

# **Global warming and its impact on water-associated infectious diseases in Eastern Africa**

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<p>The challenges today strongly related to poverty and demography are the climate changes that comes in the shapes of global warming and unstable climate systems. The changes in our climate are affecting health at many levels already today. According to numbers from World Health Organization, weather related catastrophes are taking more than 60 000 peoples' lives and that is mainly people in low-income countries. Infectious diseases are still the biggest threat to public health globally, and therefore there is a need to collect information about disease outbreaks and the sources of infection.</p> <p>This master's thesis seeks to find out the correlation between global warming and increased water-associated infectious diseases. The aim of the study is to find out what impact global warming has on the water-associated infectious diseases in Eastern Africa. The research questions are:</p> <ol style="list-style-type: none"> <li>1. What impact does global warming have on Eastern Africa?</li> <li>2. What impact does global warming have on water-associated infectious diseases in Eastern Africa?</li> <li>3. How could some of the water-associated infectious diseases be prevented?</li> </ol> <p>The study was conducted by using a scoping literature review with the framework by Arksey and O'Malley (2005). Analysis was done by using the step 5 by Arksey and O'Malley, which is about <i>collating, summarizing and reporting the results</i>. Conduction of data took place during the period of September 2017- November 2017. The databases used for data collection were the following: <i>CINAHL (Ebsco)</i> and <i>EBSCO Academic Search Premier</i> and <i>ProQuest</i>. Five themes were identified among the articles collected (n =16) and the themes are as followed: <i>Water-associated infectious diseases, Vector-borne diseases, Health impact and migration, Alternative diseases</i> and <i>Sea-level rise</i>.</p> <p>There seem to be a positive correlation between global warming and water-associated infectious diseases and health in general and global warming has an impact for people in Eastern Africa.</p>	
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<p>De utmaningar som idag är starkt relaterade till fattigdom och även demografi är klimatförändringarna som kommer i form av global uppvärmning och instabila klimatsystem. Förändringarna i vårt klimat påverkar hälsa på många nivåer redan idag. Enligt siffror från Världshälsoorganisationen tar väderrelaterade katastrofer över 60 000 människors liv och det är främst människor i låginkomstländer. Infektionssjukdomar är fortfarande det största hotet mot folkhälsan globalt, och det är därför nödvändigt att samla in information om sjukdomsutbrott och även infektionskällorna.</p> <p>Denna masters avhandling syftar till att ta reda på sambandet mellan den globala uppvärmning och ökningen av vattenrelaterade infektionssjukdomar. Syftet med studien är att ta reda på vilken inverkan den globala uppvärmningen har på vattenrelaterade infektionssjukdomar i Östra Afrika. Forskningsfrågorna är som följande:</p> <ol style="list-style-type: none"> <li>1. Vilken inverkan har den globala uppvärmningen på Östra Afrika?</li> <li>2. Vilken inverkan har global uppvärmning på vattenrelaterade infektionssjukdomar i Östra Afrika?</li> <li>3. Hur kan några av de vattenrelaterade infektionssjukdomarna förebyggas?</li> </ol> <p>Studien genomfördes med hjälp av en omfattande litteraturöversikt och inom ramen av Arksey och O'Malleys (2005) stomme. Analysen gjordes genom att använda steg 5 av Arksey och O'Malleys ramverk som handlar om att samla, sammanfatta och rapportera resultaten. Insamlingen av data ägde rum under perioden september 2017 - november 2017. Databaserna som användes för datainsamling var följande: CINAHL (Ebsco) och EBSCO Academic Search Premier och ProQuest. Fem teman identifierades bland de samlade artiklarna (n = 16) och teman är som följer: <i>Vattenrelaterade infektionssjukdomar, vektorburna sjukdomar, hälsoeffekter och migration, alternativa sjukdomar och havsnivåhöjning.</i></p> <p>Det verkar finnas en positiv korrelation mellan den globala uppvärmningen och vattenrelaterade infektionssjukdomar och hälsa i allmänhet och den globala uppvärmningen påverkar människor i Östra Afrika.</p>	
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## List of Abbreviations and Symbols

IPCC	Intergovernmental Panel on Climate Change
UN	United Nations
WHO	World Health Organization

# 1 INTRODUCTION

Today a challenge strongly related to problems of poverty, as well as demography is the climate changes that come in the shapes of global warming as well as unstable climate systems, which the world is experiencing right now. The effect the climate change has on us humans are already noticeable as they occur as more extreme weather conditions such as cloud-bursts and heat waves which in turn has led to flooding as well as drought. Climate research tend to point out that the changes of the earth's global warming as well as weather anomalies are anthropogenic- caused by humans, that is also why it is usually known as the anthropogenic global warming (Vilhelmsson & Tengland, 2016, pp. 100-101). Changes in our climate is affecting health at many levels, as it already today is estimated that an amount of 300 000 people are dying every year because of climate changes. According to the World Health Organization (WHO), weather related catastrophes are taking more than 60 000 peoples' lives, and this number is mainly in low-income countries. Furthermore, there is estimation that people at risk of being affected by climate change is more than half of the population on earth and around 325 million people are affected seriously every year. The indirect changes in the climate could cause consequences as change in water, air- and food quality and cause changes in the ecosystems, industries, agricultures, settlements as well as economy and this could lead to an increasing burden of global health problems. Two indirect effects, that are very serious, are violence and migration. The climate crisis impact could therefor increase the pressure for the population to migrate, and climate changes already acts as a casual factor in the already existing flows, as for example in the Horn of Africa. According to calculation, there will be an estimated number of 200 million up to 1 billion people, who needs to migrate due to climate changes until year 2050. (Vilhelmsson & Tengland, 2016, pp. 107-109).

Zoonotic diseases have been a big concern to humankind for more than 10,000 years and today we have an approximate amount of 75% of newly emerging infectious diseases. Zoonoses result from different genetic, anthropogenic, ecologic, climatic and socioeconomic factors. In addition, for the past 15 years, our planet has faced more than 15 deadly zoonotic or vector-borne global outbreaks and since 1980, more than 87 new

vector-borne and/or zoonotic infectious diseases discovered. Moreover, as zoonotic diseases are a major concern globally, it shows that their impacts in less developed countries are high, since the occurrence of risk factors are more frequent (Gebreyes, et al., 2014, pp. 1-2). Also, to understand what infectious diseases are, the respondent has found that infectious diseases could be explained to be changes in humans that are caused by an attack of some sort of microorganisms or/and parasites. One is mostly talking about infectious agents that enters and affects the tissues of various kinds. Infectious agents could e.g. be bacteria, viruses or mycoplasma. While, communicable diseases transmit via different organisms. Globally infectious diseases are still the biggest threat to public health (Andersson, 2016, pp. 209-210). In order to be able to control diseases there is a need to collect information about disease outbreaks and investigate the sources of infection (Andersson, 2016, p. 214).

In addition, when considering the wetlands, it turns out that wetland regions for a long time have had an important role in sustaining and supporting the economic, social and cultural livelihood in low-income countries (O'Sullivan, Lupakisyo Mwalwiba, Purcell, Turner, & Mtaló, 2016, p. 95). Threats to the wetlands are mainly acute in the areas in East and West Africa where they provide an essential resource for those living and working in their closeness. The Mara wetlands are one of many areas around Lake Victoria where anthropogenic pressures are acute (O'Sullivan, Lupakisyo Mwalwiba, Purcell, Turner, & Mtaló, 2016, p. 95). Agricultural and mining activities, together with deforestation and woodland removal are primary factors for the increased sediment loads to the wetlands (O'Sullivan, Lupakisyo Mwalwiba, Purcell, Turner, & Mtaló, 2016, p. 96). Factors that are associated with changing catchment activities have contributed to increases in sediment inputs to the wetlands and a lower energy regime from changed hydrological conditions in the downstream extent of the wetlands has resulted in considerable sedimentation and wetland expansion (O'Sullivan, Lupakisyo Mwalwiba, Purcell, Turner, & Mtaló, 2016, p. 105).

The aim with this thesis is to try to find out what impact global warming has on water-associated infectious diseases in Eastern Africa and if it is possible to prevent the water-associated infectious diseases. Carried out is a scoping literature review in order to find existing literature.

This thesis builds up by firstly introducing some more background information followed by the aim and research questions. Further, a presentation of the research methodology, followed by the literature review process, discussion and conclusion and at last recommendations for further research.

## **2 BACKGROUND**

This part of the thesis focus on discussing more about the background, in order to get an understanding of global warming and unstable climate systems and also a definition of water-associated infectious diseases will be included, as well as getting a better understanding of what countries are included in the term 'Eastern Africa' as well as its sub terms.

### **2.1 Global warming**

When talking about global warming, also known as climate change, one often refers to the changes beyond the usual natural variation. In a balanced system, carbon dioxide is a part of a natural cycle, where plants are absorbing it through photosynthesis. But something that is happening now is that we humans, by releasing more carbon dioxide through e.g. agriculture and through stored sources that we burn up, adds too much carbon dioxide to this natural cycle, which is disturbing the balance as the increased amount of carbon dioxide cannot be absorbed by the nature. (Vilhelmsson & Tengland, 2016, p. 101)

Carbon dioxide is the greenhouse gas that is most associated with climate change and it accounts for the largest share of greenhouse gas emissions and generated by combustion, e.g. in cars or combustion when creating heat or electricity. The second most important greenhouse gas after carbon dioxide is methane, which is an effect after animal production, but it is also stored in the ground, e.g. below the permafrost in Siberia,

which risks to be released in a warmer climate. The earth has never been warmer than it is today. The years 2011-2015 is according to the Meteorological World Health Organization the warmest five year period that has been measured globally, and in 2015 it was the first time in modern time that the global temperature deviation exceeded 1°C. Already a global rise in temperature with 2°C are considered to give serious consequences for society and ecosystems and that is why the limit is set there in order to avoid dangerous climate change. (Vilhelmsson & Tengland, 2016, pp. 102-103).

### **2.1.1 Consequences for public health**

The changes in our climate, is affecting health on many different levels, as already mentioned in the introduction of this thesis. Some of the examples are e.g. people dying due to climate changes and considered are the economic aspects, such as financial losses that expects to rise with 150% between 2010 and 2030. According to United Nation's (UN) Intergovernmental Panel on Climate Change (IPCC), climate change is affecting health both directly and indirectly. A direct impact is e.g. drowning due to flooding and drought due to increased heat, caused by changed weather patterns by way of increased temperatures, extreme weather conditions and sea level rise. An indirect impact of climate changes can have consequences in terms of changes in air-, water – and food quality, as well as changes in agriculture, ecosystems, industry, settlements and economics. These could lead to an increase in the global public health problems. Additionally, tropical diseases can start changing and might spread to northern Europe if the temperature keeps rising. In addition, affected is also, infectious diseases caused by bacteria, as they can spread more easily when e.g. there is a flooding. Flooding can also cause polluted drinking water. Another thing to consider is that mosquitos, which spread dengue fever, malaria, yellow fever and meningitis, are increasing rapidly in water. Global warming, as cloud bursts and flooding are also affecting crops negatively and can push up the local prices. This is especially affecting low-income countries as in absence of crops they will need to import crops to high expenses. This increases the risk for malnutrition and disease. (Vilhelmsson & Tengland, 2016, pp. 107-109).

### **2.1.2 Climate conflicts and climate refugees**

The effects of climate changes are unevenly distributed, in a way that high-income countries will be afflicted the least by them, while low-income countries will suffer the most. Through climate change, this risks the already prevailing global asymmetries and uneven living prospects to worsen. Two indirect impacts of climate change could be especially serious, which is violence and migration. Climate change is increasing the risk for political violence as well as civil war and violent riots. A future threat is that climate wars occur in future because of e.g. lack of water. The impact of climate crisis can also increase the pressure on populations to migrate and climate changes are working as a casual factor in the already existing migration flow, an example is the Horn of Africa. According to estimation there will be between 200 million up to 1 billion people forced to migrate due to climate changes until the year 2050. (Vilhelmsson & Tengland, 2016, p. 109).

## **2.2 Water-associated infectious diseases**

As we know that water is necessary for maintaining life on earth. However, on the same time we also know that water can serve as a way for hazardous substances as well as pathogenic organisms and thereby pose significant threats to humans through various paths. For the past decades, with population growth, human development, natural calamities, climate change and extreme weather events that have exercised many diverse pressures on both quantity and quality of water resources that may have promoted conditions for water-associated diseases. This is causing a great burden on global public health. Intercontinental, water-associated infectious diseases are a major cause of mortality and morbidity. There has been an estimation that about 4.0% of global deaths and 5.7% of the global disease burden were traceable to a small subset of water, hygiene and sanitation related infectious diseases, also including diarrhoeal diseases. (Yang, et al., 2012, pp. 1-2).

Furthermore, two listed United Nations goals are working on reducing the number of mortality connected to water. *UN Millennium goal 9*; which is about reducing the number of people who have no sustainable access to safe drinking water, *UN Millennium*

*goal 4*; which is about reducing the mortality rate among children under five by two thirds. Another factor to water-associated diseases are e.g. *Diarrhoea*, which is still one of the leading causes of childhood death. (Griffiths, 2007).

Moreover, to get a better understanding of the meaning of *water-related*, or as referred to in this thesis, *water-associated infectious diseases*, it is good to have an understanding that there are several sub-groups that partly explains what water-associated diseases are and these terms are shortly explained as followed:

- *Waterborne* - when a disease is waterborne, it refers to an ingested infectious agent.
- *Water-related insect vector* – insects that breed in or bite near water, e.g. yellow fever, malaria, sleeping sickness.
- *Water-based* - then it is about transmission via an intermediate host in water, e.g. schistosomiasis.

For this thesis the term *water-associated infectious diseases* will be used, including diseases that are both *waterborne* and *water-related insect vector* and *water-based*, but the collective name for this group of diseases will be referred to as *water-associated infectious diseases*. (Griffiths, 2007). Another point is that we will talk about water-associated infectious diseases, as the word infectious are referring to - as capable of causing or communicating infection (Infectious, 2017). In this case the reason for infection is contaminated water or water that serves as a basin for vector-borne diseases.

## **2.3 Eastern Africa**

Eastern Africa, which is part of the sub-Saharan Africa, is comprising two recognized regions: *The Horn of Africa* - which includes the countries: *Ethiopia*, *Eritrea*, *Djibouti* and *Somalia*. The other region is a part called *East Africa* - which is made up of *Uganda*, *Tanzania* and *Kenya*.

Furthermore, Eastern Africa consists mainly of plateaus and has most of the highest elevations in Africa. Situated in Kenya and Ethiopia are the two most striking highlands, where large areas are reaching the elevations of 2000 to 3000 meters. Another thing about Eastern Africa is the climate, as it is generally tropical, though the high elevations tend to reduce the temperatures. Moreover, the precipitation is also affected by the varying elevation, e.g. in northeastern Kenya, eastern Ethiopia and Somalia they have a limited amount of rainfall, while Tanzania, Uganda and western Kenya is receiving bountiful rainfall. (Marcus & Low, 2017).

Therefore, for this thesis, the term **Eastern Africa** is used, and the countries included are the following: *Ethiopia, Eritrea, Djibouti, Somalia, Uganda, Tanzania* and *Kenya*.

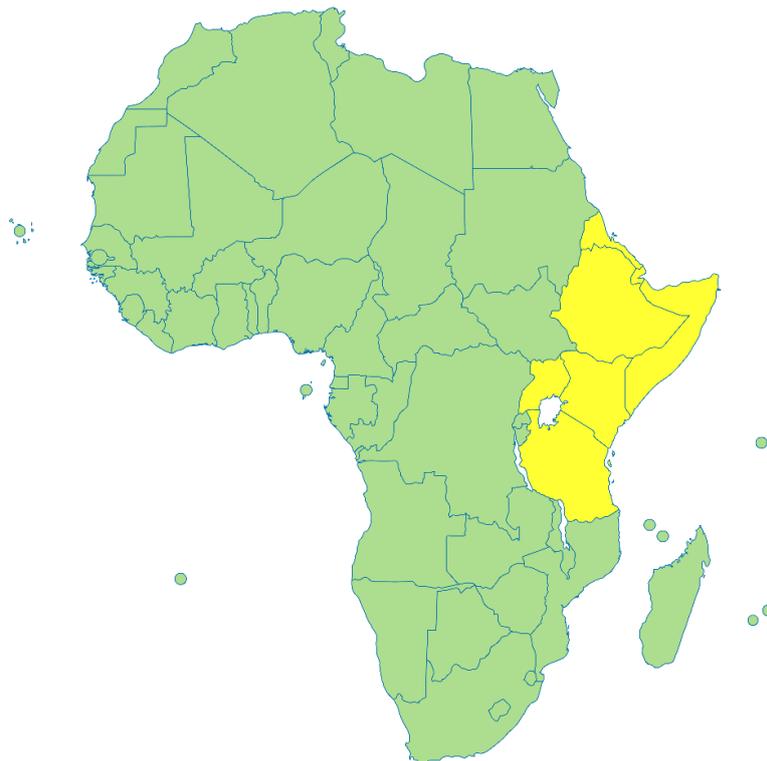


Figure 1. Eastern Africa

### **2.3.1 Tropical Africa**

When talking about Tropical Africa it is good to know that the forests of the Tropical Africa is covering about 18% of the world and spans an impressive 3.6 million square kilometers in Eastern, Central and West Africa. The countries that are included in the term Tropical Africa in the East are the following: Ethiopia, Eritrea, Kenya, Burundi, Tanzania, Uganda, Malawi, Mauritius, Madagascar, Mayotte, Mozambique, Rwanda, Somalia, and Reunion. In Tropical Africa, it tends to be a warm and hot climate, which is due to the tropical rain belt as well as the latitude. However, this varies throughout the region. In Tropical Africa, the most common diseases are Malaria, while the other mosquito-borne diseases found are Dengue fever and Yellow fever. (About Tropical Africa, 2017).

### **2.3.2 Equatorial East Africa**

When further on discussing the Equatorial East Africa we can start by talking about the Equatorial Africa. First off, the equator is the line that separates the southern hemisphere from the northern hemisphere and runs across the center of the earth at a latitude of 0 degrees. In Africa, the equator is running for almost 4,020 kilometers through seven East, Central and West countries, just south of the Sahara Desert. The equatorial countries included in the East are Somalia, Kenya and Uganda. (Which African Countries are Located on the Equator?, 2017).

## **3 LITERATURE REVIEW**

In earlier research, it were found future changes in climate and it also showed that it could have serious implications for livelihoods in East Africa; this is mainly because of increasing temperatures and changing rainfall patterns. Because of increased flooding due to climate change, it will most likely be an increase in water-associated infectious diseases. (Araujo, et al., 2016). (Shongwe;van Oldenborgh;& van den Hurk, 2010). There is also research pointing out the impact that global warming is having on e.g. stream flows in Africa, and it is expected to be an increase in runoff in eastern equatorial Africa by the year 2050. A runoff, is a measure of sustainable water availability and

is generally considered equal to the differences between evapotranspiration and precipitation and therefore to the convergence of horizontal atmospheric water flux. (Milly; Dunne; & Vecchia, 2005). Another finding was that the presence of highlands is also causing a complex pattern of malaria distribution, and it turns out that an integrated weather-disease model is indicating that there is potential epidemic risk in the larger parts of Greater Horn of Africa, especially in the East African highlands (Ermert V. , Fink, Morse, & Paeth, 2012). There is evidence indicating that transmission of water-borne disease will increase because of human-driven environmental alteration (Vora, 2008).

Further, zoonotic infectious diseases are known to have been of concern for more than 10,000 years. Newly emerging infectious diseases are today approximately about 75%. Zoonoses result from different anthropogenic, ecologic, socioeconomic, climatic and genetic factors. Data was showing that the complex nature of the zoonotic diseases and the limited resources that we have in low-income countries are a reminder that an implementation of e.g. Global One Health is crucial. (Gebreyes, et al., 2014). Continuing on the same path, one can see it has turned out that the changes in the patterns of infectious diseases most likely are one of the major consequences of climate change (Climate Change And Infectious Diseases, 2017). When considering migration one could see that e.g. Turkana pastoralists is not facing a bright future which has led to migration to different areas and countries as the environment is forcing them to move further, as a way of survival. This is one direct cause of climate change. (Blackwell, 2010). In addition, a study review that was summarizing and reviewing the different modelling and statistical methods showed that the method was suitable in order to investigate the effects of weather and climate on infectious diseases associated with water. The results came back saying it is of importance that one considers the method carefully especially when influenced by many factors (Lo Lacono, et al., 2017). So to be able to quantify the results one need to be aware of the different methods used in order to understand the results.

Furthermore, the most essential findings of this literature review is that many of the articles used are pointing out the rise of e.g. malaria distribution as well as other water-associated infectious diseases. The rise of the diseases seems to be due to global warming. There are several articles recommending future research as the theme is bringing more questions to the field of research. Migration is also on the increase, which is an-

other factor pointing out the fact that global warming is having an impact on the climate. Increased flooding and higher temperatures are indicating that it is and will continue to be one of the main challenges expected to increase. The geography of Eastern Africa, with high plateaus environment and increased precipitation and increased temperatures do indicate that there is challenges and an increase is to be expected.

This literature review indicates that there is evidence that the climate is changing and people are experiencing global warming and it is already having an impact on Eastern Africa. Moreover, it also has an impact on the increased number of water-associated infectious diseases. One also gets the understanding that the topic is of great importance especially as it is affecting so many people already today, and the number of affected people will rise. Further, there is a need to get a better understanding of how to prevent water-associated infectious diseases that are anthropogenic, especially in low-income countries in Eastern Africa, as there is not so much research conducted, as there is lack of resources.

#### **4 THEORETICAL PERSPECTIVE**

For this thesis, the theoretical perspective chosen is health promotion. This is as the research questions are aiming to find out what impact global warming has on Eastern Africa and further what impact it has on water-associated infectious diseases as well as to know how to prevent some of the water-associated infectious diseases. That takes us to the reason why we need to look at this from a health promotion view, if we want to know how to prevent diseases we need to know the causes and when knowing that we can promote health and thereby prevent further spread of disease.

Health is a very wide term that can be found hard to describe, but the World Health Organization (WHO) is defining health as the following “*Health is a state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity*” (World Health Organization, 2017). Which, is a satisfying definition of health and is taking into consideration how one feels, e.g. does one feel healthy even though one has an impairment or maybe one has a chronic disease, and yet feeling fine. It is good to

have an understanding of what health is before moving over to health promotion. On the other hand when considering health promotion, it is more about the process to help people get control over their situation and hopefully avoid getting sick and/or to get healthier. The definition provided by the WHO is very describing and according to them “*Health promotion is the process of enabling people to increase control over, and to improve, their health. It moves beyond focus on individual behaviour towards a wide range of social and environmental interventions* (World Health Organization, 2017).

Moreover, it is good to know also that for health promotion there are three key elements; *Good governance for health* – which, is about how health promotion requires that policy makers across all governments to make health the essential channel for the government policy, meaning that they should consider the health implication in the decisions taken. *Health literacy* – which is about how people need to achieve knowledge, information and skills in order to make healthy choices. It is also, about that people need to have the opportunity to make these choices as well. *Healthy cities*- this element is about to have an understanding of the key role that cities play when it comes to promote health. As a strong commitment and leadership at the municipal level is fundamental for both healthy urban planning, but also to be able to build up precautionary measures in primary health care facilities and communities. (World Health Organization, 2017). Based on this, one can understand that health promotion is playing an important role in our society and is a big part of everyday life.

## **5 AIM AND RESEARCH QUESTIONS**

The aim with this study is to find out what impact global warming has on the water-associated infectious diseases in Eastern Africa. In addition, it will be found out whether and how to prevent water-associated infectious diseases. The results of this scoping literature review will serve to give an idea of needed future research and to find out whether there are increased cases of water-associated infectious diseases in Eastern Africa due to global warming as well as whether there are strategies worked out in order to prevent them.

The research questions are as following:

1. What impact does global warming have on Eastern Africa?
2. What impact does global warming have on water-associated infectious diseases in Eastern Africa?
3. How could some of the water-associated infectious diseases be prevented?

## 5.1 Pre-understanding

The purpose with the thesis is to do a scoping literature review in order to find out whether global warming has an impact on Eastern Africa and the population and also whether that it also has impact on water-associated infectious diseases in Eastern Africa. The pre-understanding and belief is that global warming do have an impact on water-associated infectious diseases in Eastern Africa and that there is a need to figure out preventive measures in order to decrease the amount of water-associated cases, which also the literature review shows.

## 6 RESEARCH METHOD

For this thesis, conduction of the scoping literature review took place by using the framework by Arksey and O'Malley (2005). Scoping literature review is a method mainly used to map relevant literature in a field of interest. Some other reasons why a scoping literature review is to consider is e.g. that a scoping study tends to address broader topics where many different study designs could be applicable and also a scoping study is not very likely to seek to address very specific research questions and does not assess the quality of included studies. (Arksey & O'Malley, 2005, p. 20). In order to describe what a scoping study is, a definition by Arksey and O'Malley is used. As scoping study *“aim to map rapidly the key concepts underpinning a research area and the main sources and types of evidence available, and can be undertaken as stand-alone projects in their own right, especially where an area is complex or has not been reviewed before”* (Arksey & O'Malley, 2005, p. 21).

Furthermore, Arksey and O'Malley have identified four common reasons to why a scoping study could be undertaken, and the reasons are as following: *To examine the range, extent and nature of a research activity*, which is a useful way of mapping fields of study where it might be difficult to visualize the range of material that is available. Second reason is *to determine the value of undertaking a full systematic review*, meaning it could be useful doing a preliminary review using a scoping literature review to find out whether a full systematic review is feasible or not. Third reason is about *to disseminate and summarize research findings*, when doing a scoping study this way it might describe more in detail the findings as well as the range of research in particular areas of study. It is a way of summarizing and disseminating research findings to practitioners, policy makers and consumers who might be lacking of time or resources to undertake such work themselves. The fourth reason is *to identify research gaps in the existing literature*; this will further take the process of dissemination one-step forward by drawing conclusions from existing literature when taking into account the overall state of research activity. The four reasons are implying two ways of thinking about the purpose of a scoping study. The first two reasons are suggesting that the scoping study might be perceived as one part, of an ongoing process of reviewing, where the ultimate aim is to produce a full systematic review. The second two reasons are suggesting that as a method, a scoping study might be conceived, which could lead to the publication and dissemination of research findings in a specific field of enquiry. Here the aim is to identify the gaps in the existing evidence base, which is very important and will or will not lead to a full systematic review. (Arksey & O'Malley, 2005, pp. 21-22).

## **6.1 Methodological framework**

For the methodological framework, Arksey and O'Malley's framework for conducting a scoping study are used. Instead of guided by focused research questions that leads to search for specific study designs, the scoping study method is guided by the requirement to identify all relevant literature no matter of what study design it has. The process of scoping method is not direct but iterative, which requires researchers to engage with every stage in a reflexive way and to when necessary repeat steps in order to be sure that it covers the literature in a complete way. There are five different stages of conduct-

ing a scoping study and one optional step, named as step 6 in this paper. The different stages of the framework for conducting a scoping study:

Stage 1: identifying the research question

Stage 2: identifying relevant studies

Stage 3: study selection

Stage 4: charting the data

Stage 5: collating, summarizing and reporting the results

Stage 6: optional stage: Consultation exercise

(Arksey & O'Malley, 2005, pp. 22-23)

### **6.1.1 Application of framework developed by Arksey & O'Malley**

The following is describing how the application of the different stages took place in order to conduct the scoping literature study for this thesis.

### **6.1.2 Identifying the research question**

In order to be able to identify research questions, a literature review (see appendix one) was conducted to find out the already existing knowledge, presented in chapter 3, about the subject and to identify if there were any gaps and rather what kind of research that could be needed. Based on that knowledge the work of developing the research questions of this thesis took place.

The knowledge wanted, is whether global warming is having an impact on Eastern Africa. As well as, to find out whether global warming is having an impact on water-associated infectious diseases in Eastern Africa. By asking two quite similar but yet so different questions, the scope will be broader. As the health perspective for this thesis is health promotion, another aspect to find out is also, whether it is possible to prevent water-associated infectious diseases. The construction of the research questions are in a way so they are both broad yet having a depth in order to find out how to prevent the spread of water-associated infectious diseases that could be due to global warming.

### **6.1.3 Identifying relevant studies**

In order to find relevant studies a scoping literature study carried out. Used were the databases; Cinahl (Ebsco), Ebsco Academic Premier Search and ProQuest, in order to find relevant literature. The search terms used for the study were the following: '*global warming OR climate change OR greenhouse effect*' AND '*water-associated infectious diseases*' OR '*water-associated diseases*' OR '*waterborne diseases*' OR '*waterborne infectious diseases*' AND '*east Africa*'. The search were conducted during August 2017- November 2017 and only included literature that were peer-reviewed as well as only articles with publication year between January 2011 and November 2017.

### **6.1.4 Study selection**

For this study, the focus was on Eastern Africa, therefore only including articles concerning all or one of the following countries: Kenya, Uganda, Tanzania, Somalia, Djibouti, Eritrea and Ethiopia, therefor excluding literature concerning countries not listed as the countries of interest. Another issue was also that the articles included could also be articles that somehow concerned global warming and East Africa or global warming and its association with water-associated infectious diseases in East Africa. Population in question were humans and publication year was January 2011-November 2017.

### **6.1.5 Charting the data**

When it came down to charting the data, there was a table made with the literature that was found, before the search for the study was conducted, a so-called literature review (see appendix one). Later on when the search for the study started, created was a table with literature concerning the study, which is a study review (see appendix two).

### **6.1.6 Collating, summarizing and reporting the results**

In order to collate and summarize as well as report the data, the process started out by identifying different themes among the articles. Then a table of the analysis (see table 4), was established, in order to have an overview of the articles found per theme and the core findings from every theme were presented. The analysis and the illustration of the

analysis then helped in the process of summarizing the findings as well as to report the results.

## 6.2 Material description

Conduction of the material took place by basing the search on a set of research questions. The inclusion and exclusion characters were somewhat modified during the search process. Chosen articles were representing global warming and the impact it had on water-associated infectious diseases in Eastern Africa and/or the impact global warming had in general in Eastern Africa. The inclusion and exclusion criteria table as presented in table 1.

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<b>Inclusion criteria</b>	Peer reviewed articles, where the main objective was to find out global warming and its impact on water-associated infectious diseases in Eastern Africa or/and the impact global warming has on Eastern Africa
	Only including articles concerning all or one of the following countries: Kenya, Uganda, Tanzania, Somalia, Djibouti, Eritrea and Ethiopia
<b>Exclusion criteria</b>	Other types of articles or reports concerning Eastern Africa (that are not listed in the inclusion criteria) or Africa or the World Other languages
<b>Search strategy limited to</b>	Population: humans Publication year: January 2011 – November 2017 Language: English

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*Table 1. Inclusion and exclusion criteria*

## 7 RESEARCH ETHICS

When talking about ethics it means to understand how to evaluate different routes of action as well as their social consequences in a given situation. One can use ethics as a lens to understand links and power dynamics between the different groups and this can in return help us anticipate who profits and who bears the burdens. Global health ethics is about both encouraging individuals to do what is best and to avoid enormous risks of doing harm given the particular set of circumstances. (Pinto & Upshur, 2013, p. 11). The essence to ethical research no matter of where the research takes place, are concerns for the scientific validity as well as the social value of the research. Poorly designed research will bring no benefit to humanity and the criterion of social value leads researchers to be sensitive to the needs of populations. (Pinto & Upshur, 2013, p. 105). There is an ethical checklist for researchers, and the points used from the checklist for this thesis are the following; before conducting a research, the researcher should have chosen research questions relevant to the study and at the end of the research, the researcher should share the results and recommendations. Especially, if it turns out that the results is of use within the studied communities. In addition, the communication with the health authorities, community leaders and local researchers should be continued and/or established. Another thing to keep in mind is that researchers can act as advocates for the causes related to the health research in low- and middle-income countries. (Pinto & Upshur, 2013, pp. 113-115).

Furthermore, in order to consider the ethical perspective for this scoping review, the articles where found by using relevant research questions for the study and all articles selected for the data collection, were published in academic journals during the period January 2011 – November 2017 and peer-reviewed. Furthermore, the results will be open for the community to read as this thesis is going to be available also in Theseus, a service provided by the Rectors' conference of Finnish Universities of Applied Sciences, also known as Arene ry. Furthermore, University of Eastern Africa, Baraton's repository will also have the thesis available.

## 8 DATA ANALYSIS

Presented in this chapter is the data collection process as well as the method of analysis used for the thesis. Presented is also the search strategy for the data collection both in written form and as a visual table.

### 8.1 Data collection

Data collection, were conducted for the scoping study, during the period of September 2017-November 2017. The data collection followed a scoping method, a framework done by Arksey & O'Malley.

The databases used for the search was mainly three different databases: *CINAHL (EBSCO)* and *EBSCO Academic Search Premier* and *ProQuest*. The search was limited to the inclusion and exclusion criteria (see table 1). The choice of articles, were at first based on the relevance of the titles when considering the research questions and from that search; there was an amount of 23 relevant articles. Continuing by reviewing the abstracts and there was left an amount of 20 articles seen as relevant. Followed by full-text versions of all 20 articles, when reviewed a number of 13 articles, were found as relevant for the study review. Also from the references of articles, relevant for this scoping study was three more articles, which means the total amount of articles included in the scoping study were 16. Worth noting is that one of the articles retrieved from the references are from 2009.

In Cinahl (Ebsco), there were a number of five articles found, out of which one was relevant. In Ebsco Academic Search Premier, there were a number of 41 articles found, out of which seven were relevant and at last in ProQuest there were a number of 608 articles found, out of which 12 articles were relevant. ProQuest had a big number of different articles; the different MESH terms included many articles into the search, far more than in the other databases used.

Important to mention is that in all databases and searches there were also duplicates found, including the relevant articles in the different databases.

<b>TERMS</b>	<b>CINAHL (EBSCO)</b>	<b>EBSCO ACADEMIC SEARCH PREMIER</b>	<b>PROQUEST</b>
<i>global warming OR climate change OR greenhouse effects</i>	<i>n = 5</i>	<i>n = 41</i>	<i>n = 608</i>
<i>AND water-associated infectious diseases OR water-associated diseas- es OR waterborne dis- eases OR waterborne infectious diseases</i>	→ <i>1 relevant article</i>	→ <i>7 relevant arti- cles</i>	→ <i>12 relevant ar- ticles</i>
<i>AND east africa</i>			
	<i>n = 1</i>	<i>n = 7</i>	<i>n = 12</i>
	<b>TOTAL n= 20</b>		

\* The number (n=) of articles found related to the search term, in each database

\*\* Some of the relevant articles may be a duplicate, as some of the articles found were also in the other databases

Table 2. Search Strategy

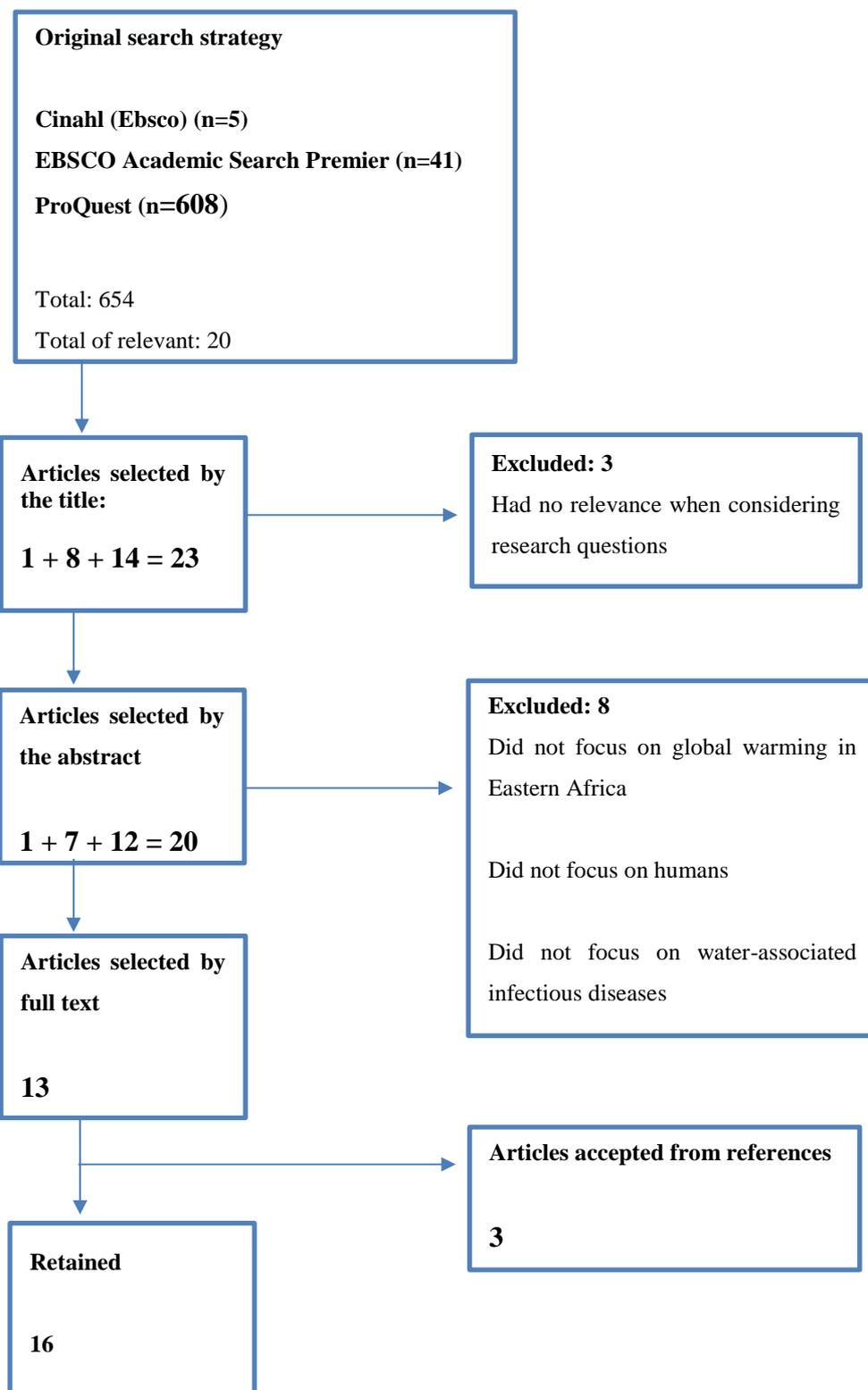


Table 3. Data collection process

## 9 RESULTS

When analyzing the data collected, it was possible to form five themes based on the titles of the articles conducted. The themes are as followed: *Water-associated infectious diseases*, *Vector-borne diseases*, *Health impact and migration*, *Alternative diseases* and at last *Sea-level rise*. The results will be presented first as an illustrated summary of the core findings, in table 4 and thereafter followed by sub-chapters describing the main findings from each category that have been established.

Worth noticing is that there were no direct articles found that brought up how to prevent water-associated infectious diseases in Eastern Africa. Most of the articles did have some suggestions or even recommendations for further research, which the author of the thesis have chosen to not bring up here, instead there will be recommendations formed by the author of the thesis based on the results found from the scoping study.

CATEGORY	NUMBER OF ARTICLES (n=)	CORE FINDINGS
Water-associated infectious diseases	n= 2	Outbreaks of water-associated infectious diseases occurred worldwide. High risks in particular in Ethiopia and Kenya. Human population density is a common significant risk factor. The accumulated temperature was a significant factor. There is a positive relationship between diarrhea and heavy rainfall, temperature, drought and flooding which are expected to increase with climate change
Vector-borne diseases	n= 7	The East African highlands are identified as epidemic prone areas, it is especially concentrated in parts of Western Kenya, parts of Ethiopia, Burundi, South-western Uganda and northern part of the Eastern Arc Mountains in Tanzania. Considerable higher temperatures and slightly higher rainfall will lead to a small or moderate increase in malaria transmission in East Africa. Studies showed evidence of a warming trend during the period 1979 to 2009. Climate should not be dismissed as a potential factor of observed increases in malaria. Influence of future climate scenarios on anticipated potential distribution risk areas for dengue epidemic risk areas is enormous.
Health impacts and migration	n= 4	There is likely to be forced displacement due to environmental changes and also migration is likely in response to, or in anticipation of climate related impacts. Studies indicates that there will be an increase in vector-borne diseases. Global warming and climate change is potentially the largest global threat to human health ever encountered
Alternative diseases	n= 2	It turns out that the model ensemble projected temperature increases up to 4 degrees over lands by the end of this century. The associated mean projected increases of risk diarrhea in the six study regions with 8-11% by 2010-2039 and 22-29% by 2070-2099.  There seem to be a correlation between temperature and cholera. The estimates predicts an increase in cholera incidences of 0.05 to 0.1 percentage point for a 1 degree Celsius increase in temperatures in Tanzania.
Sea-level rise	n= 1	In Mombasa, Kenya, it is a compelling number of people that are estimated to be located within the low-lying coastal zone in Mombasa. Low land elevations is making the drainage an issue which leads to flooding in the rainfall events. This means that as the sea-level rise it degrades the drainage, which adds to exacerbate the observed floods.
	<b>TOTALLY= 16</b>	<b>There seem to be a correlation between global warming and water-associated infectious diseases and health in general and global warming has an impact for people in Eastern Africa.</b>

Table 4. Table of analysis

## 9.1 Water-associated infectious diseases

The articles concerning *water-associated infectious diseases* was pointing out that global warming is having an impact on water-associated diseases. However when it comes to water-associated infectious diseases, it showed that outbreaks of water-associated infectious diseases occurred worldwide. On a global-scale, water-associated infectious diseases are highly correlated with socio-environmental factors. Among the countries mentioned being places of high risk for contracting water-associated infectious diseases such as malaria and dengue the countries Ethiopia and Kenya was among them. (Yang, et al., 2012). Human population density was also a common significant risk factor. Another issue was also the accumulated temperature. In addition, a majority of reviewed material focusing on heavy rainfall, flooding and temperature were reporting positive association between the exposure variable and diarrhea. Therefore, there turned out to be a positive relationship between diarrhea and heavy rainfall, temperature, drought and flooding and climate change is to expect to increase as a result. (Levy, Woster, Goldstein, & Carlton, 2016).

## 9.2 Vector-borne diseases

Another theme that came up, and that turned out to be one of the more researched areas according to the scoping study, was the *vector-borne diseases*. Several studies were pointing out the impact climate change has on the vector-borne diseases. Firstly, it turned out that the influence of the future climate scenarios on the anticipated potential distribution of the risk areas for dengue, in Tanzania, are enormous. Also when talking about dengue it turns out to be an endemic disease that exists in more than 100 countries and is continuing to spread worldwide both because of the emerging ecologic distribution areas of the disease vectors but also because of the global movement of humans. Climate has a compelling role in mosquito distribution and as a result the emerging favorable conditions, specifically the rising temperatures. Even though, dengue epidemics are driven by factors like rapid urbanization and a lack of adequate mosquito control or sanitary measures it turns out that climate is still the major driver of epidemics caused by vector-borne diseases. (Mweya, Kimera, Stanley, Misinzo, & Mboera, 2016).

Furthermore, it has shown that where there is humid and warm atmospheric weather conditions, like those prevailing in tropical lowlands throughout the year, are the areas suitable for water-associated infectious diseases like malaria. These kinds of diseases affected by climate changes are associated with increased temperatures and modified precipitation. (Ermert V. , Fink, Morse, & Paeth, 2012). In addition, there is an indication that a number of 3.3 billion people around the world are at risk of malaria infection, the disease is answerable for over a half a million deaths every year. The current climate projections are estimating that an increase in the population at risk of malaria by 2030 are 1.6 million people and by 2050 1.8 million people. The risk is specifically in East Africa where rising temperatures and other climate conditions will cause the expansion of transmission range of malaria into areas where communities earlier have been unexposed to the disease. (Onyango, Sahin, Awiti, Chu, & Mackey , 2016).

A malaria prevalence data collected for over 40 years along the Kenyan coast are showing cycles of change. These long-term cycles have been able to provide an opportunity to examine the temporal effects of e.g. vector-control, rainfall, and anti-malaria drug use. There have been peaks of increased malaria prevalence occurring during e.g. abnormal high rainfall and during El Niño. Between the years 2008-2010, the drought years can have contributed to a lower malaria-prevalence. But the parasite prevalence started again rising after 2011 during the continued drought and before the average rainfall that came in 2014. (Snow, o.a., 2015).

The East African highlands identifies as epidemic prone areas, and these areas are mainly concentrated in parts of Western Kenya, parts of Ethiopia, Burundi, southwestern Uganda and norther part of the Eastern Arc Mountains in Tanzania. This is due to considerable higher temperatures and slightly higher rainfall that leads to a small or moderate increase in malaria transmission in Eastern Africa. (Ermert V. , Fink, Morse, & Paeth, 2012). Another study also had the results that *P.falciparum* (which is a species of mosquito spreading malaria) has been on an increase since 2014. (Snow, o.a., 2015).

Studies showed evidence of a warming trend during the period 1979 to 2009. One should not dismiss the climate as a potential factor of observed increases in malaria. (Omumbo, Lyon, Waweru, Connor, & Thomson, 2011). *A.arabuensis* and *A.gambiae* sensu stricto (species of mosquitos spreading malaria) have a wide distribution across

Africa. Both species are likely to see improving conditions in regions of East Africa and southern Africa where annual temperatures are increasing. (Peterson, 2009). Ethiopia is among the countries that are showing likely increases of more than 100% in person-months of exposure towards the end of 21<sup>st</sup> century. (Tanser, Sharp, & le Sueur, 2003). These days malaria identifies also as a climate-related hazard.

### **9.3 Health impacts and migration**

Moreover, another theme presented is concerning the *health impacts and migration* due to global warming and it shows that there is likely to be forced displacement due to environmental changes and migration is likely in response to, or in anticipation of climate related impacts. This is due to the extreme climate events or environmental changes that undermine peoples' ability to stay in their place of residence. As discussed in one study it shows that the appropriate and primary focus of the international policy discourse on anthropogenic climate change is on the critical issue regarding reducing carbon emissions through mitigation efforts. This issue is an issue of major ethical, geopolitical and economic importance. (McMichael, Barnett, & McMichael, 2012). When also taking the health impacts and the climate into consideration, it turned out to be some major emerging themes. These were concerning a move towards assessing potential impacts that would be possible to avoid under different climate change mitigation scenarios. A movement towards probabilistic methods of impacts assessment and/or the consideration of impacts assessment and/or the consideration of climate modelling uncertainty and uncertainties that remain in understanding the relationship between natural and climate or human systems. (Gosling, o.a., 2011).

In addition, a review that was included in the scoping study is indicating that the climate change will increase in Ethiopia as well as have an increase in vector-borne diseases. The reviewers also concluded that there are for now no appropriately developed research on climate change and health in Ethiopia. (Simane, et al., 2016). As result of global warming mosquito survival, will increase in areas where the temperatures have not been optimal for survival as temperatures are increasing due to climate change to a more optimal temperature for the mosquitos. Another effect of global warming showed

by climate models is the high probability of serious drought in the course of the 21<sup>st</sup> century in most of Africa (and other parts of the world like Middle East, Southern Europe, USA and East Asia). The anticipation of drought and a rise in temperature is forming a serious concern regarding food security and agriculture especially in parts of Africa and Asia, especially in places where there is already a high risk of starvation and malnutrition. Global warming and climate change is potentially the largest global threat to human health ever detected. (Singh & Purohit, 2014).

#### **9.4 Alternative diseases**

Further, the results show that the model ensemble projected temperature increases up to 4 degrees over lands by the end of this century. The associated mean projected increases a risk of diarrhea in the six study regions with 8-11% by 2010-2039 and 22-29% by 2070-2099. The results are indicating that global warming is increasing the risk of diarrhea. There are concerns that global warming will cause excess deaths from e.g. diarrhea, malnutrition due to drought and crop failure, also respiratory diseases and vector-borne diseases, like malaria. Presently, about 90% of deaths globally due to diarrhea occur in Africa but also the Eastern Mediterranean region and Southeast Asia. In fact, one of the leading causes of death globally is in fact diarrhea. According to this study, it seems the future climate change could be bringing adverse increases in diarrhea. (Kolstad & Johansson, 2011)

Moreover, there seem to be a correlation between rise in temperature and cholera. The estimates predict an increase in cholera incidences of 0.05 to 0.1 --percentage point for a 1 degree Celsius increase, in temperatures in Tanzania. Additionally, when considering a rise of 1 degree Celsius the estimation of costs when managing climate-attributable cases of cholera in 2030 would be around USD 5.5 million to USD 10 million, and that is in an optimistic scenario. However, these costs are estimations based on expectations that introduction of preventive adaptation measures are done. (Trærup, Ortiz, & Markandya, 2011).

## 9.5 Sea-level rise and its impact

Now, major challenges concerning climate change is taking place globally. For coastal areas, the important components of climate change are extreme water levels and sea-level rise. It is important to have an understanding that coastal zones have a high economic importance and high ecological value and usually more densely populated than inland areas. Especially when it comes to low-income countries, it turns out that non or just a few of the coastal cities are prepared for the impacts of climate change, especially when it comes down to sea-level rise and storm events. This is often due to the coastal cities undergoing fast as well as unplanned growth and also having high population densities as well as overburdened infra structure, all leading to influence the extent of any potential impacts the cities might face as a result to changes in extreme water levels during the 21<sup>st</sup> century. In Mombasa, Kenya, it is a compelling number of people estimated to be located within the low-lying coastal zone in Mombasa. Lowland elevations are making the drainage an issue, which leads to flooding in the rainfall events. This means that as the sea-level rise it degrades the drainage, which adds to exacerbate the observed floods. (Kebede, Nicholls, Hanson, & Mokrech, 2012)

## 10 DISCUSSION

The aim with this study was to find out what impact global warming has on the water-associated infectious diseases in Eastern Africa. In addition, also to map the research gaps and/or to form some recommendations based on the findings. The research questions formed have been suitable in order to stay focused on the topic and to look for answers to them, but eventually it has been challenging to find a clear answer on how to prevent water-associated infectious diseases in Eastern Africa. For the first research question: *what impact does global warming have on Eastern Africa?* There is indication that global warming is affecting Eastern Africa, in the sense of increased weather-related happenings, which leads to increased disease burden. (Simane, et al., 2016) (McMichael, Barnett, & McMichael, 2012). Also for the second research question, *what impact does global warming have on water-associated infectious diseases in Eastern*

*Africa?* It also indicated that global warming does have an impact on water-associated infectious diseases in Eastern Africa. (Peterson, 2009) (Yang, et al., 2012). As for the third research question, *how could some of the water-associated infectious diseases be prevented?* There have not been any clear answer to that, but through identifying the causes to the increase in water-associated infectious diseases in Eastern Africa, there can be recommendations formed. In the last chapter of this thesis, one can see the list of recommendations.

Furthermore, it turns out that the preceding literature is agreeing with the idea of global warming having an impact on water-associated infectious diseases, in particular in Eastern Africa. This is the same results found in the scoping review conducted. Therefore, there is a positive correlation between the literature review and the literature study. Moreover, it was possible to establish five themes based on the findings from the 16 articles included to the literature study. The categories formed were *water-associated infectious diseases, vector-borne diseases, health impacts and migration, alternative diseases* and at last *sea-level rise*. All of these categories were analysed and the findings indicates that there seem to be a correlation between global warming and water-associated infectious diseases and health in general in Eastern Africa.

Other issues that were underscored in several of the articles where e.g. the need of considering basic approaches in order to improve public health care also including environmental and civil engineering as well as behaviour change efforts when it comes to climate change adaptation effects (Levy, Woster, Goldstein, & Carlton, 2016). Further, there was an understanding that dengue is often occurring by urbanization and the lack of sanitary and mosquito control but another major driver of epidemics is climate (Mweya, Kimera, Stanley, Misinzo, & Mboera, 2016). It also came clear that if there is no better understanding of both short-term and long-term cycles of malaria risk, it could lead to people mistakenly attribute declining or even increasing trends in malaria (Snow, o.a., 2015). There is also a lack of organized structure as there is no reliable, programs, and policy guidelines among offices, organization agencies that are targeting health and climate change. This means that there is really a need for an increased understanding of the impact global warming have on water-associated infectious diseases.

The method used for this scoping literature review is a framework presented by Arksey and O'Malley (2005). The application of the five stages of the framework, were useful in order to conduct the scoping study. The stages have turned out to be of great help as the study process went on. They gave a structure to the work and helped in leading the study and yet being comprehensive. The framework has also been a very useful tool for conducting a scoping literature review. The stages used in the framework has helped in identifying the research questions, and to identify relevant studies but also helped in dissecting the substance throughout and to figure out the direct study selection as well as served as a tool in charting the data. When it comes to the trustworthiness of this study, Elo, et al., 2014, has guided the author of this thesis. In an article written, they have described how to check the trustworthiness in a study. They made a list called: "*checklist for researchers attempting to improve the trustworthiness of a content analysis study*". This list is noting three phases to keep in mind: *the preparation phase* – data collection method, sampling strategy, the unit of analysis, *the organization phase* – categorization and abstraction, interpretation, and representativeness. Finally also *the reporting phase* – reporting results and reporting the analysis process. (Elo, et al., 2014).

However, for this scoping study as method for analysis, stage 5 from Arksey and O'Malley's framework was used while content analysis and its steps helped, as through the process the phases listed were recognized. That also helped when identifying the credibility, validity, reliability and transferability of this study. Which, is still worth noting.

Regarding the credibility of this scoping review, it has been clear what the research questions are and what is the aim. To be able to form the search terms, the respondent used a data search design to be able to structure them. The research questions were all the time kept in mind when collecting data. Moreover, the inclusion and exclusion table helped to keep the focus on wanted data and to exclude unwanted data for this scoping review. The methodology used had a well-described framework that helped to outline the aim, research questions and helped in identifying relevant studies as well as the study selection. The scoping literature review did also apply an appropriate data collection method as well as kept in mind *Stage 5: collating, summarizing and reporting the results*, from Arksey and O'Malley's framework - which consisted of collating and

helped in analysing the study. The study was applicable as the methodology used for the scoping literature review was functioning well and suitable for the search conducted. Further, it also served as a great tool to get a comprehensive field and thereby answer the research questions. The respondent of this paper is of the opinion that the design is helping in order to test the study as intended. It is possible to re-check how e.g. the conduction of data collection went as well as to repeat the steps. When it comes to this question whether it is possible to repeat the study, the respondent would agree that it is possible. As every step, is carefully outlined and therefore the result should be at least similar. It turns out to be clear how the study were conducted and in addition, the respondent has succeeded in measuring, when talking about measuring results, in this case whether global warming is having an impact on water-associated infectious diseases in Eastern Africa.

As for the transferability of this study, it is very likely to apply the results to other places outside Eastern Africa, especially if those places are having similar nature and similar struggles with weather-related climate change. It was shown in the beginning of this thesis that if global warming continues, the effects will also soon be showing in the Scandinavian countries in Europe (Vilhelmsson & Tengland, 2016, pp. 107-109).

The limitations with this scoping review are that the conduction of the scoping study was during a short period. In addition, there have not been so many studies conducted concerning global warming and its impact on water-associated infectious diseases in Eastern Africa.

## **11 CONCLUSION**

The analysis of the scoping study gives a quite clear picture of the results found. The literature indicates that there is an indication that water-associated infectious diseases occurred worldwide but the literature is also highlighting the high risks are in particular in Ethiopia and Kenya. The increased temperature does also seem to have a positive correlation with both disease and weather related phenomena. For this thesis Eastern Africa was the area in focus and the results in the scoping study indicates that there is a correlation between global warming and water-associated infectious diseases and health

in general and there seems to be that global warming is having an impact on people in Eastern Africa.

The question that rises now is whether the results will make a difference in any way. The answer is yes. It is important to understand that climate and health are having an impact on each other, and when one understands that it is easier to act in a positive way in order to e.g. help preventing water-associated diseases.

When talking about the long-term as well as short-term implications of the respondent's findings one can conclude that when considering long-term implications, one could see that the earth is getting warmer and in future bigger climate changes are to expect in Scandinavia as well. Therefore, the long-term implication could be that as we are aware of this, stakeholders should probably start a long-term project where the aim is to slow down the climate changes and start preventing the diseases followed by global warming, the project needs to design appropriate tools for this purpose. Then again when bringing up the short-term implications of the findings, realizing the fact that global warming has an impact on water-associated infectious diseases. It could be of importance to map what strategies exists already out there and how effective are they in order to develop the strategies to both slow down global warming but also to prevent water-associated infectious diseases in Eastern Africa (and later on around the world).

In addition, presented in the next chapter is suggestions for recommended further research.

## 12 RECOMMENDATIONS

In the course of this scoping study, it has been found that global warming is having an impact on water-associated infectious diseases and that it seems to be on an increase, not only in Eastern Africa, but globally (Yang, et al., 2012). Moreover, something that was not really found in the scoping study is concerning how water-associated infectious diseases could be prevented, especially when considering the impact global warming has on health and when considering how to be able to prevent the water-associated infectious diseases when looking at it from a health promotion perspective.

However, as result from this thesis as stated below, are suggestions on recommended future research.

- I. There is a need to identify methods used at this moment in order to prevent water-associated infectious diseases in Eastern Africa, and, how effective the methods are in order to be able to develop them.
- II. There is a need for increasing community awareness and knowledge about both health and climate change in order to prevent water-associated infectious diseases.
- III. There is a need to find out the strategies or projects that exist to prevent the water-associated infectious diseases, and how to improve these strategies or projects.
- IV. There is a need to find out how governments can improve policy guidelines, in order to increase awareness of how to prevent water-associated infectious diseases.
- V. There is a need to investigate what possibilities there are to develop health technology, as e.g. mHealth in order to reach out to more people and increase health literacy.

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## APPENDICES

### Appendix 1 – Literature review

Bibliography	Objectives	Method	Sample	Results
<p><i>Challenges in developing methods for quantifying the effects of weather and climate on water-associated diseases: A systematic review</i></p> <p><b>Lo Lacono, G., Armstrong, B., Fleming, L.E., Elson, R., Kovats, S., Nichols, G.L. (2017)</b></p>	<p>To review and summarize modelling and statistical methods used to investigate the effects of weather and climate on infectious diseases associated with water, in order to identify limitations and knowledge gaps in developing new methods.</p>	<p>The method for the systematic review followed the guidelines developed by Cochrane Collaboration.</p> <p>For the search terms related to water-associated diseases and quantitative methodologies, climate, and weather was of use.</p> <p>The analysis was completed by using, the ‘igraph’ package in R.</p>	<p>A systematic review of English-language papers published from 2000 to 2015.</p> <p>A number of 102 papers were included in the analysis.</p>	<p>There is a range of different methods used when studying the effect of climate and weather on water-associated diseases. Most of these methods can be connected to two main groups:</p> <ol style="list-style-type: none"> <li>1) Process based models</li> <li>2) Time series and spatial epidemiology.</li> </ol> <p>Recommendations for future research are e.g. when one is choosing the method one needs to be aware it is influenced by many factors. Critical assessment of these factors as a case-by-case basis are needed, and not be based on oversimplified prescriptive guidelines.</p>

Bibliography	Objectives	Method	Sample	Result
<p><i>East Africa's Pastoralist Emergency: is climate change the straw that breaks the camel's back?</i></p> <p><b>Blackwell, P. (2010)</b></p>	<p>To examine the livelihood strategies of the Turkana and several poverty reduction programs currently established, while also addressing the reality that traditional pastoralism may no longer be a viable livelihood option, given the effects of climate change, disease and the ensuing conflict over diminishing resources.</p>	<p>Finding out the livelihood strategies of the Turkana pastoralists and the strategies of poverty reduction programs available.</p>	<p>-</p>	<p>The findings deduct that the future for traditional Turkana pastoralists is not bright as they continue to depend on an environment that may no longer support them.</p> <p>As for recommendations, the humanitarians should shift their focus to advocate and invest in alternative livelihood strategies that generate economic independence and to help the Turkana to adjust to their changing environment.</p>

Bibliography	Objectives	Method	Sample	Results
<p><i>Africa's Climate Helping Decision-Makers Make Sense of Climate Information – East Africa's Climate: Planning for an uncertain future</i></p> <ul style="list-style-type: none"> <li>• A report by Future Climate for Africa</li> </ul> <p><b>Araujo, J., Marsham, J., Rowell, D., Zinyengere, N., Ainslie, A., Cle-naghan, A., Conforth, R., Giovan-na De Giusti, Evans, B., Finney, D., Lapforth, D., Macdonald, D., Petty, C., Seaman, J., Semazzi, F., and Way, C.(2016)</b></p>	<p>The rising temperatures and changing rainfall patterns will have significant impacts across East African society.</p> <p>Therefore, decision-makers need accessible information on likely climate change if they are to plan appropriately for an uncertain future.</p> <p>This factsheet considers how the climate is likely to change in East Africa.</p>	<p>The research, in the report is conducted and written down by leading experts in their fields and is presenting an overview of climate trends across eastern, central, western and southern Africa.</p>	<p>-</p>	<p>Future change in climate can have serious implications for livelihoods in east Africa such as; sanitation water availability and energy as climate are influencing all factors.</p> <p>The main challenge related to urban sanitation is flooding, which, is expected to increase in intensity and frequency.</p>

Bibliography	Objectives	Method	Sample	Results
<p><i>Projected Changes in Mean and Extreme Precipitation in Africa under Global Warming. Part II: East Africa</i></p> <p><b>Shongwe, M.E., van Oldenborgh, G.J. and van der Hurk, B. (2010)</b></p>	<p>To assess how the intensity of seasonal precipitation extremes is likely to change in the region, against the backdrop of probable changes in mean precipitation.</p> <p>In addition, to also assess the spatial inhomogeneties in the model projections.</p>	<p>The models used in the Inter-governmental Panel on Climate Change (IPCC) Fourth Assessment Report (AR4) is forming the major input in the analysis of changes in precipitation patterns.</p>	<p>Selected from the data available at the time of first submission was a subset of 12 coupled general circulation model simulations.</p>	<p>Turns out to be increases in both mean precipitation rates and the intensity of 10-yr wettest events, also simulated almost throughout the region, while the dry extremes are becoming less severe.</p> <p>In addition, dynamical effects, are forcing spatial inhomogeneties in the global warming-induced tropical rainfall increases.</p> <p>In most sub regions of East Africa it turns out that dynamical driven rainfall increases, which contributes up to about 30% of what are likely to work in concert with other mechanisms to force an overall increase in mean precipitation.</p>

Bibliography	Objectives	Method	Sample	Results
<p data-bbox="85 379 501 497"><i>Global pattern of trends in streamflow and water availability in a changing climate</i></p> <p data-bbox="85 619 501 762"><b>Milly, P.C.D., Dunne K.A., and Vecchia, A.V. (2005)</b></p>	<p data-bbox="519 379 837 730">To show that an ensemble of 12 climate models exhibits statistically and qualitative significant skills in simulating observed regional patterns of twentieth-century multidecadal changes in streamflow.</p>	<p data-bbox="855 379 1218 450">Used as a method to analyze data were 12 climate models.</p>	<p data-bbox="1236 379 1500 545">Selected suitable for analysis of hydroclimatic change were 165 river basins.</p> <p data-bbox="1236 593 1500 896">For a basin to be included, it needed to have data of 28 years and no more than 10% of values missing during the period of record.</p>	<p data-bbox="1518 379 2172 450">The models projected a 10-40% increase in runoff in eastern equatorial Africa by the year 2050.</p> <p data-bbox="1518 497 2172 619">Such changes in sustainable water availability would have considerable regional-scale consequences for ecosystems as well as economies.</p>

Bibliography	Objectives	Method	Sample	Results
<p data-bbox="85 379 499 592"><i>The Global One Health Paradigm: Challenges and Opportunities for Tackling Infectious Diseases at the Human, Animal, and Environmental Interface in Low-Resource Settings.</i></p> <p data-bbox="85 711 499 1062"><b>Gebreyes, W.A., Dupoy-Camet, J., Newport, M.J., Oliveira, C.J.B., Schlesinger, L.S., Saif, Y.M., Kariuki, S., Saif, L.J., Saville, W., Witum, T., Hoet, A., Quessy, S., Kazwala, R., Tekola, B., Shryock, T., Bisesi, M., Patchanee, P., Boonmar, S., and King, L.J.</b></p> <p data-bbox="85 1110 159 1134"><b>(2014)</b></p>	<p data-bbox="517 379 837 592">This review article is highlighting scientific advances, with a major attention on studies conducted in low-income countries.</p>	<p data-bbox="855 379 1216 592">Reviewing the material/ presentations presented at the International Congress on Pathogens at the Human-Animal Interface (ICOPHAI) in 2011 and 2013.</p> <p data-bbox="855 711 1216 783">360 scientists from 35 nations participated.</p>	<p data-bbox="1234 379 1498 499">A number of 130 scientific presentations in 2011.</p> <p data-bbox="1234 619 1498 738">A number of 278 scientific presentations in 2013.</p>	<p data-bbox="1516 379 2179 451">As a result the participants of the ICOPHAI recognized for capacity-building needs:</p> <ol data-bbox="1516 499 2179 978" style="list-style-type: none"> <li data-bbox="1516 499 2179 619"><b>1)</b> The development of adequate science-based risk management policies that respect transboundary and international guidelines,</li> <li data-bbox="1516 667 2179 738"><b>2)</b> accredited environmental and clinical diagnostic laboratories with an integrated and shared database, and</li> <li data-bbox="1516 786 2179 858"><b>3)</b> a sustained capacity building of applicably and appropriately knowledgeable and skilled One Health personnel and,</li> <li data-bbox="1516 906 2179 978"><b>4)</b> Ensuring improved use of existing natural resources and implementation plans based on cost-benefit analyses.</li> </ol> <p data-bbox="1516 1026 2179 1098">In addition, the findings accessed at the two ICOPHAI congresses encourages continuation of promoting One Health.</p>

Bibliography	Objectives	Method	Sample	Results
<p><i>The Impact of Regional Climate Change on Malaria Risk due to Greenhouse Forcing and Land-Use Changes in Tropical Africa</i></p> <p><b>Ermert, V., Fink, A.H., Morse, A.P., and Paeth, H. (2012)</b></p>	<p>By using an integrated weather-disease model, assessment of the potential changes in the malaria transmission was undertaken.</p>	<p>A simulation of mosquito biting rates using the Liverpool Malaria Model (LMM) was undertaken.</p> <p>The Plasmodium falciparum infection model also expanded the LMM simulations to incorporate information on the infection rate among children.</p> <p>Further, conduction of the Malaria projections were taking place with the integrated weather-disease model for 2001 to 2050 according to two climate scenarios that includes the effect of anthropogenic land-use and land-cover changes on climate.</p>	<p>Simulation of three LMM<sub>2010</sub> runs were on a 0.5° grid by daily temperatures and rainfall from different REMO integrations of the present-day climate of 1960-2000.</p> <p>Based on the two different REMO climate projections was a malaria projection, for 2001-2050.</p>	<p>In East Africa, the presence of highlands causes a complex pattern of malaria distribution.</p> <p>The temperature in these regions, reduce or disrupt the transmission, and the dry conditions along the Horn of Africa prohibits the simulated spread of Malaria.</p> <p>The integrated weather-disease model does indicate a potential epidemic risk for large parts of the Greater Horn of Africa. Identified, as epidemic-prone areas are the East African highlands. Highland epidemic risk is concentrated in parts of western Kenya, parts of Ethiopia, Burundi, southwestern Uganda and northern part of the Eastern Arc Mountains in Tanzania.</p> <p>Considerable higher temperatures and slightly higher rainfall will lead to a small or moderate increase in malaria transmission in East Africa</p>

Bibliography	Objectives	Method	Sample	Results
<p data-bbox="85 379 501 497"><i>Impact of Anthropogenic Environmental Alterations on Vector-Borne Diseases</i></p> <p data-bbox="85 619 264 644"><b>Vora, N. (2008)</b></p>	<p data-bbox="519 379 837 590">To review human-driven ecosystem alterations that may increase the transmission of vector-borne diseases.</p>	<p data-bbox="855 379 1218 638">This is a review, where presentation of different examples are brought up, in which human-driven ecological changes may be contributing to the spread of vector-borne diseases.</p>	<p data-bbox="1236 379 1500 453">A review of 41 different sources.</p>	<p data-bbox="1518 379 2172 501">The evidence reviewed in this article is indicating that in many instances the transmission of vector-borne diseases will increase with human-driven environmental alteration.</p> <p data-bbox="1518 549 2172 667">Also recommended that people remain cautious in our interactions as in avoiding unnecessary outbreaks of serious vector-borne diseases.</p> <p data-bbox="1518 715 2172 833">There is a need of further research so that we can prevent and predict future re-emerging and emerging vector-borne diseases due to environmental damage.</p>

Bibliography	Objectives	Method	Sample	Results
<p><i>Climate Change And Infectious Diseases</i></p> <ul style="list-style-type: none"> <li>A Book: Climate change and human health- risk and response</li> </ul> <p><b>Climate Change and Infectious Diseases.</b></p> <p><b>World Health Organization. (2017)</b></p>	<p>A chapter about Climate change and the infectious diseases by the World Health Organization.</p>	<p>Describing the different routes of transmission as well as the causes.</p>	<p>-</p>	<p>Changes in infectious diseases transmission patterns are a likely major consequence of climate change.</p> <p>There is a need to learn more about the underlying complex causal relationships and to apply the information to the prediction of future impacts, by using more complete as well as better-validated, integrated models.</p>

## Appendix 2 – Scoping review

Bibliography	Objectives	Method	Sample	Results
<p><i>Global Distribution of Outbreaks of Water-Associated Infectious Diseases</i></p> <p><b>Yang, K., LeJeune, J., Alsdorf, D., Lu, B., Shum, C.K., and Liang, S. (2012)</b></p>	<p>To explore the possible relationship between global distribution of water-associated infectious diseases and socio-environmental factors.</p>	<p>The Global Infectious Disease and Epidemiology Network (GIDEON) was the primary source of information on water-associated pathogens and infectious diseases.</p> <p>Socio-environmental database; included information about grid-based global human population density based on the 2000 global population dataset, that was developed by the Socioeconomic Data and Applications Center (SEDAC)</p> <p>Statistical analyses; was used for controlling reporting bias. As well as a descriptive and exploratory analysis was completed as well as the Bayesian analysis.</p>	<p>Reported outbreak events that were associated with corresponding water-associated infectious diseases from 1991-2008 were extracted from the database.</p> <p>It was an amount of 1,428 outbreaks reported.</p>	<p>Outbreaks occurred all over the world and clusters of reported outbreaks tended to be in west Europe, north India, Central Africa and Southeast Asia. High-risk areas for water-related diseases were clustered in central Africa, in particular Ethiopia and Kenya.</p> <p>Human population density was a common significant risk factor for the outbreaks caused by all categories of water-associated diseases.</p> <p>The accumulated temperature was a significant factor associated with water-related diseases.</p>

Bibliography	Objectives	Method	Sample	Results
<p><i>Untangling the impacts of climate change on waterborne diseases: A systematic review of relationships between diarrheal diseases and temperature, rainfall, flooding and drought</i></p> <p><b>Levy, K., Woster, A.P., Goldstein, R.S., and Carlton, E.J.</b></p> <p><b>(2016)</b></p>	<p>In this paper, presented are the results of the systematic review of the epidemiological associations between diarrhea and surrounding heavy rainfall, drought, flooding and temperature.</p>	<p>Identification of articles took place through a comprehensive search of the literature and by reviewing references from 54 review articles identified during the search process.</p> <p>The search was conducted in the following databases: PubMed, Embase, Web of Science and the Cochrane Collection</p>	<p>141 articles met the inclusion criteria.</p>	<p>The majority of reviewed articles focusing on heavy rainfall, temperature and flooding were reporting a compelling positive association between the exposure variable and diarrhea.</p> <p>The conclusion is that, there is a predominant trend for positive relationship between diarrhea and heavy rainfall, temperature, flooding and drought. Which, are meteorological conditions that an increase is to expect with climate change.</p>

Bibliography	Objectives	Method	Sample	Results
<p data-bbox="159 379 501 592"><i>Climate Change Influences Potential Distribution of Infected Aedes aegypti Co-Occurrence with Dengue Epidemics Risk Areas in Tanzania</i></p> <p data-bbox="159 711 501 879"><b>Mweya, C.N., Kimera, S.I., Stanley, G., Misinzo, H., and Mboera, L.E.G. (2016)</b></p>	<p data-bbox="521 379 797 639">To assess the effect of changing climate on distribution of dengue vectors in relation to epidemic risk areas in Tanzania.</p>	<p data-bbox="819 379 1267 639">Used for the study was an ecological niche models that incorporated presence-only infected Aedes aegypti data co-occurrence with dengue virus to estimate potential distribution of epidemic risk areas.</p> <p data-bbox="819 683 1267 807">Used as model inputs were the bioclimatic predictors for current and future projections.</p>	<p data-bbox="1290 379 1570 592">Model input data on infected Ae.aegypti was collected during the May to June 2014 epidemics in Dar es Salaam.</p>	<p data-bbox="1592 379 2098 504">The results showed that the influence of future climate scenarios on anticipated potential distribution of risk areas for dengue epidemic.</p> <p data-bbox="1592 547 2098 715">The risk areas are immense and results will help in guiding future public health policy decisions on surveillance and control of dengue epidemics.</p>

<i>Bibliography</i>	Objectives	Method	Sample	Results
<p data-bbox="159 379 501 592"><i>The Impact of Regional Climate Change on Malaria Risk due to Greenhouse Forcing and Land-Use Changes in Tropical Africa</i></p> <p data-bbox="159 711 501 831"><b>Ermert, V., Fink, A.H., Morse, A.P., and Paeth, H. (2012)</b></p>	<p data-bbox="519 379 799 635">Assessment of the potential changes in the malaria transmission took place by using an integrated weather-disease model.</p>	<p data-bbox="817 379 1270 499">A simulation of mosquito biting rates using the Liverpool Malaria Model (LMM) was undertaken.</p> <p data-bbox="817 547 1270 715">The Plasmodium falciparum infection model also expanded the LMM simulations to incorporate information on the infection rate among children.</p> <p data-bbox="817 754 1270 1058">Further, conduction of the Malaria projections were taking place with the integrated weather-disease model for 2001 to 2050 according to two climate scenarios that includes the effect of anthropogenic land-use and land-cover changes on climate.</p>	<p data-bbox="1288 379 1572 730">Simulation of three LMM<sub>2010</sub> runs were on a 0.5° grid by daily temperatures and rainfall from different REMO integrations of the present-day climate of 1960-2000.</p> <p data-bbox="1288 770 1572 986">Based on the two different REMO climate projections was a malaria projection, for 2001-2050.</p>	<p data-bbox="1590 379 2101 499">In East Africa, the presence of highlands causes a complex pattern of malaria distribution.</p> <p data-bbox="1590 547 2101 715">The temperature in these regions, reduce or disrupt the transmission, and the dry conditions along the Horn of Africa prohibits the simulated spread of Malaria.</p> <p data-bbox="1590 754 2101 1289">The integrated weather-disease model does indicate a potential epidemic risk for large parts of the Greater Horn of Africa. Identified, as epidemic-prone areas are the East African highlands. Highland epidemic risk is concentrated in parts of western Kenya, parts of Ethiopia, Burundi, southwestern Uganda and northern part of the Eastern Arc Mountains in Tanzania. Considerable higher temperatures and slightly higher rainfall will lead to a small or moderate increase in malaria transmission in East Africa.</p>

<i>Bibliography</i>	Objectives	Method	Sample	Results
<p data-bbox="159 379 501 544"><i>An integrated risk and vulnerability assessment framework for climate change and malaria transmission in East Africa</i></p> <p data-bbox="159 663 501 858"><b>Onyango, E.A., Sahin, O., Awiti, A., Chu, C., and Mackey, B. (2016)</b></p>	<p data-bbox="519 379 799 639">In order to address the gaps when it comes to the nature of the impacts on vulnerable communities or how well prepared they are to cope.</p> <p data-bbox="519 683 799 1082">Used for this was a systems approach to present an integrated risk and vulnerability assessment framework for studies of community level risk and vulnerability to malaria due to climate change.</p>	<p data-bbox="817 379 1270 778">Adopted was the Bayesian Belief Network (BBN) model, as they are a useful method for undertaking scenario simulations as they can assimilate different kinds of data and information including quantitative biophysical response functions, qualitative social results, spatial environmental data, and expert opinions and missing data.</p> <p data-bbox="817 821 1270 943">Used to undertake a structural analysis was the cross-impact multiplication method (CIMM).</p> <p data-bbox="817 986 1205 1018">A literature review was undertaken.</p>	<p data-bbox="1288 379 1572 639">Identified were a list of 36 variables considered as important for understanding climatic impacts and malaria transmission cycle.</p>	<p data-bbox="1590 379 2101 501">The construction of the risk assessment framework was taking place based on the conceptual systems model.</p> <p data-bbox="1590 544 2101 756">The risk of malaria infection are identified as the climate-related hazard, which is influenced by exposure to changes in climate, climate variability, land use change and land use and malaria vector attributes.</p> <p data-bbox="1590 799 2101 1059">The framework used, can be applied at a community level using both qualitative and quantitative methods with stakeholder engagement and can be adapted to other data-poor regions with similar vulnerability profiles.</p>

Bibliography	Objectives	Method	Sample	Results
<p data-bbox="161 379 499 544"><i>Changing Malaria Prevalence on the Kenyan Coast since 1974: Climate, Drugs and Vector Control</i></p> <p data-bbox="161 663 499 922"><b>Snow, R.W., Kibuchi, E., Karuri, S.W., Sang, G., Gitonga, C.W., Mwandawiro, C., Bejon, P., and Noor, A.M. (2015)</b></p>	<p data-bbox="521 379 797 683">The progress toward reducing malaria burden in Africa, has been modelled or measured by using datasets with relatively short time-windows.</p>	<p data-bbox="819 379 1267 592">A composition of 1147 age-corrected Plasmodium falciparum parasite prevalence-surveys among rural communities along the Kenyan coast took place between the years 1974 to 2014.</p> <p data-bbox="819 639 1267 804">Used was a Bayesian conditional autoregressive generalized linear mixed models to interpolate to 279 small areas for each of the 41 years since 1974.</p>	<p data-bbox="1290 379 1570 592">A number of 1144 surveys undertaken among the rural communities along the Kenyan coast during 1974-2014.</p> <p data-bbox="1290 639 1570 852">Collection of data for each of the 279 sub-locations and for every year 1974-2014 was completed.</p>	<p data-bbox="1592 379 2098 683">The results show that the prevalence of P.falciparum parasite initially was on rise from 1974 to 1987 had a dip in 1991-92. However, has remained high until 1988. Then there was a decline from 1988 until 2011, after that the prevalence has been rising through 2014.</p> <p data-bbox="1592 730 2098 895">This major decline occurred before ITNs were widely distributed and variation in rainfall coincided with some, but not all short-term cycles.</p>

Bibliography	Objectives	Method	Sample	Results
<p data-bbox="159 379 501 544"><i>Raised temperatures over the Kericho tea estates: revisiting the climate in the East African highlands malaria debate</i></p> <p data-bbox="159 663 501 783"><b>Omumbo, J.A., Lyon, B., Waweru, S.M., Connor, S.J., and Thomson, M.C.</b></p> <p data-bbox="159 831 237 858"><b>(2011)</b></p>	<p data-bbox="519 379 799 775">To find evidence that if significant temperature trends over the last three decades have occurred then climate should be included with other factors, as a potential driver of the observed increases in malaria in the region.</p>	<p data-bbox="817 379 1270 592">In the analysis of trends at Kericho, used were the meteorological station's over 30 years of quality-controlled, daily observations of maximum, minimum and mean temperature.</p>	<p data-bbox="1288 379 1574 544">Observed and analyzed were the mean temperatures between the years 1979 to 2009.</p>	<p data-bbox="1592 379 2101 544">The study presented evidence of a warming trend in observed maximum and mean temperature at Kericho during the period 1979 to 2009.</p> <p data-bbox="1592 592 2101 756">Therefore, a recommendation is that climate as a factor should not to be dismissed as a potential factor of observed increases in malaria seen in the region.</p>

Bibliography	Objectives	Method	Sample	Results
<p data-bbox="161 379 499 499"><i>Shifting suitability for malaria vectors across Africa with warming climates</i></p> <p data-bbox="161 619 405 643"><b>Peterson, A.T. (2009)</b></p>	<p data-bbox="521 379 799 1145">The researcher is combining detailed climate change scenarios for the two most compelling Africa-wide mosquito vector species, that is based on ecological niche models and detailed spatial summaries of present-day human population distributions, in order to calculate shifting patterns of potential human exposures to malaria across Africa that is expected of the coming half-century.</p>	<p data-bbox="822 379 1270 635">Incidence data for vector species obtained from a recent detailed compilation that has been the basis of a previous analysis. In this study, the researcher focused on two species with a wide distribution.</p> <p data-bbox="822 683 1270 802">The data obtained are a result from a sampling that was intense in some countries.</p>	<p data-bbox="1292 379 1572 595">For <i>A.arabuensis</i> and <i>A.gambiae</i> sensu stricto, there were 581 and 501 incidence records available respectively.</p>	<p data-bbox="1594 379 2098 451"><i>A.arabuensis</i> and <i>A.gambiae</i> sensu stricto have wide distributions across Africa.</p> <p data-bbox="1594 499 2098 667">Both species are likely to see improving conditions in regions of East africa and southern Africa, in areas where annual mean temperatures are increasing.</p>

<i>Bibliography</i>	Objectives	Method	Sample	Results
<p data-bbox="161 379 499 499"><i>Potential effect of climate change on malaria transmission in Africa</i></p> <p data-bbox="161 619 499 770"><b>Tanser, F.C., Sharp, B., and le Sueur, D. (2003)</b></p>	<p data-bbox="521 379 799 962">The researchers used a large set of parasite surveys that has been done throughout Africa in order to produce a spatiotemporally validated model of malaria transmission, and to project the effect of three climate scenarios by Hadley Centre global climate model (HadCM3) climate experiments</p>	<p data-bbox="822 379 1270 499">Used as the basis for the seasonality model, was a long-term monthly rainfall and temperature data.</p>	<p data-bbox="1292 379 1572 499">Based on the data on weather-based data from 1920 to 1980.</p> <p data-bbox="1292 547 1572 667">The data for population estimates used was from 1995.</p>	<p data-bbox="1594 379 2098 547">The seasonality models estimated that on a mediocre there is about 3.1 billion persons-months of exposure to malaria in Africa every year.</p> <p data-bbox="1594 595 2098 762">Ethiopia is among the countries that are showing likely increases of more than 100% in person-months of exposure towards the end of 21<sup>st</sup> century.</p>

<i>Bibliography</i>	Objectives	Method	Sample	Results
<p data-bbox="159 379 501 451"><i>An Ill Wind? Climate Change, Migration, and Health</i></p> <p data-bbox="159 571 501 691"><b>McMichael, C., Barnett, J., and McMichael A.J. (2012)</b></p>	<p data-bbox="519 379 801 1010">This review is exploring the role health impacts play in population movements and examine the health implications of three types of movement that are likely to be induced by climate change, as the following: resettlement schemes, forcible displacement by climate impacts and migration as an adaptive response.</p>	<p data-bbox="819 379 1272 595">The risk assessment draws on research into the health of migrants, refugees and people in resettlement schemes as analogs of the likely health consequences of climate-related migration.</p>	<p data-bbox="1290 379 1563 403">Based on 134 references.</p>	<p data-bbox="1592 379 2101 547">Most likely, there will be forced displacement due to environmental changes and extreme climate events that will undermine peoples' ability to live in their places of residence.</p> <p data-bbox="1592 595 2101 754">In addition, Migration is also likely in response to, or in anticipation of, climate-related impacts and will most likely be within countries and contribute to urbanization.</p> <p data-bbox="1592 802 2101 922">Furthermore, there might be planned resettlement of large populations to reduce their exposure to climate impacts.</p>

<i>Bibliography</i>	Objectives	Method	Sample	Results
<p><i>A review of recent developments in climate change science. Part II: The global-scale impacts of climate change</i></p> <p><b>Gosling, S.N., Warren, R., Arnell, N.W., Good, P., Caesar, J., Bernie, D., Lowe, J.A., van der Linden, P., O’Hanley, J.R., and Smith, S.M. (2011)</b></p>	<p>A review of recent developments in studies assessing the global-scale impacts of climate change published since the Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report (AR4).</p>	<p>The review focused on studies with a global perspective to climate change impacts. Cited is both national and regional studies.</p>	<p>Review of literatures covering six main impact sectors, concerning themes like coastal impacts, sea-level rise (SLR), ocean acidification, biodiversity and ecosystems, desertification, water resources, agriculture, food security and human health.</p>	<p>As a result, the review is highlighting three major emerging themes, which are of great importance for the policy- and decision-making process. Which are as the following:</p> <ol style="list-style-type: none"> <li>1) A move towards assessing potential impacts that could be avoided under different climate change mitigation scenarios relative to a business-as-usual reference scenario; and</li> <li>2) a movement towards probabilistic methods of impacts assessment and/or the consideration of climate modelling uncertainty; and</li> <li>3) Uncertainties that remain in understanding the relationship between natural and climate or human systems.</li> </ol>

<i>Bibliography</i>	Objectives	Method	Sample	Results
<p data-bbox="161 379 499 499"><i>Review of Climate Change and Health in Ethiopia: Status and Gap Analysis</i></p> <p data-bbox="161 619 499 786"><b>Simane, B., Beyene, H., Dersessa, W., Kumie, A., Berhane, K., and Samet, J. (2016)</b></p>	<p data-bbox="521 379 799 595">This review was to assess Ethiopia's existing situation on issues related to the climate change, environment and health.</p> <p data-bbox="521 643 799 850">In addition, to identify the gaps and needs and address them through training, research and capacity building.</p>	<p data-bbox="822 379 1270 691">Conduction of research took place through a literature review of available secondary data as well as by interviewing key informants within different national organizations that are involved in climate change adaptation and mitigation activities.</p>	<p data-bbox="1292 379 1572 451">Various data between the years 1961 until 2011</p> <p data-bbox="1292 499 1572 571">Interviews with several key informants</p>	<p data-bbox="1594 379 2098 595">The results are indicating the rate of climate change will increase in Ethiopia. The study also showed there has been both dry and wet years and there is a warming trend in temperature over the last 50 years.</p> <p data-bbox="1594 643 2098 715">Also there is an increase in vector-borne diseases and weather condition-related diseases</p> <p data-bbox="1594 762 2098 882">Increase in surrounding temperatures are usually having a correlation with waterborne disease outbreaks.</p> <p data-bbox="1594 930 2098 1137">Climate change-induced flood is also resulting in the interruption of drinking water sources that could lead to pollution that increases the risk of exposure to water-borne pathogens, which in turn causes water-borne diseases.</p>

Bibliography	Objectives	Method	Sample	Results
<p><i>Public Health Impacts of Global Warming and Climate Change</i></p> <p><b>Singh, A., and Purohit, B.M. (2014)</b></p>	<p>This article is reviewing and emphasizing the direct and indirect impacts of global warming and climate change on various health aspects along with establishing a social perspective.</p>	<p>An essay was written using the material found regarding the theme: Public Health Impacts of Global Warming and Climate Change</p>	<p>There was a number of about 15 sources used.</p>	<p>Global warming and climate change is potentially the largest global threat to human health ever encountered.</p>
<p><i>Uncertainties Associated with Quantifying Climate Change Impacts on Human Health: A Case Study for Diarrhea</i></p> <p><b>Kolstad, E.W., and Johanson, K.A. (2011)</b></p>	<p>To indicate a method to assess a range of plausible health impacts of climate change while handling uncertainties in an unambiguous manner.</p>	<p>A range of linear regression coefficients, combined to compute projections of future climate change-induced increases in diarrhea.</p>	<p>Results from five empirical studies and a 19-member climate model ensemble.</p> <p>Analysis of six geographical regions took place.</p>	<p>It turns out that the model ensemble projected temperature increases of up to 4°C, over land in the tropics and subtropics by the end of this century.</p> <p>The associated mean projected increases of relative risk of diarrhea in the six study regions were 8-11% by 2010-2039 and 22-29% by 2070-2099.</p>

Bibliography	Objectives	Method	Sample	Results
<p data-bbox="161 379 499 496"><i>The Costs of Climate Change: A Study of Cholera in Tanzania</i></p> <p data-bbox="161 619 499 735"><b>Trærup, S.L.M, Ortiz, R.A., and Markandya, A. (2011)</b></p>	<p data-bbox="521 379 797 823">The idea with the study is to integrate historical data on rainfall and temperature with the burden of disease from Cholera in Tanzania and, to use socioeconomic data to control for the impacts of general development on the risk of cholera.</p>	<p data-bbox="819 379 1267 451">Collection of historical data on deaths and cases of cholera.</p> <p data-bbox="819 499 1267 571">Creation of three datasets for the purpose of the analysis.</p>	<p data-bbox="1290 379 1570 592">Data covering the cholera cases throughout the country was collected from January 1998- December 2004</p> <p data-bbox="1290 639 1570 895">Second data set for cholera cases and deaths for Tanzania during 1977 to 2004 and for 21 of its regions during the years 1998 to 2004.</p>	<p data-bbox="1592 379 2098 451">There seems to be a correlation between temperature and cholera.</p> <p data-bbox="1592 499 2098 667">The linear correlation between total rainfall and cholera is not compelling. Suggesting that cholera cases in Tanzania per chance explained better by temperatures than by rainfall.</p> <p data-bbox="1592 715 2098 874">The estimates in this article predicts an increase in cholera incidences of 0.05 to 0.1-percentage point for a 1 degree Celsius increase in temperatures for Tanzania.</p>

<i>Bibliography</i>	Objectives	Method	Sample	Results
<p data-bbox="161 379 499 544"><i>Impacts of Climate Change and Sea-Level Rise: A Preliminary Case Study of Mombasa, Kenya</i></p> <p data-bbox="161 663 499 810"><b>Kebede, A.S., Nicholls, R.J., Hanson, S., and Mokrech, M. (2012)</b></p>	<p data-bbox="521 379 799 866">The paper aims to provide a wider, quantitative context to the potential coastal flooding risks as well as anticipated impacts on Mombasa based on physical exposure and socioeconomic vulnerability to sea-level rise and climate extremes.</p>	<p data-bbox="822 379 1270 544">The focus of this analysis was to provide a quantitative and wider context to the potential impacts of coastal flooding on Mombasa.</p>	<p data-bbox="1292 379 1572 687">Because of the lack of detailed information and accurate data on coastal defense system in Mombasa, assessment of protection could not take place.</p> <p data-bbox="1292 727 1572 986">The analysis assessed exposure under a range of projected sea-level rise scenarios that gave a good indication of the worst-case scenario.</p>	<p data-bbox="1594 379 2098 499">An estimation of a compelling number of people are to be located within the low-lying coastal zone in Mombasa.</p> <p data-bbox="1594 539 2098 659">Lowland elevations is making the drainage an issue, which leads to flooding in the rainfall events.</p>

