THE WEST AFRICAN EBOLA OUTBREAK AND THE DEVELOPMENT OF HEALTH

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I, the undersigned Zoltán Szászi, hereby declare that I am the sole author of this thesis. To the best of my knowledge this thesis contains no material previously published by any other person except where due acknowledgement has been made. This thesis contains no material which has been accepted as part of the requirements of any other academic degree or non-degree program, in English or in any other language. This is a true copy of the thesis, including final revisions.

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ABSTRACT

This thesis studies the reasons of the 2013-2016 West African Ebola pandemic. Its field of inquiry is the reasons behind the differing mortality rates in the West African countries throughout the course of the crisis. In order to study this, the thesis relies on a qualitative focused comparison case study methodology. Based on the relevant literature, a theoretic framework and a dedicated research methodology studies the major epidemiological, health policy-related, international, governmental and societal factors of the pandemic. The primary findings suggest that although much progress had been made in the development of health in West Africa, primarily, in Liberia, following the two-decades-long period of civil war and political unrest, there still were major shortcomings. The health governance of development policy suffers from major structural issues and the infrastructures in the countries were not prepared for horizontal epidemiological threats. The societies were also very unprepared for the nature and magnitude of the crisis. Furthermore, the thesis suggests possible avenues of policy development to better prepare for future threats.

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List of Abbreviations

DALY: Disability-adjusted life year

DHS: Demographic and Health Surveys

DTP3: Commonly combined vaccination of diphtheria-tetanus-pertussis (whooping cough)

EVD: Ebola virus disease

HCV: Hepatitis C

HCW: Healthcare worker

TB: Tuberculosis

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Introduction

The 2013-2016 West African Ebola outbreak was a massive epidemiological humanitarian crisis. The pandemic was primarily caused by the Ebola virus disease (EVD), a tropical illness endemic to Sub-Saharan Africa. The disease was first identified in 1976 and has since appeared in mild, sporadic outbreaks throughout the continent in places including Nigeria, the Congo region, the African Great Lakes region and South Sudan. However, the 2013-2016 disaster was the first instance of a large-scale EVD epidemic. The crisis primarily affected three West African countries – Guinea, where the outbreak originated, Sierra Leone and Liberia. Throughout the course of the outbreak, at least 28 000 cases of infection have been observed with at least 11 310 fatalities,[1] with more than 17 000 people continuing to suffer from post-Ebola syndrome, an adverse post-viral syndrome that plagues EVD survivors.

The research question of this thesis is the following: *Why did the 2013 Ebola outbreak in West Africa become a severe pandemic in certain countries and how can such diseases be stopped in the future?*

EVD is a tropical viral disease which primarily affects blood vessels in the cardiovascular system, muscles and internal organs and has an average 40% mortality rate. It is a zoonotic disease spread by animal vectors (primarily, fruit bats) as well as the bodily fluids of the infected. At first, the unexpected 2013 outbreak in Guinea did not differ from previous Ebola outbreaks in forested areas of Sub-Saharan Africa. However, the disease spread relatively rapidly over borders into Sierra Leone and Liberia and reached the countries' heavily

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[1] John Kinsman et al., "Development of a Set of Community-Informed Ebola Messages for Sierra Leone," *PLoS Neglected Tropical Diseases* 11, no. 8 (7, 2017): 1–20, https://doi.org/10.1371/journal.pntd.0005742.

populated urban areas, marking the first instance of an EVD outbreak in population centers.[2] The countries' underdeveloped health infrastructures could not handle a pandemic proportion viral outbreak, which led to partial shutdowns in the local health infrastructure. This, aside from limiting the countries' defenses against the epidemic, further worsened the general health status of the population.

The environment of the West African shore was unfortunately primed for disaster and was one of the primary factors of the outbreak. Sierra Leone has a dense, population with a 41% urbanization rate and a population of 7 million over a 77 thousand km^2 area. The flora is indigenous tropical forest, home to disease vectors of many diseases, including EVD.

Liberia is 110 thousand km^2 in size with a population of approximately 4.5 million. The urbanization rate is 58%. Most of the country's land area is mountainous, with tropical rainforest vegetation and little arable land which makes the consumption of bushmeat widespread – Which is coming from potential animal vectors.

The modern history of the West African coast has been shaped by post-colonialism, civil unrest, political instability. The instability of the region left much of the governmental infrastructure in ruins and prey to looters.

One factor in the EVD outbreak was the severely dysfunctional government structures in the region and the lacking health infrastructure.[3] Another is a general state of poverty and poor hygienic conditions. The societies were also unaware of the severity of the disease.

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[2] Robert A. Fowler et al., "Caring for Critically Ill Patients with Ebola Virus Disease. Perspectives from West Africa," *American Journal of Respiratory and Critical Care Medicine* 190, no. 7 (28, 2014): 733–37, https://doi.org/10.1164/rccm.201408-1514CP.

[3] "Project GB-1-113608 Support to the Liberia Health Sector Strategy Documents," accessed June 5, 2019, https://devtracker.dfid.gov.uk/projects/GB-1-113608/documents.

However, there also were environmental factors at play. The disturbed savannah forest and rainforest habitats are very close to dense population centers. To make matters worse, while humans live close to tropical fauna (fruit bats, monkeys and primates) that are typical vectors of the disease, much of the population of these countries regularly consumes bushmeat, which is obtained from game in the local forests.

VICE's video documentary explored that much of the Liberian urban population distrusted governmental sources on Ebola and the government generally.[4] Much of the bushmeat supply of the urban populations of Liberia, including the capital Monrovia comes from the densely forested area Lofa which is also a location where a new strain of HIV was discovered.

With 14 thousand infected and a mortality of 4 thousand, Sierra Leone had the highest level of contagion as well as roughly half of the victims were located in the country. Meanwhile, there were around 10 thousand infected in Liberia with a fatality of 4 thousand. In order to study these differences, I am going to employ a qualitative focused comparison case study method.

In the first chapter, I am going to review the literature on development policy in relation to the governance of health. I will also review the contemporary literature on the pandemic in relation to the global governance of health. Then, in the second chapter I will lay down the study's theoretic basis and construct a research method. In the third chapter, I will employ this method in two case studies in order to find answers to the research question. In the fourth chapter, I will base recommendations on the findings of the study.

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[4] VICE News, *Monkey Meat and the Ebola Outbreak in Liberia*, accessed May 29, 2019, https://www.youtube.com/watch?v=XasTcDsDfMg&t=573s.

Chapter 1: Literature and evaluation of past policy measures

1.1. Literature review

The global governance of health in a large part has to rely on development policy, as the burden of disease largely falls on underdeveloped societies. However, there is a gap in the theoretic understanding of the development policy solutions for health. Based on McGillivray's explanation, traditionally, the development literature is largely based on socio-economic centered approach to societal development.[5] The central axis of development is still the focus on catalyzing economic sustainability.

Based on Kingsbury's understanding of the environment in development, there is a positive change regarding the environment and health regarding environmental change and its human health aspect for societies.[6] However, the environmental discourse in development policy seems to center on industrial activity and global warming centering on anthropomorphic changes on the planet, and neo-malthusian debates.

These development debates fail to recognize the immediate epidemiological threats of environmental change in the shadow of big picture planetary dangers. The discourse fails to recognize the equally immediate danger of known – and unknown – tropical diseases that can be unleashed into human society by the disruption of tropical habitats. EVD is just one example of this, and so was HIV/AIDS. The academic discourse always circles back to economic policy – Which suggests that health takes a back seat when economic development is in question.

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[5] Mark McGillivray, "What Is Development?," in *International Development: Issues and Challenges* (New York, NY: Palgrave Macmillan, 2008), 21-50.
[6] Damien Kingsbury, "Environment and Development," in *International Development: Issues and Challenges* (New York, NY: Palgrave Macmillan, 2008), 271–98.

Taking to account Phillips and Vershasselt's explanation of health, there is some recognition in the literature that human activities, the physical environment and the biological environment are interwoven factors that affect human health.[7] However, communicable diseases other than the leading global epidemics (HIV, TB, HCV, malaria, etc.) seem to be of secondary importance next to the admittedly serious issues of primary environmental risks, based on Bentham.[8]

There is some progress. Recently, contemporary development literature realizes that human health does not simply rely on economic development. Contemporary development policy highlights important factors behind the human health development problems – The 10/90 problem of disproportionate health research according to Schrecker, the socio-economic risk factors of cities in the global south, the HIV/AIDS pandemic.[9]

The same time, if we take into account Stirling's explanation of risk and precaution based on science, we can see that environmental policy and environmental health studies are equipped to use risk analysis or the precautionary principle.[10] The disease burden of Sub-Saharan Africa does not only stem from anthropomorphic issues and climate change but also from the hard environmental factors.

Aside from EVD, a typical example is malaria.[11] This disease is endemic to the tropical belt and has been such a primary risk factor for much of human history that most of the selective pressure on the modern human genome has been caused by malaria alone. We cannot ignore

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[7] David R. Phillips and Yola Verhasselt, "Introduction: Health and Development," in *Health and Development* (London, UK: Routledge, 1994).
[8] Graham Bentham, "Global Environmental Change and Health," in *Health and Development* (London, UK: Routledge, 1994).
[9] Ted Schrecker, "Development and Health," in *Introduction to International Development* (Don Mills, Ontario, Canada: Oxford University Press Canada, 2012), 373–88.
[10] Andrew Stirling, "Risk, Precaution and Science: Towards a More Constructive Policy Debate," *EMBO Reports* 8, no. 4 (April 4, 2007): 309–315.
[11] Max Roser and Hannah Ritchie, "Malaria," *Our World in Data*, November 12, 2013, https://ourworldindata.org/malaria.

the fact that disease-struck regions of the tropics do not lie in the mild and forgiving temperate belt.

The same time, developing countries' ministries tend to be notoriously corrupt and spectacularly ineffective to be good health stewards, according to Sama and Nguyen.[12] This makes it harder for development programs to reach sustainable goals. While governments, as Collier puts it, "cannot defy gravity",[13] the study of governance in development usually focuses on the socio-economic aspects in developing countries.

Based on these tendencies in the literature, there is a gap between the development studies' understanding of health and the findings of health policy and medical science. First, relying on the work of Huber et al., we can conclude that the basis and definition of health in development studies is still rooted in the mid-twentieth century understanding of health and disease, focusing on acute illnesses, which is a too limited scope.[14] This prevents the employment of more horizontal approaches in health development, tackling issues with chronic disease and environmental factors.

Second, the health aspects of development studies lack the necessary health policy basis of health geography that we see in the study of Daily et al.[15] These factors include the environmental risk factors of respective communities and societies as well as epidemiological risks of urbanization and habitat disruption.

Third, development policy lacks the environmental health approaches of accounting for environmental determinants in population health. A framework similar to that put forward by

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[12] Martyn T. Sama and Vinh-Kim Nguyen, "Governing Health Systems in Africa," in *Governing Health Systems in Africa* (Dakar, Senegal: Council for the Development of Social Science Research in Africa, 2008), 3-14.
[13] Paul Collier, "Bad Governance in a Small Country," in *The Bottom Billion* (New York, NY: Oxford University Press, 2007), 64–78.
[14] Machteld Huber et al., "How Should We Define Health?," *BMJ* 343 (July 26, 2011): d4163, https://doi.org/10.1136/bmj.d4163.
[15] Gretchen C. Daily et al., "The Value of Nature and the Nature of Value," *Science, New Series* 289, no. 5478, (2000): 395–96.

Huynen et al.[16] can show that while certain proximal determinants (Food, water) are accounted for in development theory and practice, distal or contextual determinants are not accounted for. In the framework of Huynen et al., the health geography would be a contextual determinant, part of the ecologic setting. However, distal determinants, for example the ecosystem goods and services used in the society are not often considered.

1.2. Systematic issues with the development and governance of health

The case of the West African Ebola epidemic was a crisis in development policy, health policy and the international governance of human health. (For a map of the outbreak, see Apendix 4) Whether or not the epidemic was unpreventable or an outcome of fatal flaws in policy design is a question that ties into the field of inquiry of this study. We must review the literature on development and health in relation to the EVD crisis in order to formulate a research theory and methodological research design for the thesis.

The literature exploring the disaster highlights issues in the development policy solutions employed in the affected countries. However, the problems run deeper than individual country cases. Contemporary development policy suffers from serious structural problems in the areas of epidemiology and health policy.

First, according to Flessa and Marx[17], the development infrastructure dedicated to the handling and eradication of diseases has a limited vertical approach, focusing on a few global diseases, primarily HIV/AIDS and sexually transmitted diseases like HCV as well as leading

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[16] Maud MTE Huynen, Pim Martens, and Henk BM Hilderink, "The Health Impacts of Globalisation: A Conceptual Framework," *Globalization and Health* 1 (August 3, 2005): 14, https://doi.org/10.1186/1744-8603-1-14.

[17] Steffen Flessa and Michael Marx, "Ebola Fever Epidemic 2014: A Call for Sustainable Health and Development Policies," *The European Journal of Health Economics* 17, no. 1 (January 2016): 1–4, https://doi.org/10.1007/s10198-015-0710-0.

global diseases: TB and malaria. While the international governance of health must address these issues and formulate countermeasures to these epidemics, this approach blinds the involved governments, organizations and populations to unseen epidemiological threats, to which Ebola is a prime example. There is a lack of horizontal structures, monitoring and preparedness. This is very much in line with the gaps in the literature. A horizontal expansion of the development of health must be built on a wider theoretic basis which revisits the definition and theoretic understanding of health and illness.

Second, health policy is becoming a secondary consideration in development programs. While the economic perspectives of sustainable development are thoroughly considered in development projects, agencies and organizations tend to focus less on sustainable health goals. This is apparent in the lack of professional competency in the health aspect of development. Organizations often outsource important work and do not devote the necessary time and resources to health policy. The vertical approach leads to a mindset in which the "health box is ticked."

Third, according to Rull et al.,[18] development policy is not prepared for epidemics. While illnesses like diarrheal diseases, measles or malaria that are endemic to the tropical belt generally have steady and unchanging characteristics normally – Basic reproduction number, infection rate, mortality rate, DALYs caused by the disease – these numbers can skyrocket in an ongoing epidemic, to which the health infrastructures maintained by development policy are not adapted. The limited approach to handling leading diseases does not provide a sound professional basis for identifying approaching or sometimes even ongoing epidemics.

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[18] Monica Rull, Ilona Kickbusch, and Helen Lauer, "Policy Debate | International Responses to Global Epidemics: Ebola and Beyond," *International Development Policy | Revue internationale de politique de développement* 6, no. 6.2 (December 8, 2015), https://doi.org/10.4000/poldev.2178.

Fourth, there is generally a lack of measures to handle health crises. Development policy often lacks the necessary research methods needed to identify threats and arm infrastructures with the needed policy measures. The vertical approach also means that in the health infrastructure of countries targeted by development policy, certain policy measures are not taken that would be crucial in monitoring diseases and preparing for outbreaks. Mosquito nets, condoms and sex education can help with certain diseases – However, more thorough monitoring would be needed,[19] and according to Marx,[20] stakeholder involvement, broader health education and community projects would be needed to prepare populations against other (often unknown) diseases.

Fifth, there is a tendency in the international governance of health of overly securitizing diseases,[21] which leads to misguided policymaking and infrastructures that are unequipped to handle epidemics. The security aspects of global diseases can and should not be ignored. However, there are already other structural issues with the global governance of health and securitization has the tendency of distorting the agenda setting of policy as well as lead to the employment of policy measures that use up even more of the already limited budget and operational capacity of intergovernmental organizations and governments.

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[19] Arlene C. Chua et al., "The Case for Improved Diagnostic Tools to Control Ebola Virus Disease in West Africa and How to Get There," *PLoS Neglected Tropical Diseases* 9, no. 6 (June 2015): 1–6, https://doi.org/10.1371/journal.pntd.0003734.

[20] Michael Marx, "Ebola Epidemic 2014-2015: A Wake-Up Call for Sustainable Health Governance and Development Policy," accessed May 30, 2019, https://intr2dok.vifa-recht.de//receive/mir_mods_00002944.

[21] Peter Wilkin and Abdulai Abubakarr Conteh, "Neoliberal Health Reforms and the Failure of Healthcare in Sierra Leone: The Case of the Ebola Crisis," *African Studies* 77, no. 3 (July 3, 2018): 428–50, https://doi.org/10.1080/00020184.2018.1473237.

Chapter 2: Theoretic and methodological framework

2.1. Theoretic framework

Based on the review of the literature and secondary sources, the following outline can be mapped of the crisis with causal factors that led to the 2013-2016 Ebola crisis.

First, the international development projects launched in the affected countries focused primarily on the augmentation of their economies, governments and infrastructures.[22] There were efforts of strengthening the health infrastructures, especially in Liberia, however, the operational approach taken was based on the outdated development understanding of population health. These projects employed the traditional vertical health policy approach, focusing primarily on major diseases (Malaria, tuberculosis, HCV, diphtheria, typhus, etc), without regard to the more distal factors of environmental risk. Furthermore, the development of the health infrastructures were not fine-tuned to the population distribution in the respective countries and the general infrastructure development did not account for the environmental health risk factors. (Population density, proximity to disturbed rainforest habitats, access to animal disease vectors, lacking disease vector control)

Second, due to the still dysfunctional governmental health infrastructures, the lacking monitoring, enforcement measures, disproportionate population distribution, the 2013 December outbreak could spread to population centers unhindered, where the general

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[22] The World Bank, "Liberia - Monrovia Urban Development Project" (The World Bank, November 30, 1981), http://documents.worldbank.org/curated/en/385921468091176954/Liberia-Monrovia-Urban-Development-Project; "Project GB-1-113608 Support to the Liberia Health Sector Strategy Documents"; The World Bank, "Environmental and Social Assessment and Management Report" (The World Bank, March 1, 2005), http://documents.worldbank.org/curated/en/152311468113093528/Environmental-and-social-assessment-and-management-report; "FREETOWN WASH & AQUATIC ENVIRONMENT REVAMPING PROJECT," African Development Bank, accessed June 5, 2019, https://www.afdb.org/en/projects-and-operations/project-portfolio/p-sl-e00-004/.

weakness of the health infrastructure and lacking governmental response did not stop the spreading of the disease.

Third, the governmental and international responses were inadequate. Governmental responses to the disease were slow, inadequate; the infrastructure was underdeveloped, underfinanced and understaffed. The existing staff was not protected, infection protection and control (IPC) measures were severely lacking.[23] International response to the disease was likewise slow. Various countries received various levels of assistance and international organizations were sluggish in their reaction time, although the tardiness was somewhat balanced by huge resource commitment.

Fourth, the societies were unequipped to handle the disease. On the one hand, the affected societies did not tend to trust their respective government and oblige to the enforcement of rules or to cooperation with the authorities. On the other hand, these societies, primarily the urban populations, were unfamiliar with the Ebola disease and lacked the societal norms and defense measures that other populations, primarily tribal societies in other regions of the continent developed. Many turned to traditional healers instead of professionals, or even distrusted official medical workers.

The working theory of the study is that these factors together led to the 2013 December outbreak developing into a humanitarian crisis. The study will employ a qualitative methodology to investigate the validity of this theory.

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[23] Haitham Shoman, Emilie Karafillakis, and Salman Rawaf, "The Link between the West African Ebola Outbreak and Health Systems in Guinea, Liberia and Sierra Leone: A Systematic Review," *Globalization and Health* 13, no. 1 (4, 2017): 1, https://doi.org/10.1186/s12992-016-0224-2.

2.2. Methodology

The research is based on the structured, focused comparison qualitative case study method. The reason for this is that although quantitative methods fare well with health-related academic inquiries, especially, epidemiology, this thesis focuses more on the public policy aspects of the crisis than the epidemiological modeling of the outbreak. The topic involves development policy as well as health policy and this multidisciplinary approach requires the rich theoretic basis of a qualitative research method.

The method of this thesis is made to be a structured comparison. In the case selection, I decided to focus on two cases of Ebola outbreak throughout the crisis, namely, the case of Liberia and Sierra Leone. These two countries were selected because they have comparable levels of economic development, societal history, government effectiveness and infrastructure development level, however, the crisis concluded in the countries with drastically different outcomes in terms of contagion and mortality rate numbers, which make these two excellent for comparison in testing the theory.

The method is geared specifically toward the handling of the EVD epidemic in the 2013-2016 time window by separate governments. For the understanding of the events and the differing outcomes, I structured the five theoretic factors into five focused independent variables: *Population health, Health infrastructure, Societal tendencies, Governmental response* and *International response.* The dependent variables in this study are the observed outcomes: The respective numbers of total infection, total mortality, and more specifically, the mortality rates in the countries.

There was no new data gathered for this study, however, the methodology relies on primary data sources for four variables: *Population health, Health infrastructure, Societal tendencies, International response.* These primary data sources are the following: The Democratic and

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Health Surveys (DHS) program's 2013 Liberia survey and 2013 Sierra Leone survey, the Afrobarometer survey series Liberia Round 5 (2012) and Sierra Leone Round 5 (2012) surveys, databases from the HumData library of the Centre for Humanitarian Data by the united Nations Office for the Coordination of Humanitarian Affairs, databases from the open source data site OurWorldInData by the University of Oxford, the QWIDS database of the OECD, and Version 9 of the Varieties of Democracy V-Dem dataset. For the data sources of the individual data factors, see Appendix 2.

The research design aims to integrate primary data from various research fields. Each variable in the model is composed of a set of indicators, which are in turn based on multiple data factors of descriptive quantitative data. The theoretic basis of the study is prepared to be used to evaluate the quantitative data and assign qualitative values, therefore translating the clusters of data factors into the indicators of the complex independent variables.

1. Table: International response

Variable	Indicators	Factors	Data type	Date
Inter-national response	Aid influx	Private	Primary	2014
		Public ODA increase	Primary	2000-2017
	Organizational response	Ebola centers functional	Primary	2014
		Ebola centers pending		
		Ebola centers closed		

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The International response variable is based on two indicators – Aid influx and Organizational response. Aid influx measures two data factors. The first is private aid flowing exclusively into the country, which is a proxy for the international interest turned toward the country in question. It is not a direct representation of all the private foreign commitment to solving the crisis in the respective country, there have been numerous donations to funds that handled crisis management in the entire region. This proxy factor only shows how much the respective country was "favored" by private donators expressed in exclusive private aid to the country. The second factor is public ODA increase, the percentage increase in the average ODA flowing into the country in the 2013-2016 period compared to the 2000-2017 average.

Organizational response measures three data factors: The numbers of functioning, pending and closed Ebola centers in the countries by the end of 2014. This shows foreign commitment to the respective country in terms of organizational capacities.

2. Table: Societal tendencies

Variable	Indicators	Factors	Source type	Date
Societal tendencies	Trust in government	Trust to solve health	Primary	2012
		Difficulty of accessing health perception	Primary	2012
	Attitudes towards disease	Importance of health perception	Primary	2012

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The Societal tendencies variable measures the population's response to governmental health policy, importance of health and perception of health issues as well as disease. This variable has two indicators, Trust in government and Attitudes towards disease. All data factors here

rely on the 2012 Liberia and 2012 Sierra Leone Afrobarometer surveys. The first is made up of two data factors. Trust to solve health measures the percentage of responders who answered the question how well they think the government handles health with "Very badly" or "fairly badly". Difficulty of accessing health perception measures the percentage of responders that answered the question how easy do they find accessing health services with "Very difficult" or "Difficult." (This data factor is not meant to measure actual access to health services – There is a separate data factor for that in Health infrastructure.)

The Attitudes towards disease indicator is based on one data factor: Importance of health perception. This factor measures the percentage of responders that mentioned "Health," "AIDS," or "Sickness/Disease" as one of the three primary problems of their respective country.

3. Table: Population health

Variable	Indicators	Factors	Data type	Date
Population health	Demography	Life expectancy	Primary	2000-2015
		Infant mortality	Primary	2000-2015
		Urbanization	Primary	2013
	Sanitation	Poor sanitation deaths	Primary	2000-2017
		Diarrhea deaths	Secondary	2016
		Unsafe water deaths	Primary	2000-2017
		Poor sanitation	Secondary	2016

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		DALY children		

The Population health variable is also based on two indicators, Demography and Sanitation. This shows the general health level of the populations in the beginning of the crisis as well as how much poor hygiene was responsible for the crisis. The Demography indicator is based on three factors: Life expectancy, Infant mortality and urbanization rate. The first is the average life expectancy of the countries between 2000 and 2015 in years. The second is a yearly average of infant mortality rates between 2000 and 2015 in the numbers of deaths under age 1 per 1000 live births. The third is the urbanization rate of the respective countries according to Statista.com and WHO reports. The Sanitation indicator is made up of four data factors: Poor sanitation deaths, which measures yearly average deaths in connection with poor sanitation conditions and Unsafe water deaths which measures yearly average deaths connected to diseases caused by contaminated water source and no access to clean water. Diarrhea deaths and Poor sanitation DALYs for children (measuring disease-adjusted life years for the <5 years population segment) are based on the WHO's global health atlas data.

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4. Table: Health infrastructure

Variable	Indicators	Factors	Data type	Date
Health infrastructure	Vaccination	DPT3	Primary	2000-2015
		Measles	Primary	2000-2015
	General health infrastructure	Issues with access to public	Primary	

		hospital		
		Fighting HIV	Primary	2000-2015
		Maternal mortality	Primary	2013
	Ebola infrastructure	Health care worker ebola	Primary	2014-2015
		Health care worker death	Primary	
	Health communication	Education 15+	Primary	2000-2018

Health infrastructure reflects the governmental infrastructure which played a pivotal role in the handling of the crisis, and in turn, this variable is the most complex. It is made up of four indicators: Vaccination, General health infrastructure, Ebola infrastructure and Health communication.

The Vaccination indicator is measured by two factors: DTP3 vaccination and measles vaccination. These two serve as proxy factors for the general functionality and coverage of the health infrastructure in terms of ability to combat diseases. These two proxies were selected because they represent population immunization measures which are cardinal for any society, therefore, even in the most underdeveloped countries have to reach a high percentage.

DTP3 is the name for the combined vaccine for diphtheria, pertussis (whooping cough) and tetanus. Measles is one of the most contagious communicable diseases with a basic reproduction number of 16-18,[24] which is almost 8-12 times higher than an average influenza strain. This makes the required immunization level of any population to be at least higher

[24] "The Basic Reproduction Number (R0) of Measles: A Systematic Review. - PubMed - NCBI," accessed May 30, 2019, https://www.ncbi.nlm.nih.gov/pubmed/28757186.

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than 90%+, making any lower number ineffective and marking a dysfunctional health infrastructure.

The General health infrastructure indicator is made up of three data factors. Issues with access to public hospital is a factor that identifies the portion of the population which does not have basic access to public hospitals or healthcare facilities or the only way for them to gain access is at great difficulty. This factor is measured by primary data gathered in three DHS household surveys. In the case of Liberia the questions "How far is the nearest hospital in minutes" and "method of transportation" are considered and responders who are in at least 60 minutes' walking distance or 120 minutes private/public transportation distance away from the nearest hospital are considered to not have basic access to public hospitals. In the case of Guinea, the questions "Why not go in a health facility" are considered and the answers "No money," "No facility in the area," "Bad reception at hospital" are considered, which mean that there is either a facility in the vicinity which is private and the responder does not have the funds anyway, or there is a hospital but for some reason the responder cannot get treatment there, or else, the answer directly states that there is no hospital – All three leading to the same conclusion, that public healthcare is not accessible to the responder in the vicinity.

In the case of Sierra Leone, the answer to the question, "is it a problem to access the hospital" is considered and the answers stating that it is a "big problem" are counted as no access to healthcare. The individual values of the factors will be calculated as percentages from the response rates of the respective surveys.

The other two data factors of The General health infrastructure are Fighting HIV and Maternal mortality. The first is the percentage decrease of total HIV prevalence in the population between 2000 and 2015, which signifies the development of the general coverage

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of health policies in the country. Although the previous chapter has shown that a general systematic issue of health in development policy is a vertical approach to the major diseases (Including HIV), the other factors cushion for the distortion in the general development of health. (If the vertical approach is true then the numbers will show progress even if the overall state of the health infrastructure worsens.) The last factor, Maternal mortality, shows the annual deaths of mothers in childbirth or shortly after giving birth per 100 000 live births. Since maternal mortality is in large part caused by infections or other preventable causes, the ability to shield vulnerable young mothers at maternity wards signifies the level of development in the health infrastructure.

The Ebola infrastructure indicator shows how much the health capacity of the respective governments was adaptable to the specific health factors of Ebola. Since Ebola requires preparation on the part of hospitals and medical facilities and the training of personnel and staff, an unequipped and unprepared healthcare infrastructure will lead to high contamination rates which will be in turn followed by high rates of the contagion of the personnel. This is reflected in the Ebola worker contagion factor. Another important factor is how much the medical facilities can take care of their crucial personnel who have been infected, with high rates of healthcare worker deaths suggesting worse handling of the crisis. This is reflected in the Health care worker deaths factor.

The final indicator in the General health infrastructure is Health communication. This is measured by the factor education 15+, which measures the average years of education over the age of 15 in years in the respective country. This is an important indicator because a recurring criticism of development policy and the governance of health is a lack of emphasis on horizontal health development and a lack of focus generally on education, which is an important societal structure needed for health awareness.

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These three variables are based on primary sources and are engineered specifically to measure for the general status of the populations, the health infrastructure's general level of preparedness and its ability to adapt to the specific crisis at hand at the beginning of the EVD outbreak as well as the burden shared by the international community in the handling of the crisis.

The remaining Governmental response variable is based on secondary sources. It is made up of the indicators Containment and Health policy measures. These are based on secondary data gathered from country reports from WHO as well as news sources. The use of secondary sources here will ensure a higher coverage of available information.

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Chapter 3: Case studies

3.1. Assigning values to the variables

As explained in the methodology chapter, the research method's variables are each based on indicators, which are in turn, based on data factors. These descriptive statistical data factors are based on primary research data except for the *Governmental response* variable. The numeric data is turned into qualitative values based on secondary literature where applicable, or else, evaluated by the observation of the data. For the evaluation method, see Appendix 1. For the original data, see Appendix 3 and for the data sources, Appendix 2.

3.2. Case study: Sierra Leone

5. Table: Sierra Leone variables

Variable	Indicators	Factors	Value
International response	Aid influx	Private	Equality in favor
		Public ODA increase	Twice the average
	Organizational response	Ebola centers functional/dysfunctional ratio	Moderate efficiency
Governmental response	(Secondary source data)		
Societal tendencies	Trust in government	Trust to solve health	Low trust
		Difficulty of accessing health perception	Moderate percieved difficulty
	Attitudes towards disease	Importance of health perception	Very low importance
Population health	Demography	Life expectancy	Very low
		Infant mortality	Very high
		Urbanization	Below average
	Sanitation	Poor sanitation deaths	Very severe
		Diarrhea deaths	Very severe
		Unsafe water deaths	Very severe

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		Poor sanitation DALY children	Very severe
Health infrastructure	Vaccination	DTP3	Very low
		Measles	Very low
	General health infrastructure	Issues with access to public hospital	Catastrophic
		Fighting HIV	Bad
		Maternal mortality	Very high
	Ebola infrastructure	Health care worker infection/death rate - Equipment for disease	Unequiped
	Health communication	Education 15+	Low

Sierra Leone suffered the bulk of the infections throughout the epidemic. Out of the 28 646 total recorded cases, 14 124 were located in the country. However, with 3 956 deaths, the observed dependent variable (Death rate) takes the lower value out of the two cases (28%). While the outbreak started in December 2013, no significant governmental response was formulated until June 2014 and by December, Sierra Leone surpassed Liberia in the number of infections.[25] This shows that *Governmental response* was slow. The same time, experience was lacking and IPC measures were only deployed months after the pandemic started.[26]

The *International response* variable shows little difference between the cases. The influx of private donations was less exclusively dedicated to Sierra Leone, (1.4%), the public ODA spending increase surpassed the average global increase (35%) almost by two times (69%). However, the organizational response of the international community was ineffective, only 50% of the new Ebola centers were functional by the end of 2014.

The *Societal tendencies* variable shows slight differences. Note that the evaluation of the data factors relies on data that is at times only marginally different from that of Liberia, however,

[25] "WHO | Ebola in Sierra Leone: A Slow Start to an Outbreak That Eventually Outpaced All Others," WHO, accessed June 10, 2019, http://www.who.int/csr/disease/ebola/one-year-report/sierra-leone/en/.
[26] Shoman, Karafillakis, and Rawaf, "The Link between the West African Ebola Outbreak and Health Systems in Guinea, Liberia and Sierra Leone."

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the Sierra Leone and Liberia figures consistently follow the same respective patterns through data factors. The distrust in the government's capacity to solve health (28.3%) is lower here similar to the perceived difficulty to access health (48.3%). The society, similar to Liberia, places a low importance on health in general. (13%)

The *Population health* variable is first that shows major deviations between the cases. Life expectancy (53.67 years), infant mortality (9.2%) are both lower than that of Liberia. The population is more distributed (41%). Sanitation is severe across the board, poor sanitation deaths (1235), diarrhea deaths (3269), unsafe water deaths (1442) and poor sanitation-caused DALYs for children under 5 (106 097) are all much higher than they would be with equal conditions but proportionate to Sierra Leone's larger population. This variable, at first, seemingly contradicts the results of the dependent variable since worse population conditions should indicate higher death rates in pandemics, however, the cardinal factor here is the lower urbanization rate.

The final variable, *health infrastructure,* likewise seemingly contradicts the results. The figures here are either comparable or worse than Liberia. The two proxy factors for immunization and in turn, defense against pandemics, measles and DTP3 are higher, (72.12% and 70.75%) respectively, but both are comparable in the sense that they fall below acceptable levels of immunization. Public access to healthcare is equally catastrophic in both countries (With SL having a marginally higher rate of lack of access, 37%). In terms of the general health infrastructure, Sierra Leone is in a worse state, with a 0.4% increase in HIV prevalence and very high maternal mortality. (1100) This is also apparent in the Ebola response infrastructure's state of unpreparedness (71.9% HCW deaths) and a general lack of ability for health education with a low value (3.89 years) of after-15 education.

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3.3. Case study: Liberia

6. Table: Liberia variables

Variable	Indicators	Factors	Value
International response	Aid influx	Private	Equality in favor
		Public ODA increase	Above average
	Organizational response	Ebola centers functional/dysfunctional ratio	Moderate efficiency
Governmental response		(Secondary source data)	
Societal tendencies	Trust in government	Trust to solve health	Low trust
		Difficulty of accessing health perception	Major percieved difficulty
	Attitudes towards disease	Importance of health perception	Very low importance
Population health	Demography	Life expectancy	Low
		Infant mortality	Very high
		Urbanization	Above average
	Sanitation	Poor sanitation deaths	Severe
		Diarrhea deaths	Very severe
		Unsafe water deaths	Severe
		Poor sanitation DALY children	Very severe
Health infrastructure	Vaccination	DTP3	Very low
		Measles	Very low
	General health infrastructure	Issues with access to public hospital	Catastrophic
		Fighting HIV	Good
		Maternal mortality	Regional average
	Ebola infrastructure	Health care worker infection/death rate - Equipment for disease	
			Unequiped
	Health communication	Education 15+	Low

The EVD outbreak in Liberia is a more enigmatic case. While the data on Sierra Leone undoubtedly points towards disaster, the data on Liberia suggests that the country was positively recovering and progressing better after the two-decades-long civil war period. Still,

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the dependent variable (death rate) here is higher; With 4809 deaths out of 10675 infection cases, it rests at a high 45,04%.

As opposed to Sierra Leone, the pandemic in Liberia opened with a drastic and fast-paced outbreak followed by a long struggle on the part of the government and the international community to contain the spreading of the disease in the more densely populated country. The government tried to build an Incident Management System but it was understaffed. Its head was the Deputy Health Minister/Chief Health Officer who had to oversee other areas too without much operational assistance.[27] This was expanded in August 2014, in large part with international help. However, on the operational side, the government was not equipped to train crucial staff for transporting Ebola patients and due to lack of road access, staff routinely had to travel on foot for up to 8 hours to reach communities.[28] In multiple counties, crucial medical equipment had been already depleted even before cases with infection could have appeared.[29]

The *International response* variable does not show major deviations. Private donations were slightly more dedicated in this case (2.8% exclusivity), the public ODA increase was much lower, still, much above the global 35% average. (45,7%). The organizational efficiency of the international aid community was comparable (57%).

The *Societal tendencies* variable shows a slight divergence. Trust in government is slightly, but consequently lower here, with major perceived difficulties in accessing health (52.9%)

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[27] Pillai Satish K. et al., "Developing an Incident Management System to Support Ebola Response — Liberia, July–August 2014," *Morbidity and Mortality Weekly Report* 63, no. 41 (2014): 930.
[28] Summers Aimee et al., "Challenges in Responding to the Ebola Epidemic — Four Rural Counties, Liberia, August–November 2014," *Morbidity and Mortality Weekly Report* 63, no. 50 (2014): 1202.
[29] Forrester Joseph D. et al., "Assessment of Ebola Virus Disease, Health Care Infrastructure, and Preparedness — Four Counties, Southeastern Liberia, August 2014," *Morbidity and Mortality Weekly Report* 63, no. 40 (2014): 891.

and higher rates of distrust in the government's ability to solve health issues (32.5%). The public put a low importance on health comparable to SL (14.2%).

Population health is a major deviation. The high urbanization rate (58%) is a stark difference. Otherwise, life expectancy (58.9 years) and infant mortality (6.7%) are low and very high results respectively. Poor sanitation deaths (720) and unsafe water deaths (869) are severe; poor sanitation-caused DALYs for children (37 217) and diarrheal deaths (1053) are very severe. However, these figures are all better than those of Sierra Leone, coming closer to the Sub-Saharan average numbers and showing massive recovery in the population. They do not explain the high EVD death rate.

The *health infrastructure* also shows a better state. Immunization rates for measles and DTP3 (58.68% and 64.25%, respectively) are generally very low and lower than those of SL, however, the (still Catastrophic) publically accessible healthcare is in a slightly better state (33% inaccessibility). Fighting HIV is well progressing (-2.7%) and maternal mortality (640) reached a lower regional average. The Ebola infrastructure's state of unpreparedness is lower (50.7%) and the health-wise important education system is better with higher Education 15+ (4.97)

3.4. Comparing results

7. Table: Comparing qualitative variables

Variable	**Sierra Leone**	**Liberia**
International response	well-funded but slow in response and ineffective in delivery.	well-funded but slow in response and ineffective in delivery.

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Governmental response	slow, lacking experience, problems with mobilization, untrained staff	slow, lacking experience, problems with mobilization, problems with infrastructure, untrained staff
Societal tendencies	generally low trust in the government and in the health infrastructure with low focus on health	definitively low trust in the government and in the health infrastructure with low focus on health
Population health	less urbanized, more rural population with generally very low health conditions and very severe issues in sanitation	more urbanized population with low to mixed health conditions and severe to very severe issues in sanitation
Health infrastructure	in a generally critical condition and being severely unequipped for a major pandemic	mixed to critical condition and being mostly unequipped for a major pandemic

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At first, the independent variables do not seem to explain the observed diverging outcomes in death rates (28% in Sierra Leone and 45.04% in Liberia). Both the *International response* and *Governmental response* variables are comparable in the two cases. *Societal tendencies* shows slight but consistent divergence insofar as Liberia's values for the population's trust in the government are somewhat lower. These are within a reasonable margin for error, however,

the results are consistent across the board. *Population health* shows the first major divergence in the fact that Liberia is much more urbanized and dense in population compared to Sierra Leone. However, the final two variables show considerable divergence in the favor of Liberia. The country's population health was in a much better state leading up to the crisis, as compared to that of her sister country's respective figures. The *Health infrastructure* likewise tilts the scales in favor of Liberia with better figures for most factors except for immunization, showing definitive progress in the development of health.

The variables alone would show that it was mostly the Liberian higher level of urbanization and the society's lower trust in the government's capacities to solve health issues which led to higher death rates in Liberia. However, relying on the strength of the qualitative method, the comparison of the results with the study's theory yields different results.

The theory lists the overreliance on socio-economic change, infrastructure and a traditional vertical health approach as its first cause for the pandemic. This is supported by the case studies. Especially Liberia needed massive health investment in the last two decades and the figures are very much in line with the development project trends referenced in the previous chapter. The lower HCW death rate suggests an overall slightly better equipped Liberian health workforce. The *Population health* and *Health infrastructure* variables generally follow this pattern. The more favorable figures in both the *Demography* and *Sanitation* indicators of *Population health* reflect the efforts undertaken by international development projects in addressing general health issues. These however, are some of the narrow primary targets of health governance. A much lower number of diarrhea-related, poor sanitation-related deaths, a decrease in the poor sanitation-related DALYS in children show that there was progress in the targeted areas.

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However, this also shows the shortsightedness of the development solutions for health. The high number of population distrust in the government shows the lack of horizontal approaches, the lack of extensive community outreach and stakeholder engagement. This is in agreement with the overall low perceived importance of health in the country.

The second cause listed by the theory is the dysfunctional health infrastructure which was not geared toward the population distribution and monitoring of the health environment. This is also very palpable in the results. *Health infrastructure* backs this argument up with figures. A lower maternal mortality shows better hygienic conditions in hospitals. A stark -2.7% decline in HIV prevalence shows the results of traditional health development. Seemingly, health was progressing well, based on the figures of the targeted diseases – Aside from the better state of *Population health*, the *Health infrastructure* indicator mostly shows progress. However, issues outside the traditional paradigm of health governance (the focus on the major communicable diseases) were still very much present. Despite the progress in major areas, the accessibility of the health infrastructure (33%) is better but still critical for being below the minimum population healthcare access (80% according to the literature). Immunization is not only very low but falls behind even Sierra Leone (Both Measles and the DTP3 immunization is much lower than the desired threshold levels for societal herd immunity).

The third cause listed by the theory is that governmental and international responses were slow and inadequate. This is also backed by the case studies. The secondary sources list governmental issues which reflect a general lack of competency for handling tropical pandemics both organizationally and in terms of staff and infrastructure. The data factor *Ebola infrastructure* shows very high levels of healthcare worker deaths in both cases as well. The international response was well-funded but slow and inefficient in both cases which

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is reflected in the unusually high levels of aid but a slow progression in the establishment of Ebola clinics.

The fourth cause listed by the theory is that societies were unequipped to handle the pandemic. Both case studies partially confirm this. The generally low level of perceived importance of health not only suggests the lacking community outreach of health policy but also the societies' inexperience with trending tropical belt diseases. The high level of distrust in the government arguably hindered possible avenues of communities' cooperation with local and national authorities. The observation in the literature that traditional healers were preferred, nurses and other HCWs were often stigmatized and diseases are still often seen as outcomes of supernatural phenomena is partially confirmed by the data factor *Difficulty in accessing health perception.* Another possible cause for the reliance on faith healers is consistently higher levels of perceived lack of access to healthcare than actual inaccessibility figures (52.9% as compared to an actual 33% in the case of Liberia and 48.3% as opposed to an actual 37% in Sierra Leone). In the case of Liberia, a higher distrust in the government is interestingly mirrored by a higher gap in the perceived and the actual levels of inaccessibility to public healthcare, showing a major lack of information on health in the society.

In summary, the case studies show that the divergence in death rates between the two cases can be explained through the observation of the independent variables and their comparison with the theory. The independent variables that can explain the diverging observed outcomes are *Societal tendencies, Population health* (mostly the *Demography* indicator) and *Health infrastructure.*

Liberia diverges from Sierra Leone with an overall better *Population health* but with a higher level of urbanization. *Societal tendencies* are also less favorable towards the government and health policies in the country. *Governmental response* and *International response* were both

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inadequately slow and ineffective in both countries. The *Health infrastructure* was in an overall better state in Liberia in terms of the traditional health governance approach of vertical focus on major trending communicable diseases, but showed a lack of horizontal monitoring and equipment for health risks. Three causes in the theory (Traditional health approach, ineffective infrastructure, slow and ineffective international and governmental response) are confirmed and the fourth (Society unequipped for pandemic) is partially confirmed by this.

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Chapter 4: Policy suggestions

4.1. Finding population health determinants

To understand the risk factors that threaten Sierra Leone and Liberia, policy makers must rely on more detailed multi-disciplinary research. While policies should be based on thorough risk analyses and also the consideration of the precautionary principle in relation to those risks, the scope of the study does not permit a broad environmental health analysis of the region. Lacking the scope of environmental science and policy, my policy recommendations will be based on a crude adaptation of the conceptual framework laid down by Huynen et al. to identify population determinants based on sector and proximity. The determinants already under the scope of development policy are marked in italics.

Framework for Liberia

8. Table: Preliminary analysis of Liberia population health determinants

	Institutional determinants	**Economic determinants**	**Socio-cultural determinants**	**Environmental determinants**
Proximate determinants	Failed governmental measures to regulate bushmeat	Low economic development increases consumption of bush meat	No social norms regulating the consumption of bushmeat	Tropical rainforest environment: Rabies, *Ebola, HIV*
	Immunization programs		Burial rituals	Unidentified threats of disturbed rain forest habitats
	Hospital hygiene (Hospital contamination and maternal mortality)		Potential contamination through infection of faith healers	
	Disease containment wards			
	Health staff			
Distal	Lack of horizontal	Economic	Health	

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determinants	monitoring	development, trade	knowledge	
		Port of Monrovia in contact with much of the world (South America!)[30]	Community engagement	
		If Port of Monrovia outbreak happens, can halt the economy	Stakeholder engagement	
			Attitudes towards HCW	
Contextual determinants		*Economic infrastructure* needs development	Dense population dangers	Sub-Saharan Africa disease burden: *Tuberculosis, Influenza, Diphteria, Tetanus, Pertussis, Diarrheal diseases*
		Food security unimproved	Very low trust in government	Tropical belt diseases: *Malaria*

Economic development determinants influence the bushmeat consumption of society, which affects the handling of potential zoonotic disease vectors. Also, much of Liberia's economy relies on maritime commerce. The country is the world's second most favored flag of convenience state. The through traffic in the Port of Monrovia is both an economic opportunity and a risk factor which has to be addressed. What is also important is that if a health crisis even temporarily cripples the maritime commerce of the Port of Monrovia, (where 90% of the country's economic activity is conducted) then it will have a devastating impact on the economy of the country and in turn, on population health.

[30] Eline Terneusen, "Sector Scan: The Logistics Sector in Liberia" (Liberia Netherlands Business and Culture Council (LNBCC), 2017), https://www.rvo.nl/sites/default/files/2018/07/Sector-Scan-Liberia-Logistcs.pdf.

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In the socio-cultural sector, horizontal health approaches should focus more on stakeholder and community engagement as well as health education and more fundamental environmental health measures should be considered to handle the potential health geography risks of the disturbed tropical rainforest. Also, the high urban population density and the population's distrust in the government should be addressed.

Framework for Sierra Leone

9. Table:Preliminary analysis of Sierra Leone population health determinants

	Institutional determinants	**Economic determinants**	**Socio-cultural determinants**	**Environmental determinants**
Proximate determinants	*Immunization programs*	Low economic development increases consumption of bush meat	No social norms regulating the consumption of bushmeat	Tropical forested savannah and rainforest environment: Rabies, Ebola, HIV
	Hospital hygiene (Hospital contamination and maternal mortality)		Burial rituals	Unidentified threats of disturbed rain forest habitats
	Disease containment wards		Potential contamination through infection of faith healers	
	Health staff			
Distal determinants	Lack of horizontal monitoring	Economic development, trade	Health knowledge	
			Community engagement	
			Stakeholder engagement	
			Attitudes towards HCW	
Contextual determinants	*Transport infrastructure* needs development	*Economic infrastructure* needs development	Low trust in government	Sub-Saharan Africa disease burden: Tuberculosis, Influenza, Diphteria, Tetanus, Pertussis

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		Food security unimproved		Tropical belt diseases: Malaria

The country is less densely populated, however, its health infrastructure needs more work. The core issues with the overly vertical development approach, the lack of horizontal monitoring and outreach as well as education however are present here as well.

4.1. Networked monitoring

The proposal is to expand the horizontal capacities of health infrastructures by establishing health monitoring centers. These would be fashioned after the economic model of anonymous HIV clinics. In the same fashion as HIV clinics offer testing services to patients anonymously, health monitoring centers would conduct blood sampling and testing for patients who suffer from either EVD-like symptoms[31] or symptoms from other typical regional diseases.

Considering the fact that the physical environment presents many of the health risk factors, the northern regions of Liberia, the eastern regions of Sierra Leone and the capitals, Freetown and Monrovia would need to be monitored first with at least one monitoring centers in the main ports of both cities.

In Liberia, the first target to monitor is Monrovia and the Port of Monrovia. Monrovia's population of 930 thousand presents a challenge of its own in terms of monitoring and the city would require multiple testing facilities on its own. The next target is Voinjama, a city of 26 500 inhabitants and the capitol of Lofa county, which is primarily vulnerable to environmental threats. Lofa is a center for the bush meat trade and is in the heart of the woodlands of the West African shore. Its larger region is not only interconnected with the

[31] "Diagnosis | Ebola (Ebola Virus Disease) | CDC," March 27, 2019, https://www.cdc.gov/vhf/ebola/diagnosis/index.html.

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two other countries but also ground zero for multiple diseases. (Among others, as the sources indicated, EVD and HIV.) The next targets should be Kakata, Gbarnga and Bensonville, the three largest cities after Monrovia, all located in the central part of the country, close to the capital.

In Sierra Leone, aside from the capital Freetown and the Port of Freetown, the two largest cities, Bo and Kenema in the south, need to be monitored as well as Makeni, in the central part of the country and Segbwema and Kailahun in the forested areas along the Moa river.

It would be best to accompany these with monitoring centers in Guinea, primarily, Nzérékoré in the southeastern part, close to Lofa in Liberia, and Guéckédougou upriver on the Moa from Kailahun and in the capital Conakry.

With five monitoring clinics in each capitol, one in each seaport, four regional clinics in Liberia, five in Sierra Leone, two in Guinea, the number of monitoring clinics would total at twenty-nine. Considering the HIV clinics these are fashioned after, which can range between $1100 and $16100 in startup costs and up to $153000 in annual costs including counseling[32] and calculating with a less optimistic $20 000 for startup and $200 000 per monitoring clinic, the annual costs for the region would be around $6 380 000. Although that is a high figure, for context, the proxy data factor for exclusive private donation to Liberia during the crisis returned the value of $6 289 000 which was around 2.8% of the private donations, which is a fraction of all donations.

However, the backbone of this monitoring system should be an online cloud database that interconnects the monitoring clinics in a dedicated network. The closest infrastructural analogue would be the new DIAS cloud storage center being built in Poland for the European

[32] Ashley A. Eggman et al., "THE COST OF IMPLEMENTING RAPID HIV TESTING IN SEXUALLY TRANSMITTED DISEASES CLINICS IN THE UNITED STATES," *Sexually Transmitted Diseases* 41, no. 9 (September 2014): 545, https://doi.org/10.1097/OLQ.0000000000000168.

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Space Agency's Copernicus earth observation program which cost $17.8 million.[33] This would ensure the geographic monitoring of diseases between the monitoring clinics, serving as a first line of defense against environmental health factors. The total cost with the establishment of the clinics and the network storage and the cost of the first year of operation would total at $24 280 000.

For a map depicting the locations of the suggested clinics, see Appendix 5.

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[33] "Copernicus DIAS Is Biggest ESA Contract for Poland to Date," SpaceNews.com, December 22, 2017, https://spacenews.com/copernicus-dias-is-biggest-esa-contract-for-poland-to-date/.

Conclusion

This thesis studied the 2013-2016 West African Ebola outbreak and the diverging mortality rates in West African countries throughout the pandemic.

The research question of the thesis was the following: *Why did the 2013 Ebola outbreak in West Africa become a severe pandemic in certain countries and how can such diseases be stopped in the future?*

This study employed a research method based on a variety of primary (as well as to an extent, secondary) data sources in order to find answers to this inquiry. The methodology used a qualitative focused comparison case study method. For the case studies, I chose to research Sierra Leone and Liberia. The observed outcome, mortality rate by the end of the crisis in 2016, in the case of Sierra Leone and Liberia, were 28.04% and 45%, respectively, which is a major difference.

The cases were built on the comparison of five independent variables which were used to explain the divergence in the observed outcomes. These were *International response, Governmental response, Societal tendencies, Population health* and *Health infrastructure.*

The main findings are the following: While the *International response* and *Governmental response* were very similarly slow and inadequate, *Societal tendencies* showed the first divergence with a small, but consistent lower level of societal trust toward the government, governmental policies and health policy on the part of Liberia, which arguably affected policy efficiency. *Population health* and *Health infrastructure* showed that Liberia was in a considerably better state than Sierra Leone, which does not explain in itself the higher Liberian mortality rate. However, the variables also show that although Liberia was doing better in terms of the traditional vertical health development approach, its denser, more urban

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population was not better shielded against tropical disease outbreaks. Horizontal approaches, monitoring, societal engagement, health education all were low or missing in both countries.

Based on these findings, the answer to the research question is that the structurally flawed health infrastructures, the lack of protection against environmental health risks such as diseases, the missing policy evaluation and design that could handle health geographic issues and horizontal challenges, the lack of preparedness and awareness in the societies, the overly vertical approach to health policy and epidemiology on the part of international development projects and the slow and inadequate governmental and international response all contributed to the pandemic in both countries. However, while on paper, Liberia was doing better, the above-mentioned factors meant that its more dense, more urban society, which was also less trusting of its government, was unequipped to sudden disease outbreaks and this led to higher mortality rates despite considerable previous health developmental progress.

The thesis also laid down rudimentary policy measures that could help patching holes in existing policies.

The global disease burden still largely falls on Sub-Saharan Africa. Health does not only depend on economic development or societal progress. Diseases will continue to spread, pandemics will continue to break out without regard to human borders, societal barriers or economic figures. The still-present health issues of the West African shore affect tens of millions, and in the larger context, the lives of hundreds of millions in people in Sub-Saharan Africa. The next HIV-like tropical viral disease can appear in the disturbed rainforests of the West African shore practically any time, causing global ramifications. Meanwhile, health issues still mean immeasurable suffering and death for tens of millions of people. The book cannot be closed on the development of health.

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Appendices

Appendix 1: Data factor value assignment method

Variable	Indicators	Factors	Method for determining value				Source
International response	Aid influx	Private	Equality in favor	Favored			OECD QWIDS
			<10% Not significant exclusive donation	10%< Significant exclusive donation			
		Public ODA increase	Below average	Average	Above average	Twice the average	
			<35.5%	35.5%	35.5%<	2x35%	
	Organizational response	Ebola centers functional	Inefficient	Moderately efficient	Efficient	Highly efficient	
		Ebola centers pending	<40%	around 50%	80%<	90%	
		Ebola centers closed					
Governmental response	(Secondary source data)						
Societal tendencies	Trust in government	Trust to solve health	Very low trust	Low trust	Majority trusts	High trust	
			<20%	20-50%	51% +	80% +	
		Difficulty of accessing health perception	Low percieved difficulty	Moderate percieved difficulty	Major percieved difficulty	Very high percieved dificulty	
			<20%	20-50%	51% +	80% +	
	Attitudes towards disease	Importance of health perception	Very low importance	Low importance	Important for majority	Important for overwhelming majority	
			<20%	20-50%	51% +	80% +	
Population health	Demography	Life expectancy	Very low	Low	Average	Above average	
			45-55	55-65	72 (65+)		WHO[34], OurWorldInData
		Infant mortality	Very high	High	Average	Above average	
			5-10%	2.7-5%	2.7	0.8 (Europe)	WHO[35]
		Urbanization	Below average	Average	Above average		
			<54%	54%	54%+		World Bank
	Sanitation		Very severe	Severe	Moderate	Good	
		Poor sanitation	1000	100-999	30-99	2-29	WHO Dynamic reports[36]

[34] "WHO | Life Expectancy," WHO, accessed June 13, 2019, http://www.who.int/gho/mortality_burden_disease/life_tables/situation_trends/en/.

[35] "WHO | Infant Mortality," WHO, accessed June 13, 2019, http://www.who.int/gho/child_health/mortality/neonatal_infant_text/en/.

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		deaths					
		Diarrhea deaths	1000	100-999	30-99	2-29	WHO Dynamic reports
		Unsafe water deaths	1000	100-999	30-99	2-29	WHO Dynamic reports
		Poor sanitation DALY children	1000	100-999	30-99	2-29	WHO Dynamic reports
Health infrastructure	Vaccination	DTP3	Very low	Low	Acceptable	Good	
			0-74%	75-80%	80-85%	86%+	Herd Immunity: History, Theory, Practice[37]
		Measles	Very low	Low	Acceptable	Good	
			0-80%	81-90%	90-95%	96%+	Measles vaccination is Best For Children: The Argument of Relying on Herd Immunity Fails[38]
	General health infrastructure	Issues with access to public hospital	Catastrophic	Highest acceptable			
			20%+	20%			WHO report[39]
		Fighting HIV	Good	Bad			
			Decreasing value	Increasing value			
		Maternal mortality	Very high	Regional average	World average	Developed	
			846+	546-846	246-346	<70	UNICEF Data[40]
	Ebola infrastructure	Health care worker ebola	Well equiped	Unequiped			
			0-30%	30%+			Pandemic (H1N1) 2009 Risk for Frontline Health Care Workers[41]
		Health care worker death					
			Low	Rough global average	High		
	Health communication	Education 15+	<5	6.37-9.42	9.42 +		NationMaster database[42]

[36] "Public Health and Environment," WHO | World Health Organization, accessed June 13, 2019, http://gamapserver.who.int/gho/interactive_charts/phe/wsh_mbd/atlas.html.

[37] Paul E. M. Fine, "Herd Immunity: History, Theory, Practice," *Epidemiologic Reviews* 15, no. 2 (1993): 265–302, https://doi.org/10.1093/oxfordjournals.epirev.a036121.

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[39] "WHO | New Report Shows That 400 Million Do Not Have Access to Essential Health Services," WHO, accessed June 13, 2019, https://www.who.int/mediacentre/news/releases/2015/uhc-report/en/.

[40] "Maternal Mortality," UNICEF DATA, accessed June 13, 2019, https://data.unicef.org/topic/maternal-health/maternal-mortality/.

[41] Caroline Marshall et al., "Pandemic (H1N1) 2009 Risk for Frontline Health Care Workers," *Emerging Infectious Diseases* 17, no. 6 (June 2011): 1000–1006, https://doi.org/10.3201/eid1706.101030.

[42] "Countries Compared by Education > Average Years of Schooling of Adults. International Statistics at NationMaster.Com," accessed June 13, 2019, https://www.nationmaster.com/country-info/stats/Education/Average-years-of-schooling-of-adults.

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Appendix 2: Data factor sources

Variable	Indicators	Factors	Source
		Private	HumData[43]
	Aid influx	Public ODA increase	OECD QWIDS[44]
		Ebola centers functional	
		Ebola centers pending	
International response	Organizational response	Ebola centers closed	HumData[45]
Governmental response		(Secondary source data)	
		Trust to solve health	
	Trust in government	Difficulty of accessing health perception	
	Attitudes towards disease	Importance of health perception	
Societal tendencies			Afrobarometer[46]
		Life expectancy	V-Dem Version 9[47]
		Infant mortality	V-Dem Version 9
	Demography	Urbanization	Statista[48], World Bank database[49]
		Poor sanitation deaths	
		Diarrhea deaths	
		Unsafe water deaths	
Population health	Sanitation	Poor sanitation DALY children	OurWorldInData[50]

[43] "Financial Tracking of Private Sector Contributions Ebola 2014 - Humanitarian Data Exchange," accessed May 22, 2019, https://data.humdata.org/dataset/financial-tracking-of-private-sector-contributions-ebola-2014.
[44] "QWIDS - Query Wizard for International Development Statistics," accessed June 13, 2019, https://stats.oecd.org/qwids/.
[45] "Ebola - West Africa - Ebola Treatment Centres, Isolation Wards Hospitals and Transit Centres - Humanitarian Data Exchange," accessed May 22, 2019, https://data.humdata.org/dataset/ebola-west-africa-ebola-treatment-centres-isolation-wards-hospitals-and-transit-centres.
[46] "Afrobarometer Data, [Sierra Leone] [Round 5] [2012(Updated July 2015)] Available at Http://Www.Afrobarometer.Org," accessed June 13, 2019, https://afrobarometer.org/data/sierra-leone-round-5-data-updated-july-2015; "Afrobarometer Data, [Liberia] [Round 5] [2012(Updated July 2015)] Available at Http://Www.Afrobarometer.Org," accessed June 13, 2019, https://afrobarometer.org/data/liberia-round-5-data-updated-july-2015.
[47] Michael Coppedge et al., "V-Dem Country-Year Dataset 2019" (Varieties of Democracy (V-Dem) Project, 2019), https://doi.org/10.23696/vdemcy19.
[48] "Sierra Leone - Urbanization 2007-2017 | Statistic," Statista, accessed June 13, 2019, https://www.statista.com/statistics/455922/urbanization-in-sierra-leone/.
[49] "Urban Population (% of Total) | Data, World Bank," accessed June 13, 2019, https://data.worldbank.org/indicator/SP.URB.TOTL.IN.ZS?locations=GN.
[50] Hannah Ritchie and Max Roser, "Causes of Death," *Our World in Data*, February 14, 2018, https://ourworldindata.org/causes-of-death.

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	Vaccination	DTP3	OurWorldInData[51]
		Measles	OurWorldInData
	General health infrastructure	Issues with access to public hospital	Demographic and Health Surveys (DHS) Program[52]
		Fighting HIV	OurWorldInData[53]
		Maternal mortality	OurWorldInData[54]
	Ebola infrastructure	Health care worker ebola	HumData[55]
		Health care worker death	HumData[56]
Health infrastructure	Health communication	Education 15+	V-Dem Version 9

[51] Samantha Vanderslott and Max Roser, "Vaccination," *Our World in Data*, May 10, 2013, https://ourworldindata.org/vaccination.

[52] Liberia Institute of Statistics and Geo-Information Services - LISGIS et al., *Liberia Demographic and Health Survey 2013 [Dataset] LBHR6AFL.DTA Liberia Institute of Statistics and Geo-Information Services (LISGIS), Ministry of Health and Social Welfare [Liberia], National AIDS Control Program [Liberia], and ICF International. 2014. Liberia Demographic and Health Survey 2013. Monrovia, Liberia: Liberia Institute of Statistics and GeoInformation Services (LISGIS) and ICF International* (Monrovia, Liberia: LISGIS and ICF International, 2014), http://dhsprogram.com/pubs/pdf/FR291/FR291.pdf; Statistics Sierra Leone - SSL and ICF International, *Sierra Leone Demographic and Health Survey 2013 [Dataset] SLHR61FL.DTA Statistics Sierra Leone - SSL and ICF International. 2014. Sierra Leone Demographic and Health Survey 2013. Freetown, Sierra Leone: SSL and ICF International.* (SSL and ICF International: Freetown, Sierra Leone, 2014), http://dhsprogram.com/pubs/pdf/FR297/FR297.pdf.

[53] Max Roser and Hannah Ritchie, "HIV / AIDS," *Our World in Data*, April 3, 2018, https://ourworldindata.org/hiv-aids.

[54] Esteban Ortiz-Ospina and Max Roser, "Global Health," *Our World in Data*, August 22, 2016, https://ourworldindata.org/health-meta.

[55] "Number of Health-Care Workers Infected with Ebola - Humanitarian Data Exchange," accessed June 13, 2019, https://data.humdata.org/dataset/number-of-health-care-workers-infected-with-edv.

[56] "Number of Ebola Health-Care Worker Deaths - Humanitarian Data Exchange," accessed June 13, 2019, https://data.humdata.org/dataset/number-of-health-care-workers-deaths-by-edv.

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Appendix 3: Country data

Factors	Liberia	Sierra Leone	Value	Source type	Date
Private	6 289 931	3 258 208,09	US Dollars	Primary	2014
Public ODA increase	45,70%	69,04%	Percentage	Primary	2000-2017
Ebola centers functional	15	11			
Ebola centers pending	25	9			
Ebola centers closed	1	1	Number	Primary	2014
(Secondary source data)					
Trust to solve health	32,50%	28,31%	Percentage	Primary	2012
Difficulty of accessing health perception	52,96%	48,30%	Percentage	Primary	2012
Importance of health perception	14,20%	13%	Percentage	Primary	2012
Life expectancy	58,98	53,67	Years	Primary	2000-2015
Infant mortality	67,15	92,25	Number	Primary	2000-2015
Urbanization	58%	41%	Percentage	Primary	2017
Poor sanitation deaths	720	1235	Number	Primary	2000-2015
Diarrhea deaths	1053	3269	Number	Secondary	2000-2016
Unsafe water deaths	869	1442	Number	Primary	2000-2017
Poor sanitation DALY children	37217	106097	Number	Secondary	2000-2018
DTP3	58,6875	72,125	Percent	Primary	2000-2015
Measles	64,25	70,75	Percent	Primary	2000-2015
Issues with access to public hospital	33%	37%	Percent	Primary	
Fighting HIV	-2,70%	0,40%	Percent		2000-2015
Maternal mortality	640	1100	Number	Primary	2013
Health care worker ebola	378	307	Number	Primary	2014-2015
Health care worker death	192	221	Number	Primary	2014-2015
Education 15+	4,97	3,89	Years	Primary	2000-2018

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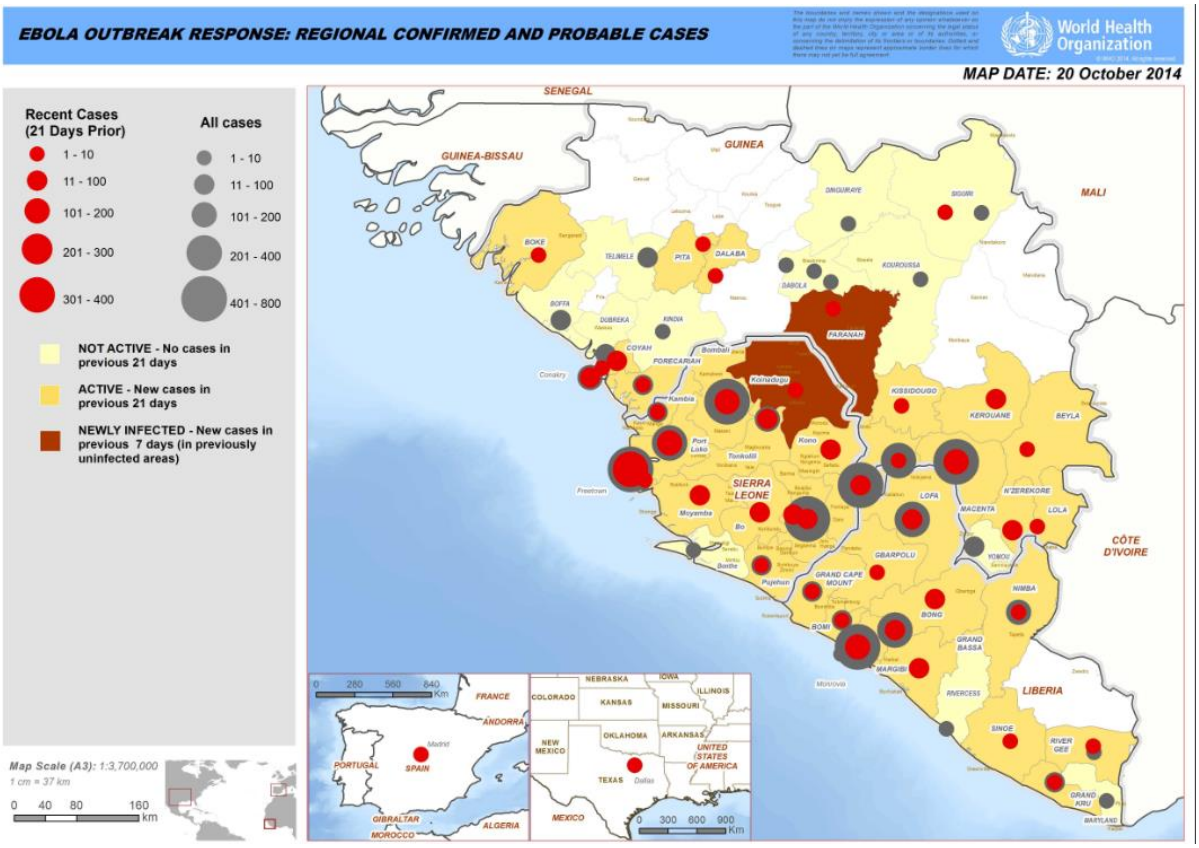
Appendix 4: Regional Ebola outbreak map



Source: WHO Ebola maps[57]

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[57] "WHO | Ebola Maps," WHO, accessed June 13, 2019, http://www.who.int/csr/disease/ebola/maps/en/.

Appendix 5: Map of suggested monitoring clinics

Image source: Google maps[58]

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[58] "Google Maps," Google Maps, accessed June 13, 2019, https://www.google.com/maps?q=west+africa&rlz=1C1GCEA_enHU797HU797&um=1&ie=UTF-8&sa=X&ved=0ahUKEwjJ1OL8refiAhWhxoUKHeHYCJ8Q_AUIESgC.