also found out about an Emory student group in the Emory MPH program called SORT, or the Student Outbreak Response Team. Once I learned about SORT, I sent an email to the student volunteers there and asked if they were maybe interested in learning about OpenStreetMap, and they were. So I also organized two training courses on that.

In early August, friends in the poxvirus program, one of them had deployed to Liberia I believe at the time, and so he sent me an email asking if I could help him find detailed satellite imagery of the areas of the outbreak that they were investigating. I tried to do that as quickly as possible, too, because they're my friends and I wanted to help them, and because I was really excited about the ways in which satellite imagery that CDC could access and share and use could hopefully help organize and manage the response in a more efficient manner. Because fundamentally, I think that maps can be really valuable tools in public health and anywhere a map can be made and shared and used, I try to help and support. I got name-requested by that friend in Liberia.

Q: Do you mind identifying the friend?

Lash: That was Ben [Benjamin P.] Monroe in the poxvirus program, and he was working with another colleague, Dr. Joel [M.] Montgomery. I actually had known Joel because Joel and Dr. Darin Carroll were friends when they both worked together in the Viral

Special Pathogens Branch. Joel was CDC country director in Kenya at the time, and so he had been asked to deploy to Liberia. He was the acting country director. So he sent a name request back to the CDC EOC and asked for me in name because he thought GIS was needed in-country. Unfortunately, my supervisors denied that request. I was very disappointed, but again, they said we hired you to do this one project, very specific project, the Yellow Book, and so they said that that was most important. We continued to work on the Yellow Book maps, and if there was ever any free time, I would try to be responsive to these other needs, and it became quiet in my office. The Yellow Book has a lot of editing of the text that goes on, but the maps had a separate deadline that was a month later than when the text needed to be submitted. My immediate team lead had—because in August, CDC's response to the Ebola outbreak and the fact that it had expanded to include Liberia and Sierra Leone, the response was ramping up, and the Global Migration Task Force is what my division often stands up in the IM [incident management] structure. My colleagues within the Travelers' Health Branch were increasingly becoming involved in the Ebola response. Personally, I was really envious. I felt like—or rather I knew, because of these name requests, that people thought that they needed mapping skills in-country and I really wanted to be able to support that. It was particularly lonely and a little sad as we were trying to finish the Yellow Book and offices were becoming vacant as people moved down to the EOC [Emergency Operations Center]. I had a colleague who went out to Texas when the Ebola case happened at the Texas hospital. She was sent there to help coordinate some of the communications work, etcetera. Eventually, my friend and colleague Dr. Yoshi [Yoshinori J.] Nakazawa, he deployed because he works in the poxvirus group with Ben Monroe. As this need for a

GIS person in the field was sent out, Yoshi volunteered, and so he went to Freetown, Sierra Leone. As he was nearing the end of his deployment, he again sent a request back for me, and this time, the Yellow Book maps were nearing completion. My supervisor said, “As long as the maps are done before you leave, yes, you can go.” My experience was that they scheduled my deployment for I believe November 15<sup>th</sup> or thereabouts, in the middle of November, and I was working overtime through the weekends before that, and we finished the Yellow Book maps about forty-eight hours before I deployed.

[break]

Q: I am back with Dr. Ryan Lash, and when we adjourned, I think we had just been about to jump into his deployment to Sierra Leone in, what, November of 2014?

Lash: Yeah, November 2014. It was before Thanksgiving. I think it was about a week before Thanksgiving. It was with great excitement that I finally received permission, and this was going to be the culmination of lots of different planning and experiences. I can remember back to graduate school when we were working on filoviruses and Marburg maps, thinking then I was going to help identify the reservoir of these diseases. Like, I was going to help solve a really important public health problem. We didn't quite accomplish that at the time, but nonetheless, the seed had been planted. Similarly, back in 2008, I also was fortunate to meet my wife, and so at home we continued to have these shared conversations and shared interest in the service of public health, of being able to respond to outbreaks, the excitement of international travel, and the ability to use our

unique skill sets and training to help improve public health. At the time, she was—we met working in the poxvirus program—she was doing laboratory animal studies and was a laboratorian, also finishing up her PhD at Emory University. It just so happened that she also was defending her dissertation and completing her degree within about that same week of my departure. Personally, it had been a very busy time. I obviously had been working long hours as well. One of the things that I was reminded of as I was preparing for this interview was the fact that for us personally, we were both supportive of each other. She was also eager to deploy if needed. At that point, CDC's support of setting up a remote laboratory to do the diagnostic specimen testing was getting going, and eventually, she would be invited to deploy as well, so she got that experience. And yet, once the decision is made to deploy, particularly at that time for the Ebola response, the EOC was cracking. It was eye-opening and pleasantly surprising to see that you could get the necessary approvals and you could get a plane ticket and you could be on the plane, in this case, within the matter of a week. That was incredible and I think speaks volumes to the number of people and the resources and the training that CDC has here to support an international response. It was truly impressive.

Q: Sorry, small question. Did you have to go through a round of immunizations in that week?

Lash: Fortunately, when I arrived at CDC in the fall of 2007, there was a monkeypox investigation going on in the Republic of Congo. The poxvirus team was relatively small and they didn't know what the nature of that outbreak response was going to involve, and

so actually when I arrived at CDC, I quickly got vaccinated and got the approvals for international deployment. Fortunately, I was—I think we now say “responder-ready” or something like that. But yeah, I had to have an occupational health clinic visit. There was I think a full day, if not at least a half day’s worth of training for deployers. They were beginning specific training presentations. I remember through that orientation, they were talking to us about the protocols in place for in-country safety measures, etcetera. So at that point they were talking about that you weren’t touching people in-country, you weren’t shaking hands, they were preparing us for the idea that we might encounter a sick Ebola patient since they didn’t know what everybody would be doing. If some people would be going to the field, CDC people weren’t supposed to be in hospitals, so we weren’t supposed to be in close contact. Later on, we would find out that one of the drivers that I almost rode with was an Ebola patient and was ill with Ebola. I remember at that point, they were issuing every deployer PPE [personal protective equipment]. We were being deployed with gowns and gloves, and that day in training I remember we were practicing how to don and doff our PPE, even for the map makers of the group because things were changing so quickly and people were being asked to help and to do things that may have been outside of their regular duties and responsibilities. That was all very exciting. I felt relatively well prepared, at least for the physical part of getting in-country, but what wasn’t clear was what we were going to be doing on a day-to-day basis. Because my colleague, Yoshi Nakazawa, was there in-country, I had been able to communicate with him and he was able to tell me some of the basics.

Part of what was unique for this response was the idea that people with GIS and mapping skills specifically would be going to the field and going to at least the in-country offices. My mother said to me, “Why do they need maps in Africa, can’t you make maps here?” I had to explain to her that no, there are aspects of the map-making process and the need for timeliness of maps, etcetera, that was better served by having somebody there in-country than being here in Atlanta. Internally, I think that that’s maybe a question that is open to debate and open to discussion. The EOC has unique mapping capacity, but one of the things that they couldn’t provide was people to respond with that mapping and GIS skill set, to deploy. It’s a problem still today, and with Ebola, one of the things was that CDC was only able to deploy FTEs, federal government employees. Contractors weren’t able to travel. That’s one area that I don’t know if we’ve fully addressed since then, at least if there are decisions about policies and public health infrastructure. Whether we have more people with GIS and mapping skills who are FTEs and are able to deploy, I don’t know yet whether that’s improved. But at the time, that was a major limitation was finding those FTEs who had the GIS skill set to go.

Yoshi had told me, “You’re going to get your CDC-issued laptop, but it’s not going to have any mapping software on it. Fortunately, you’re going to have administrative privileges, so you need to install as much of that software before you go.” So the last day before I deployed, I was installing that software. I was also installing graphic software because sometimes the mapping GIS software itself may not be sufficient for making the detailed maps that I would want to make, and also I was a little concerned that those Yellow Book maps might need some changes or updates eventually. I was installing lots

of that custom software myself. Also, I had been in communication with other mapping stakeholders, so CDC had ties to other government agencies that could help supply satellite imagery, so I actually received two or three hard drives with full satellite imagery mosaic the country of Sierra Leone, and I was carrying those with me.

Q: Who sent those to you?

Lash: Other US government agencies were able to provide that. CDC has the ability to access high resolution satellite imagery collected routinely through commercial satellite imaging companies, so that imagery is available to anybody in the world at a cost. The US government has a bulk order in place so that any government agency can request and receive that satellite imagery at no cost to the agency, so that's a real benefit to CDC and to public health work, is that we could have access to that imagery. The problem in the Ebola response was 1) not many people knew of that resource; 2) not many people knew how to access it because the way that they would normally share it wasn't in a format that could be used say by Google Earth, or it wasn't as though your phone could just connect to a particular location. Many responders were faced with limited bandwidth, not having a good cell phone connection, etcetera, and so the ways in which people would normally want to access that satellite imagery and could currently do at the time with Google Maps or Google Earth didn't work in this situation because the imagery wasn't formatted in a way and wasn't put on a server and it was really large. As I mentioned, two or three hard drives, I think it was well over a terabyte of satellite imagery. I was carrying that with me because these initial requests I'd received back in August were, hey, can you help us get

high resolution satellite imagery of these villages in Liberia, or these villages in Sierra Leone? And the problem was, that imagery is a really large amount of computer data. Even with limited bandwidth, even in country offices, etcetera, couldn't easily access or download that imagery. I was carrying that physically on hard drives with me. But nobody at CDC really knew that I had that imagery and that I was carrying it. There were no rules against me doing that, but it just wasn't widely known that we had that technical capacity. Similarly, once I got there in-country, nobody really knew that I had this data, and because of its unique format and the requirements for the specialized mapping software to read those data formats, not many people could use it. And in fact, when I got there in-country, I never used it. The data sat in a safe in the offices because the mapping requests I received never really required me to use that information. But it was an interesting experience, thinking about if somebody stops me and asks why I have three hard drives of satellite imagery of Sierra Leone, who's going to ask that question and who's going to know and who's going to help explain that if I need help? That was a little weird. [laughter] But it does point back to the important point that the Ebola response was a whole of government response. The [US] President was actively involved. I remember hearing the week before I deployed, President [Barack H.] Obama's voice over the loudspeaker in Building 21, there was a conference call. It was part of the excitement and satisfaction of knowing that nearly anything the US government had resource-wise was being offered up and being provided. In this case, these other government agencies who worked with satellite imagery on a regular basis were happy to share and overnighting this information. I feel regretful of the fact that I probably required somebody to work late to get those drives sent to me and whatnot, but nonetheless.

Q: So where are we then?

Lash: Basically, we're up to the preparations of deployment. Back to the personal anecdotes, I deployed I think on a Saturday evening. My wife drove me to the airport, and she had our dog in the car with her, and she dropped me off at the [Hartsfield-Jackson] Atlanta International Airport, said our goodbyes, and as she pulled away she later told me that it just hit her all of a sudden, like wow, I was leaving on a four-week deployment. She'd been defending her dissertation, and I'd been working on the Yellow Book. On my way to the ticket counter, she called my cell phone and said, "Hey, I need to come back for a hug." So she came back around in the driveway, and we met outside and shared a longer hug and a longer goodbye. And then I headed off.

One of the exciting parts of the deployment was the fact that CDC was sending lots of people, and so there was a team of people you were headed over there with. At the gate, I eventually met up with some of the CDC folks, but it was people from all across the agency. There was nobody there who I personally knew before, and we all headed off together. Our travel was from Atlanta to Brussels. European countries had begun to restrict which locations Ebola deployers could fly through. We'd already at that point had the imported human cases in returned volunteers. There was confusion at the airports in New Jersey and elsewhere about whether returning volunteers needed to be quarantined. My wife and I had actually discussed if she deployed while I was gone that we were going to send our dog to stay with her parents because there was the case in Spain where

these returning volunteers had had a dog they came home to and they were being forced into quarantine and people didn't know if dogs were infectious. There was a swirl of chaos in the air. At that point in time, Dr. Inger [K.] Damon was taking over as the incident command manager, and that actually provided a sense of personal comfort because Inger had been the branch chief of the poxvirus program when I was working there and when my wife was working there. We had that personal relationship with Inger, and we felt like—and I remember telling my dad, a medical professional himself, he also was anxious about the idea of me deploying. I said, “I understand. But Dr. Damon is back there at CDC and is helping take care of things and is going to do her best to make certain that nobody is taking unnecessary risks and helping them get what they need if they're in trouble.” So I had that personal connection that provided me reassurances.

I arrived in-country. The plane left Brussels, it landed in Dakar, Senegal, which was an emotional moment for me because that was the African country that I had traveled to and studied in during my master's thesis. I had the experience when I was in Dakar of meeting people, and they would always ask, how do you find Senegal, how do you find Dakar? Do you like it here? And I would say, yes, yes, I love it. They'd say, do you think you'll come back, will you want to come back? And I said, oh, yes, I would love to come back. And I'd never been back. Still haven't been back, except for when that plane landed and refueled in Dakar. So that was an emotional moment. Once it left Dakar, it landed in—I don't remember if it landed in Guinea or in Liberia, but I think we made another stop before we landed in Freetown that night. You get off late at night, and you've probably heard from other responders the experience of traveling in a bus to a ferry

terminal, getting on a ferry that doesn't quite look like any ferry you've ever been on in your life, and take a boat out into the black ocean—or across the bay—and get to the hotel.

I arrive at the hotel and there's my friend, Yoshi, waiting for me. It was a nice reunion to see Yoshi, and yet you're tired and you're feeling overwhelmed, and I certainly felt overwhelmed that night. Yoshi was working. It was maybe ten thirty at night or eleven, I don't know how late it was, and he was going to be departing within forty-eight hours, so he was trying to do a hand-off of everything that he knew and everything he felt like was going on. The Ebola outbreak was not under control at that point in November. It was definitely getting worse. There was a palpable anxiety amongst everybody who was there about what needed to change and what resources were needed to help stop, and so you definitely picked up on that. Yoshi—his name might surprise you. Yoshi is Japanese-Mexican, and in our friendship we've often shared drinks of tequila. So that night he had a bottle of tequila that he'd brought with him that I don't think he'd ever opened in the time that he was there, and so that night we drank a glass or two of tequila in his hotel room and he tried to fill me in and also encourage me. I was feeling overwhelmed.

Yoshi's role in the response was he was beginning to stand up the monitoring and evaluation piece of the epidemiology team based in the country offices there in Freetown, so that was at the time based out of the Radisson Blu [Mammy Yoko Hotel] conference room, which became affectionately known as “the Cave” by most CDC deployers. Also, the National Ebola Response [Center], the NERC, was being stood up in Sierra Leone,

and so Yoshi had been a bit of a liaison between the NERC and all the different groups that were there. We had made plans that night that we'd reconvene in the morning, we'd have breakfast, and there was another CDC deployer from CDC's National Center for Health Statistics, NCHS, in Hyattsville, Maryland, who I'd never met before—a woman named Lena [Yelena] Gorina I believe was her name. She arrived in-country on the same flight that I did, and she also was getting assigned to the epi [epidemiology] team.

We had breakfast the next morning and we sat down with the epidemiology team lead, Dr. Tony [Anthony W.] Mounts, and Dr. Mounts has spent most of his career overseas in different foreign posts for CDC. He was going to be rotating out in a few days, but he also had been tasked with overseeing the epidemiology team. Apparently, the deployment dates and the types of deployers in-country, the communication about that was not very systematic. We basically sat down and Dr. Mount said, "Who are you and what do you do?" Each of the new epidemiology team members introduced themselves and talked a little bit about their skill set. There was some confusion by Yoshi about since he'd named-requested me, was I going to be doing the exact same job that he had been doing, or was there going to be other responsibilities that were assigned to me. That confusion was apparent on that first day because Yoshi was trying to—he had in his mind a list of things that he wanted to hand off, but he'd been doing a one-person job, and now Lena and I were there, so there's two people, so we had to figure out who was doing what work. Lena had lots of specific questions that she was interested in. She is an incredible person, and eventually I think maybe deployed five or six times to Sierra Leone after this, her first deployment. It was very apparent as soon as we got there this is a very dynamic

situation, people are being asked to do lots of different things, and you would be called to learn or to use any variety of different skills.

The story that I think I want to try to focus in on here is about the surveillance data, the national surveillance data, and the challenges we faced in trying to map that data.

Because as I left Sierra Leone eventually after my deployment was extended—originally it was scheduled for four weeks, and there was a need and concern by the CDC country leadership that they needed more staff, particularly through the holidays, through Thanksgiving and Christmas, and they didn't know how many people would be available. They basically on the first day we arrived said, if you can extend your deployment, we're supportive of that, we need as many people as we can. After a week or two, I would learn in communicating with my wife that she was going to be deploying over Christmas to the laboratory team, and so depending on her deployment dates and if I came home at four weeks, we would maybe see each other for forty-eight hours or something like that and then she'd be turning around and leaving. I thought, well, if I could stay here, Christmas is going to be weird this year. If I go home, I'm going to have my three weeks of monitoring. When I come back, I don't know if I'm going to be around my dog, don't know if I'm going to see my family. I could probably stay in Sierra Leone and spend Christmas here, too, and so I was open to that idea.

Q: I want to ask, and I know that this will come through as you describe what happens next. In that initial confusion in the beginning about whether you were taking on Yoshi's

role or to what degree you would be doing your own thing or taking on additional roles, how did that get sorted out?

Lash: On a day-to-day basis. I think that that is representative more broadly about this evolving role for mapping and GIS skills in disease outbreak and response activities. As I mentioned earlier, I was aware of the fact that MSF had been experimenting with deploying GIS responders, people with GIS skills. They eventually had published a report<sup>1</sup> summarizing what those GIS responders were doing and the value that that added to the outbreak response. It seemed to be overwhelmingly successful and beneficial. They subsequently revised that report, just highlighting how useful and valuable it was. That was all going on at the same time CDC was responding, and it wasn't clear—CDC wasn't necessarily communicating with MSF about those specific details. CDC responders were seeing these maps from MSF, they were talking about the great maps that MSF was making in various countries, but it's not necessarily as regimented and clear cut about what the needs are and the value of maps are for decision making. When maps are available or the ability to make maps is there, people seem to want to see maps and want to see data mapped, and that was the specific and memorable request I eventually had in making a map of the neighborhoods of Freetown and the number of Ebola cases occurring in those neighborhoods. The process for making that map is something I'd like to describe in more detail here in a bit. But more generally, it's not well-established policy. There's no SOPs [standard operating procedures] for the types of skill sets that

---

<sup>1</sup> Luege T. GIS Support for the MSF Ebola Response in Guinea 2014. Geneva, Switzerland: Technical Support to the Operations, Logistics Department, Médecins Sans Frontières, Operational Center Geneva, 2014. Accessed on 29 October 2018. Available at: <https://reliefweb.int/report/world/gis-support-msf-ebola-response-guinea-2014-case-study>

need to be present in a CDC rapid response team. Some of that is changing as I learn here with CDC's Global Rapid Response Teams, GRRT. They have tried to document and tried to recruit more mapping and GIS people. One of the things we found through the course of staffing a mapping and GIS position in-country in Sierra Leone was, again, the restrictions about it being FTEs, and many of the technical mapping experts currently at the agency are often contractors. There are a number of MPH-educated CDC staff who are learning more and more about GIS and mapping, but their level of knowledge of the technology and their skills for using it are often a little bit more limited. They may not be as familiar and knowledgeable about how to use satellite imagery or how to pull in different types of data formats or how to make more sophisticated maps, etcetera. I hope that in the future, there will be more consideration and thought put into identifying what types of skills and infrastructure CDC should maintain and can contribute in the future for public health.

In answering your question, how was that sorted out, I left the country feeling like I had contributed in a variety of different ways, but I ended up doing a different job than what Yoshi had been doing and the responsibilities that he had. One of the primary sources of geographic data that people wanted to see mapped was the case data. The case data was coming out of the case investigation forms—that was the primary data form in which it was being collected. The data was being entered into, in Sierra Leone, an Epi Info-based system, database. That computer software system was rapidly evolving and trying to be improved upon because there had been limitations in the way that software operates for how much data could be collected, how it could be entered, how it could be shared,

etcetera. We were asked to help resolve some of those problems on the monitoring and evaluation team because fundamentally, what Tony Mount said to us that first day was, look, here is the recent national surveillance report, and we see a trend—if we look at the laboratory case data, we’re seeing that the labs are reporting X number of laboratory-confirmed cases each week and it’s going up, and we’re looking at the data out of Epi Info and the case investigation forms, and we’re not seeing the same trend. It’s not going up at the same rate, and we don’t know what to believe. It looks like from the laboratory data—which we have a fair amount of confidence in, but we know that not everybody’s getting laboratory diagnoses in real time, etcetera—that the outbreak is getting worse. But our epidemiologic case database isn’t showing the same thing and we don’t know why and we don’t know what to believe. As an epidemiology team, we were tasked with trying to improve the processes for collecting that data, for entering it into a database, and for making that data accessible and analyzing it near real time, so that we could be more accurately showing what the trends were and have evidence to know how the outbreak was changing and evolving over time. The problem is the data, the different pieces of data seem to be showing conflicting information. He didn’t know why and he needed our help in helping to answer that question.

Also, the response has a structure to it, and it’s not all centralized. There’s too much work to be done, there’s too many different problems to work through at local and regional scales for the country offices to be managing that all at one time, and yet the country offices needed information from those local and regional areas to be able to make decisions and to be able to allocate resources and to make requests to international donors

for what was needed. And that's, I think again, kind of the unique role that maps can play because those decision makers at the country level need an understanding of what's happening at the local and regional level, and a map can communicate that pretty concisely and clearly if the data that the map is based on is valid and accurate.

So that was kind of the problem that we were being presented with, is we have concerns about the validity and the accuracy of the human case data at that time because it shows a different trend than the laboratory data and we don't know why. There was a question about whether I'd be deployed out to one of the regional offices or the district offices in Sierra Leone to help answer that question at the district level and find out what's going on with the data entry process and the data flows. There was suggestion that maybe I do a tour of multiple district offices to try to gather as much information as possible.

Meanwhile, Yoshi had been housed in Freetown nearly the entire time, and he had been working at the Ministry of Health [and Sanitation] offices where they were working to compile this data nationally and compile the laboratory data, etcetera, and to publish that through daily situational awareness updates. Those daily situational awareness reports included maps that were being updated daily. Yoshi was the person who was actually making those maps on a daily basis. So that was one thing I did, a responsibility of his that I ended up taking on. But initially, the epidemiology team lead needed information about what was going on at the district offices, so he ended up sending me to the Tonkolili district offices the second day I was there, with the expectation that I would continue to make daily and weekly maps remotely. That was an interesting task and challenge.

After he had those discussions, Yoshi then took us to the Ministry of Health offices, where he was showing us what he had been doing. We met people there who said we'd like to be trained in GIS and mapping because we don't have anybody here in the Ministry of Health who can make maps for us in the way that you're making maps and we would like that skill. So Yoshi had said, "Hey, Ryan can help provide that training," and I said, "Sure, I can help provide training." And then Yoshi took me to the NERC offices, and there he introduced me to various folks that were there in the NERC, and one of the international organizations was called Map Action. Map Action is a nonprofit organization in the UK of volunteers from across the GIS and mapping community there who respond to international humanitarian disasters, be it earthquakes or disease outbreaks. Those people take time away from their regular day jobs and actually use vacation time to go and respond. As Yoshi was introducing me, they said, great, we're leaving soon, too. It would really be great to have this technical capacity for GIS and mapping of the epidemiologic data, to have somebody new who can do that. And they said, here is a gentleman, I've forgotten his name, but he's a local Sierra Leonean, and he has some mapping and GIS skills, so he's going to help take on this responsibility as well, but he's going to have some questions and he's going to need data. Great, you can be that person. And I was like, wait, why, Map Action? Why are you leaving again? And that's how they explained that they were volunteers and their vacation was up. [laughs]

They left the country very shortly after I arrived. All of this, when I think about this as the ways in which maps and mapping resources were managed and utilized in the national response structure, to me it suggests that in the way in which laboratory capacity

was being thought about and ensuring that there was adequate supplies and resources and that eventually there was coordination between the CDC lab and the Chinese lab that eventually was set up. Making certain that they all were using the same assays and that they were all reporting the results in the same way, etcetera. That level of coordination wasn't there for maps, and that's a justifiable decision. The laboratory diagnostic data and being able to laboratory confirm whether somebody has Ebola or doesn't have Ebola is really important, and I understand why that level of management was taking place. But the map component was relevant as well, and that's one of the things that I observed is just that geography as a skill set at CDC is relatively unique. I believe there are maybe four PhD geographers now at the agency. People who would be thinking about this process of how do you take the case data and map it and be able to do that regularly and routinely and accurately? There's not a whole lot of people I think who are very attuned to that specific problem and thinking about it, and that was the thing that shocked me as Yoshi was explaining things. It shocked me in that I realized, wow, I've got a valuable skill set here. Because we eventually learned that the case investigation forms that were being used for the Ebola response were just like the smallpox eradication investigation forms that were being used before. They asked patients, where do you live? And they recorded that information, or it was to be recorded by a village name and a district name and a province name and a country name. But what we learned is that not everybody knows or is able to report that information because there's not standardized household addresses and because sometimes the patients were either dead or too young or too sick to be able to report that information. Yet, we eventually got to the point where this question about what neighborhoods in Freetown had the most Ebola cases because we

were going to potentially introduce a citywide quarantine and go house to house and search for cases. That could only be supported through knowing in great detail and with great accuracy and great confidence the geographic information. So I was shocked to think that we're using the exact same approach to collecting that geographic information, and then trying to map that geographic information as it was done during the smallpox eradication campaign and yet here we are in 2014 and we've got Google Maps and we've got deployers with GPS devices in their phones, etcetera. I've thought a lot about these challenges after the fact, and I don't have any insight into whether there was a better system that could be used than the one that existed at the time. One of the things that was really problematic though was what we had for where villages were and what their names were, some of that information was still coming from those old paper maps that had been made by the US government back in the 1950's and '60s and '70s and '80s. We didn't at that point have a good connection with Statistics Sierra Leone, the national census agency, and part of what I would learn when I did very briefly visit the district offices was that there were census records, there were updated village maps. Eventually, I would see a presentation from Statistics Sierra Leone, and they had the statistics department people doing computerized GIS work and they had computer databases. But at the time when I arrived in-country and when I left, we still didn't have a good connection there and we weren't being able to leverage those resources. That's, I think, an opportunity for discussion and thought after the fact, because the way it was left, the process for me to make my map was to look at that geographic information. If village name was missing because it was a cadaver or a child that that case was, and they were found on the side of the road, sometimes you can't figure out where that person lived but, obviously, we were

swabbing those dead bodies and we needed to know whether they died of Ebola. If we didn't have village name, then you could at least record what was the neighborhood or the ward. I'm failing at the moment to recall what the political administrative boundary terminology was used in Sierra Leone districts. There were districts, but there's another unit beneath districts that's smaller and I don't know if it's wards. That's what I'm calling neighborhoods at the moment. It's a geographic unit for which there could be multiple villages around.

Q: Chiefdoms?

Lash: Maybe chiefdoms, yeah, that might be the proper word. Analogous to a county here in the United States where even though you don't know the specific village as a point, you do know that all of these cities or villages fall within this broader administrative area. You could see—so that information can be collected in different ways, and one of the things we would learn in the data entry process was that at the level of the case investigation form being completed and the geographic information being collected and entered, it didn't always happen in the field at the point at which a body was being picked up or at the health treatment center when blood was being drawn, because either people didn't know what those additional place names were, they didn't know the chiefdom that they lived in or something like that. But one of the problems we had to weed through was all of this incomplete or missing or imprecise information to make the maps. Do you feel like I've given you an adequate picture of the challenges faced in making the maps as well as an appreciation for the personal connection I felt in trying to solve this problem?

Q: I think you have. I think it's remarkable how similar—I'm sure there were lots of differences, but similar to your monkeypox mapping back in 2007. I guess you haven't gotten to the solution phase yet. Are you suggesting that one solution might be for people not to identify a village name, but something that's higher up that scale of hierarchy? So not village but chieftdom, or if not chieftdom, then something higher up than that?

Lash: I'm suggesting that that is one way of solving the problem of missing or incomplete data would be to give us the most basic or most general information you can provide about the geographic location. So in the case of someone who's already died and you obviously can't interview them, yes, you could use that information. That though is even still kind of complicated and can be misleading in the context of the Ebola outbreak because we knew of situations through the contact tracing and case investigations of somebody who might've been exposed in a different area. One of the questions that was being asked of these maps is—so these maps combine live human cases of people who are now in Ebola treatment centers, but they also include dead people. All we're asking these people, if we can, is: where do you live? But “where do you live” can be answered in different ways, too. Where was I born. It could be interpreted as, where was I born. Where does your family now live, versus where did you sleep last night? Or if you go and work in Freetown if you are a seasonal laborer and you've gone to work in the field, or you've gone someplace else for work. There are lots of different ways that you can answer that question of where did you live? Epidemiologists are not naïve to that. They understand that that's a complicated question and so acknowledging that is just basically

I think kind of a fundamental problem and challenge of the mapping process, but it's definitely something that a map user needs to be cognizant of when it comes to the decision making. In the case of Ebola, I don't know that this idea of translocation of cases necessarily impacts the overall picture nationally. It's definitely something that had to be sorted out and definitely had to be focused on later on in the outbreak, as the outbreak was concluding and they were eventually trying to show that they were Ebola-free. They did need to do the detailed mapping at that level. But at this time during the outbreak, we were just trying to get a more complete picture. Going back to this initial discussion with the epidemiology team lead, we weren't even actually talking about geographic information at that point. We were talking about the number of cases. We didn't know at that point in time whether the epidemiologic information was accurately reporting to us the number cases. The laboratory data suggested that it was not, and so we needed to know even just the basic case information regardless of whether we have any information about geographic—of where they resided, regardless of whether we have their age or birthday or sex or their name, etcetera. At the national level, we just needed to know that we were getting data in real time that was accurate. By the time I left Sierra Leone, I personally still did not have confidence that we had solved that problem. It was incredibly complex in all the different locations because there are lots of different ways in which the data could be entered and captured, and lots of different problems with the way in which that information was moving and how quickly it made it from a paper form collected in one district to a database managed by somebody else to a database that had been sent, or the latest database that was being sent. I don't want to go into the details of that too much because at least from my experience as a mapper and a GIS person, that

kind of data and information flow isn't as important as just knowing that that problem existed. In terms of what my responsibilities and duties were as I arrived in-country and what I was being assigned to do and what I was being asked to do, people couldn't necessarily articulate. Nobody knew what the problems were with the data flow or with the database data entry problems.

Let's narrow down and focus a little bit more now on this particular map that I did end up making. I was making daily maps for the daily situation reports, and that was at the district level.

Q: And that's what you were taking over from Yoshi?

Lash: That's what I was taking over from Yoshi, yeah. There were like eleven—I think those are districts [note: fourteen at the time].

Q: Yes, districts.

Lash: We were making daily reports from those districts, and that was coming in from information from the Ministry of Health, and that flowed pretty well. Again, what we didn't know was the time lag and how long it took that information from a case being identified and coming into an Ebola treatment center to how long before that data was entered into the national database and how long before it was sent on to us. We were receiving daily updates, but we didn't know what time lag there was in those numbers

and how long it was taking them to change or update. Making those maps on a daily basis, it becomes quite routine. I sit around, I wait until the afternoon or sometimes later in the evening to get that email from the Ministry of Health, and then within thirty minutes usually, I could turn around and make that map. I was emailing that out to over two hundred people by the end, and that had people all along the chain of command and it was being sent externally as well. We were including external partners. That was rewarding and satisfying to think that the map I'm making right now is informing everybody.

Separately, Ebola is spreading within the city of Freetown. The numbers appear to be increasing. We know the treatment centers are seeing larger numbers. We know the contact tracing is happening but it appears incomplete. Because of it being in Freetown, we have the Freetown District—Freetown is actually in Western District, so we had the Western District epi team. We could see them on a daily basis because they stayed at the same hotel with us, and so we were getting updates from them regularly. And we find out from them that there appears to be a two-week lag in how long it takes for the case investigation forms, once they are received at the Western District Ebola Emergency—the DERC—we had the NERC and the District—

Q: District Ebola Response Center.

Lash: Thank you, yeah. There appeared to be a two-week lag at the DERC from when they were receiving the contact investigation forms before they were being entered in.

They were getting too many, they didn't have enough data entry people. Eventually, their servers were crashing because they had more cases than the software system was set up to be able to support. We were trying to solve that problem on Christmas Eve. But at this point, we have found that there's a two-week lag, and we've also found that they're recording geographic information in a variety of different ways. In the city of Freetown and in Western District, there were some—Western District is a large peninsula. It includes some very rural areas and forests in remote places, but it also includes all of the city of Freetown, a sprawling capital city. It's not necessarily clear on the case investigation forms when they're being used in Freetown, Sierra Leone, what you enter into that first blank. Elsewhere in the country, it was being interpreted as a village, but does the city of Freetown have villages? They might have neighborhoods, but that wasn't necessarily the name being used on the case investigation form. Even then, what are the boundaries of neighborhoods? That's something that we don't even have well defined necessarily here in the United States. And yet also, there's not a robust addressing system so we can't necessarily ask everybody what your mailing address is. But we occasionally would get that because some people did have mailing addresses, or sometimes in various countries, even though it may not be the location for the postal service, there might be an addressing system for the water system or for the electrical or the telecommunications. Those different industries may go in and assign household numbers. So occasionally, you would get something that looked like a number and a road, but here I am just arriving in Sierra Leone, never been there before, and Google couldn't process that address. So I'm seeing these things coming into the database and I'm still trying to decide, what is the level of accuracy I can complete? Lots of things are missing at the village level, so we go

one step up, which I'm going to call "ward" right now. We're going to say that the ward is in between a village and a district. But again, there's this confusion about the boundaries of those wards, much like I said confusion about neighborhood boundaries. Eventually, what we discovered was, okay, first, there's lots of missing data, like more than fifty percent of the records are missing. There's nothing there in the database. Working with the district epis [epidemiologists], we started to ask, can we fill in this missing data? Because what we were finding was the ward was missing, but there was something in the village or address field. Then the question is, can we find a local Sierra Leonean expert who can tell us what ward that location falls in? The district epi comes back to me and says, yeah, we can do that, but we need a map. The DERC doesn't have a map of these locations, and there's not agreement on what the names of all those locations are. So we were able to find some of that data. Independent of CDC's GIS efforts, there was Doctors Without Borders there also working on GIS, but this was one of the things that was complicated and confusing was there was no—eventually, I think the NERC, the National Ebola Response Center, would serve this coordination role. But that hadn't been well established at the time I was in-country. So there wasn't real, clear communication as well as lines of authority between who was doing what and how information was being shared and who had access to the most accurate data, and also, how you knew what data set was most accurate. Because sometimes—there was a website called the Humanitarian Data Exchange, which was a website, HDX, that had been set up for Ebola, and another website that the State Department and USAID [United States Agency for International Development] had helped support called the Ebola Geonode. These were data sharing websites specifically for GIS data that had been

created and been used across different African countries for which different GIS users, other mappers, could post and share data. CDC was not contributing data there, but we were consuming data from those different resources. Somebody else had basically created a national data set of these wards of Freetown, but I didn't know what sources they had used, and when I shared it with my colleagues, the district epis, they said, look, our data entry folks say it's pretty good but the names here need to be changed. So we made those changes. We printed them out, a big wall map, and they began going through the missing records and helping to fill that in. We did that over maybe the course of a week, and I believe it was within a couple of days before Thanksgiving we produced the first map. This was the most up-to-date map we had at that time at this ward level. We were pretty proud of ourselves for that accomplishment, and it had taken several days of work. Like I said, we had to make this other reference map for the DERC to use. But we wanted people to be really clear, we knew independent of the geographic information cleaning that we had been doing, we knew independently there was still the data entry lag. So we reported to folks that this lag existed.

I completed the map late, like eleven thirty or midnight that night, and I emailed it out to the district epis and to the country leadership and to Inger Damon back here in the EOC. We shared it internally and said, this is our most accurate map available. And they said, great, can you make us one with the latest data possible, and can you do that quickly? [laughs] To correct the record here, I think the data that we had mapped originally that we had cleaned up, it was maybe a month old, it was maybe four weeks, there was probably a four-week lag. That was like the best available data set that came from the

DERC that we started with when we started this whole cleaning process. But rightfully so, leadership said, hey, we need to know what's happening now, not what happened four weeks ago. So we were able to get a more updated data set, and now we tried to do the cleaning process in a twenty-four hour period, or less than twenty-four hours.

What happened was Dr. Desmond [E.] Williams was there in-country, and I had just met him, and he and Dr. Oliver [W.] Morgan together were in charge of having a meeting with the president of Sierra Leone and the minister of health, and they were discussing this proposal of a Western Area Surge that was going to be quarantining certain neighborhoods and trying to administer malaria prophylaxis to eliminate people who may have had fevers because of malaria and not Ebola, and ultimately to identify any lingering Ebola cases. This was being discussed, and they needed a map of the neighborhoods, at the neighborhood level, to know which neighborhoods to do this in. Once they'd seen that I could make that map, they said great, but I saw Desmond that morning over breakfast and he said, "We have this meeting this afternoon. Can you update the map by that time?" I said, "Sure, if that's the map you need, I'm going to try to make that map." So we worked feverishly over the next six hours, and I quickly emailed that map to Desmond either just before he left or he got it in the car on his way to that meeting.

Myself and the team felt accomplished, and we eventually a day or two later would have Thanksgiving dinner at the US Ambassador's house. I nervously was introduced to him and his deputy. When she heard my name, she goes, "Oh, you're the one who sends out

the daily situation report maps, we see your map every day.” She says, “Mr. Ambassador, this is Ryan Lash, he’s the one who makes the maps.” And he goes, “Oh, I really appreciate those maps, those are great.” I’d never met an ambassador before, but I carried home with me a cocktail napkin from Thanksgiving, and I made a note on the cocktail napkin that Mr. Ambassador had said he knew my name and that he liked my maps.

That was a map that I had always felt proud of and accomplished, even though we would experience other hardships, and overall when I eventually left Sierra Leone in January of 2015, felt discouraged by what appeared to be an epidemic which was still not really under control and epidemiologic case investigation data that was still incomplete at times, etcetera. I continued to feel particularly proud about that map, and yet when I got back and I started to tell people more generally about my experiences there, other things had happened to where when I got home, I didn’t feel so confident that we were turning the corner, that we had stemmed the tide of Ebola in the country, and I personally had kind of shifted focus towards some other responsibilities.

I remember coming home. It was hard. My wife was still deployed, so I returned home on my own. I actually had developed a rash on my neck. We didn’t know what it was, but a friend who was actually the laboratory lead at the time, Dr. Chris [Christopher D.] Paddock, an infectious disease pathologist—and he became a dear friend—looked at it, a picture I had sent him back in Sierra Leone. He goes, “That looks like impetigo, you should probably go see a doctor for that.” So now, here I am in Atlanta, having returned from Sierra Leone about forty-eight hours earlier, I’m taking my temperature three times

a day, and I'm now being told that I should go see a doctor. I called the occupational health clinic here at CDC and I said, "I've got a rash, I think I need to see a doctor, what do I do?" They said, "Do you have a fever?" Ruling out, do I have Ebola? But of course they went through the process. They eventually called me back, very responsive, quickly, they say, "Yes, we agree, you're not an Ebola risk. You can just go see your primary care provider." I said okay. So I called my primary care provider and was like, "Hi, I need to see Dr. Perry. I have a rash, but just so you know, I work at CDC and I just returned from Sierra Leone. I don't want this to be alarming, but just in case." Of course, they were alarmed. They said, "We're going to have to call the county health office or the state health department and we'll call you back." They call and get their information and call me back and say, "Dr. Perry said he'd be happy to see you, but we're just concerned about any possible chance of exposing anybody in the waiting room. So we'd like you to come in the back door." They described to me where the back door was, and this is January 2015, so it's cold outside. I go and knock on the back door because, of course, the back door doesn't have a door handle. Nobody's answering the door, and so then I'm looking through the glass door into the waiting room, trying to get the receptionist's eyes. I'm calling the front desk and nobody's answering and I'm waiting. Eventually, they meet me and bring me a gown and a mask, and I come in through the back door with my gown and my mask and the nurse sees me and she's in a gown and a mask. Here I am, I've just got a skin rash on my neck, and the nurse says, "I can't imagine what it was like doing that work, but if you don't mind, I'm going to keep my gown and my mask on." Great. Dr. Perry comes in, he looks at me and goes, "So you haven't had a fever at all, these are your symptoms?" He's like, "Go ahead and take the gown and the mask off,

that's a little silly." Dr. Perry was great. He treated me, got me some antibiotics. So that was my little brush with the experience and the stigma of potentially being sick, potentially being an Ebola patient, etcetera.

Coming back was—I returned with mixed emotions. As I thought more about the map, I began to research a little bit more, and I was surprised to find out that Map Action, the UK group that was providing maps, had actually made ward-level maps prior to my arrival when Yoshi was still there. Yoshi had given them the national surveillance database, and they'd gone through some of the cleaning process, and they produced that map. So I was a little disappointed because now I found out that my map wasn't the most detailed map or wasn't the first most detailed map. Then I felt conflicted further because while I was there, people in the NERC had been asking me for copies of the Ebola surveillance database, and I had been working with that data but I didn't have the authority to share that data and I had asked my colleagues at the Ministry of Health and said, can we share, we've gotten this data request. But there were no clear policies about sharing of data, and people were very concerned about particularly knowing that there were these quality control issues and incompleteness of the data issues, and concerns about how that would be shared and who would make certain decisions and whether people would be criticized for the data not being cleaner and more complete, etcetera. So as I thought back about what was the appropriate historical record of my accomplishment of making this map, yeah. I still am left kind of speechless in how I think about it. Certainly, it was great that I was able to make a map that was useful to the people who needed a map and wanted to use a map for their decision making at the time, so that was

great. Yet realizing that the capacity to make that map had existed previously, and then that there wasn't a clear plan in place for sustaining that capacity after those particular groups left, it reflects one of the gaps that can obviously occur through the course of the chaos of this whole outbreak and the response. I still have copies of the map. I feel a little less reverent towards it as I did when it was first made, but that's the story of the map.

Q: I guess I don't completely understand still, sorry. So another map had been created previous to this one?

Lash: Correct. A ward-level map of the Western District, where the city of Freetown is found, had been made previously using the national surveillance data set. It had been made by Map Action folks, the volunteers that were helping to support the NERC. They had found the boundary data, they had gone through and worked through cleaning that data, because that data obviously had missing geographic information as well.

Q: Were they working with similar data to what you had?

Lash: Yeah. My colleague, Yoshi, had shared that with them previously. Many people would've been very interested in having that information. Obviously, this map was primarily motivated—or updating this map was primarily motivated by this decision being made by the president and at the national leadership level. But access to that type of geographic information would have been, and is, particularly valuable for people who are doing social mobilization, so they could know where to target their communication

and outreach efforts, and elsewhere. The need for a map with that level of geographic detail was there, and the capacity to regularly make and update that map was a capacity that existed with the UK Map Action folks, but because their departure wasn't coordinated with a precise and specific handoff to maintain that capacity elsewhere, be it by CDC or some other organization, then the ability to make that map or even the knowledge now by the new communications people that it was possible to make a ward-level map had been lost. I brought that capacity back with me, and was very excited to help make a useful map, and yet sustaining that capacity became problematic because of this combination of the skill needed to make the map, which was unique, that didn't require a PhD but it did require somebody needing the basic GIS skills. Eventually, when I deployed, CDC did commit to maintaining in-country GIS capacity and we found a series of several epidemiologists with an MPH level of training who knew how to use the basic GIS software and could continue to replicate and maintain those maps. Also, in the time that I extended my deployment for three additional weeks in December, I had begun training staff at the Ministry of Health in how to use GIS software so that they could continue or eventually learn how to make those maps and take it over. And they were able to do that eventually after I left. So there was a will to continue to support this, but one of the things that would've made this easier was if we had had the coordination with Statistics Sierra Leone, who already had detailed maps. They were the ones who had the expert knowledge and some of the database about what the local geography was and how to help convert these place names into points on the map or into their proper wards and things like that. That piece hadn't happened by the time I left, nor in the time that I was continuing to communicate and support those efforts afterwards. That would've been

something that could've improved things. So you're right. I guess there's no reason to feel disappointed or discouraged by that. I guess though the way that I felt about it reflects I think some of my personal passion and interest in seeing maps and GIS tools become routine and become a priority that CDC can assist and routinely provide. So I think any time that I re-tell these stories and think about and reflect upon it, it's my desire to see us more routinely do that, and in a way that that capacity is sustainable and readily accessible so that anywhere we go in the world, we could be able to provide that mapping capacity for outbreaks. Now, as we have this conversation today, we have had the Ebola outbreaks in the Democratic Republic of Congo, both in Équateur and now in North Kivu, and mapping of those outbreaks continues to be a really important component of how we understand things. In Équateur, there was an article published in *The Atlantic*<sup>2</sup> within a week or two of that outbreak occurring and becoming widely publicized that said maps of the Équateur Ebola outbreak are wrong because the maps of the health districts were inaccurate, were outdated. And nobody knew that at the time because the people who were making those maps were working remotely, they weren't in-country, and they were working from a line listing that just said, this case is from this health district. How were they to know that the map they were using to locate that health district didn't accurately show where that health district was? And yet, as this article for *The Atlantic* was emphasizing, it was significantly—there were significant differences in what the accurate map should have been and eventually was, versus the map that was originally being made. It presented a strikingly different view of what the risk was of the disease

---

<sup>2</sup> Young, Ed. Most Maps of the New Ebola Outbreak are Wrong. *The Atlantic*. 21 May 2018. Accessed 29 October 2018. Available at: <https://www.theatlantic.com/health/archive/2018/05/most-maps-of-the-new-ebola-outbreak-are-wrong/560777/>

spreading to the highly urbanized areas and the populations, etcetera. It was a matter of a case being reported in a health district that either was a health district that was centered on and included all of this highly urban area, or it was the case of that health district being drawn in such a way that it was mostly rural areas but touched on a little bit of the urban area. The impact on the way we perceived the population at risk based on where those current cases were being reported from was dramatically different depending on whether that was a district that included only the highly populated and urban areas versus something that was on the edge.

Q: Just because I'm curious, and I'll go back and read the article because it sounds really interesting. In reality then, which was it?

Lash: It was—now I'm questioning my own recollection of the article. [laughter] I'm fairly certain that the situation was in fact a little less dire than what the original map was proposing.

Q: So perhaps that area was a little more rural and the threat to the highly urban population was—

Lash: Was less, I believe. But we'll both review that and correct the record if needed. So I think for me personally, somebody who's passionate about maps in public health, that only seemed to serve to highlight the important role of maps for outbreak response for our understanding, if not at the local level, certainly at the leadership and at the general

public's awareness of these things. The situation today in North Kivu as I understand it, continues to be equally problematic because our understanding of where villages are and what their names are and what the boundaries of particular health districts are in that particular war-torn area where it's difficult for public health responders to get on the ground and to provide technical support, etcetera, is diminished and hindered. So our ability to make accurate maps to support necessary decision making is limited as well. To me, I see those hopefully as opportunities for me to continue to have an impactful public health career and hopefully trying to build that capacity and ensuring that it is one that everybody is aware of and can prioritize appropriately.

Q: I was going to ask this question at the end, but I think actually it fits in here pretty well. You were talking earlier about that discussion you had with your mom about, well, can't you do mapping from Atlanta? Why is it necessary to go into the field? I'm wondering if now you could tell me. Can you make the case? Why is it important? What is added for having mappers on the ground in an emergency situation like this?

Lash: The specific examples from my own experiences that I can reference would be in this particular scenario where we were focusing on trying to clean up and make a more complete data set at the neighborhood level for the wards of Western District Sierra Leone, remotely, we would probably have been working with a spreadsheet of the case data with these different village names, and remotely, we would've had access to this file downloaded from the GIS data sharing website for which we don't actually really know where that data came from or how recent it was. But it would've been the only data we

had, and so we would've used it remotely. So the potential problem there would be if we were matching up erroneously the place names in our spreadsheet of cases with the wrong districts, because either the names were incorrect or there are at least a few examples I can recall where wards were named the same thing but one would be Ward 1 and the other one would be Ward 2. I think Kissy Town was one, like Kissy Town 1 and Kissy Town 2, I think, may have been neighborhood names. In our case, what I found was that it was frequently occurring—I don't know if it was the majority of the time or not—but it was frequently occurring that if a patient was able to be interviewed when they arrived at a treatment center, that they would hopefully be able to report their village or their address. But then in that hierarchy of information that goes from, what ward was that in and what district is that in, that information wasn't often captured in the interview of the case themselves. That instead was completed oftentimes at the district level, at the data entry level. So whatever is entered there is reflective of the judgment of the district officials or of the data entry officials. It doesn't matter really what the accuracy of their judgment—their judgment is the truth because they're the ones on the ground. But if our databases don't reflect their judgment, if we're using different maps, then we're not going to be making maps that are truthfully accurate and consistent with the data that's there.

Q: Or useful to them.

Lash: Yeah. And in this case, if I am remotely away, I wouldn't necessarily be aware that that problem exists, and I may not have the personal relationship with the district epi to

be able to say, as I was in this case—Dr. Monique [A.] Foster was the district epi who I was working with on this project. To say to Monique, okay, it seems like there might be inconsistency in how we are identifying which villages are in which wards. Would it be helpful if we made a wall map so that all of the data entry people could be using the same map? Could this not solve our problem of ensuring consistency that we are looking at the same thing? That's the solution we ended up utilizing, and it seemed successful for us.

But if I was the remote mapper, I may not have known that Dr. Foster was there, that she was willing to make this a priority in her list of many different competing questions and interests that she needed to do on a day-to-day basis. Being there on the ground allowed me to have that relationship, eventually to go out to the DERC myself and to meet the data entry people and to build those personal relationships, and for there to be an instant feedback loop where now, Monique gets the experience and the satisfaction of knowing that she was working to help make that map. Even though I made the map, I don't take credit for the entire map. I was the one who was able to technically make the map, but I used the data and required the help of lots of other people, and those personal relationships are incredible valuable. The other thing that I would impress upon my mother would be that in this case, we made a map and showed proof of concept, and that map was sent out at one or one thirty in the morning, and it was seen, and by eight thirty or nine o'clock that next morning, locally, I was being asked to update that map. In Atlanta, unless our mappers are here 24/7 [twenty-four hours a day, seven days a week], which we did have some of that capacity but it wasn't necessarily always in place, there would've been a five-hour delay in that person receiving that request. And in this case, we needed to update that map in six hours. So now we have a map that needs to be made

in one hour if it was going to be used by the president and the country leadership to be seen. So in this case, that time difference I think made a difference.

Q: Thank you. That was brilliant. So in other words, it's the proximity to the local knowledge. Recognizing that mappers need to be on the ground—I try not to do this, but I always do this, damn it. It's about recognizing the value of the local populations and their specific knowledge and bringing that and really using it for the response.

Lash: I think you're right, and I think in this case, one of the other things that when you are working as a remote mapper—and I've done that job before, it's difficult—is in this case, a short story to tell. While I was there in Freetown, I was meeting people and being introduced as the map maker, and I got an invitation by a person outside of CDC I'd met at the NERC. I believe she was a friend that Yoshi had met. I forget which NGO [nongovernmental organization] she worked for. But she said that her NGO had secured a bunch of GPS devices, and since we were having such difficulty in matching up place names on the map, her organization was going to distribute these GPS devices and she invited me to come to the training session so that I could understand what was going on. So I went to the training session that day. I reported back to the epi team lead, "Hey, I've heard this is happening, do you want me to go?" And they said, "Sure, go check it out." So I get there and the presentation was being led by members of the Statistics Sierra Leone organization, the census organization, and their director or leadership was now presenting to all of these local case investigation folks. He was explaining to them what GIS was and the way in which they could use their GPS data. He was there to assist and

support, and what he wanted them to do was he wanted them to collect the GPS data, and then he wanted them to send him back that GPS data, but he also wanted them to send him the case investigation data. So it was this discussion about his organization, Statistics Sierra Leone, offering up these services and also wanted to be invested and involved in making maps and helping to stem the outbreak. As best I could understand at that point, they weren't involved. So I think there was a local communication and potentially a local political issue about which parts of the Sierra Leonean government were involved in the response and what their responsibilities were, and personally, I saw it as a gap where Statistics Sierra Leone seemed to have expertise that could have been beneficial, and at the time I was there, wasn't really being taken advantage of. This to me exemplifies, again, the value of being there on the ground with my expert map knowledge, is I'm able to think systematically about how do we match up and how do we solve this problem of connecting place names to the most accurate and contemporary geographic data.

Realizing that the Ministry of Health doesn't have that capacity apparently; that Statistics Sierra Leone, the census bureau, does seem to have that capacity; and maybe we, in supporting the overall whole of government response, need to ensure that those two organizations are working successfully together. If I had stayed there longer, that might have been something I could help do. But more generally, at the time that I was involved in the epidemiology team, it wasn't something that the epidemiology team had the capacity to support and to build those types of relationships. Again, as a remote mapper, I probably wouldn't have been attending that meeting to have realized that some of that data infrastructure did exist, but it was just a matter of connecting up the right folks and ensuring that there was broad agreement about who was doing what and why and how.

Q: Can you tell me more about the district epidemiologists who you worked with and what your work was like with them?

Lash: Sure, I'd be happy to. The epidemiology team basically consisted of district epidemiologists who were typically assigned to different districts, and then the monitoring and evaluation team, M&E, which was based in the capital of Freetown, and then the epidemiology team lead, and then eventually I think there may have been a deputy team lead as well. The district epidemiologist would be sent out to the districts, and sometimes there was considerable travel that was required to get to the district locations. There were a lot of differences in those different districts about the types of resources and the types of problems that people were addressing. Oftentimes, the district epis worked pretty independently. They were frequently encouraged and able to travel back to Freetown on the weekend so that we could have in-person meetings and discuss how to better coordinate across and ensure that there was complete communication across those different groups. But people often thought of the district epis as the field epis, and particularly, current and former CDC EIS [Epidemic Intelligence Service] officers, I think, were very attracted to those district positions where they were managing case investigations, they were going out and ensuring that contact tracing was happening on a routine basis, ensuring the completeness of that data. They were managing data and information flows between the treatment centers, the transport of laboratory specimens, and the data entry, etcetera. I observed that many of those district epis were generally excited about that fieldwork, and I, myself, was kind of inspired. That kind of disease

detective type work is the shoe leather epidemiology that makes those folks kind of famous, or at least the job famous amongst public health. One of the rewarding things that I was able to do while I was there was I was able to show some of the district epis while I was there, I was able to introduce them to OpenStreetMap. They were used to deploying and not having maps or not having accurate maps or not having digital maps that they could match with the GPS to track where they were going. And because of the success of the OpenStreetMap efforts and the coordination that was happening across all of the different Ebola-affected countries, the OpenStreetMap database was being rapidly improved. And one of the valuable things you could get from satellite information was you could at least get a sense for where villages were within your district. If you were traveling along a road or you were stopped along a road or stopped in a village and hearing reports of other potential contacts of a case in a village that was down—you know, the locals would tell you, oh yeah, it's down this road, you just follow this road for however the long distance is. Through the OpenStreetMap technology, they were able to have access to maps on tablets that didn't require a data connection, so they worked offline, but it used the GPS in the device, and they could pan and zoom and they would find those villages. I was really encouraged to hear from friends in Freetown that they saw a stack of these Android tablets sitting there, and they weren't yet being used, and to say to my new friend, Dr. Colin [A.] Basler, who was headed off to Koinadugu [District], I think, I said, "Hey Colin, do you need maps?" "Oh yeah, we always need maps." I was like, "Okay, well I don't know how accurate this map is but I'm going to put it on this tablet and just take it with you and let me know if it works." And sure enough, the next weekend I'd see Colin and I'd say, "Hey, did you try using the map?" "It works great, it's

awesome!” It was really affirming, again, to see that this mapping technology, in this case being supported by volunteers outside of CDC who could be anybody anywhere in the world working on mapping, were making Colin’s job easier and better. That’s been a compelling story to hear about and also exciting, again, to think about the ways in which access to map information and to the technology and in a format that is most useful can make the work of the field epidemiologists easier and more efficient. There’s a photo of Yoshi, Yoshi did a second deployment to Sierra Leone, and he ended up being assigned to I think it’s Kono District. It was the district north of Freetown along the border with Guinea.

Q: Kambia?

Lash: Yes, Kambia, that’s right. Yoshi, when he went back, they didn’t need additional help on the monitoring and evaluation team so they sent him out to Kambia. So I assigned Yoshi with the same task. I was like, “Hey, could you take a tablet with OpenStreetMap and let me know how accurate it is?” Yoshi kind of staged this photo for me, but it really is Yoshi on the middle of a dirt road next to an SUV [sport utility vehicle] and he’s pulled out the tablet and the tablet is showing him the road that he’s on, the village that’s up beyond the horizon that he can’t see, and he later took another picture inside the SUV and there’s the village already on the map. Things like that I think are compelling use cases for the ways in which this technology—and to me, one of the cool things about the OpenStreetMap project is the fact that it’s something that CDC can support and certainly benefit from, but it also exists outside of CDC, and it’s free data

which anybody anywhere in the world, including any part of the Sierra Leonean government, can have access to. I see that as a type of public health infrastructure that could be sustained over the long term and a really valuable output of this. It seems as though others had that idea as well. I've heard Bill [William H.] Gates talk about the polio eradication campaign and the way they're using maps and also including some OpenStreetMap work, the ways in which that geographic data infrastructure is hopefully going to be a valuable and sustainable secondary outcome of the broader public health efforts for managing and eradicating diseases.

[break]

Q: You had mentioned at the beginning how your Yellow Book work became important for Ebola. Did you get into that?

Lash: I may have misspoken there. The Yellow Book mapping work wasn't really connected to the specific projects and activities I was doing with Ebola. They both were enjoyable and challenging to me, but it was kind of different mapping conditions, so I think it was more the fact I was preparing myself when I deployed, knowing what my primary supervisors had said about the need for those Yellow Book maps to be done. I actually have a funny story of in fact being asked to fix one of those Yellow Book maps while I was in Sierra Leone. I got that email when I was out in one of the district offices, and because I had downloaded and installed that software and brought with me all of the Yellow Book maps, I was actually working on fixing those maps while riding along the

road traveling back to Freetown that day. While I was doing that trip, one of the interesting side notes from the personal experiences of the response was when I arrived in-country, I was sent out to the district of Tonkolili. I met up with folks for—I ended up I guess just spending one night. I went out on like a Thursday night, spent Friday, and I went to the district health offices. I think I was there for two nights. I went to the district health offices, and then I got invited to go to an adjacent district health office as well about an hour away. It was two different field epis. They were both staying at the same hotel. When I went to the adjacent district field offices, which the names are escaping me at the moment, I rode with a different driver, and then we went back to Freetown together. A week later, we found out that in fact one of the district drivers was the one who'd contracted Ebola, and that he had been sick and hiding his symptoms. Consequently, the people who—the CDC people who he had been driving had now been exposed to Ebola, and for a brief period of time, I didn't remember the name of my driver. I remember riding with those colleagues, and those were the colleagues that eventually had to be emergency evacuated back out of the country. For a brief period of time, I was like, hey, when we were riding in that car together, was that the driver who's now sick? Was I in that car or not? And initially, people were like yeah, you were. And I was like, oh my goodness, this is how the end of my Ebola deployment is going to go, I'm going to have to be emergency evacuated. It turns out eventually we figured out that I wasn't in that car, that there had been some swapping of drivers at the last minute. It was just one of those moments that was like, wow, this is really real. There are people all around us doing all different types of jobs who could be exposed, and that could impact our risk. Fortunately, because of the resources that CDC had available, I felt safe

knowing that anything we needed there in the field in terms of our own personal safety, those needs were going to be met even if they seemed exceptional, and the types of resources that were made in this case, a private flight back from Sierra Leone to the United States, that those resources were going to be made available to take care of people. I'm really proud of the agency for the way they managed that type of stuff and personally, just fortunate that I wasn't in that car at that time that day.

Q: True that. That could have been a traumatic experience.

Lash: My mom probably would have felt different about my continued service if that had happened to me. [laughter]

Q: One thought that crossed my mind when I was thinking about mapping neighborhoods is issues of, how did you deal with issues of privacy there? I mean I know you're probably not dealing with such atomized info when you're mapping as people's names and even their exact addresses—you talked about how that didn't always really exist in places like Freetown. Was that something that was on your mind and that you had to deal with on the job?

Lash: Yeah. Privacy and confidentiality issues are always a concern when making maps of public health information. Oftentimes, that information is anonymized or aggregated in such ways that it can become anonymized. So it's not necessarily something that me as the map maker has to address as my primary responsibility. However, in this instance I

actually did have access to that personally identifiable information. I did have the full case investigation database with individual names, dates of birth, phone numbers, contacts, etcetera. Certainly, anybody in this map making role has to have adequate training in public health ethics and be conscientious of how that information is managed and stored. And it is in fact one of my concerns with the occasional request I was getting for sharing data. Because even though my point of contact may have been with the GIS people and these other groups, it needed to be discussed and addressed in a systematic way, which we never really did while I was there, and so as a result I chose not to share this data to those folks. But it was definitely something people had to be conscientious of. In my case, what we were doing was the maps we were making was aggregating the data to that ward level, and so as a result, we weren't displaying pins at the GPS point location of the house of the particularly infected individual. Now, for contact tracing, that type of information didn't need to be acquired and was often managed at the DERC level. There were examples I saw when I had visited a few DERCS where you saw detailed roadmaps of the particular wards with pushpins or markers locating the household locations, but I wasn't responsible for making any of those maps.

Q: I guess my last question would be—I guess it's a two-parter. Do you have any memories that I haven't prompted for, or anything you'd like to talk about that we haven't gotten to so far? And then, anything else generally that you'd like to say, any final reflections?

Lash: The things that come to mind that I haven't talked about. One is that as a map maker and a geographer, one of the things that I'm learning is that my skill set is unique and valuable and I feel inspired by the work I've been able to do during the Ebola response as to why my skill set is valuable to public health. I really am optimistic at this point that I can continue to contribute uniquely to public health in invaluable and resourceful ways. To that end, I continue to seek new opportunities and hope, even though deploying and doing fieldwork is not part of my current responsibilities in the Travelers' Health Branch, maybe in the future there might be some other opportunities for that to come up.

I think one of the things that was incredible particularly about that time, I think I've described a little bit about what felt like the personal hardship and the discouraging elements of being there in-country. One of the things that was really inspiring about the whole experience is realizing that there were so many different CDC people and employees that we work with that also felt similar calls to action and a desire to serve and to help in a time of crisis, that they themselves were willing to sacrifice Thanksgiving holidays with their families or Christmas holidays with their families to be there doing that work. My wife and I were unique because we'd been married that year and that was our first Christmas as a married couple and we spent it separately. She worked a twelve-hour day that day testing blood specimens and diagnosing more Ebola cases, and I don't think there's any other way that she would've wanted to spend that time. And I, at my sixth week of deployment at that point in time, was feeling a little bit more drained. I was still comforted and supported by all the other CDC employees that were there. It was

interesting to realize in the stressful and challenging times that most people were working in how much camaraderie and collective goodwill there was amongst my coworkers, amongst the people we get to work with here at CDC. That was really encouraging, and I think part of what motivates me to want to continue to work with these people over the course of my career. My wife and I have both commented on how many friendships we gained from that time there and how many people we met. It was awesome to meet so many people who do such different things during their day-to-day jobs, but were available and wanted to do that work at the same time. The friendships that we've made have been really fantastic, and even though in-country there was a rule about no handshakes and no touching each other, now that we're all back here and we know that we're Ebola-free, it seems like we hug each other a little bit tighter and certainly more frequently because of the common bond that we share through that. It is unfortunate when these outbreaks happen that they hurt vulnerable people, but it is rewarding to be able to feel like you can do something to help the afflicted and that you can do so when times are tough. You can rely on the goodwill of the other people you get to work with. We certainly don't hope for additional Ebola outbreaks, but I think everybody who was involved in that response feels compelled to want to try to answer that call if it comes again.

To that end, I think one of the things that has been challenging for me to process is to think about the things that could've been different or we would like to do different in the future and realizing that an outbreak response like that is both challenging, and in some ways you are restricted by the tools and the skills that you have there at the time. But

having also been involved in the Zika response since then and working on that from the headquarters' perspective, I realize that in public health, these major outbreak response scenarios are an opportunity for innovation and for trying new things and doing things differently than the status quo because the conditions call for it and because there's a new impetus and there's new resources for that. I've seen and been a part of some innovation, again, with maps and mapping technology with the Zika response that I think has opened other people's eyes to the value and to the needs, etcetera. I do think of these things as opportunities to share and to educate other people on what I can contribute, the value of maps. That certainly was documented from MSF and what they reported. They said that their field epidemiologists and their in-country leadership had not previously had mapping resources at their disposal in the way that MSF provided during the response, and that that has changed their opinion of the importance of that skill set. So I think from the mapping end, it's important, and yet it's also important to be realistic and realize that the agency has to be cognizant of the really broad range of public health infrastructure that CDC has built and can build and all the different things they can do. It is challenging, when you have such a broad range of tools, to pick from and prioritize those things. As a map maker, even though in the Ebola context it seemed pretty important, it is but one of many important tools and techniques that CDC can contribute. So it was great to feel like we got a shining moment then, and to be humble, recognizing that you may not necessarily be the first to call, but there might be other opportunities in the future. The one thing I think I've taken away from mapping and modeling so far in the ten years of a public health career—I guess maybe fifteen if you count what I did as a graduate student—the story of the John Snow cholera map is one that has become mythological I

think. Realizing that there's been very few pump handles since the days of the cholera map, to the extent that we still deploy ring vaccination strategies and administering Ebola vaccines and other public health interventions. That's an example of the importance of spatial analysis and identifying things and prioritizing public health efforts based on what's there. Sometimes, that requires a beautiful, nuanced map. Sometimes it doesn't require a map at all, and that's okay, too. I think I personally take away, again, just being reinvigorated that there will be times that this skill set is valuable and useful.

Other anecdotes, I've touched on the personal thing. My wife and I, as public health employees, I think both feel similarly that we would be happy to serve in the ways that we did or in other ways if needed in the future. I think that kind of concludes—

Q: It's a just conclusion I think. Thank you so much, Dr. Ryan Lash. As I said, it's been a total privilege to have you here. Thank you.

Lash: It's been my privilege and my honor. I had the unique experience during my master's thesis on historical maps of malaria to go to the WHO [World Health Organization] headquarters and archives and to dig into correspondence about maps and about the stories that are behind how some of those maps were made. It's been a real privilege to hopefully try to contribute a little bit more history and insight into how maps were made during the Ebola response so that maybe one day somebody else will be interested and find that information useful.

Q: That's what I'm hoping.

Lash: Thank you, Sam.

Q: Thank you.

END