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Impacts of climate change on human health in the West Africa Sahelian countries: A review

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ABSTRACT

Human health is considered worldwide an important resource for the entire population living in a given community. Despite its vital importance, climate change poses many threats to the health system and well-being of people. This paper aimed at reviewiing the impact of climate change on human health in the Sahelian countries. In this study, the data used are secondary data from the existing literature from the West Africa Sahelian countries between 2002 and 2023. The key words employed in this research include climate change and health, climate diseases, climate change and human, health and health impacts. Findings from the research revealed that vecto-borne diseases, water-borne diseases, food diseases, malaria are climate change related diseases that are common in the Sahelian countries. The study reports that the climate change mamifestations such as floods, strong winds, and increased temperatures are some causal factors of human death with common diseases such as malaria. For exemple extreme weather events is responsible for the deaths of 32% of people in Mauritania, 18% in Senegal between 2000 and 2019 and 86% in Niger from 2010 to 2017. The paper concludes that the impact of climate change on human health is linked to an increase in the number and frequency of natural disasters (floods, droughts, wind, etc.) that claim many victims and the prevalence of infectious diseases. Based on these results, the study recommends for the inclusion of climate change policy, project and programmes in the health sector and integrating climate change education into medical school curricula.

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INTRODUCTION

Generally speaking, human health is seen as both a product and a determinant of well-being. Human health is considered a source of income for the entire population living in the community. The setting up of a global organization World Health Organization (WHO) by

the UN underscores its importance. According to the World Health Organization, “Better health is essential to happiness and well-being. Better health also contributes significantly to economic progress, since healthy populations live longer, are more productive and save more” (David, 2011 pg 2). Despite its vital importance, climate change poses many threats to the health system and well-being of people worldwide. The impact of climate change on human health can be directly related to climate change manifestations (temperature modification floods , droughts, etc.) or indirect to climate change related environmental degradation (water pollution, , air pollution, etc.) or related to the dust, fog/haze extreme heat leading to human dead (Watts et *al*., 2015).

In 1992, UNFCCC defined climate change as "changes that are attributed directly or indirectly to human activity that alter the composition of the global atmosphere and that are in addition to natural climate variability observed over comparable periods" (UNFCCC, 1992 pg 3). It is a global problem because every country around the world is aware of the impacts of this phenomenon even if the impacts are of a different degree from one country to another. It also has a major impact on the achievement of Sustainable Development Goals (SDGs) (Huppmann & Hinge, 2017).

The WHO reports that climate change is responsible for at least 150,000 deaths per year, a figure that is expected to double by 2030. At the same time, forecasts for the year 2100 show an average temperature increase of 1.0 to 3.5°C. This increase in temperature is favorable for the manifestation vector-borne diseases such as malaria yellow fever, dengue etc. (Githeko et *al*., 2000). The estimated rise in temperature in the Sahel in 2050 is estimated at 1.6 degrees Celsius compared to equatorial countries where the rise is estimated at 1.4 degrees Celsius (OXFAM, 2022).

To address this issue, states must make use of broad policy frameworks that call for joint action to address the impact of climate change on human health (Ramirez, 2017). These include the Paris Agreement for Climate Action and Resilience Building, which is one of the important perspectives helping to achieve the United Nations Sustainable Development Goals 2016-2030 (Bangert et al., 2017; Ramirez, 2017). According to a report of the Intergovernmental Panel on Climate (IPCC, 2014), the influence of man on the climate is increasingly important, its impact is observed on all continents and in all oceans ((IPCC, 2014). Since the industrial revolution, the concentration of carbon dioxide (CO_2) in the atmosphere has only increased (Dibor et *al*., 2021).

Africa as a whole and some of the western Sahel regions (Burkina Faso, Niger, Mauritania, Nigeria, Chad, and Mali) in particular are not immune to the impacts of climate change. According to the IPCC, the Sahel is one of the most vulnerable regions in the world to the effects of climate change, due to poverty and the strong dependence of populations on natural resources, the fragility of ecosystems, the precariousness of infrastructures and limited scientific and technological capacities (IPCC, 2007). Indeed, The number of people exposed to such risk is amplified by social factors: the distribution of population density resulting from urbanization, and changes in population demographics relating to agein.

According to the Climate Risk Index (CRI) published by German Watch, most of the Sahel countries rank at the very bottom of the list which confirms they are the most vulnerable to climate change impact (Sartori & Fattibene, 2019).. These changes have contributed to the evolution of humans by forcing them to develop skills to adapt to these changes. However, these were slow. The current situation is marked by a rapid modification of the climate (Swynghedauw, 2021). The impact of climate change on human health can be summarized as an increase in the number and frequency of natural disasters (floods, droughts, wind, etc.) that

claim many victims and the development of infectious diseases (Pipien, 2018). A concrete example is the spread of the Lassa virus in West Africa which is an important factor in climate change (Redding et al., 2016; Sweileh, 2020).

Countries in the Sahel feel more the impact of climate change because of its strong dependence on agriculture and livestock breeding. However, in terms of greenhouse gas emissions, the West Africa Sahelian countries have a low contribution. For example, the G5 Sahel countries have a global emission 1% (World Bank, 2022). One of the importance of the Sahel region in the context of global climate change, is that they receive external subsidies from developing countries to fight climate change.

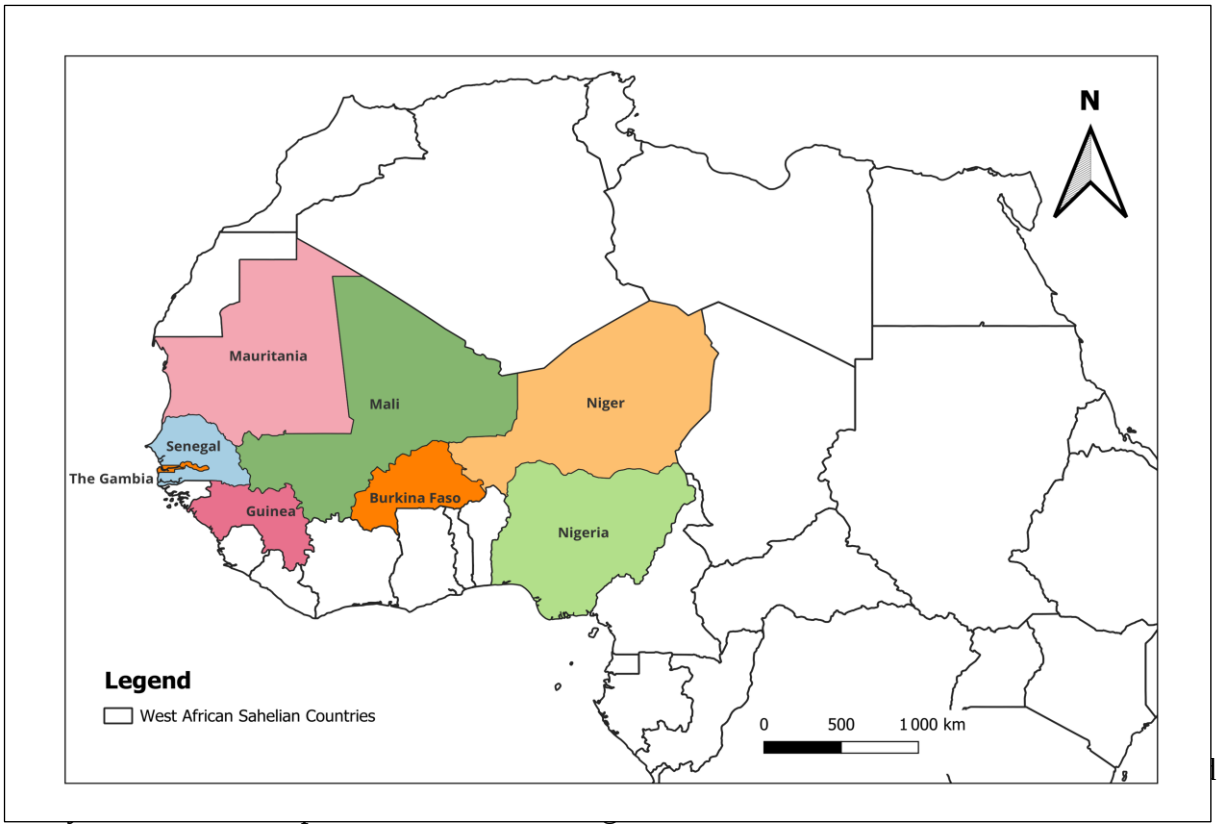
There are several limitations to the available information related to climate and human health in the Sahelian countries (Jean-François Jusot, 2017). First, most of the studies carried out about climate and health are done on an individual basis at the regional level. Second, most of the in-depth studies and regional assessments of the human health impacts of climate change have been seen elsewhere in the high income countries. As a result, this review tries to take stock of some of the impacts of climate change on human health encountered in Sahelian countries.

MATERIALS AND METHODS

study areas

West Africa is maybe one of the regions of the world most sensitive to climate change. There are two geographical units in Africa: the Sahelian region, which is the focus of this study, and the countries of the Gulf of Guinea.

The recent study is conducted in the countries of the Sahel, namely: Senegal (14° 14' N and 14°32' W), Mali (17° 00' N and 4° 00' W), Niger (11 °37 and 23°33 north latitude and 0°10 west longitude), Burkina Faso (13° 00' N, 2° 00' W) and Mauritania (20° 00' N and 12° 00' W) (Figure 1). Average annual precipitation varies from year to year and decade to decade, but generally is lower in the north (100 to 200 mm) than in the south (500 to 600 mm) and is limited to the summer months of June to September (USAID, 2017). The climate is tropical, arid in the north, and semi-arid in the south. It is marked by high temperatures (between 28 and 30 0C annual average), even scorching from April to May, especially during the dry season. Rainfall generally begins between May and July, peaks in August, and ends around September-October. The Sahel is conventionally located between isohyets 100-200 mm in the north and 500-800 mm in the south.



Data collection

The data used to develop this article are secondary data from the existing literature from Sahelian countries, which constitute the samples for our study. These are sampled between 2002 and 2020 via Google Scholar, PubMed and some WHO websites. The key terms used in different research include climate change and health, climate diseases, climate change and human health and health impacts.

We used the Boolean operator AND by combining the different keywords to increase the relevance of our searches and also limit our search field.
Filter used:

i. Type of article: Systematic review, original paper, Books, ect.
ii. Date of publication: 2002 to 2023
iii. Language: English, French

Accompanied by a manual search on the secondary references listed

Inclusion criteria

We have included articles dealing with climate change and dermatological conditions that meet the above criteria.

Non-inclusion criteria

Not included were:

iv. Articles for which the full version is not available;
v. Articles dealing with climate change other than in the Sahel.

We based our definition of health impacts on the WHO definition of health as "a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity.

Data processing: Our data were entered and processed with Microsoft Word. We also used QGIS Software to do the map of our study area.

RESULTS

Climate change negatively impacts human health and well-being through its impacts on the weather, ecosystems, and the human system. This impact increases the exposure of populations to extreme events, modifies the environment, and facilitates the transmission of diseases and the movement of populations. Indeed, changes in flooding, temperature rise, and environmental health impacts have led to increased mortality and morbidity rates and diseases such as malaria, dengue, Lassa fever, Rift Valley fever, Lyme disease, Ebola virus disease, West Nile virus, and other infections (Atwoli et *al*., 2023). In Niger, Burkina, and Nigeria, the impacts of flooding resulted in the loss of life and degradation of the living conditions of people who lost their homes, livestock, and land (Opoku et al., 2021).

The recent Intergovernmental Panel on Climate Change (IPCC) Special Report on the Impacts of Global Warming of 1.5 °C) states that "climate-related risks to health, livelihoods, food security, water supply, human security, and economic growth are projected to increase with global warming of 1.5 °C and to increase further".
The pathways by which climate change and climate variability will affect human health pass through different processes related to various social, environmental, ecological, and economic
factors, and the spread, survival, and growth of pathogens play a central role in the transmission diseases (Cissé, 2019a):

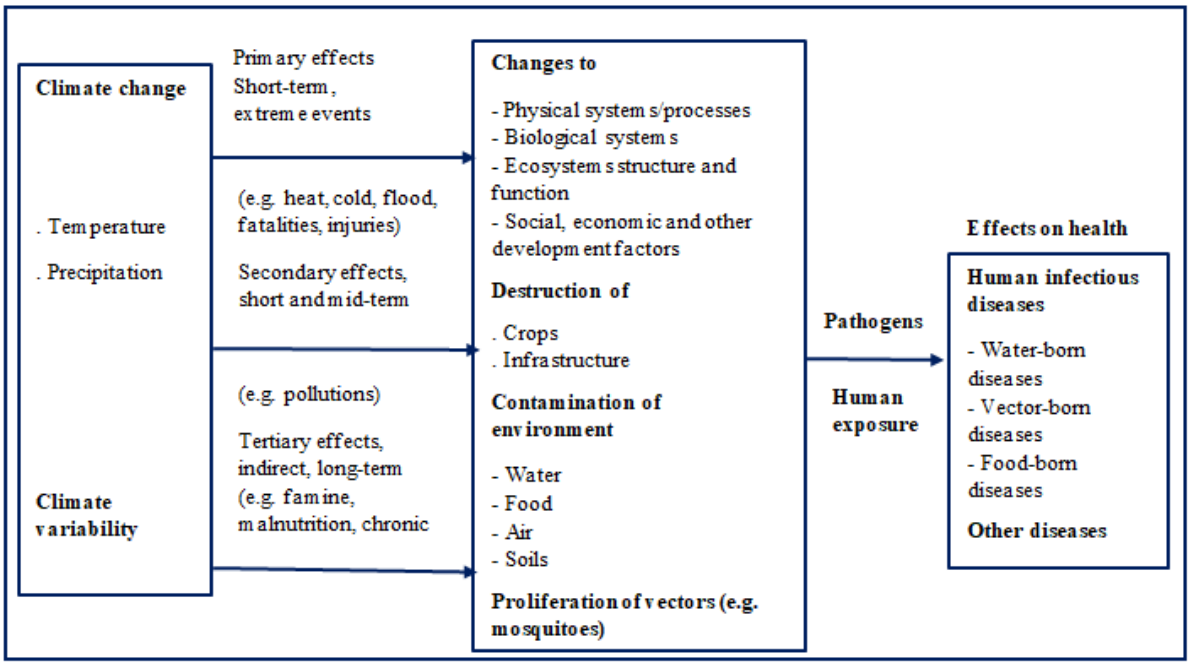


Figure 2: *Pathways by which climate change affects the heath with a focus on human infectious diseases (water-borne diseases, vector-borne diseases, and food-borne diseases). Adapted to Cissé, 2019.*

Vector-borne diseases

Vector-borne diseases contribute significantly to the burden of communicable diseases worldwide. Vector-borne diseases vary from a region to another. Githeko et *al*., (2000) highlighted the different vector-borne diseases encountered in the different regions of the world.
6

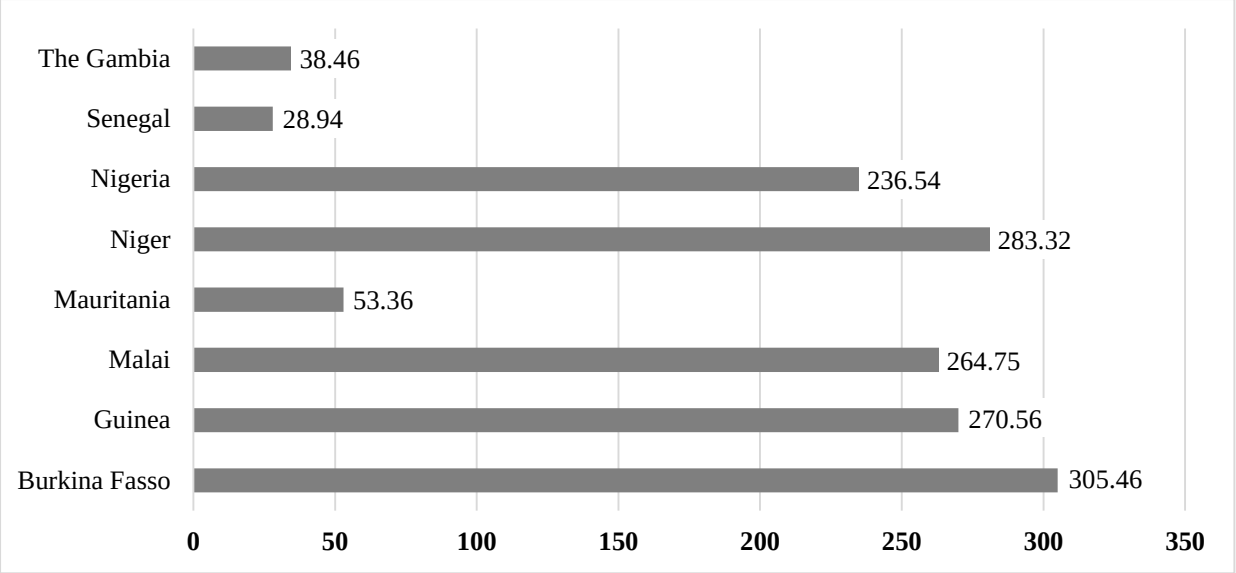
Table 1: *Summary of the most vector-borne diseases encountered in the world*

Vector-born diseases encountered in different regions of the world	
Africa	Malaria, schistosomiasis, onchocerciasis, trypanosomiasis, filariasis, leishmaniasis, plague, Rift Valley fever, yellow fever and tick-borne hemorrhagic fevers.
Europe and some of the countries of the former Soviet Union	Malaria and Lyme disease which are transmitted by mosquitoes and ticks.
South America	Malaria, leishmaniasis, dengue fever, charges disease and schistosomiasis.
Other diseases	American trypanosomiasis, kalaazar and schistosomiasis.

Other diseases cited in table 1, affect people around the world but the burden of vector-borne diseases is higher in tropical and subtropical regions due to poor socio-economic conditions (Manikandan et *al*. 2022) and environmental conditions. Human activities are responsible for all these diseases which contribute enormously to the modification of the normal climate, thus favoring the modification of the biology of vectors and parasites. Like other regions of the world, sub-Saharan Africa is characterized by a climate conducive to most vector-borne diseases. In the Sahelian countries, malaria is common vector-borne diseases encountered in the region (CDC- Atlanta, 2011; Ekwebene et *al*., 2021; Labiru et *al*., 2022; Agrica, 2023).

The diversity of vector agents is sensitive to variations in the region's climate and has the potential to redistribute to new habitats, resulting in a new distribution of diseases (Githeko et al., 2000). Some studies have shown that harmattan winds are the main cause of meningitis spread. The harmattan blows from November to May in the Sahel (Githeko et al., 2000). However, the winter schedule is undergoing a clear change due to climate variability (Jusot, 2017).

Malaria is nowadays one of the main causes of mortality in the Sahel. An infectious disease caused by parasites of the genus Plasmodium, malaria is transmitted to humans through the bites of infected female mosquitoes of the genus Anopheles. In this sense, malaria is a major public health problem with more than 200 million cases and causes up to 1 million deaths each year (Ratmanov et *al*., 2013).The mosquito species *Anopheles gambiae*, *A. funestus, A. darlingi*, *Culex quinquefasciatus*, and *Aedes aegypti* are the main agents of transmission. The living environment can influence the affection of vector-borne diseases in the countries of Sahel. For instance, studies have shown that in South America more than 70% of the population lives in cities and only a small proportion is exposed to infections that occur in rural areas. Unlike in Africa where more than 70% of the population lives in rural areas where vector control, for example the elimination of breeding sites, is often difficult (Githeko et *al*., 2000). The figure below shows the number of deaths per 100 000 population caused by malaria in children under 5 years old in 2019.



Source of data: *WHO website, 2023*

Figure 3: Death caused by malaria per 100 000 populationin the West Africa Sahelian countries in 2019).

An increase in temperature decreases the maturation time and fecundity of these species. The most concrete example of the impact of temperature on these species is the rapid digestion of blood by the female mosquito, which increases the feeding interval and thus infection and reproduction (Githeko et al., 2000). In the case of *trypanosomiasis*, a prolonged change in rainfall can affect the epidemiology and transmission of the latter. Authors explained that, *Anopheles gambia* prefers warm and humid areas, while A arabiensis has adapted to drier areas. They gave an example of Senegal, where gastropods of the species *Biomphalaria Pfeiffer* transmit Schistosoma mansoni during the rainy season and S. haematobium is transmitted by Bulinus globosus during the dry season. The same studies in Tanzania and Zimbabwe have concluded that prolonged changes in rainfall have an impact on the distribution of gastropods and thus on the spread of diseases. Cholera cases are associated with heavy rains as well as floods impacting water quality in Nigeria. Rainfall and temperature increase cases of death (Opoku et al., 2021).

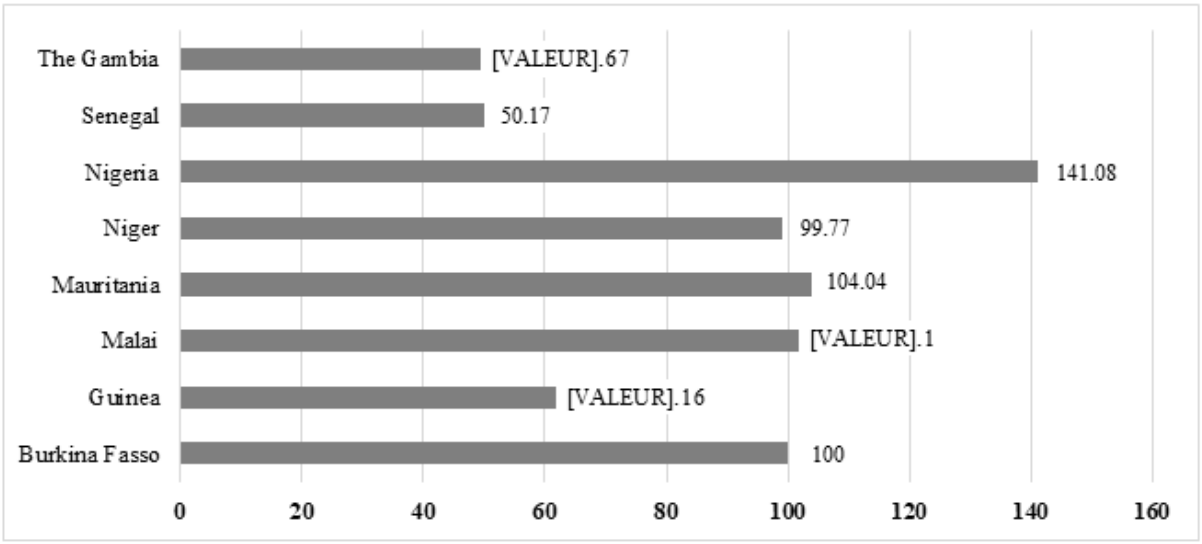
Water-borne diseases

Waterborne diseases are diseases caused by pathogenic microbes spread via contaminated water. The United Nations (UN) reported in 2017 the impact of severe flooding resulted in acute human and physical losses, reflected in river overflows, displacement of people, and an increase in disease burdens and deaths in Mali, Ghana, Nigeria, Burkina Faso, and Niger (Opoku et al. 2021). Authors reported that several cases of waterborne diseases have been observed in many parts of the continent with Buruli ulcer and schistosomiasis known in Nigeria. In addation, water-borne diseases related to extreme weather events are also the source of the death of million person in the Sahelian countries . Diseases related to extreme weather events are summarised in the table 2 below.

***Table 2**: Water-borne diseases related to extreme weather events*

Water-borne diseases related to extreme weather events (e.g. flooding)		**Sources**
Burkina Fasso	diarrhoea, and respiratory diseases	CDC- Atlanta, 2011
Mali	Diarrhoea, respiratory diseases, malnutrition, HIV / AIDS, meningitis and mortality through extreme weather events	Peter et Jeremy, 2013
Mauritania	Diarrhoea and cholera, as well as tuberculosis, HIV and respiratory diseases	Mauritania-Agrica, 2023
Niger	Diarrhoea and cholera, respiratory diseases, meningitis, measles, injury and mortality through extreme weather events	Niger - Agrica, 2020
Nigeria	Cholera, skin cance, typhoid, malnutrition etc.	Ekwebene et *al*., 2021; Labiru et *al*., 2022
Senegal	Diarrhoea, Borreliosis, a tick-borne disease	GIZ, 2022

It is necessary to take flooding into account as one of the consequences of climate change. In Africa, more specifically in the Sahel, where hygiene is threatened, flood-related diseases (cholera, diarrhea, malaria, etc.) play a key role in the deterioration of human health. For more than 30 years, the countries of the Sahel have experienced very critical floods coupled with losses estimated at billions of dollars and hundreds of thousands of displaced people. These displacements have led to a significant drop in public health indicators because displaced people live in unbearable situations with poor sanitary conditions and no access to drinking water.In countries like Mauritania, WHO estimates that "around 2.150 individuals, including 1.700 Children under the age of 5 years, die each year from diarrhoeal diseases, and nearly 90% of these deaths are directly attributed to poor quality of WASH (WHO, 2013; Cissé 2019)". According to the Central Intelligence Agency (2018) "the majority of known food and waterborne diseases in Mauritania are bacterial and protozoan diarrhea, hepatitis A and typhoid fever". Influenza in Niger shows a marked seasonality during the first three months of the year under the influence of a low minimum temperature. The figure below shows the number of deaths per 100,000 population caused by diarrhea in children under five years old.



Source of data: *WHO website, 2023.*

Figure 4: Death caused by malaria per 100 000 populationin the West Africa Sahelian countries in 2019

The existing literature shows that the most significant under-five mortality rate in the world is observed in Burkina, Mali, Mauritania, Niger, and Chad, whose main deaths are linked to pneumonia, weakening, and malaria (USAID, 2017). According to USAID, the Sahel records the lowest human health indicators and simultaneously suffers from the effects of four recurrent food crises, all of which have occurred in the past ten years.

Food borne diseases

Food-borne illnesses occur following the absorption of food polluted by microbes or chemical substances (Cissé 2019a). The risks of food contamination are general because it is present throughout the food chain, from food production to consumption and involves the contamination of water, soil or air (Cissé, 2019). Globally, the highest rate of foodborne illnesses is seen in Africa. Unsanitary water used for household and food preparation was one of the main causes of this disease. According to studies conducted by OXFAM, events such as the lack of rainfall in many Sahelian countries and floods in other countries are one of the causes of the nutritional crisis in these parts (OXFAM, 2022).

The decrease in rainfall and the increase in temperature give way to drought, causing a decrease in agricultural productivity, which results in malnutrition in the affected areas (Opoku et al., 2021). Estimates say that by 2050 the temperature in the Sahel will increase by 1.6 while it will be 1.4 in the equatorial countries (Githeko et al., 2000). According to the UN, 33 million of the 300 million inhabitants of the Sahel are food insecure. Approximately 4.7 million children under the age of 5 are acutely malnourished. In Burkina and Niger, more than 80% of the population is below the poverty line. The recent climatic events in Africa, notably the floods in Niger, Nigeria, and Burkina Faso and the drought wave, have resulted in enormous crop losses in the Sahel. This value is 77% and 60% respectively in Mali and Nigeria (UN, 2018; Sartori et Fattibene, 2019). The Sahel has developed some strategies to adapting to this climate change which is irrigated agriculture to increase its productivity. However, it must be said that irrigation contributes to the spread of malaria and schistosomiasis (Githeko et al., 2000). The Sahelian countries of West Africa, more precisely Burkina Faso and Mauritania, are classified among the most vulnerable regions to climate change in the world due to temperature increases of up to 1.5 times higher compared to other countries (USAID, 2017; Cissé,2019).

Extreme weather events

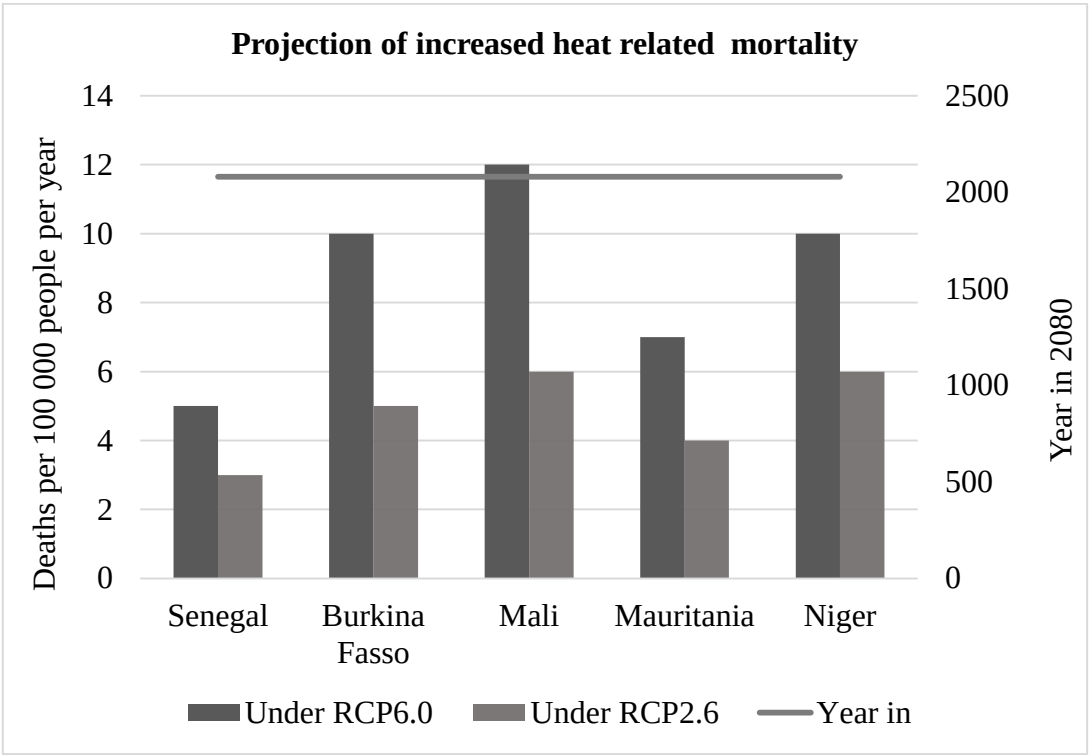
Extreme weather damages the water and food supply, increasing food insecurity and malnutrition, which causes 17 million deaths annually in Africa. According to the Food and Agriculture Organization of the United Nations, malnutrition has increased by almost 50% since 2012, owing to the central role agriculture has in African economies.Variations of temperature, relative humidity, and rainfall contribute strongly to the proliferation of mosquitoes, the causal agents of malaria. This phenomenon plays a very important role in the spread of malaria in Niger.

In Niger, the diseases linked to climate change are climate-sensitive diseases such as malaria, respiratory diseases (asthma, pneumonia, coughs/colds, etc.), meningitis, measles, cholera, malnutrition, waterborne diseases (diarrhea), dehydration, etc. The National Framework for Climate Services (CNSC) reported in its bulletin n°3 of August 2022 that the epidemiological situation of confirmed malaria in Niger where 60 1447 cases were recorded

nationally in 2021 and 53 1681 cases in 2022. The CNSC explains that the number of malaria cases in Niger increases with rainfall. In addition, there are cholera epidemics due to cross-border exchanges with epidemics already present in neighboring countries (Nigeria, Chad, and Mali), where Niger recorded 5,590 cases in 2021, including 166 deaths in seven (7) of the eight (8) regions (CNSC, 2022).

Extreme weather events are a real problem for human health, especially among children in the Sahel countries. A recent study conducted in Ouagadougou, Burkina Faso by Bégin-Galarneau (2021), showed that the most common sign observed in children in times of very high heat is the feeling of intense thirst (dry mouth), followed by 'high perspiration. This study revealed that in Burkina Faso, 33.3% of children have difficulty sleeping, 28% grow up with skin folds or pimples on the skin, 27.6% are stricken with fever, 14.2% 14 .2% suffer from severe headaches and 11.5% do not love to eat. This is due to climate change which continues to sow fear and terror in the countries of the Sahel. In addition, a recent study showed that extreme weather events is responsible for the deaths of 32% of people in Mauritania, 18% in Senegal between 2000 and 2019 and 86% in Niger from 2010 to 2017 (Nouaceur, 2020)

The main health issues encountered in Niger are morbidity and mortality resulting from vector-borne diseases, i.e. water-borne diseases resulting from extreme weather events (flooding, etc.) such as diarrhea and cholera, respiratory diseases, meningitis, measles, injuries and deaths from extreme weather events (GIZ, 2021). According to GIZ the increase in temperature will cause an increased frequency of heat waves in Niger and finally a high number of heat-related mortality. It's estimation reported that heat-related mortality will reach around 6 deaths per year per 100,000 inhabitants in 2080 .The figure 2 below gives the information of projection of increased heat related mortality of some of the Sahelian countries by 2080 (Under RCP2.6) compare with the year 2000 (Under RCP6.0).



Source of data: *Agrica, 2023*

Figure 5: Projection of increased heat related mortality by 2080 (Under RCP2.6) compare with the year 2000 (Under RCP6.0). With RCPs (Representative Concentration Pathways).

Recent assessments stipulate that due to the increase in greenhouse gas (GHG) concentrations, and the repercussions of climate change, the temperature of Burkina Faso should increase by 3 to 4°C on the horizon. 2080-2099 (Peters et *al*., 2022). These assessments are consistent with those of Niger, due to rising greenhouse gas (GHG) concentrations, air temperature is expected to increase by 2.0°C to 4.6°C (very likely range) by 2080 (GIZ, 2021). This shows that the necessary measures must be taken now by the States of the Sahel countries to stop the occurrence of any risk related to the effects of heat on human health. According to USAID (2017), changing rainfall cycles have seen an increase in flood frequency and intensity in almost all of Burkina Faso, much of southern Niger and Chad, and large parts of Mali.

DISCUSSION

This study focuses on the impact of climate change on human health in the Sahelian West African countries. The data collected during our various readings allowed us to bring out four major points through which the climate affects the health of the population. These include waterborne diseases, vector-borne diseases, food diseases, and extreme weather diseases. The parameters to be taken into account about health in the context of climate change are climatic parameters such as temperature, humidity, wind, and food. Indeed these four parameters appear to be the most affluent on human health.

When it comes to water- and food-related diseases, one of the greatest impacts of climate change on human health is the death of children. Water-related diseases occur when food (including water) infected with microorganisms or chemicals is ingested. This confirms the result of (Cissé, 2019)which states that the death of millions of children each year from illnesses caused by acute diarrhea, many of these deaths are undoubtedly from contaminated food or water. The unsustainable use of chemical fertilizers and pesticides upstream to conquer soil fertility and improve agricultural productivity is at the root of this phenomenon. In addition, the chronic drought of the Sahel also contributes to the affection of water-related diseases because there are not enough treatment systems for water drawn from wells and backwaters.

The increase in temperature has a heavy burden on human health in the Sahelian countries by causing the spread of certain diseases. According a study conducted by Githeko et *al*., (2000), the increase in global temperature will lead to a strong spread of vector-borne diseases in general and more specifically in Africa where the climate is tropical and warm. They go on to say that temperature variations have impacts on disease vectors as well as their hosts. This assertion is also supported by the research of (Swynghedauw, 2021), where they found the rise in temperature increases the development of vector populations and the number of bites, reducing the extrinsic i.e. the time required for the biting vector to become infectious. According to clinician data from the study on the influence of climate on diseases in Niger, periods of heat are periods when the flow of patients increases and when the morgue is found crowded (Jusot, 2017).

The West African Sahel, recognized as one of the areas most impacted by climate variability, has been experiencing floods and droughts in recent years. Many authors have written and discussed the impact of climate variability on health. According to studies carried out by (Lowe et *al*., 2021) the increase in rainfall creates breeding nests favorable to the vector, thus

contributing to an increase in their population. Drought episodes can contribute to significantly reducing vector breeding sites. Paradoxically, water storage during drought episodes could constitute a new nest of pathogens (Goshua et *al*., 2021).The modification of the precipitation regime also presents an important element that can impact the health of the population. Indeed, according to (Githeko et *al*., 2000), these changes may have effects on vector habitats. They depend on mosquitoes for example, which experience a significant multiplication in periods of high rainfall.

Climate change is having a considerable impact on food security in the West Africa Sahelian countries. According to Piya et *al*., (2003) food security is defined as a set of interdependent factors. These include purchasing power and production potential. Climate change may cause an increase in hunger, through its direct effects (soil degradation, temperature variation) on production and its indirect effects on food purchasing power . Because of soil degradation and temperature variations, there will not be a good yield, leading to increased hunger and malnutrition (FAO, 2014).

CONCLUSION

The paper presents an overview of some common diseases related to the impacts of climate change on human health encountered in the Sahelian countries. This includes water- and food-related diseases, vector-borne diseases, and extreme weather events.These diseases affect human health through different processes related to various social, environmental, ecological, and economic factors, and the spread, survival, and growth of pathogens play a central role in the transmission of diseases.

Many factors explain the cause of these diseases in the Sahelian countries. First, Poor agricultural practices due to the unsustainable use of chemical fertilizers and pesticide residues contribute to the contamination of food and water used by humans. Second, the environmental conditions in the Sahel are largely in a poor and insanitary states. More than 70% of the African population lives in rural areas and is in perfect cohabitation with nature controlled by several pathogenic vectors. Third, ignorance of climate impacts, pushes people to carry out activities likely to harm the environment. Finally, chronic poverty and ineffective policies on climate change and health of African countries prevent a timely response to the diseases related to climate change.

Overall, the impacts of climate change on human health in the countries of the Sahel remain fluid. This inconsistency is due to geographic variations and the varying capacities of countries to adapt to climate change. The study however recommends that;

1. Governments of West Africa Sahel countries need to integrate climate change into their health policies, projects and programmes at all levels (i.e. national, regional and local). This takes into account strengthening the skills of health professionals.
2. Research institutions intensify research on the link between climate change and health and proposing evidence-based adaptation strategies to climate change.
3. Public health planners, policy makers and other relevant stakeholders need to understand how climate change will affect public health in their regions to enable them to address these issues.
4. Medical schools need to include climate change and health in their curricula in the aforementioned countries.
5. Civil Societies should support overnments to increase awareness of the impacts of climate change on human health at the national, regional and local levels.

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