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Final Report

Assessment of Climate Change-related Risks and Vulnerabilities in the Health Sector in Togo

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The success of the use and dissemination of the results, as well as the implementation of the recommendations of the adaptation measures, will ultimately depend on their ownership by the national stakeholders. They will have to take into account the need to integrate climate change adaptation into the strategies and planning of the health sector, but also the other relevant sectors involved in the well-being of the Togolese people.

Dr Hanna SCHMUCK (Team Lead), Dr Stefan KIENBERGER (GIS Expert), Dr Olga BASSONG (Health Expert), Claire BELLUARD (adelphi) and Martina EIFRIG (EPOS)

List of Abbreviations and Acronyms

AR5	IPCC Fifth Assessment Report
BIO	Biological Susceptibility
CDD	Consecutive Dry Days
CHW	Community Health Workers
CORDEX	Coordinated Regional Climate Downscaling Experiment
DALY	Disability-Adjusted Life Year
DHAB	Directorate of Basic Hygiene and Sanitation
DHIS2	District Health Information Software 2
GCMs	Global Climate Models
GIS	Geographic Information System
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
IFRC	International Federation of Red Cross and Red Crescent Societies
IPCC	Intergovernmental Panel on Climate Change
LLINs	Long-Lasting insecticidal Nets
LTS	Length of Transmission Season
MEDDPN	Ministry of Environment, Sustainable Development and Nature Protection (Formerly MERF)
MERF	Ministry of Environment and Forest Resources (Now MEDDPN)
MIT	Ministry of Infrastructures and Transport
MSHP	Ministry of Health and Public Hygiene
NAPCCA	National Action Plan for Climate Change Adaptation
NCCAP	National Climate Change Adaptation Plan 2017–2021
NCSD	National Council for Sustainable Development
PHUs	Peripheral Health Units
PR10	Annual count of days when precipitation ≥ 10 mm
ProSanté	Project on Health System Strengthening – Sexual and Reproductive Health and Rights
QALY	Quality-Adjusted Life Year
QUIBB	Survey on Combined Questionnaire of Basic Welfare Indicators (Survey published by the Ministry of Development Planning & the National Institute for Statistics, Economic and Demographic Studies)
RCMs	Regional Climate Models
RCP	Representative Concentration Pathway
SMHI	Swedish Meteorological and Hydrological Institute
SUS	Generic Susceptibility
Tmax	Maximum Temperature
UNFCCC	United Nations Framework Convention on Climate Change

Executive Summary

According to the latest report of the Intergovernmental Panel on Climate Change (IPCC), hereinafter referred to as 'AR5', climate change undeniably affects human health. On the one hand, it increases the frequency and intensity of natural disasters (the direct cause of death and injuries) and, on the other hand, it causes temperature variation and precipitation that leads to the aggravation of climate-sensitive diseases.

In Togo, the threat of climate change to health has been confirmed by official documents. Studies of the Ministry of Environment, Sustainable Development and Nature Protection (formerly known as the Ministry of Environment and Forest Resources), have concluded that effects of climate change contribute to the continued spread of vector-borne, water-borne and infectious diseases (MERF 2015 a and b). This is all the more problematic for Togo which does not yet have a climate change adaptation strategy specifically for the health sector.

Thus, in order to assess the health sector's vulnerability to the effects of climate change, the Ministry of Health and Public Hygiene requested the support of GIZ through the Project on Health System Strengthening – Sexual and Reproductive Health and Rights (ProSanté). Through the ProSanté Project, funded by the German Federal Ministry for Economic Cooperation and Development (BMZ), which is being implemented since September 2017 in Lomé and Kara, GIZ operates in the health sector in Togo, in collaboration with the MSHP.

ProSanté Project objectives include enhancing the resilience to the effects of climate change, thereby contributing to the broader goal of strengthening the Togolese health care system as a whole. It is in this regard that an assessment of the health sector vulnerability to the effects of climate change was commissioned and conducted by the Consortium EPOS and adelphi firms, in collaboration with national stakeholders.

The overall objective of this study is to identify and assess the health risks arising from the effects of climate change, as well as the adaptive capacity of the health system. The findings of this assessment have led to the mapping of climate-sensitive diseases and can serve as a reference for the development of a climate change adaptation plan for the health sector with a view to strengthening the capacities of the health systems in order to protect and improve the health of the population for responses to instability and climate change.

The assessment was conducted by a team of experts of EPOS/adelphi Consortium: Dr Hanna Schmuck as Team Lead/Expert in Risk and Vulnerability Assessment, Dr Stefan Kienberger as Expert in Geographic Information System, Dr Olga Bassong as Health Expert and Claire Belluard as Technical Support person.

The approach and methodology of the assessment are based on the concepts of risk and vulnerability assessment developed in *The Vulnerability Sourcebook* (GIZ 2014) and the *Risk Supplement to the Vulnerability Sourcebook* (GIZ 2017). The core element of the approach is developing impact chains, a tool which serves to identify and visualize all the factors that, through a chain of causal relationships, lead to the risk – the ultimate purpose of the assessment. In the AR5 conceptual framework, risk is determined by three components: hazard, exposure and vulnerability, which are further made up of multiple factors.

During the course of this assessment, a participatory process involving representatives of institutions related to the health sector in Togo identified three major risks and their respective impact chains (see Annex 1). In the context of this assessment, the three risks are three climate-sensitive diseases, namely malaria, respiratory infections/conditions and meningitis. A three-day field visit (in the Maritime and Kara regions) was also carried out to check the factors of the impact chains and to get an overview of the capacities of local facilities, in particular with regard to the recommendations for adaptation measures.

Subsequently, the team collected the available quantitative data to define the indicators chosen to measure the risk factors identified in the impact chains. The selection of indicators taken into account in the assessment was therefore based on data availability; some indicators were equally relevant to the study but they could not be used due to the lack of information to measure them.

Once the values of these elements were calculated for each of the risk components (*hazard, exposure, vulnerability*), the final values of the risks could be extrapolated. The next step consisted in exploiting

the results through their mapping (see Annex 2), developing recommendations on adaptation measures and preparing the report.

Key Results for Malaria Risk:

- The main *hazard* areas are in the central and southern districts, particularly along the coast and the south-west part of Togo. Risk factors for malaria include the length of the transmission season, the number of people infected, as well as floods, stagnant water and inadequate sewage disposal, which all create conducive breeding conditions for mosquitoes.
- The main areas of *vulnerability* are everywhere in Togo, but in particular in the districts of Moyen-Mono, Plaine de Mô, Oti and Anié. The most important factors that characterize vulnerability to malaria are the level of education, availability of mosquito nets in households, access to health services and resources. The most vulnerable population groups due to their biological disposition are children under five years of age, pregnant and nursing women, the elderly, immune-impaired people and the chronically ill people. Generic vulnerability refers to people working outdoors and on low income.
- By aggregating the preceding elements, current conditions show that overall, the districts in central and southern Togo have higher risk values than the districts in the north (with the exception of the western districts in the south). The five main areas at risk are mainly in the south, namely Vo, Lacs, Moyen-Mono, Kpélé and Bas-Mono.
- For future climate scenarios, modelling indicates a decrease in the length of the malaria transmission season in the future. However, given the predicted evolution of the hazard index, the effect will be insignificant and the conditions will remain conducive for malaria across the country.

Key Results for Respiratory Conditions/Infections Risk:

- The areas where *hazards* are most significant for respiratory conditions/infections are in the North, with a gradual decline southward. Hazard conditions are influenced by people who are already infected, air and climate pollution (exhaust gases, wildfires, waste burning, particulate matter, etc.), high temperature amplitudes and dry periods.
- *Vulnerability* results also show higher values in the northern and central districts. The highest value is in the district of Plaine de Mô, followed by Bassar, Oti, Doufelgou and Tchaoudjo. Factors of vulnerability include, first, the level of education, hygienic conditions, poverty and access to health services. Regarding vulnerable groups, there are people with asthma, elderly people, and children under the age of five.
- By combining the previous components, it follows that the risk areas are in the northern and central districts, with the highest risk values in Oti and Kpendjal, followed by Tandjoare, Doufelgou and Tône.
- For climate risks, two climate change indicators were used, namely Consecutive Dry Days (CDD) and maximum temperature. At present, these two parameters are higher in the north than in the south. On average, these indicators are expected to increase until the end of the century, suggesting that the risk is expected to increase in the north of the country.

Key Results for Meningitis Risk:

- The main *hazard* areas of meningitis are mainly in the north, with a gradual decline towards the south. Meningitis *hazard* conditions are influenced by the infected people, as well as all the factors contributing to air pollution (aerosols or dust) that are temperature rise and drought, land cover and land use and deforestation. Indeed, the drying of the nasal mucous membranes by these factors facilitates the penetration of bacteria into the body.
- Regarding *vulnerability*, the highest values are in the Plaine de Mô, followed by Kpendjal, Sotouboua, Tchamba and Anié. The areas of increased vulnerability are therefore scattered throughout the country while the lowest values are in the southern and south-eastern districts. The main vulnerability factors are lack of access to health care, lack of education, relatively high numbers of children under 10, migration dynamics and inadequate vaccination programmes (particularly for the most at-risk population category, namely people who are between two and 29 years).

- Based on the analysis of the aforementioned considerations, it can be concluded that the regions of northern Togo are the most at risk for meningitis. The highest risk value is found in Kpendjal, in the north-east of Togo, followed by Oti, Cinkassé, Tchamba and Tône. Similarly, Tchamba, although located in the centre east of Togo, is characterized by an exceptionally high value compared to the rest of its region.
- For future climate risks, the two indicators considered are again the Consecutive Dry Days (CDD) and the maximum temperature. At present, these factors give rise to the disease in the northern regions. For future projections, the trends have been described above and the same observation is made about respiratory infections: the risk of meningitis is expected to increase in the north of the country.

Beyond the indications that it provides through its findings, the added value of this assessment is that it confirms the main difficulties or obstacles identified in similar assessments. It also reveals a number of additional data-related challenges – the need to build national capacity to share and manage climate change knowledge across institutions; importance of having an integrated vision of climate risk covering environmental, socio-economic or health aspects; decline in the use of results given the availability of data and method; etc.

Regarding the content of this study, it is innovative in various aspects: First, the AR5 risk concept was used, which is a novelty for Togo. In addition, qualitative and quantitative approaches were used, adding a touch of innovation to the risk analysis reference method implemented. In addition, an in-depth quantitative assessment was carried out for the three diseases, in particular for the current conditions and providing such a level of specific details is unprecedented for the country in question. Finally, based on a good framework of quantitative indicators and the most recent climate projections for this region, this report revealed uncertainty about future scenarios.

The assessment also provides recommendations for specific adaptation measures based on the results previously described, best practices from other countries with similar conditions and a desk review of existing strategies and policies in Togo. Measures should be streamlined through three pillars targeting key factors identified in the impact chains: a) increase people's understanding of risks and how to reduce or avoid them, b) improve access, geographic coverage and quality of health services, and c) take structural measures to make sanitary facilities resilient to extreme weather events.

Following a brief definition of these three pillars, specific measures are proposed and classified for the three identified health risks, as well as for other weather events that are harmful to health (heat waves, torrential rain, strong winds and periods of drought). Measures can be integrated into existing programmes or serve as a starting point for a new programme. However, to ensure their success and sustainability, they must be adapted to the geophysical and socio-cultural context. Although Togo is a small country, it is characterized by a variety of ethnic groups each with their respective cultural norms and traditions.

In conclusion, the study proposes a multi-sectoral assessment of the capacities and physical state of health services, particularly at the peripheral level, in districts that have been identified as high-risk areas.

In the light of these considerations, this assessment provides a good basis for developing an action plan (including cost estimates) and seeking funding. At the same time, health officials will need to intensify their efforts, particularly at the national level, to ensure coordination with other sectors and that health adaptation measures are integrated into their respective policies. Stronger advocacy is needed to make it clear that the health of the Togolese people is an essential prerequisite for the country's development. In this respect, dissemination of the results at the central and regional level, by the target groups and according to the guidelines developed during the validation workshop (in November 2019), will be of paramount importance.

Communication materials (posters, flyers, etc.) may be produced with target groups to be used in health centres. Also, the translation of this assessment into English should be considered, in order to share the results in international networks, with GIZ headquarters and key partners. In addition, the outcomes of the assessment can be integrated into the content of the training on the nexus between climate change and health dedicated to decision makers of the Ministry of Health and based on a WHO and GIZ training manual.

Adaptation is ultimately about building resilience. To this end, a strategy for the adaptation of the health sector to climate change needs to be developed based on WHO guidelines, and particularly the *WHO Guidance to protect health from climate change through health adaptation planning* (WHO 2015 a) or the *Operational framework for building climate-resilient health systems* (WHO 2016).

Finally, based on this strategy and a list of priority facilities and measures, it will then be necessary to seek financial support to finance these measures and consequently the health sector adaptation strategy.

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1 Introduction

1.1 Background and Objectives of the Assessment

Togo is divided into five administrative regions, Savanes, Kara, Centrale, Plateaux and Maritime and 39 prefectures. The population in 2017 was estimated at 7.5 million. The population growth of 2.4% per year, with a fertility rate of 4.8 children per woman, is putting a significant pressure on basic social infrastructure and services such as education, health, access to energy and clean water, and food security.

Poverty is still widespread, although the poverty rate has declined from 61.7% to 55.1% between 2006 and 2015 and was estimated at 47.4% in 2017 (World Bank 2019). Poverty is predominantly a rural phenomenon, with 69% of rural households living below the poverty line in 2015. Female-headed households experience higher poverty rates than male-headed households – 57.5% versus 55%. The high socio-economic vulnerability of women can be explained, among other things, by lower economic opportunities and under-representation at higher levels and decision-making.

The climate in Togo is tropical, varying significantly between the southern and northern regions. It is subdivided into two large zones: a Sudanese-type zone to the south and a Sahelian-type zone covering the northern half. Warm and humid, the climate is conducive to the proliferation of disease vectors and is partly responsible for the national epidemiological profile dominated by infectious and parasitic diseases.

However, according to the latest report of the Intergovernmental Panel on Climate Change (IPCC), climate change undeniably affects human health. On the one hand, it increases the frequency and intensity of natural disasters (such as heat waves, floods and droughts), thus being the direct cause of death and injury. On the other hand, climate change causes change in temperature and precipitation patterns, leading to the aggravation of many highly sensitive diseases.

The Third National Communication on Climate Change (MERF 2015a), which is the synthesis of thematic and sectoral studies conducted during the process, focused on national circumstances, greenhouse gas inventories, proposed mitigation measures to contribute to emissions reductions, climate change adaptation measures and other information relevant to the effective implementation of the UNFCCC. Within the framework of this third national communication, various studies have been carried out. Of these, one is particularly relevant to the assessment discussed in this report, the one that dealt with the 'urban settlements and health facilities' sector. (MERF 2015 b.)[1]

That study concluded that effects of climate change, in particular the rise in temperatures and increased precipitations contribute to the continued spread of vector-borne, water-borne and infectious diseases. This is all the more problematic for Togo which does not yet have a climate change adaptation strategy specifically for the health sector. Thus, in order to assess the health sector's vulnerability to the effects of climate change, the Ministry of Health and Public Hygiene requested the support of GIZ through the Project on Health System Strengthening – Sexual and Reproductive Health and Rights (ProSanté).

Through the ProSanté Project, which is being implemented since September 2017 in Lomé and Kara and funded by the German Federal Ministry for Economic Cooperation and Development (BMZ), GIZ operates in the health sector in Togo, in collaboration with the Ministry of Health and Public Hygiene. ProSanté Project objectives include enhancing the resilience to the impacts of climate change, thereby contributing to the broader goal of strengthening the Togolese health care system as a whole. It is in this regard that an assessment of the health sector vulnerability to the effects of climate change was commissioned and conducted by the Consortium EPOS and adelphi firms, in collaboration with national stakeholders.

The overall objective of this study is to identify and assess the health risks arising from the effects of climate change, as well as the adaptive capacity of the health system. The findings of this assessment have led to the mapping of climate-sensitive diseases and can serve as a reference for the development

[1] Other studies: MERF c, d, e and f.

of a climate change adaptation plan for the health sector with a view to strengthening the capacities of the health systems in order to protect and improve the health of the population to help them deal with instability and climate change.

In summary, this assessment of climate change-related risks and vulnerabilities in the health sector aims to strengthen the monitoring and projection of the evolution of climate-sensitive diseases and to develop a climate change adaptation strategy for the health sector. The results will help to inform key stakeholders on the need for capacity building in health systems to prevent or mitigate the adverse impacts of climate change on people's health. Areas of highest risk are identified and represented using risk and vulnerability maps, developed using a Geographic Information System (GIS), also making it possible to identify recommended adaptation options.

1.2 Climate Change and National Institutional Framework

1.2.1 The Background of Climate Change

All the expected effects of climate change in Togo presented in this section will have an impact on the health risks assessed in this report in the coming decades.

Given the expected changes and their environmental and socio-economic impact on Togo, the government has responded to climate change by relying on various strategies and institutions. The relevant institutional system includes the following main bodies: (i) the Minister of Environment, Sustainable Development and Nature Protection (MEDDPN); (ii) the National Commission on Sustainable Development (CNDD); (iii) the National Committee on Climate Change and (iv) the Directorate of Environment, which is the national implementing entity of the UNFCCC (MERF 2015 a: 35).

At the national level, there are constitutional provisions to promote sustainable development and to mainstream environmental management, including climate change, in the institutional and legal framework. These include Article 41 of the Constitution (MERF 2015a: 35). To implement these provisions, the Togolese government has taken regulatory measures integrating climate change into policies, programmes, projects and development plans in various sectors, mandating actors at all levels, including local communities, to take into account the measures provided for in the national communications and the national strategy for the implementation of the UNFCCC.

Togo has also introduced several processes, including the development of a National Adaptation Programme of Action (NAPA) in 2009 and the initiation of a medium and long-term National Adaptation Planning since 2014 (GIZ 2016). Indeed, on the basis of the NAPA, Togo started the national adaptation planning process in 2014 with the financial and technical support of the German Cooperation.

An intersectoral committee has been established for the coordination and implementation of this process: the technical committee for the coordination of the process of integrating climate change adaptation into planning and budgeting, chaired by the Ministry of Development Planning and co-chaired by the Ministry of Economy and Finance and the Ministry of Environment. This committee provides guidance, expertise and is in charge of monitoring and evaluation in this area (GIZ 2016).

By initiating this process and creating institutions, Togo confirms its commitment to systematically integrate climate change adaptation into its planning documents. To this end, a guide was commissioned by the Ministry of Development Planning, with the support of the German Cooperation (GIZ 2016).

This process led to the formulation of a new National Climate Change Adaptation Plan 2017–2021 (NAP). The overall objective of the NAP is to contribute to inclusive and sustainable growth in Togo through the reduction of vulnerabilities, the strengthening of adaptive capacity and the increase of resilience to climate change. With a view to reducing vulnerability in the health sector, the proposed NAP measures include (i) integrating climate change adaptation into planning documents (ii) developing emergency medical services, and (iii) developing and implementing a national health watch plan.

1.2.2 The Institutional Framework of the Health Sector

The National Health Development Plan (PNDS) 2017–2022 seeks to introduce a health policy to '*ensure the highest possible level of health for the entire population by making every effort to develop a system based on public and private initiatives, individual and corporate, accessible and equitable, able to fulfil the right to health for all in particular the most vulnerable*' (Ministry of Health and Social Protection 2017: 9).

The Ministry of Health oversees the Occupational Medicine Department, the Institute of Hygiene, the National Malaria Control Programme and the Directorate of Disease Control and public health programs that are responsible for vector control. It also assumes responsibility for health education programmes in collaboration with the Joint Faculty of Medicine and Pharmacy of the University of Lomé, now referred to as the Health Services.

Health services are provided across the country by the following two sectors:

- The public sector, which accounts for the major part of the health care service delivery, with 67% of the health care facilities distributed according to a pyramid system (See Figure 1 below); *
- The private sector with 33% of health facilities, mostly for-profit, fairly developed and essentially made up of hospitals and private practices/clinics[2].

However, the pervasive practice of consulting traditional practitioners is a reality that should not be overlooked. Although traditional medicine is extensively used by the population, especially in rural areas, it is very poorly organised. Statistics on the number of traditional therapists are unreliable, many of them are working informally.

Health Administration in Togo is organised according to a hierarchical pyramid structure and is composed of three levels: the central or national level, the intermediate level and the peripheral level.

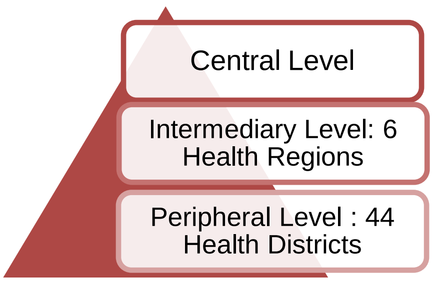

Figure 1: Organisation of the Health care System in Togo (Ministry of Health 2018)

1. Central Level: Office of the Minister, Permanent Secretariat, related directorates, divisions and units, national reference hospitals and Teaching Hospitals.
Mission: formulation, monitoring and control of health policies and standards
2. Intermediate Level: Regional Health Directorate, Specialised and Regional Hospitals.
Mission: training, monitoring and inspection
3. Peripheral Level: Prefectoral health Directorate/District Health Directorate, District Hospitals, Peripheral Health Units (PHUs).
Mission: operationalisation (implementation of interventions)

According to the National Health Development Plan 2017–2022 (2017: 10), the first-contact care is structured around three levels:

(i) the Community Health Workers (CHWs), who provide care, through delegation of health care tasks, at the family and community level and are expected to act as an interface between the community and health services;

(ii) the Peripheral Health Units (PHUs) is the cornerstone of the care system and from which community outreach activities are carried out through an established strategy;

(iii) the district hospital which is the first level of reference.

[2] It is mainly concentrated in the capital where there is a greater solvency of the demand. The true scope of private profit-making health facilities remains unknown because it is not included in the Health Information System. This sub-sector is currently poorly regulated.

In addition to the first-contact care, the second level of reference and getting medical care is the regional hospitals. Tertiary health care is provided in the country's three university teaching hospitals and in specialist reference hospitals.

CHWs then play a critical role: they make it possible to offer to the community, under the responsibility of the Head of health care units (PHUs), the essential health products and services, according to the package that was defined and for which he was trained. He takes part in the monthly meetings of the PHU. He is chosen by his community among the volunteers who are men and women willing to assist, to help their neighbours spontaneously, without waiting for any special pay in return. Since they do not receive any remuneration, they must be motivated by the spirit of volunteerism.

Owing to the fact that CHWs themselves hail from the communities and are most familiar with local issues, they can serve as critical links for adaptation measures, as proposed in Chapter 4 of this report. In addition, the presence of CHWs facilitates the supply of basic health care to the poor and vulnerable people, as only 14.5% of the '*poorest in urban areas with larger gaps in rural areas have access to a medical doctor*'; this figure rises to 27.1% for the richest (Ministry of Health and Social Protection 2017: 10). Finally, the analysis of the differences between the economic groups in Togo shows that the mortality of children under five years of the richest 20% is almost three times less than that of the poorest 20%.

Nevertheless, the current community health system has several shortcomings, including the low education level of the CHWs, the lack of a clear definition of their area of intervention, the failure to meet selection criteria and procedures, the lack of a clear CHWs status, the disparity and low level of motivation and inadequate training and follow-up of CHWs to meet the real needs on the field (Ministry of Health 2015: 10).

This brief overview of the relevant actors of the health sector and their various roles can be supplemented by further analyses on the subject, like one of the studies conducted by GIZ and presented below.

1.3 Overview of Relevant Studies on Health and Climate Vulnerability

As part of this assessment, GIZ ProSanté commissioned two studies from national consultants:

a) The development of the map of governmental and non-governmental actors in the area of health and environment in Togo (Sant'anna 2018);

b) A literature review and synthesis of vulnerability assessments to climate change in Togo and West Africa over the past ten years (Kogbe & Banka 2019);

c) Research and development of a synthesis of studies on the vulnerability of the health and environment sector, as well as climate change adaptation in the sub-region (beyond Togo) (Kassankogno 2019).

a) The first study (a) contribute to developing a stakeholder mapping in these sectors; it will be taken into account in the process of the health sector adaptation to climate change.

The analysis highlighted the need to engage technical and financial partners involved in environmental health because of their importance and influence on the development of the sector and the people – who are the first to be affected by climate change. However, national and international associations and organisations, sectoral or global platforms, training schools, etc. have proven expertise in the field and are therefore important actors to be taken into account in the process. The mapping will serve as a central element for the development of a dissemination strategy for the key findings of this report.

b) The second report (b) revealed that eight climate change vulnerability and adaptation assessments have been carried out for Togo over the past ten years, covering different sectors, such as water resources, agriculture, and energy (See MERF 2010 and MERF b, c, d, e and f).

For the West African sub-region, eleven studies were identified and analysed in the report. The relevant reports published by MERF in the context of this assessment are those on urban settlements and health (MERF 2007a and 2015 b). They focused on four distinct geographical areas based on their specificities: (1) the coastal zone, (2) the plateaus and mountains, (3) the plains and depressions and (4) the

Savannah region. Four climate risks, with impacts varying from one geographical area to another, are also identified: (1) heavy rain, (2) drought, (3) extreme heat and (4) sea level rise that can cause flooding as well as infrequent rainfall.

However, these vulnerability assessments for urban settlements and health facilities are not specific to the health sector alone but include all urban settlements. They do not specify the impacts of climate risks on health in different geographical areas, but they nevertheless give an overall idea of the relationship between climate change and health by describing the physical, economic and social impacts.

The most recent of these assessments was published in 2015 (MERF 2015 b) as part of the 'Third National Communication on Climate Change' (MERF 2015 a).[3] The following relationships between climate change and health were identified:

- Changes in temperature and increased precipitation would lead to the proliferation of vector-borne diseases such as malaria, diarrhoea, water-borne diseases such as cholera, respiratory conditions such as rhinitis and sinusitis and infectious diseases.
- Floods and high winds will cause economic and human loss and increase rural exodus and climate-induced displacement.
- The isolation of several areas, with traffic difficulties due to congestion, could result in a disruption of economic activities such as the decline in agricultural yields, and fisheries production, the destruction of economic infrastructure, transportation and communication, as well as the destruction of homes and fires.
- Malnutrition and famine will cause illness and death, especially among children and the elderly.
- In general, the proliferation of disease and the rise in population mortality will affect the poverty rate and reduce economic growth in the country.

The most vulnerable groups identified in the above-mentioned study are children under five years of age, pregnant women, the elderly, people with disabilities and people living with HIV AIDS or other chronic diseases.

Finally, the study (MERF 2015 b) strongly recommends to assess the impact of climate change on the emergence and/or development of major pathologies. GIZ/ProSanté therefore commissioned the study discussed in this report to fill that gap.

In conclusion, there is currently no comparable assessment available in Togo, which adopted a quantitative (and qualitative) methodology and an integrated risk approach similar to that of this assessment (see Table for more details).

Table 1: Overview of the Relationships with Similar Studies (Kogbe & Banka 2019)

Study as indicated in Kogbe & Banka 2019	Target sector using a quantitative approach	Relationships with this study
Study 2: Water Resources Vulnerability and Adaptation to Climate Change [2015]	Water	Basic information but no direct link because it is not health-related
Study 6: Urban Settlements and Health Facilities Vulnerability and Adaptation to Climate Change [2007]	Urban settlements and health	• Important information about the health sector in general • No comparable quantitative approach applied • In principle, no contradictory finding
Study 8: Agricultural Vulnerability and Adaptation to Climate Change [2010]	Agriculture	No direct link because it is not health-related
Study 9: Ecosystems and populations Vulnerability to	Ecosystems and populations	• Health assessment focused on the entire West Africa

[3] See Chapter 1.2 for reasons why the modelling of this study was not based on the scenarios of these studies.

climate change in West Africa [2017]		• In principle, findings consistent with those of this study • Development of the impact chain as a basic tool
Study 13: Impacts of Climate Change on Market Gardening in Northern Burkina Faso: The Case of Ouahigouya [?]	Market gardens	No direct link because it is not health-related
Study 14: Third National Communication on Climate Change in Côte d'Ivoire [2017]	Agriculture, Soils, Water Resources, Livestock, Fisheries, Coastal Zones, Human Health	• Important information about the health sector in general • No comparable quantitative approach applied • In principle, no contradictory finding
Study 16: Capacity building in response to the Adverse Effects of Climate Change on the Health of Disadvantaged Populations in Urban and Peri-urban Areas in Côte d'Ivoire	Health (Malaria, Helminthiasis)	• Comprehensive local study with household surveys • Not comparable to this study
Study 18: Second National Communication on Climate Change in Senegal [2010]	Water resources, Health, Coastal areas, Agriculture, Fisheries	• Important information about the health sector in general • No comparable quantitative approach applied • In principle, no contradictory findings

c) The Synthesis of Studies of c) (Kassankogno 2019) involves countries other than Togo and therefore did not fall within the scope of this assessment, which relates to the national level.

Table 2: Overview of the Relationships with Similar Studies (Kassankogno 2019)

Study as indicated in Kassankogno 2019	Target sector using a quantitative approach	Relationships with this study
Study/Document III: Health vulnerability and adaptation assessment to climate change in Accra, Kumasi and Tamale [2017]	Health (malaria, diarrhoea, schistosomiasis and acute respiratory infections)	• Important information about the health sector in general • No contradictory findings
Document/Study IV: Report on the health sector vulnerability and adaptation assessment to climate change, Burkina Faso	Health	• Important information about the health sector in general • No contradictory findings • Different geographical environment
Document/Study V Guinea: Health Sector Vulnerability and Adaptation (V&A) Assessment to Climate Change [2017]	Health (Malaria, Acute Respiratory Infections (ARIs), diarrhoeal diseases	• Important information about the health sector in general • No contradictory findings • Different geographical environment
Document/Study VI: Health Sector Vulnerability and	Health and environment (malaria, acute respiratory infections)	• Important information about the health sector in general • No contradictory findings

Adaptation Assessment to Climate Change in Mali [2017]		• Different geographical environment

Nevertheless, there is an assessment that of the health sector vulnerability to climate change in Benin (Osse et al., 2019) which is of interest, because Benin is a neighbouring country of Togo with quite similar climatic and socio-economic characteristics. This assessment followed a quantitative approach and provided relevant information for testing malaria impact chains for this study in Togo. However, the outcomes of the assessment conducted in Benin cannot be compared to our findings for the following reasons:

(i) The assessment conducted in Benin is based on the old IPCC terminology (contained in the fourth report), which focuses on vulnerability and contains different definitions.

(ii) The assessment conducted in Benin followed a methodological approach (using observational data and regression models) different from the one we applied and which is based on a deductive approach using (spatial) indicators as per the *Vulnerability Sourcebook* (GIZ 2014).

(iii) In addition, it should be noted that the study of Osse et al., (2019) provides results on climate change up to 2050, while this study covers the 2050 and 2100 climate periods with two different scenarios (RCP 4.5 and RCP 8.5).

(iv) In addition, the approach adopted in Benin does not use a set of climate models; it is simply the extrapolation of spot observation data to a surface without taking into account weather features (such as altitude, etc.). On the contrary, the best regional model on climate change currently available in the region was used for this study.

(v) Finally, this study uses a malaria-specific variable (the length of the transmission season) to capture changes in the malaria cycle, which is based on state-of-the-art climate models using malaria-specific modelling (multi-model approach; Caminade et al., 2014).

For these different reasons, this study cannot be compared with the results of the report of Osse et al., (2019).

1.4 Major Climate-sensitive Diseases

The 2015 QUIBB analysis of morbidity in the population reveals that, at the national level, 23.9% of the population was ill or injured in the four weeks preceding the survey (Ministry of Development Planning & National Institute of Statistics, Economic and Demographic Studies 2015). It is higher than the proportion in 2011, which was 20.6%. Malaria remains the leading cause of morbidity (56.5%) at the national level, regardless of the residential environment, sex or age group. Stomach pain (10.9%) and injury/trauma (5.1%) are the second and third causes of morbidity mentioned by the population. These first three cases affect children under five more than other age groups, regardless of sex.

However, some of these causes are not directly related to climate. One of the primary tasks of this study was therefore to select the health risks associated with climatic conditions in order to identify and decide which diseases to focus on.

Climate change has a direct impact on certain categories of diseases and, first, vector-borne diseases, in particular by making the conditions for vector survival and reproduction more conducive. In addition, increased precipitation exacerbates the spread of infectious agents and temperature contribute to their growth, making water-borne and foodborne diseases highly susceptible to climate change. Moreover, the hardening of climatic conditions also leads to a degradation of air quality which is a contributory factor for certain diseases such as respiratory infections or meningitis. The table below gives examples of diseases for each of these categories in the Togolese context.

Table 3: Major Categories of Climate Change-related Diseases

Category	Disease	Climatic Factor
Vector-borne diseases	Malaria	Flood, extreme heat
Water-borne diseases	Diarrhoea	Flood
	Onchocerciasis	Extreme heat, drought
	Dracunculiasis	Heat
	Cholera	Flood
Airborne and heat-related diseases	Meningitis	Extreme heat, drought
	Cardiovascular and cerebrovascular diseases	Extreme heat, drought
	Acute bronchitis, bronchiolitis	Extreme heat, drought
	Pneumonia	Extreme heat, drought
	Asthma	Heat, drought

Regarding vector-borne diseases, according to the National Health Development Plan 2017–2022 (Ministry of Health and Social Protection 2017), malaria remains 'the major public health concern in Togo'. Nearly half of all deaths (47%) among children under five years of age are due to this disease. In 2015, it accounted for 44.9% of outpatient visits, 26.4% of hospitalisations and 19.1% of hospital mortality causes[4]. The trend analysis shows a spread of malaria: 1 million to 1.5 million new cases over the 2014–2015 period, but with a decline in the mortality rate of this disease.

Despite a relatively satisfactory pattern of Long-Lasting Insecticidal Nets (LLINs) coverage (with the percentage of households with at least one ITN increasing from 56.7% to 65% between 2010 and 2014), effective use, assessed based on the percentage of children under five years of age who slept under LLINs the previous night declined from 57% in 2010 to 43% in 2014, with significant regional disparities.

In addition, between 2010 and 2015, the epidemiological landscape was marked in particular by bacterial meningitis and cholera outbreaks (Ministry of Health and Social Protection 2017). However, cholera has declined significantly since 2015 thanks to the introduction and monitoring of stringent measures.

In general, many health problems are linked to poor access to drinking water and sanitation, with factors affecting unsafe water bodies, poor or non-existent vector control, unhealthy food, exposure to chemicals, inadequate or inappropriate disposal of waste, as well as unsafe working environments, which may also pose environmental health risks. These factors are now aggravated by the negative impacts of climate change and unplanned urbanisation (Ibid.).

Being cognisant of all these considerations and observations, the team had to make a selection of the main risks the assessment should focus on as a matter of priority. The decision on the health risks assessed in this study was made in a participatory manner, as part of a rather detailed process described in the next chapter (see 2.3). In line with the considerations described above and as a result of the selection process, the following three climate-sensitive diseases were selected for the purposes of this assessment: malaria, respiratory infections and meningitis. This selection of risks was an essential preliminary stage in defining the scope of the study and initiating the risk analysis process on a clear basis.

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[4] It should be noted that intermittent preventive treatment of malaria in pregnancy has been free since 2013. The same is true for the treatment of simple malaria among children under five except for severe malaria cases.

2 Methodology

2.1 Approach and Steps of the Assessment

This section outlines the methodological approach used to conduct the risk and vulnerability assessment which is the purpose of this report. Here, we provide information on the reference documents, the methods used (quantitative and qualitative), the resources used and the stakeholders consulted.

The methodological approach applied in the context of this vulnerability assessment is based on a generic method described in the *Vulnerability Sourcebook* (GIZ 2014), developed by GIZ in collaboration with adelphi and EURAC, as well as the *Risk Supplement to the Vulnerability Sourcebook* (GIZ and EURAC 2017), which updates the *Sourcebook* based on the new definition of the risk concept according to the 5th IPCC Report (AR5). For this assessment, we followed the definition of the term risk and its different components (including vulnerability) developed in the AR5. The concept of vulnerability has been defined in more detail in order to take into account the public health context (see Chapter 2.2.).

These manuals provide details on how to develop and conduct climate change risk and vulnerability assessments. This method was conceptualised and developed by GIZ and adelphi. Based on the most recent IPCC report, it represents the cutting edge of international scientific knowledge and provides a systematic methodology that can be applied in different spatial and thematic contexts, therefore allowing for some comparability of the results. It can also be applied again in the future, to facilitate the monitoring of risk and vulnerability levels, to assess potential impacts and to propose appropriate adaptation measures.

Moreover, the use of this method is perfectly in line with the international framework for the development of National Adaptation Plans (NAPs) which aims at promoting effective adaptation to climate change in developing countries, as is the case for Togo (see Chapter 1).

The figure below (Figure 2) illustrates the main methodological steps that were followed by the consultants in order to carry out the study, following the call for projects and the selection of the consortia to conduct the study with four main experts. Initially, the scope of the assessment was outlined: the spatial and temporal scopes were defined, as a result the scope of the study was clearly defined. The various steps of the assessment were refined and adjusted to the context and timeline of activities. The number of key risks (or climate-sensitive diseases) to be assessed was also identified and the risks identified in collaboration with stakeholders. On this basis, the team was able to develop the impact chains, thanks to qualitative information, gathered during a first workshop in Lomé in February-March 2019 and quantitative information, through a preliminary literature review.

Impact chains are the mainstay of the methodology used in this assessment. It is a tool for scrutinising and visually representing all causal factors that contribute to a particular risk – namely, here, a climate-sensitive disease. Once identified, all risk elements can be measured, which also makes it possible to quantify the risk.

This quantification was carried out at the next stage, which involved the identification and measurement of indicators (steps 3 to 7 in Figure 2 below, detailed in Section 2.5) which is a method whereby a value is given to the various risk components. The elements are quantified one by one and then aggregated into different domains corresponding to the two main risk components (hazard and vulnerability). Once the value of these two components was determined for each of the three diseases, the team was able to deduce the final risk values. The outcomes of this risk assessment were then analysed, mapped and presented in this report.

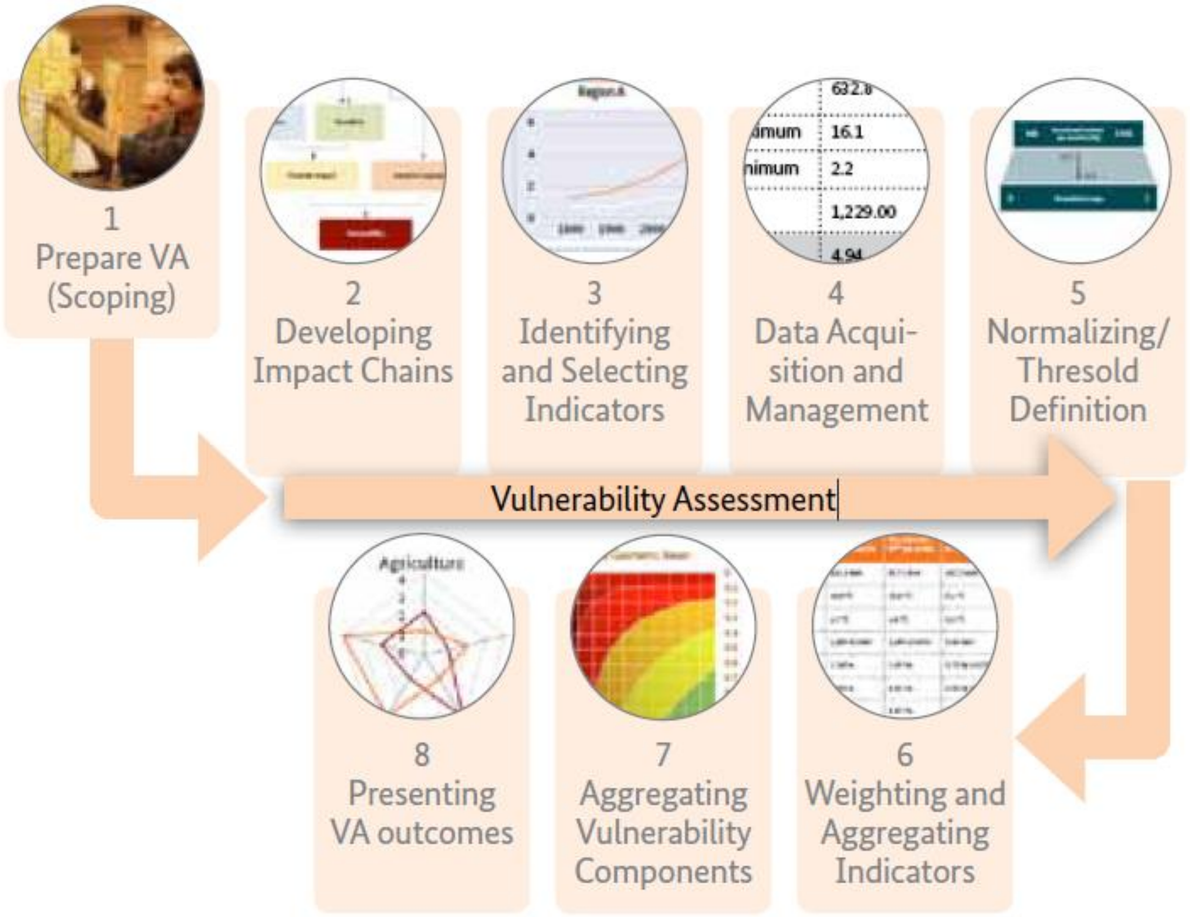

Figure 2: Chronology of the Steps of the Assessment according to the Modules of the *Sourcebook*

2.2 Use of Climate Change Data

A brief presentation of the effects of climate change in the Togolese context provides a better understanding of the risk assessment and the selection of the three diseases it focused on.

First, it is necessary to highlight the climate variability that characterizes the Togolese context of climate change. 'Climate variability' refers to average weather conditions varying between years or decades, which is a natural phenomenon that can be observed over comparable periods. 'Climate change' is a change that can be directly or indirectly attributed to human activity, altering the composition of the global atmosphere and is added to the natural climate variability. Anthropogenic climate change which is a global phenomenon due to the greenhouse effect is now widely documented and its trends are known.

As part of this vulnerability assessment, climate data from the Swedish Meteorological and Hydrological Institute (SMHI), that compiled the existing climate models for the West African region into three coherent sets, were used. These sets are available for two scenarios proposed by the IPCC, namely RCP 4.5 and RCP 8.5.

We used two different scenarios for this assessment:

a) The RCP 4.5 scenario is slightly above the 2 °C target but it still takes into account ambitious mitigation measures, which represent a path for stabilisation of radiative forcing by 2100.

b) The RCP 8.5 scenario corresponds to a continuous increase in emissions until 2100 and can therefore be considered a status quo or a 'worst-case scenario'.

Results are available for three climatic periods, in 30-year period span: 1981–2010, 2031–2060 and 2069–2098 (the periods were defined by SMHI/CORDEX Africa and reflect the current climate conditions of the middle of the century and projections for periods until the end of the century; the climatic periods are on average 30 years). The expected future climate change is significant at the end of the century (2069–2098) between the two scenarios. Until the middle of the century (2031–2060), however, the differences between RCP 4.5 and RCP 8.5 are minimal. The reason for this is that the climate system reacts with a certain time lag. Nevertheless, it is certain that we must expect changes in the years and decades to come.

Here, it was decided to work on the set of 4 GCMs-2RCMs, that is, the set that compiles four Global Climate Models and two Regional Models. All climate data used in this assessment are from the CORDEX Africa programme. Although the resolution of the dataset is 50x50km², it represents the quintessential data available for Africa. Due to the small size of Togo (56,600 km²) compared to the resolution of climate models, the results should be interpreted with caution. Because of this rather coarse precision, it is not advisable to interpret the grid cells of the climate models individually; it is thus advisable to draw a general pattern or model from the data. This assessment followed this consideration in the description of the results below.

2.3 Selection of Health Risk Assessed

The participants of the workshop on impact chains organised in February-March 2019 in Lomé listed the following health problems as being the most prevalent in Togo: malaria, respiratory infections, meningitis, malnutrition, cholera, diarrhoeal diseases, cardiovascular diseases, skin diseases, accidents, HIV/AIDS, hepatitis A, rabies, and others (Lassa fever, etc.). Due to the scope of the task, it was agreed that the assessment should focus on three climate-sensitive diseases. It was therefore necessary to prioritise the different diseases in order to assess the most important risks.

The next step was therefore a selection of the three risks to be assessed. To do this, it was first necessary to determine which of these diseases are influenced or determined by climatic factors, in order to ensure their alignment with the objective of the assessment. At this stage, due to the diversity of experiences and roles and occupations of the participants, there were challenges which are discussed in more detail in Section 2.7. To overcome this obstacle, the team of consultants and GIZ/ProSanté conducted a multi-criteria analysis to select the three climate-sensitive diseases to be assessed. The selection criteria were as follows: a) funding gaps and partner and programme interventions put in place, b) data availability for the study, c) priority of the Togolese Ministry of Health, d) impact: DALY, QALY, morbidity, mortality, e) existing capacities to intervene, f) similar studies in the sub-region (Benin, etc.), g) influence of climate change.

Through discussions between the team and key ProSanté partners, the following health risks were selected based on the criteria and the mean values: (1) malaria, (2) respiratory infections/conditions and (3) meningitis. The results of this classification are set out in Annex 6.

Once the final selection of the three risks to be assessed was made, the three corresponding impact chains could be developed.

2.4 Development of Impact Chains

According to the *Risk Supplement to the Vulnerability Sourcebook*, which updated the risk and vulnerability assessment methodology based on the new definitions in the 5th IPCC Report, risk is defined as '*potential or uncertain consequences or impacts of an event or an activity with respect to something of value*' (GIZ and EURAC 2017). Still according to the *Sourcebook*, the risk, the ultimate purpose of the assessment, results from the interaction of three components, from which it is necessary to determine the constituent factors and the index in order to deduce the final value of the risk:

- **Hazard**: '*The potential occurrence of a natural or human-induced physical event or trend or physical impact*' that may cause '*loss of life, injury, or other health impacts, as well as damage and loss to property, infrastructure, livelihoods, service provision, ecosystems, and environmental resources* "(GIZ and EURAC 2017). It is therefore any potential source of damage, caused by both natural/physical and human-induced phenomena.
- **Exposure**: '*The presence of people, livelihoods, species or ecosystems, environmental functions, services, and resources, infrastructure, or economic, social, or cultural assets in places and settings that could be adversely affected*.' (GIZ and EURAC 2017).

- **Vulnerability**: '*The propensity or predisposition to be adversely affected. Vulnerability encompasses a variety of concepts and elements including sensitivity or susceptibility to harm and lack of capacity to cope and adapt* '(GIZ and EURAC 2017).

In this assessment, the conceptual framework of the *Supplement Sourcebook* was used to guide the assessment of risks and vulnerabilities related to the three diseases at the national level. Vulnerability is largely social, which in our view encompasses various socio-economic and demographic factors and could be extended to institutional, ecological or cultural dimensions (which was partly addressed in the qualitative study). To define more clearly vulnerability in the context of protection against these diseases, the terms 'susceptibility' and 'lack of capacity' were used. Susceptibility represents the propensity of societies or humans to be negatively affected by vector-borne diseases. This requires a distinction between generic susceptibility (SUS) and biological susceptibility (BIO). Generic susceptibility includes the general underlying factors and the general predisposition of societies to diseases (e.g. poverty, demographic change, conflict, etc.). Biological susceptibility is related to clinical manifestations of malaria/infections/meningitis, which for example depend on malnutrition, disease co-infection and/or immunity (Kienberger and Hagenlocher 2014).

On the basis of these definitions, the team has therefore identified all relevant elements for each of these components and for each of the climate-sensitive diseases considered in this assessment.

Impact chains lie at the heart of this methodological approach and serve as a common thread throughout the process. They contribute to identifying the major impacts of climate change. They also illustrate the cause-and-effect relationships of climate change by identifying factors related to exposure, vulnerability and hazard, i.e. the 'risk components'.

These impact chains are based on contributions from stakeholders during a workshop conducted specifically for this purpose, which took place in Lomé in February-March 2019. Based on the evidence gathered, a draft of the impact chains was developed. These provisional impact chains were then fine-tuned and verified through a literature review (MERF 2007a and b, MERF 2010, MERF 2015 b, Kassankogno 2019, Kogbe & Banka 2019, Kienberger & Hagenlocher 2014, Ministry of Health 2018, Ministry of Health and Social Protection 2017, Ministry of Development Planning & National Institute for Statistics, Economic and Demographic Studies 2015, Osse et al., 2019), and some available data. They were validated by the team of consultants in collaboration with GIZ/ProSanté, as well as project partners. The three impact chains selected are presented below.

These are the final versions of the impact chains for the three target diseases. The factors that have been incorporated into the quantitative assessment are indicated by boxes. The other factors were not used for the assessment due to limited or unavailable datasets.

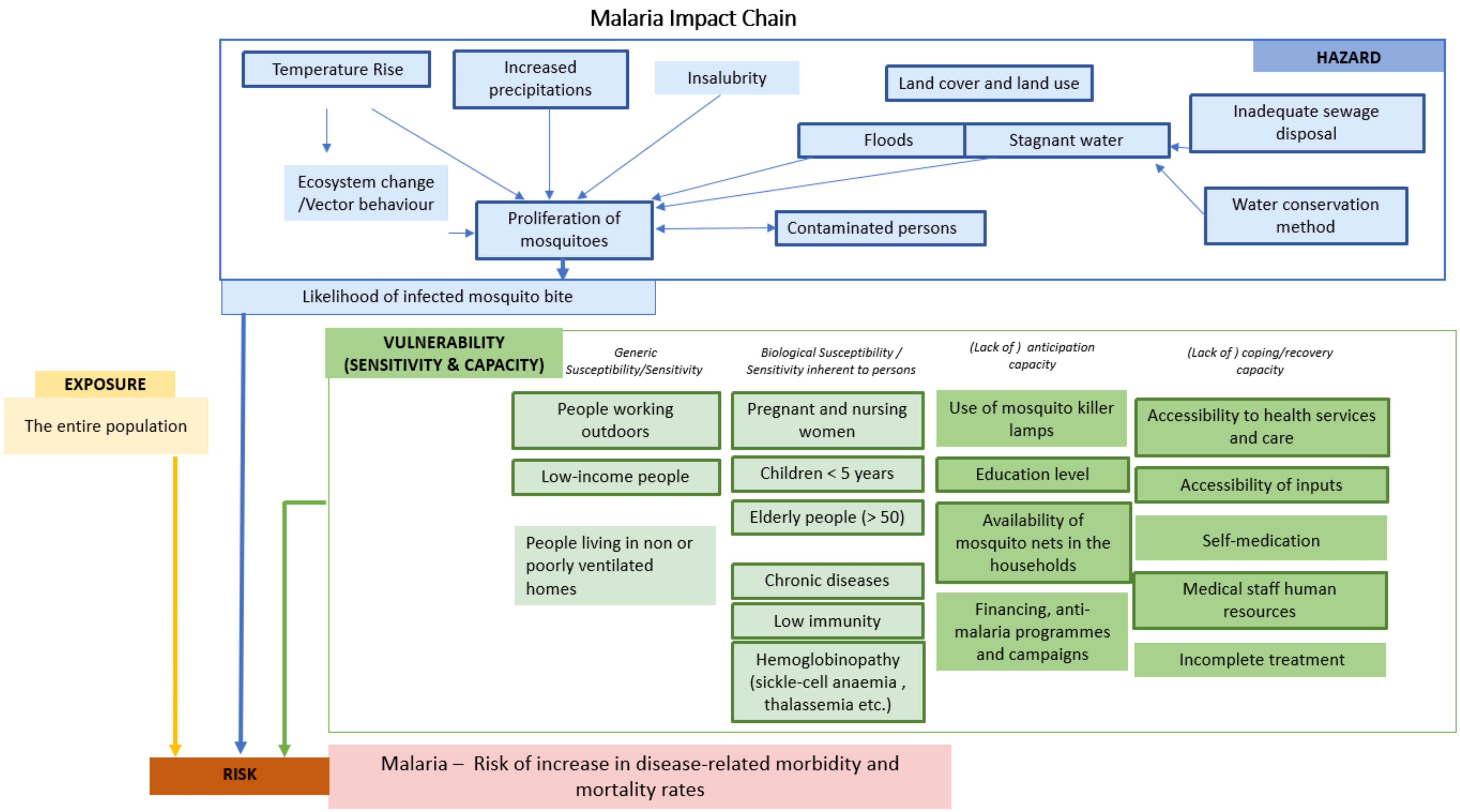

Figure 3: Malaria Risk Impact Chain

Hazard, exposure and vulnerability factors converging towards the risk of malaria-related morbidity and mortality are represented in the impact chain. The factors symbolised by a box with a frame are those that were taken into account in the quantitative analysis and that made it possible to calculate the risk index.

- **Malaria Hazard Factors**

It should be noted that a significant hazard factor for malaria is mosquito proliferation, which was measured in this assessment by the 'length of the transmission season' (Caminade et al., 2014), a climate-based indicator developed specifically to characterize the malaria cycle (see Annex 2 for a detailed overview of the indicators). This factor is the result of different climatic and environmental elements, human-induced or not, that converge and participate in the hazard. These elements include floods and stagnant water (main mosquito breeding sites) but also insufficient sewage disposal, which is also conducive for mosquito proliferation. The hazard also took into account the percentage of people infected, who are hosts of the parasite and thus contributing to its spread.

- **Exposure**

In terms of exposure, no indicator was taken into account in the quantitative assessment (see also 2.5). According to the *Sourcebook*, exposure is used as a 'relevance factor'. For the three diseases targeted in this study, the overall population is relevant and the final risk does not depend on the number of people in the districts. Taking this factor into account would therefore have distorted the results, as it would have resulted in higher risk values in some regions simply because they are more populated. In addition, in all diseases, some vulnerability indicators already cover demographic aspects, but based on more specific areas, such as the percentage of children and elderly people.

- **Vulnerability to Malaria**

However, some population categories are more at risk than others; this has been identified as 'vulnerability'. Thus, the percentage of people working outdoors was used in the calculation, as they are naturally more exposed. In addition, poverty is a generic vulnerability factor, as it implies an overall lack of resources and less favourable living conditions. In the same way, other characteristics increase the vulnerability of certain population groups and thus the risk associated with malaria: the affected groups here are nursing mothers and pregnant women, children under five years of age, the elderly people, or people suffering from certain preconditions or diseases. The respective percentages of each of these vulnerable groups were therefore used to calculate the final risk value.

Finally, the impact chain identifies gaps in the adaptive or coping capacity, which increase the risk of malaria-related morbidity and mortality. This includes the level of education, as measured by the 'percentage of the illiterate population' indicator, because the level of general risk awareness and the means of protection against it are linked to the level of education. The factor relating to the presence of mosquito nets, the use of which reduces the probability of mosquito bites and therefore of infection, was also measured and included in the final calculation. Finally, access to health services and care was analysed quantitatively in order to be treated, via the average distance from health facilities, the accessibility of inputs (data on days of treatment interruption), as well as the lack of health personnel (qualified personnel for 10,000 inhabitants).

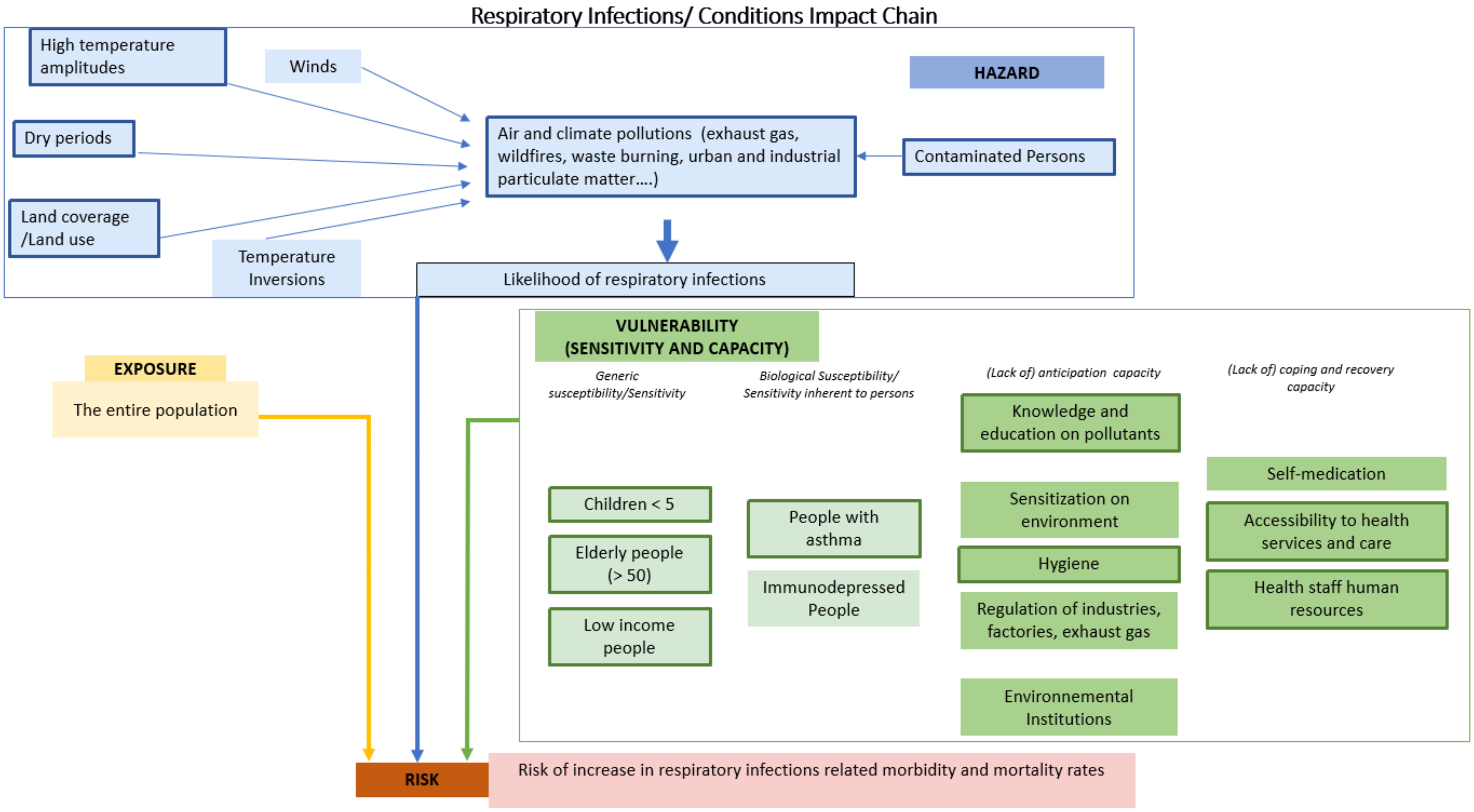

Figure 4: Respiratory Infections Impact Chain

Here again, the impact chain gives an overview of the main factors of hazard, exposure and vulnerability that, taken together, lead to the risk of morbidity and mortality associated with respiratory infections. As with malaria, only the factors in the boxes with frames were taken into account in the quantitative analysis.

- **Respiratory Infections Hazard Factors**

Regarding hazard, air and climate pollution are central elements whose influence on the final risk has been measured through several indicators: exhaust gases on roads and in industrial areas, wildfires, burning of waste, cooking food with firewood, and the use of charcoal in homes and urban particulate matters, all of which contribute to air pollution identified as the main cause of respiratory infections. High temperature amplitudes as well as dry periods were also considered in the quantitative assessment of the risk of respiratory infections due to the fact that they contribute to a dry air environment because any dry climate is conducive to dusty and polluted air. Finally, some land cover classes also contribute to air pollution.

- **Exposure**

Following the same logic as for malaria explained in the previous paragraph, the team did not include exposure in the calculation, here again only one factor was considered, the entire population.

- **Vulnerability to Respiratory Infections**

Finally, in terms of vulnerability factors, the percentage of children under five years of age and the elderly (over 50 years of age) who are particularly vulnerable to respiratory infections, as well as the percentage of people on low income (poverty being a generic vulnerability factor) were measured and taken into account in the calculation of final risk value. The ‘people with asthma’ factor, quantified using the ‘percentage of asthma consultations’ indicator also came into play as a cause of additional vulnerability.

The general level of awareness of the risk and the means of protection against it, linked to the level of knowledge or education on the pollutants, as well as the lack of hygiene, that put a strain on the immune system and make the body more vulnerable to other attacks, are the two factors of lack of anticipation that were used in the quantitative risk assessment. Finally, for the category ‘lack of coping and recovery capacity’, consideration was given to accessibility to health services and care, calculated on the basis of the average distance from health facilities, as well as the lack of health personnel, based on the number of qualified personnel for 10,000 inhabitants.

A rationale for the use of each indicator for the three target diseases is provided in the table in Annex 2.

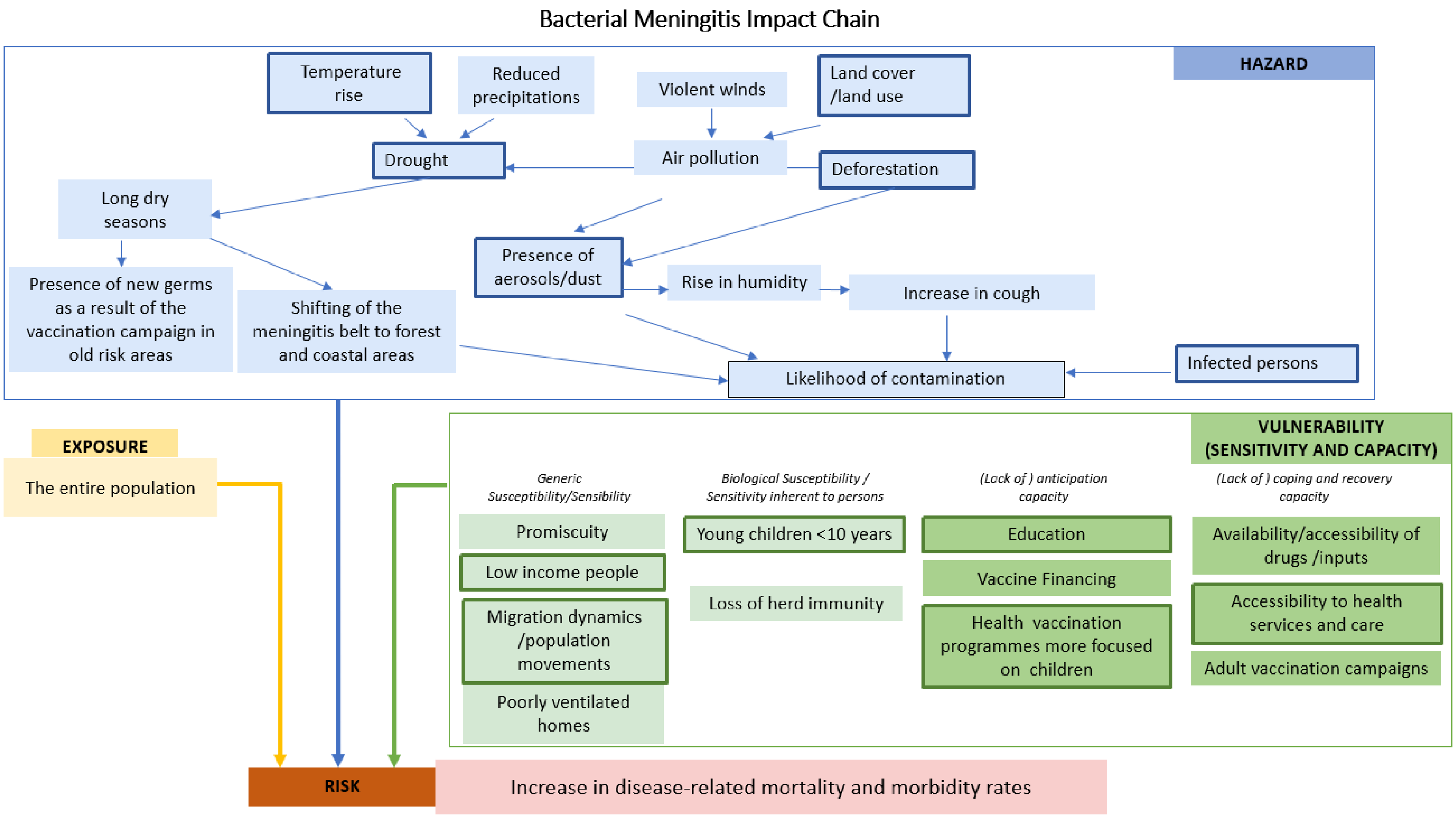

Figure 5: Meningitis Risk Impact Chain

The impact chain on the risk of meningitis-related morbidity and mortality provides details on key components of the aforesaid risk and on elements that have been integrated into the quantitative analysis that are symbolised by boxes.

- **Meningitis Hazard Factors**

In terms of hazard, the assessment first focused on drought, as well as on the rise in temperatures which contribute to a drier environment. A dry climate induces a dusty and polluted air that irritates the respiratory tracts and alters their integrity. This leads to further spread of the disease because the upper respiratory tract is the entry point of bacteria into the body. Land cover and land use, deforestation, and the presence of aerosols or dust were also taken into account for the same reasons. Finally, infected individuals, measured by the number of cases of meningitis per 100,000 people, were included in the quantitative analysis.

- **Vulnerability to Meningitis**

In terms of exposure, this component was not considered individually in the quantitative analysis, for the same reason as the one put forward for other risks. However, population-related factors with more specific criteria were used in the assessment, including poverty, again as a generic vulnerability factor, as well as children under 10 years of age, who are particularly vulnerable to meningitis. Similarly, the migratory dynamics and population movements, represented by the percentage of population residing for two years or less in the prefecture, have been analysed as population flows are potential vectors and thus increase the spread of the disease.

Once again, regarding capacity, the quantitative analysis focused on education as a means of protection against the disease, but also on vaccination programmes targeting children, as an important risk reduction strategy. Finally, accessibility to health services and care, calculated based on the average distance from health facilities, was measured and contributed to the calculation of the final risk value for meningitis.

2.5 Quantitative Methodology

2.5.1 Data Collection and Identification of Indicators

The development of the impact chains is followed by the development of indicators, which are used to calculate the value of each of the factors identified in these chains. To identify the indicators, there are several possible methods, which can also be combined: review of the existing literature, modelling or experts' opinions. In the next section, we describe the indicators and the data used for the quantitative assessment. The table in Annex 2 presents in more detail each factor and its associated indicator, including the data source, attributes used, temporal and spatial resolution, etc. The table also includes an overview of the indicators for which we did not find data and the reasons for this.

The availability and quality of data are critical to the relevance of the results of a risk assessment (Annex 2). This aspect was one of the main challenges of this study and explains in particular why all factors of the impact chain could not be included in the quantitative assessment. Among other things, the quality of the DHIS2 data has been a significant limitation, because although this platform provides a wealth of information, a detailed assessment revealed significant gaps.

In addition, if the census data were available, they had to be manually integrated into a Geographic Information System, which proved largely time-consuming. Census data are from 2010, which are the most recent data available for this assessment. Other data such as those from QUIBB were requested, but could not be received in time to be included in the assessment. MICS6 data was not available when the assessment was carried out and do not exist in the required resolution (prefectural level).

The assessment (and therefore the data used) covers the whole of Togo on a prefecture-wide scale. For malaria, 19 indicators were identified (six for hazards, thirteen for vulnerability), for respiratory infections 16 (eight for hazards, eight for vulnerability) and for meningitis twelve (six for hazards, six for vulnerability). Annex 2 provides a complete overview and rationale for all the indicators that were used.

Overall, the indicators were selected based on consultations held at the Impact Chain Workshop and the Methodology Workshop, held in Togo. On this basis, an indicator framework was developed (see Annex 2), taking into account the scientific literature where appropriate. In addition, the expert from the public health team provided the necessary knowledge to support this information. It should be noted that the group of national experts that participated in the Impact Chain Workshop was not fully representative in terms of heterogeneity and diversity. The team had to adapt and revise the impact chains accordingly.

The 'hazard' component mainly includes the results of climate models, as well as other environmental factors such as land use, water bodies, fires and deforestation. In addition, infected people are also a 'hazard factor' because they are sources of disease transmission to others.

For malaria, we applied a model result specific to this disease, which is the length of the transmission season (a frequent indicator in malaria modelling). The results are derived from the integration of several malaria models and are therefore the leading-edge knowledge available at the global level (Caminade et al., 2014).

For respiratory infections and meningitis, extreme climatic indices were used to represent the causes of drought and rising temperatures.

The vulnerability component consists of four sub-domains (Kienberger and Hagenlocher 2014), including (see also Chapter 2.2.):

- Biological susceptibility, which represents the pathological aggravating factors characterizing individuals who may be affected by the disease in question (for example, chronic patients or young children);
- General susceptibility such as poverty;
- The ability to anticipate a disease through awareness and prevention behaviours;
- The healing capacity, such as access to health infrastructure and medicines.

For the vulnerability indicators, various data sources were used, including census data, data from the ministry of health and DHIS2[5] (see Annex 2).

Conceptually, the third component of risk is exposure. It refers to the relevance of risk: who/what is at risk? For all risks, in this case the three target diseases, the assessment identified the entire population and this factor was therefore excluded from the modelling. Indeed, indicators concerning the population are already included in the calculation of vulnerability (children under five years old, the elderly, etc.). They therefore already imply that the most relevant aspects of exposure (in other words: the population) are already taken into account in the modelling. Conversely, including the population as a whole in the assessment would have meant that the final results of the risk would have been too strongly influenced by the number of inhabitants of the prefecture. This would have distorted the results, increasing the risk in the more populated prefectures, when it is not so much the number of inhabitants per se that matter, but more other factors such as population density or age. It was therefore decided that the assessment should focus on environmental and socio-economic risk factors.

2.5.2 Preliminary Data Processing and Standardisation of Indicators

Initially, pre-processing of datasets is not covered in the *Vulnerability Sourcebook* (GIZ 2014) method. It is specifically about developing descriptive statistics and identifying missing values/outliers, as well as cases of multi-collinearity. For this stage, the assessment followed the best practices available to develop composite indicators (OECD 2008). Descriptive statistics and correlation analyses for the different diseases and risk areas are available in Annex 3. The missing values, which existed only in a few cases in DHIS2, were processed using a data imputation method. For outliers, flattening and asymmetry were evaluated. In some datasets, a winsorisation process (replacing the outlier with the next lower value) was used. Such outliers were found mainly in Lomé as well as in some other prefectures (for example: Plaine de Mô for health accessibility, or Tandjoare for vaccination against meningitis). For the indicators remaining above the threshold, but whose values are close, no further winsorisation has been performed. A detailed overview is available in the tables in Annex 3. Due to the strong correlation, no indicators had to be excluded.

Once identified, the indicators must be standardised, which implies standardising their values in order to make them comparable. Indeed, indicators are measured in different metrics, with different units and heterogeneous distributions of values, preventing their final collation. In order to make this comparison and aggregation possible, they are assigned the same scale of magnitude. In this case, we applied the so-called min-max normalisation, which standardizes the data on a linear scale from 0 to 1 (see Figure 6 below).

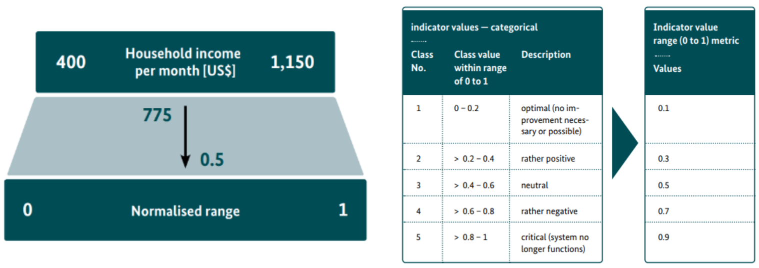

Figure 6: Illustration of Standardisation Model (Source: GIZ and EURAC 2017)

[5] DHIS2 data could only be used to some extent due to gaps and inconsistencies. See 'Limitations' section of the assessment.

2.5.3 Weighting and aggregation

Weighting is an intermediate stage necessary for the aggregation of indicators. It involves assigning weights to the different indicators, with the aim of highlighting certain factors in relation to others by giving them greater weight in the formula.

At the workshop held in June 2019 in Lomé, it was agreed that the weighting of indicators would be carried out by national experts, but no workshop specifically intended for such an exercise had been planned for this assessment. The solution that had been reached was to collect the weights through an online consultation. A Google form was prepared, in which each factor could be weighted and shared with GIZ and DHAB. Unfortunately, the team did not receive any response to this survey. As a result, it was decided to adopt an equal weighting approach, often used in similar studies. In general, therefore, the indicators were not weighted individually. However, a more general weighting took place, assigning climate-related indicators 50% of the total weight while the remaining 50% were allocated among the remaining indicators. This was done to reflect the importance and relevance of climate factors. The weights can be found in the table of indicators in Annex 2.

The indicators were therefore aggregated according to the diagram in the figure below. Vulnerability and hazard indicators were aggregated using an arithmetic mean, resulting in hazard and vulnerability sub-indices (or composite indicators). These sub-indices were then jointly aggregated to produce a final risk index for the present, mid and end of the century for the two climate scenarios (RCP 4.5. and RCP 8.5), using a geometric mean approach.

Natural hazards and vulnerability were weighted equally (50% of the risk each). The use of geometric means has been preferred here, because it makes it possible to consider zero values of hazard or vulnerability as leading to zero risk. This implies that if there is no hazard, the risk does not exist either (despite the vulnerability). This is in line with the methodological and conceptual approach adopted, whereby each of the three components is a necessary condition for risk and that the absence of only one of them leads to the absence of risk. On the other hand, an arithmetic mean would only be the average of the values and the risk would still exist even if one of the components is null.

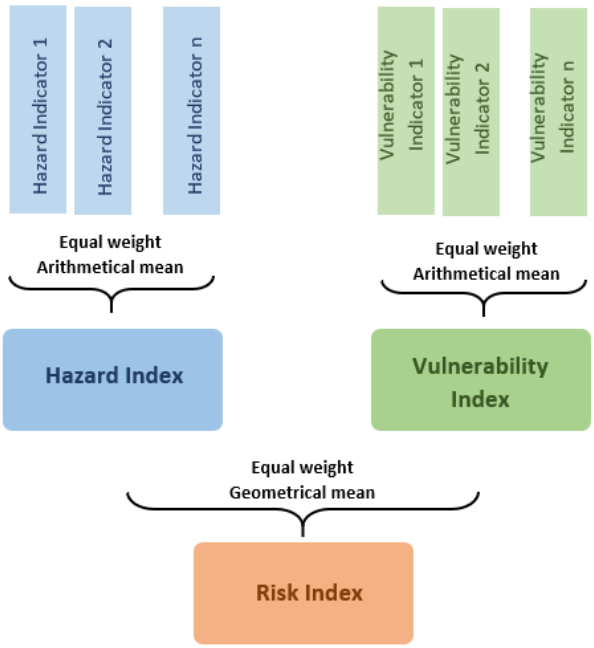

Figure 7: Weighting Method and Aggregation of Indicators

The aggregation of indicators for the final disease risk index was only carried out for current climatic conditions. Due to the lack of data on future scenarios for the other hazard and vulnerability indicators, it is not possible to develop a sufficiently robust combined future risk index, because only one or two indicators would have been affected. Instead, we provide specific climate change indicators for the respective diseases in order to be able to assess the potential future impacts of climate change. This impact on future disease risk is discussed in the outcomes section below.

2.6 Qualitative Methods

Two field visits of a total duration of three days were conducted: one day in the Maritime region in March and two days in the Kara region in June 2019. The two regions were chosen to represent the southern and humid tropical climate zone and the dry Sahelian zone respectively. It should be stressed that the two field visits were not exhaustive, as the collection of qualitative information was only considered as complementary to the quantitative assessment. The collection of qualitative data is normally not part of the approach of either the *Vulnerability Sourcebook* (GIZ 2014) or the *Risk Supplement to the Vulnerability Sourcebook* (GIZ and EURAC 2017). Nonetheless, field visits were added to this study in order to enrich the data and obtain relevant information not necessarily reflected in the literature.

Qualitative data collection was guided by the following objectives:

- Obtaining additional information on the risks to be assessed that are not taken into account in the quantitative data;
- Obtaining information on knowledge and perceptions of the impact of climate change on local health and adaptation measures;
- Gaining insight into the accessibility, use and capabilities of local health facilities (human resources, equipment, physical conditions, etc.) as guidance and basis for recommendations on climate change adaptation measures.

The following groups have been identified as target groups:

- Representatives of local authorities;
- Staff of health facilities;
- Key community members (local leaders, teachers, local health committee leaders, traditional leaders, CHWs, traditional healers);
- Groups of the most vulnerable people, such as pregnant and nursing women, children, elderly people, chronically ill people.

The team based its approach on qualitative methods that are explained in detail in WHO 2015, IFRC 2008 and CARE 2010. In the light of the field visits and the time available, the following methods were applied and adapted to the local context:

- Semi-structured interviews: Semi-structured interviewing is a form of guided interviewing in which only a few questions are defined in advance. The questions, which are open-ended, are intended to facilitate an informal dialogue on a given topic. This interview technique can be used both to give information (e.g., to raise awareness about meningitis) and to get information (e.g., to get an insight of what people know about meningitis).
- Focus group: Focus group discussion is an organized dialogue between people who are knowledgeable about a community and who are chosen to be part of the group in order to give their opinion and to report on their experience on a given subject.
- Seasonal calendar: The seasonal calendar consists in using a double-entry table with each column corresponding to one month of the year and each row corresponding to an important phenomenon. When the table is completed by the community, the team can see when health problems occur. The analysis facilitates the development of prevention methods and makes it possible to reveal the months for which the early warning system on an epidemic is important. The seasonal calendar is also an important source of information for planning activities and interventions. The results of this exercise for the communities visited in Kara are available in Annex 4.

The team visited the following intermediate and peripheral health facilities and met with their staff:

- In the Maritime Region: PHUs of Atitogo, Agbetiko and Masséda, the public hospital of Afangnagan and the private hospital in Afangnagan (Hôpital Saint-Jean de Dieu)

- In the Kara Region, the regional health directorate was interviewed, as well as the prefecture-level directorate at the General Hospital at the prefecture-level in Kanté, the Health and Social Care Centre of Yadè-Bouhou and the Polyclinic of Kozah.

In addition, the team interacted with representatives from the following communities:

- Maritime Region: Atitogo, Agbetiko and Masséda.
- Kara Region: Bebeda, Koudjoukada and Yadè-Bohou.

Qualitative data were also collected through meetings with health facilities and their staff at the central level (in Lomé), either through specific visits including interviews or through the workshop on impact chains, enabling stakeholders to participate in working groups and plenary discussions.

Meetings and interviews were also conducted with international institutions active in the field such as UNICEF, the European Union, WHO, as well as the Togolese and German Red Cross Societies.

The information from the interviews was incorporated directly into the assessment presented in this report[6]. The field visit was brief but provided a better understanding of the local conditions and context, the main community health problems and the challenges of health facilities. The visit was particularly useful in developing recommendations for adaptation options (see Chapter 4).

2.7 Limitations of the Assessment

- **Climate data:** In this assessment, we used state-of-the-art climate ensembles. However, the resolution of the data (~50 × 50 km²) as well as the relatively small area of Togo is a limitation. As such, the overall picture is very coarse and the individual grid cells should be interpreted with caution. This is all the truer for the climate indicators, which have been aggregated for the prefectures whose surface area is even more restricted. Here, therefore, it is about focusing on trends. In addition, climate models are generally characterized by uncertainties, which is an inherent problem in precipitation modelling.
  Specific data on future climate change scenarios are available in Togo, as published in MERF documents (2015 a and 2015 b). However, these datasets were not used in this assessment for the following reasons: (i) the indicators on 'consecutive dry days' and the 'length of the malaria transmission season' are not available; (ii) the scenarios are based on WorldClim data, which only take into account global climate change models, whereas the GHIS dataset used in this assessment is based on one of the global and regional climate models (CORDEX Africa – Coordinated Regional Climate Downscaling Experiment in Africa) specifically adapted to Africa; (iii) WorldClim data are reduced to 100x100m² (MEDDPN 2015 a). This approach is highly questionable due to methodological limitations and the quality of the data required for such a fine resolution. Such high resolutions are not even applied in data-rich environments, such as in Europe or similar environments.
  Beyond these reasons and by way of clarification, this study does not aim at replacing or throwing into question the existing climate assessments in Togo (in particular the 2015 a and 2015 b NMDPMs). For this assessment, we rely on the CORDEX-Africa ensembles established by SMHI and describe the key climate parameters for the datasets below and use specific climate indicators (such as CDD and Tmax), as provided to us. During this assessment, it was not possible to compare and validate the CORDEX-Africa ensemble with the data models provided by MEDDPN (2015 a). However, the CORDEX-Africa ensemble represents the cutting edge of current knowledge in terms of an appropriate resolution for Africa, for the reasons stated above. There may be discrepancies between the various models – particularly for precipitation – due to the general uncertainties in precipitation modelling.
- **Scenarios for the future:** For the coming decades, we will only be able to develop climate scenarios (not forecasts), with their inherent uncertainties. The assessment does not include future projections for socio-economic and environmental variables. As a result, maps of future risks are not developed. To interpret future impacts of climate change, disease-specific climate indicators (such as length of the malaria transmission season, consecutive dry days and maximum temperature) are provided.
- **Coverage of all risk factors:** Most of the factors identified in the impact chains could theoretically have been incorporated into the quantitative assessment. However, in practice, not all factors could be taken into account due to the lack of data. We have highlighted the factors used in the quantitative assessment by means of boxes in the impact chains. In addition, some factors simply cannot be quantified, by their nature or because no data are available (for example, enforcement of laws). The field visit with qualitative methods attempted to fill these gaps.

[6] Following the explicit request of the national authorities (GIZ/ProSanté partner), the names and contact details of the people met have not been revealed to ensure privacy and anonymity.

- **Consultation on the weights to be assigned to the indicators:** Due to the limited response from experts to the online consultation, this approach could not be applied. Ideally, this is done in a workshop setting, where the final choice of weights can be agreed upon. On the other hand, other assessments using the *Vulnerability Sourcebook* method have followed the equal weights approach, which seemed to be a good way to get around this difficulty and move forward.
- **Data access and quality:** Accessibility of the necessary datasets is an important issue. Compared to the team's past experiences in other countries, we can nevertheless speak of relative success in Togo. It is important to take into account the fact that not all datasets cover the same period: for example, census data are from 2010, while other indicators are from 2018. For DHIS2 (which remains an excellent data source), the quality of some datasets was insufficient (this has been documented in a separate report). For the development of some indices we had to deal with outliers (modified data entries are documented in Annex 3). Finally, it is important to bear in mind that there may be other non-detectable data quality issues that may impact the results.
- **The field visits** and thus the collection of qualitative data were certainly useful and enriching. However, much more time would have been needed to make their contribution to the outcomes of the assessment truly meaningful.
- **Multi-sectoral contributions,** which consist here in getting expert knowledge from different organisations and institutions, would have been necessary to explore issues around the malaria cycle – to estimate whether a temperature rise will have a real negative influence on mosquito proliferation, for example
- **Expert consultation:** During the various workshops, the participation of national experts was limited. This pertains in particular to the workshop on impact chains, as well as the workshop on validation of results. Having a number of institutions and people available at the same time is certainly a challenge. However, it is recommended that much more emphasis be placed on identifying and inviting key national experts.

3 Results

The results of the mapping are presented at the prefecture level. For each disease, a current map including the corresponding hazard, vulnerability and risk indices is provided. In addition, the exposure layer (number of people per prefecture) is filled in (see map in Annex 1). The five prefectures with the highest risk values are also highlighted and histograms show the contribution of each component to the risk. It is therefore possible to identify the most sensitive areas and to adjust the adaptation measures to the specific prefecture and its socio-economic and physical conditions.

Each map is developed using the same pattern: the upper part presents the risk index, while the lower band is composed of the components taken into account in the calculation of the index, which are vulnerability and hazard. The complete maps are available in Annex 1. In each case, the components were aggregated using the same method described above, namely arithmetic and geometric mean with equal weights (see Figure 7 above).

For future climate scenarios, separate maps are provided. They show the current condition as a baseline (left) and incorporate the variations in the climate signal for the selected climate indicators (right). As an example, the map of consecutive dry days includes the following elements: a reference map for the climate period from 1981 to 2010 and two projections into the near future (2031–2069) and far future (2069–2098). For the two projections into the future, two scenarios are proposed: the 'optimistic' scenario (RCP 4.5) and the 'pessimistic' scenario (RCP 8.5). These scenarios have been established by the IPCC and depend on the evolution of greenhouse gas concentrations. They model the future climate with different assumptions about the quantity of gas emitted.

In addition to the mapping analysis (quantitative), observations and findings of field visits (qualitative) in the Maritime and Kara regions are presented to better illustrate the findings and provide a basis for the adaptation options recommended in Chapter 4.

3.1 Climate Change in Togo

In the case of Togo, most of the long-term projections (2071–2100) seem to point to a significant year-round increase in temperatures, ranging from two to more than four degrees Celsius depending on the scenario considered. What we can observe, is that in the worst-case scenario, we observe a greater increase in temperature in the north than in the south, which leads to average temperatures of about 32 °C.

The following maps show the average temperature for the period 1981–2010 and the future temperature evolution for the periods 2031–2060 and 2069–2098. The first set of maps presents the results of the Representative Concentration Pathway (RCP) optimistic scenario, that is, in the event of a reduction of the main greenhouse gases in the atmosphere (such as carbon dioxide and methane emissions). The second line maps represent the most pessimistic scenario, where gas emissions would not decrease, causing the temperature to rise. In this case, the temperature increase for the end of the century reaches two to four degrees Celsius across the country.

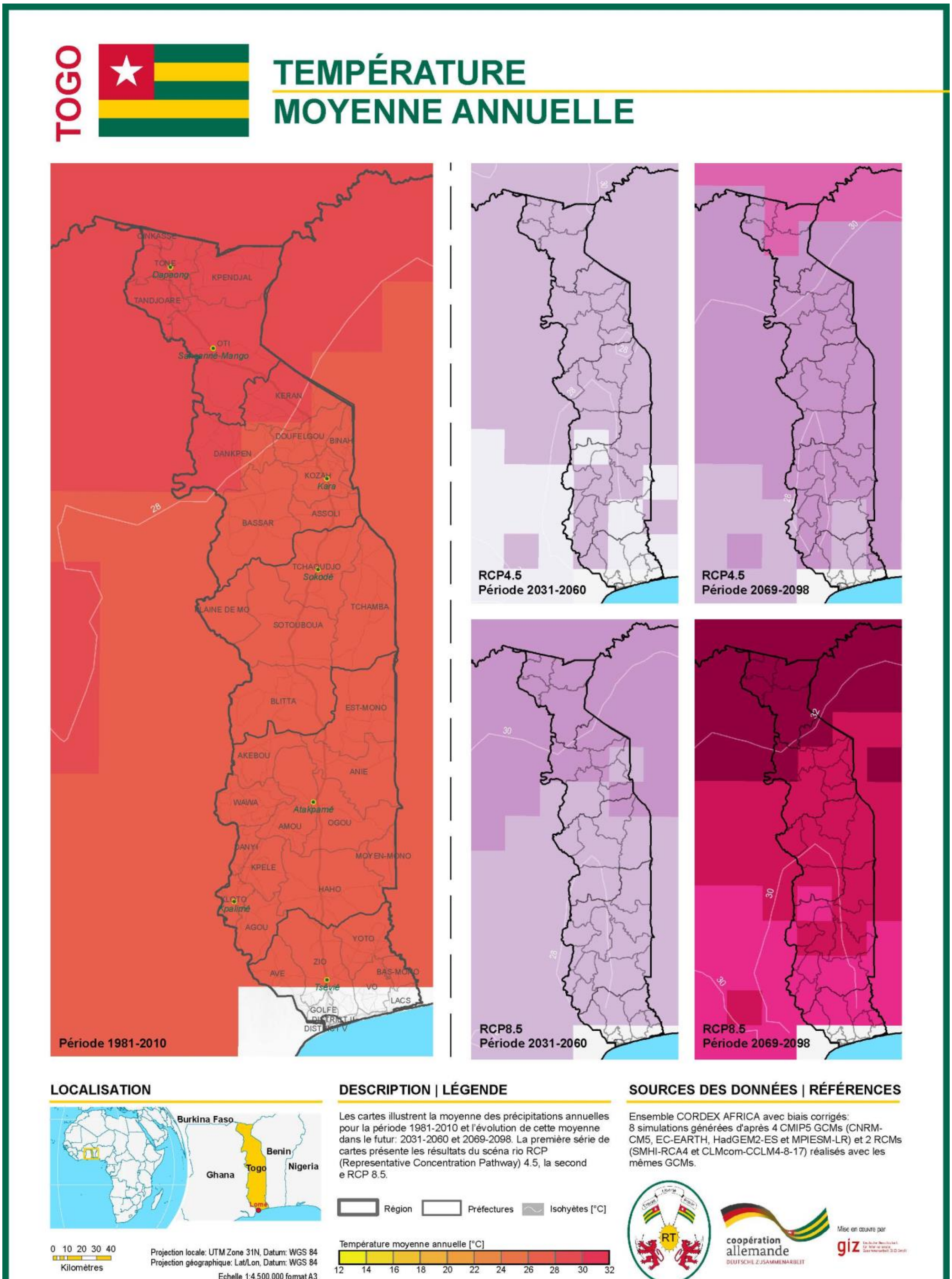

Figure 8: Map of the Average Annual Temperature

With respect to precipitation, a decrease in total amount can be expected, which is again similar (and less severe) until the middle of the century, with a much greater decrease in the RCP 8.5 scenario by the end of the century. The data suggest that the decline could be greater towards the south. However, this should be treated with caution due to model uncertainties.

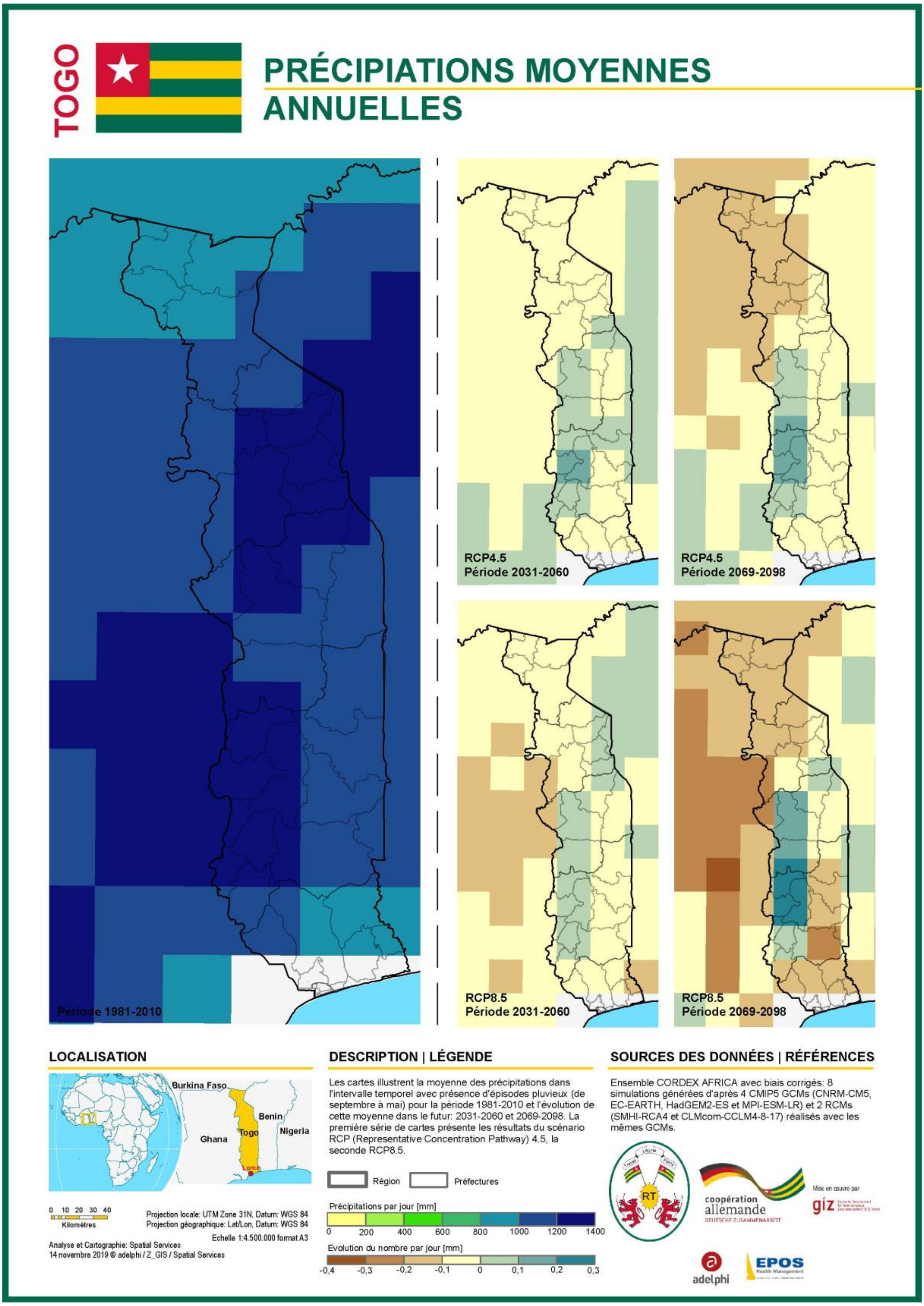

Figure 9: Map of Average Annual Precipitations

Additional maps, including extreme climate indices, can be found in Annex 1. Within the context of the assessment, maps of ‘consecutive dry days’ and ‘consecutive wet days’ present the relevant information that has been used:

- Consecutive Dry Days – an approximation for droughts – indicate that there will be an increase in dry days, especially in the northern part of Togo. It is interesting to note that in the RCP 8.5. scenario of the end of the century, the increase is less, with even a decrease in the south.
- The Consecutive Wet Days index shows a much clearer picture, which is a general downward trend for the country as a whole, with again a much stronger decline for the RCP 8.5 at the end of the century.

In terms of precipitation intensity, the PR10 dataset (days of precipitation> 10 mm) shows a decrease in the upper north, while there is a slight increase in the central and southern parts of Togo.

Again, it should be noted that the precipitation results should be taken with caution, due to the uncertainties associated with precipitation modelling and the rough resolution of the model results in relation to the small total area of Togo.

In addition, the field visits conducted as part of this assessment provided details on the perception of climate change at the local level. For instance, both health workers and community residents are already aware of extreme weather events such as heat waves, delayed rainy seasons, prolonged droughts, heavy rains and thunderstorms. Respondents are aware that these phenomena damage local infrastructure, reduce agricultural yields and contribute to temporary or permanent migration to urban centres or outside the country.[7]

It also emerged from the field visits that heat waves and heavy rains are a concern for residents, as they make access to health services more difficult. Extreme weather events themselves damage health facilities and therefore pose a risk to the staff and patients.

Yet, although people are observing the extreme weather events occurring today and some people have heard about ‘climate change’ in the media, the population is not necessarily aware that these events will continue and even intensify and might have impacts on health, including for the most vulnerable groups.

[7] In particular, people of the Kara region said that young people, who are the largest labour force in the fields, go to Nigeria for several months to look for work.

3.2 Malaria

Malaria risk assessment for current conditions indicates that prefectures in southern and central Togo have higher risk values than those in the north, with the exception of some prefectures in the west.

The five prefectures most at risk are located in the south (Vo, Lacs, Moyen Mono, Kpélé and Bas-Mono). These prefectures not only have high malaria risk values, but also high vulnerability values (Figure 10).

This is also consistent with observations that most malaria cases occur in the prefectures of central and southern Togo. The risk is indeed strongly influenced by climatic conditions, which are more conducive in the south than in the warmer and partially dry areas of the north. However, other risk factors, such as the presence of water bodies, also play an important role. In addition, the number of infected people and the method of domestic water conservation increase the risk index in some prefectures. What should be considered with caution are the relatively high values of infected people in the city of Lomé, which can be explained by a higher number of reported malaria cases, due to the mobility of people from other prefectures to Lomé, which has better equipped hospitals (for more details, see graphs in Annex 5).

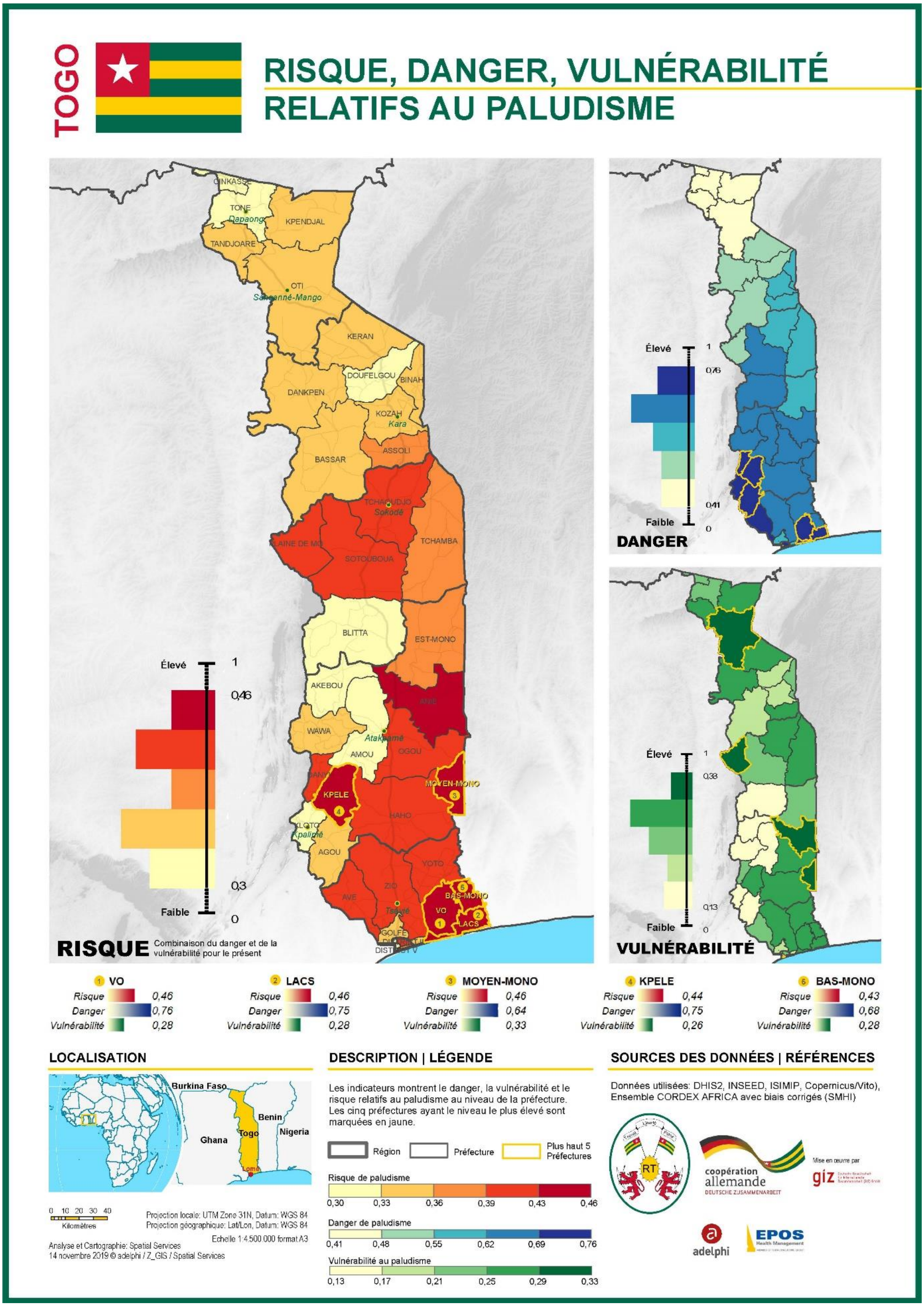

Figure 10: Map of Malaria-related Risk, Hazard and Vulnerability

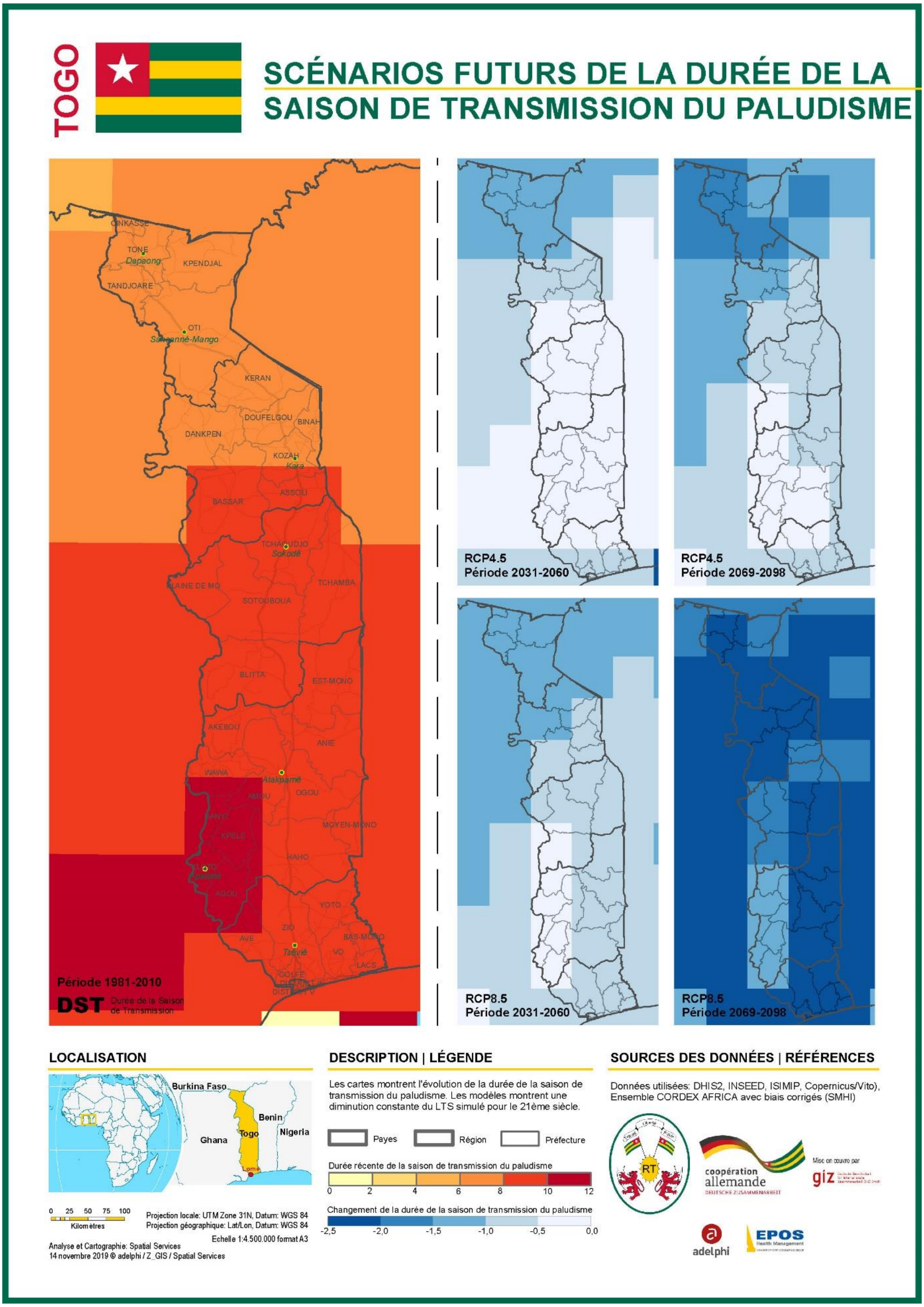

Figure 11: Future Scenarios of the Length of the Malaria Transmission Season

PREF	REGION	Risk Index	Hazard Index	Vulnerability Index
VO	MARITIME	0,46	0,76	0,28
LACS	MARITIME	0,46	0,75	0,28
MOYEN-MONO	PLATEAUX	0,46	0,64	0,33
KPELE	PLATEAUX	0,44	0,75	0,26
BAS-MONO	MARITIME	0,43	0,68	0,28

Figure 12: Top 5 Malaria-Risk Prefectures in Togo

The bar charts (Figure 12) show the respective index values (see Annex 5 for more details). These bar charts allow the user to identify detailed intervention options. For example, Figure 12 shows that the contributions of risk and vulnerability factors vary. In Moyen-Mono, the vulnerability component is higher than in other prefectures and special attention should therefore be paid to this area. On the other hand, Kpélé has high risk values, which are mainly due to high values in the area of hazards and lower vulnerability scores. Bar charts are also useful when identifying concrete intervention measures for individual indicators (see Annex 5 for more details).

In the case of malaria, the climate indicator used was the Length of the malaria Transmission Season (LTS). For this assessment, a multi-model mean was used, developed in the context of a comparison exercise of different malaria models (Caminade et al., 2014). Although it is a dataset originally designed for global application, it currently provides the best estimate of malaria risk in Togo, due to the lack of detailed and high resolution malaria models for this region. During this assessment, it was not planned to apply a more detailed dynamic malaria model based on downscaled climate data. The results show the observation mentioned above, with higher LTS values to the south than to the north. This is explained by the more conducive climatic conditions for the cycle of the carrier mosquito in the south.

The results of the current socio-economic vulnerability to malaria (Figure 10) show a slightly different pattern from the results for the 'hazard' component presented in the previous paragraph, with areas of vulnerability scattered throughout the country. Moyen-Mono has the highest vulnerability score, which is also reflected in a high-risk value. However, other areas of vulnerability exist (Plaine de Mô, Oti and Anié). In Moyen – Mono, indicators such as the high number of people working outdoors, poverty, sickle cell disease, lack of access to nets, as well as the availability of medicines play an important role (see also Kienberger & Hagenlocher 2014). Overall, the vulnerability models are very diverse and specific to the context of the different prefectures of Togo. The lowest vulnerability scores can be observed in Western prefectures (such as Kloto, Akébou, Agou, Blitta, Amou, etc.) that have good mosquito net coverage.

For the length of the malaria transmission season in the future (Figure 11), the data show a slight decrease in the duration of transmission days for the whole of Togo. The largest decline can be observed in the northern prefectures, due to high temperature increases (up to 37–38°C; see Craig et al., 1999), which increase mortality in the malaria cycle. The decrease in LTS is weaker towards the south but must be interpreted with caution as these models present inherent uncertainties. Overall, most parts of the country are still expected to maintain malaria-friendly conditions in the future. Given this observation from a climate perspective, we are unable to predict changes in malaria risk due to the lack of vulnerability scenarios.

In conclusion, it can be argued that efforts to mitigate the risk of malaria can be better focused on both hazard and vulnerability. Exploring the values of vulnerability indicators for each prefecture could support the identification of targeted and appropriate adaptation measures (see Chapter 4).

Qualitative data reveal that malaria continues to be perceived as a major health problem, both by health workers and community members surveyed in the Maritime and Kara regions. This observation is somewhat surprising, as all households surveyed received mosquito nets at the last distribution about three years ago and reported using them. In addition, awareness and knowledge of the cause, transmission, symptoms, and consequences of malaria as well as the use of health facilities were rated high among the individuals interviewed.

Why then does malaria remain a health risk and a major cause of death? Surveys have revealed that, in general, residents do not like to use mosquito nets freely distributed, because their texture does not allow sufficient air ventilation. One of the factors behind the high prevalence of malaria is the lack of precaution or misuse of nets: Sometimes people lift the nets at night to allow ventilation or do not place them properly under their mattresses or mats. Some also indicated that their nets had holes. However, because it seems that treated nets are not available on the market or in pharmacies, people have to wait for the next distribution to replace their damaged nets.

Moreover, although malaria patients receive treatment in health facilities (in severe cases, some patients have to spend the night), in most of the facilities visited by the team, there were no nets on the beds. The reasons given were stock shortages or theft of nets by patients (see Picture).

Picture 1: Beds with no mosquito nets in a health facility.

More detailed additional studies would be needed to determine if people check the inside of the nets before attaching them, if they install them properly and if they are careful at night when leaving the bed. Given that malaria cases are still very high, it can be assumed that there is still important work to be done on the dissemination and demonstration of methods of correct use of the net.

However, ensuring that people sleep under an intact and properly secured mosquito net is not the only solution to eradicate malaria. Measures should also be taken to prevent people from being bitten during mosquito peak hours (especially at sunset) and to eliminate mosquito breeding sites (see Chapter 4).

Nonetheless, none of the interviewees mentioned the existence or use of commercial mosquito repellents and no one seems to be aware of their existence. Just like mosquito nets, they are also very difficult to find on the market or in pharmacies and, when they are, they are very expensive. There are, however, local methods that were brought to the team's attention during the visit to the Kara region and that probably exist in other parts of the country. In Kara, people grow, install or burn specific plants called ‘watekpissou’ or ‘potuneze’, which means ‘the grandmother of mosquitoes’, to prevent mosquitoes from breeding inside and outside homes (see Picture opposite).

Picture 2: Local mosquito-repelling plants

3.3 Respiratory Conditions/Infections

The spatialisation of the risk of respiratory infections is different from that of malaria. Indeed, the highest risk values are found in the northern prefectures and the moderately high values in the north-central regions (Figure 13). The southern part of the country has relatively low values.

The highest risk values are found in the prefectures of Oti and Kpendjal (both with equal high risk values) followed by Tandjoaré, Doufelgou and Tône. All these prefectures have relatively high values for both hazard and vulnerability and it is the ‘hazard’ component that contains the most significant elements in terms of influence on the risk index. This is due to the high values of the two climate indicators, namely consecutive dry days (reflecting drought conditions) and temperature. The northern zone is influenced by the Sahel as a result of Togo's geographical characteristics.

In addition, the high value of wildfires and the more favourable land cover types increase the hazard and therefore risk values in northern regions. Several prefectures also have higher values for some hazard indicators (e.g., land cover types, people infected, exhaust gas), while others have lower values for consecutive dry days and maximum temperature (for more details, see graphs in Annex 5). The results of the risk assessment of this study are also consistent with the observation that there are more cases of respiratory infections reported in the northern regions.

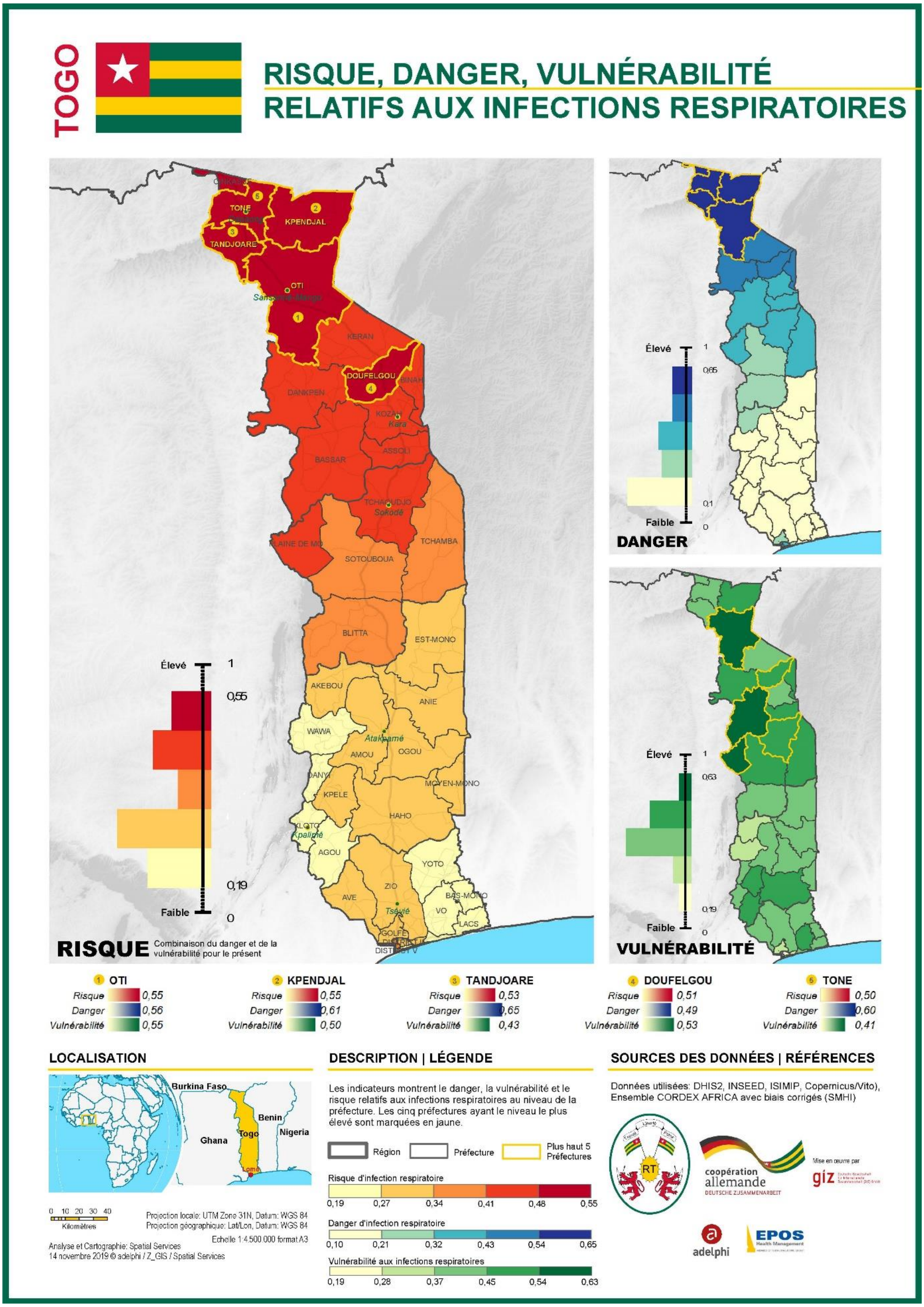

Figure 13: Map of Risk, Hazard and Vulnerability relating to Respiratory Infections

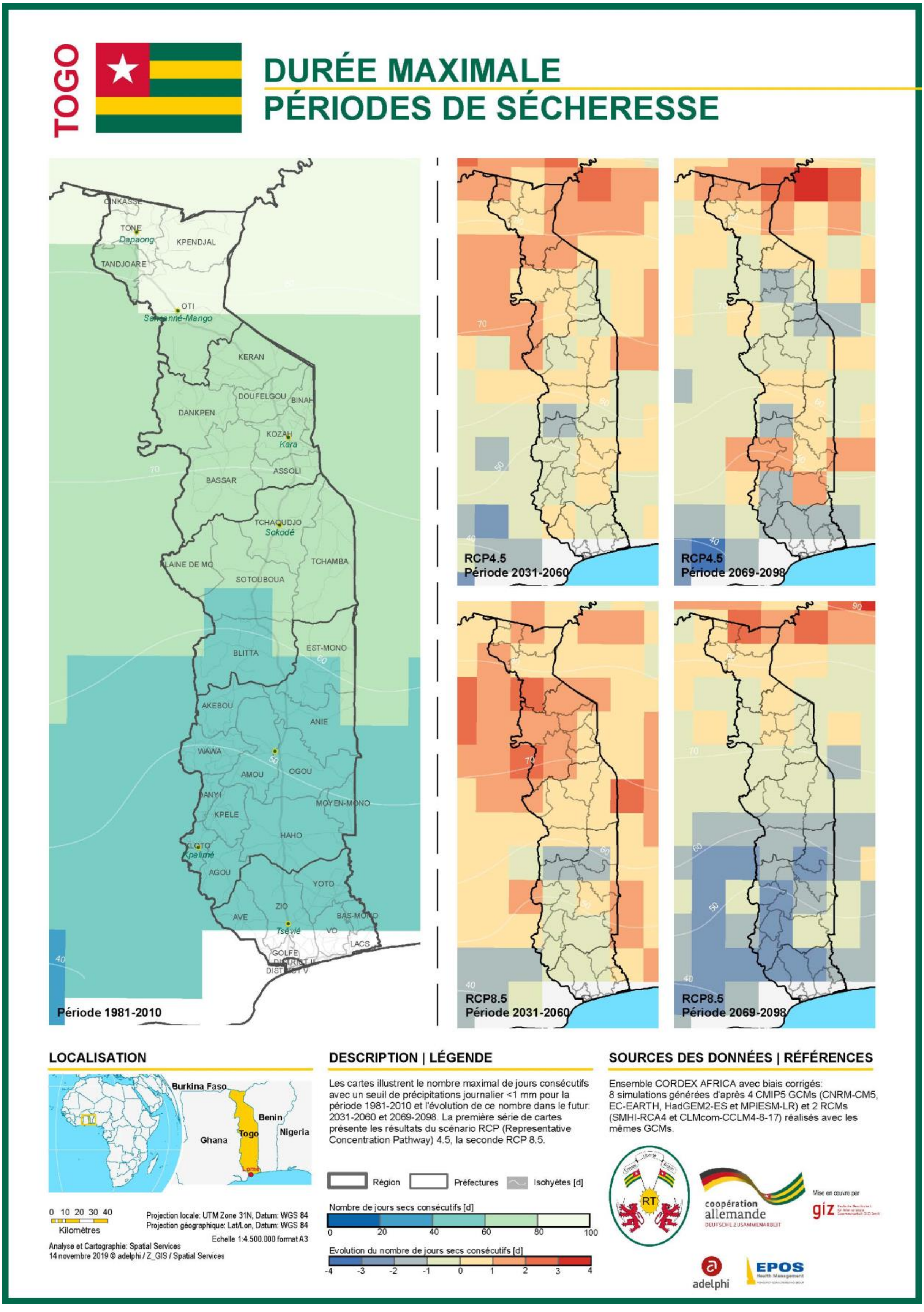

Figure 14: Map of the Maximum Duration of Drought Periods

A map of the maximum temperature can be found in Annex 1.

PREF	REGION	Risk Index	Hazard Index	Vulnerability Index
OTI	SAVANES	0,55	0,56	0,55
KPENDJAL	SAVANES	0,55	0,61	0,50
TANDJOARE	SAVANES	0,53	0,65	0,43
DOUFELGOU	KARA	0,51	0,49	0,53
TONE	SAVANES	0,50	0,60	0,41

Figure 15: Top 5 Respiratory Infections – Risk Prefectures in Togo

The bar charts show the respective index values (see Annex 5 for more details).

Air quality is one of the major risk factors for respiratory infections. Results show that values for particulate matter are higher in northern prefectures. In addition, the city of Lomé shows high values in the road traffic exposure indicator.

The outcome of the socio-economic vulnerability assessment also reflects the higher values in the northern and central prefectures. The highest value is found in the Plaine de Mô prefecture, followed by Bassar, Oti, Doufelgou and Tchaoudjo. The high vulnerability values in the Plaine de Mô can be attributed to a lack of education and hygiene problems. In addition, the lack of access to health services and the high proportion of children under five years of age also contribute to the socio-economic vulnerability of the prefecture. Again, each prefecture has its own vulnerability characteristics that can be studied individually. It can thus be observed that the prefectures with the highest vulnerability scores have profiles similar to that of the Plaine de Mô, but not identical. Some are characterized by additional factors, such as the level of poverty and difficulties related to the personnel available in the health facilities.

In terms of future projections (Figure 14), consecutive dry days are predicted to increase substantially northward until 2031–2060 for both scenarios considered. Then for 2069–2098, it is interesting to note that RCP 8.5 shows a decrease in drought for the southern part and only a slight increase in the north. Maximum temperatures are expected to increase throughout the country until the end of the century, with the most notable increase in the RCP 8.5 scenario. In general, it can be concluded that the risk is expected to increase, especially in the north of the country.

Overall, the highest risk can be observed in the northern and central prefectures, influenced by both high values in the hazard and socio-economic vulnerability components. The study shows that climate change will increase this risk, but at the same time it helps to identify vulnerability issues at the level of each prefecture that could be improved.

During the **qualitative data** collection, respiratory infections – 'flu' – were also mentioned as one of the most common health problems among the people the team interacted with during the field visits. Infants and young children are particularly affected during the dry season, from November to March. Self-medication is a common method of treatment, but in severe cases the child is taken to a health facility for treatment.

Picture 3: Waste burning in Kara next to a primary school.

However, prevention methods, such as washing hands with soap, avoiding draughts and wearing appropriate clothing, were not mentioned. In addition, awareness and knowledge about harmful emissions from local cooking methods, waste burning, etc. are extremely low.

Picture 4: Waste in the city of Kara

Thus, the lack of awareness, motivation and initiative to maintain a clean and healthy environment was one of the main observations of the field visit. It is common to cook using plastic waste and other harmful substances as fuel, with an infant on his or her back or a child at the side. Private or public garbage cans barely exist, and public dump sites are not managed. In the city of Kara, this situation is very worrisome, especially during the rainy season, as residents dump the waste in the open on the streets and on farms.

3.4 Meningitis

The northern areas of Togo have the highest risk of meningitis, followed by a few prefectures in the north-central part of the country (Figure 16). Kpendjal in north-eastern Togo has the highest risk score. This prefecture is then followed by Oti, Cinkassé, Tchamba and Tône. Tchamba is the exception as it presents a high risk compared to the rest of the region (central-east), due to both medium and high values of hazard and socio-economic vulnerability.

Kpendjal is characterized by high values for the hazard and vulnerability components. Again, and in the same way as for respiratory infections, this is due to the high values of the climate indicators (consecutive dry days and high temperatures). Both reach their peak in the northern regions, with lower values towards the south. This is due to the geographical characteristics of Togo, where the northern zone is influenced by the Sahel. In addition, favourable land cover classes, a higher number of infected people, as well as high levels of particulate matters contribute to higher risk values.

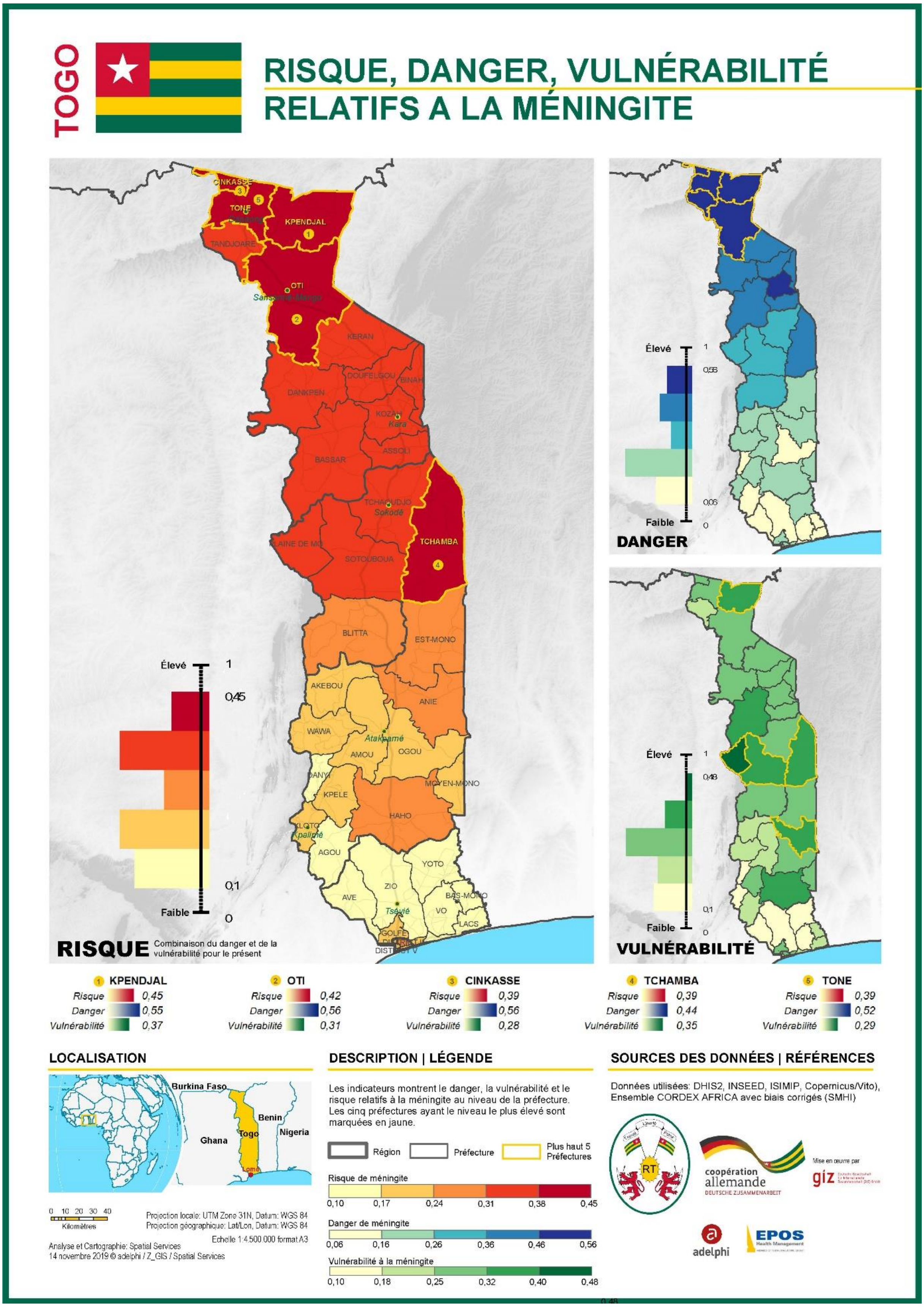

Figure 16: Map of Risk, Hazard and Vulnerability relating to Meningitis

PREF	REGION	Risk Index	Hazard Index	Vulnerability Index
KPENDJAL	SAVANES	0,45	0,55	0,37
OTI	SAVANES	0,42	0,56	0,31
CINKASSE	SAVANES	0,39	0,56	0,28
TCHAMBA	CENTRALE	0,39	0,44	0,35
TONE	SAVANES	0,39	0,52	0,29

Figure 17: Top 5 Meningitis-Risk Prefectures in Togo

The bar charts show the respective index values (see Annex 5 for more details).

While the hazard index again shows a clear north-south trend, the profile of socio-economic vulnerability is more diversified. Again, the southernmost prefectures – including Lomé – generally have the lowest vulnerability values. However, some medium and high levels of vulnerability can be observed in the southern regions – such as Haho, which ranks 6th among the most vulnerable prefectures. The highest vulnerability is again found in Plaine de Mô, followed by Kpendjal, Sotouboua, Tchamba and Anié. As for respiratory infections, the results for Plaine de Mô can be explained by a lack of access to health care, a lack of education and a relatively high number of children (in this case, under 10 years old). In Kpendjal, the high number of children and the lack of education are once again critical and contribute to the high vulnerability to meningitis.

For possible future scenarios (Figure 14), the same applies to meningitis as to respiratory infections: a slight increase in risk can be observed towards the southern prefectures. As mentioned above, the evolution of consecutive dry days leads to much greater changes towards the north, with longer dry days. The greatest increase can be observed up to 2031–2060 in both scenarios. For 2069–2098, it should be noted that scenario RCP 8.5 shows a decrease in drought for the southern part and only a slight increase in the north. As for respiratory infections, the trend in maximum temperatures is similar and continues across the country, with the greatest increase in the RCP 8.5 scenario towards the end of the century.

In general, the highest risk may be observed in the northern and central prefectures, influenced by both high values in the areas of hazards and socio-economic vulnerability. Climate change will add to this risk as it is expected to lead to increased droughts and high temperatures. The trends observed are therefore the same as for respiratory infections, which is not surprising because some of the indicators, especially for climate hazard, are the same.

In terms of **qualitative data**, meningitis is not perceived as a high risk by community residents, as past epidemics have so far been sporadic and not widespread. However, health personnel are very concerned about the low level of awareness among the population about the hazard, methods of transmission, symptoms and the need for treatment.

Moreover, the quantity of vaccine available is not sufficient for the entire population between the ages of 2 and 29 – the risk group defined by the WHO. In addition, in the event of an epidemic, people in the neighbouring communities cannot be vaccinated.

Even if vaccination campaigns are regularly conducted, there is concern that new germs from neighbouring countries could enter Togo and move southwards. For example, a new strain of meningitis – W 135 – emerged during the last outbreak in 2016 in the Kara region. This strain requires a trivalent (A, C and W) vaccine, which was not available (the currently available vaccines are the bivalent vaccines for group A and C strains).

Health staff at the peripheral level are very concerned about the situation because they lack technical skills and human resources for diagnosis. The fact that there is no laboratory at the PHU level leads to delays in germ identification.

4 Recommendations of Adaptation Measures

This chapter provides recommendations for adaptation measures based on the outcomes of the assessment, best practices from other countries with similar conditions, and a desk review of existing strategies and policies for Togo (see Section 1.2 for an institutional overview of the Togolese health sector). The options aim to

a) reduce the vulnerability of groups whose well-being is already at stake and who would likely be further threatened by climate change,
b) strengthen existing capacities; and
c) develop new skills and strategies to deal with climate change.

Adaptation measures are often formulated in a rather general and vague manner, such as ‘building the capacity of health facilities’ and ‘training health staff’. Staff and facilities, as well as ‘end users’ or beneficiaries – the most vulnerable groups and individuals – are thus often overlooked. Capacity building becomes an end in itself. To avoid this pitfall, the proposed measures focus on the most vulnerable groups and include

- activities that require little or no additional financial resources, as they can be easily integrated into ongoing activities (e.g. information and awareness raising);
- Measures that focus on materials, equipment and construction facilities.

Measures have been developed along two strategic focus areas. While the purpose of this report is to assess the three climate-sensitive diseases, the options proposed do not only cover these three risks; some are somewhat more general. In order to clearly distinguish the measures applicable specifically to the three target diseases from those relating more generally to climate change, the measures are presented in two tables below:

1) Options for the three diseases selected with geographical details (high-risk prefectures), and
2) Options for projected changes in weather events (extreme heat waves, prolonged dry seasons and heavy rainfall with high winds).

These two types of measures can be integrated into existing programmes or form a new programme. However, to ensure their success and sustainability, they must be adapted to the geophysical and socio-cultural context[8]. Although Togo is a small country, it comprises a variety of ethnic groups, each with their respective cultural norms and traditions.

4.1 Effects of Climate Change on the Most Vulnerable Groups

As explained in previous chapters, the assessment identified the most vulnerable groups through a consultative and participatory process with key stakeholders in the Togolese health sector. They are children, pregnant and nursing women, the elderly, the chronically ill people or disabled, and people working outdoors.

The people consulted during the field visits in the Maritime and Kara regions listed the same groups as those that are the most affected by health problems, and added ‘single mothers’.

These classifications are in line with the WHO categorisation (2015) below.

Table 4: The Most Vulnerable Groups to Climate Change

The most vulnerable groups	Climate-related vulnerability
Infants and children	Thermal stress, air pollution, water/food-borne diseases, vector-borne diseases, malnutrition

[8] A seasonal calendar as the example of the Kara region can serve as a basis for planning.

The most vulnerable groups	Climate-related vulnerability
Pregnant women	Thermal stress, extreme weather events, water/food-borne diseases, vector-borne diseases
Elderly people and chronically ill people	Thermal stress, air pollution, extreme weather events, water/food-borne diseases, vector-borne diseases
Poverty/socio-economic disadvantage	Thermal stress, air pollution, extreme weather events, water/food-borne diseases, vector-borne diseases
People working outdoors	Thermal stress, air pollution, vector-borne diseases, exposure to UV radiation

4.2 The Three Pillars of Adaptation of the Health Sector in Togo

It became already clear during the development of the impact chains and later during the field visits that certain elements were recurring and that commonalities were emerging between the different risks. While some of the prescribed measures are identical, in any case the majority of the measures can be grouped into three main areas. Health sector adaptation to climate change can therefore be streamlined through the following three pillars, targeting the key factors identified in the impact chains and field visits:

1) Increasing knowledge of risks and how to reduce or avoid them
2) improving access, geographical coverage and quality of health services
3) Improving buildings: climate resilient infrastructure in health facilities and communities

It should be noted that there is a fourth pillar, which includes policy and governance in the health sector and in the context of climate risk management and adaptation. This pillar is outside the scope of this assessment so it is not described in detail in this report. While the purpose of this assessment is to support policy and governance in the fight against health risks by identifying the main risk factors, it is not meant to provide an in-depth institutional analysis of the policy and governance context in Togo. Specific recommendations concerning this area are therefore not included in this report. It is, however, important to at least mention this issue of policy/governance, both in the management of health risks and in the context of adaptation to climate change. In this regard, the integration of health risk management and climate change adaptation as well as cooperation between different institutions in this field are essential prerequisites for the management of current and future climate risks in the health sector.

4.2.1 Information, Knowledge and Behaviour Change

The level of education and knowledge of the causes of health risks is a key factor in the vulnerability of an individual or group. Many practices that are harmful to health are based on habits, traditions or customs and not necessarily on lack of resources or poverty.

A key factor for appropriate behavioural change is the knowledge of facts. Access to the education system (and thus to literacy) is an essential element, but access to information that is understandable and relevant to the affected group is equally important. Awareness-raising activities, information campaigns and training for specific groups are key to behaviour change and thus adaptation. The content of the information, methods and tools to be conveyed should be adapted to the target group to ensure relevance and understanding in terms of the level of education, main occupation/activity, etc.

Comprehensive information and awareness campaigns on climate change and its impact on health are recommended for the following target groups:

- Rural Population

- Semi-urban and urban population
- Leading entrepreneurs (factory owners, etc.)
- Staff of health facilities (at all levels)
- Community Health Workers (CHWs)
- Teachers and students

Messages and information can be conveyed in the local languages of the region through radio, television, social media, posters, leaflets, drama, etc. The content of information campaigns should include:

- The main drivers of climate change at the local (wildfires, deforestation, etc.) and international levels;
- The trends and impact on life and livelihoods in Togo (especially for farmers, herders, small entrepreneurs, traders, workers, etc.);
- Opportunities to reduce environmental degradation at the household and individual levels in Togo (logging, charcoal use, fires, waste management, sewage system, etc.);
- Adaptation methods: improving hygiene at the household level (waste management, sanitation, maintenance of water sources, adequate storage of drinking water, etc.), storm and rain-resistant construction techniques, or climate-friendly farming methods (adaptation of farming techniques to new climatic trends) to ensure food security and a balanced diet, etc.

Specific training should be provided to Community Health Workers (CHWs) and health facilities staff at the operational level (see Figure 3 in Chapter 1.3). Training sessions can be integrated or added to initial, continuing or separate training.

4.2.2 Access to Appropriate Health Services and Geographical Coverage

During the field visits, the team noted a difference between the health facilities in the Maritime and Kara regions. However, this finding cannot be generalised, as there are also well-maintained and equipped structures in the north, especially where there is support from a programme. The field visits also revealed that while the supply of medicines was rated as satisfactory by staff in both regions, the physical condition and the equipment of the health facilities visited in the Kara region are inadequate and can sometimes pose a risk to those working therein and patients (see Pictures below).

Working conditions in the North are difficult not only because of the deplorable condition of some facilities, but also because of the much warmer weather conditions and the vast areas that have to be covered to reach the housing units. The settlement structure is scattered, and a village can cover several square kilometres with poor road infrastructure. Coupled with the obvious lack of health services in the north of the country, there is a high turnover of staff; posts remain vacant for long periods of time.

Self-medication is widespread in both urban and rural areas (see Chapter 1.5). Most of the medicines are supplied from neighbouring countries and Asia. These drugs are sold on the street and in households at affordable prices (see Picture). Unauthorised medicines are also sold, for example chloroquine for malaria.[9]

Picture 4: A street medicine vendor

However, local knowledge and traditions can also be useful and offer an untapped potential. People in the Kara region plant or burn certain plants that are said to protect against mosquitoes because of their scent (see Chapter 3.1).

Consultation with local traditional healers is still very frequent in the communities visited in the Kara region. There was a good level of cooperation among health staff for patient orientation and exchange of information on diseases and epidemics, which could serve as an example for regions where this is not the case.

[9] During a field visit, advertisements for chloroquine were found even in a health facility, although health workers know that this drug has become ineffective for the treatment of malaria.

Picture 5: Tricycle motorcycle in a health facility in the Maritime Region

Picture 6: Facilities in a health care centre in the Maritime region

Picture 7: Facilities in a health care centre in the Kara region

Picture 8: Beds in a health care unit in the Kara region

Access to and quality of health services for the most vulnerable groups could be improved through the following key interventions:

- Deploy/increase the number of health care staff in remote and vulnerable prefectures and consider professionalising the status of CHWs;
- Implement the mobility plan to ensure staff permanence in remote health care centres;
- Establish and implement a system of financial benefits for staff working in remote health facilities to ensure appropriate qualification, continuity, commitment and motivation of staff;
- Increase cooperation with traditional and local healers in identifying health risks in their respective localities, referral to health care centres and provision of medicines;
- Improve the surveillance and control systems proposed in existing national strategies, such as the *National Malaria Control Strategic Plan 2017–2022* (Ministry of Health 2018) and the *Strategic Plan for the Prevention and Control of Infection in Togo* (2020–2022).

4.2.3 Climate Resilient Health Facilities

Strong wind and rain endanger patients in some health facilities (see picture) as well as private homes. Heat waves can also cause serious problems, especially for the elderly, chronically ill people and pregnant women. These weather events can make working conditions very difficult in health facilities in some regions, and this in turn has a negative impact on staff performance and efficiency.

Picture 9: Damaged Ceiling of a PHU

Storm, rain and flood-resistant construction techniques have become a key element of climate change adaptation not only at the international level but also in Togo.[10] To cope with the heat, air conditioners are not an option in all cases in hospitals, especially in remote areas without electricity.

[10] Useful sources include UN Habitat and the Togolese Red Cross Society which, in cooperation with architects and civil engineers, have developed low-cost construction techniques based on locally available materials in different parts of the country.

The recommended activities are as follows:

- Rehabilitation and structural strengthening of health service buildings to withstand high winds, heavy rains and flooding so that they do not pose a risk to staff and patients;
- Use of SMART Hospital development techniques recommended by WHO (PAHO/WHO 2017).
- Installation or improvement of wastewater and waste management mechanisms in health care centres;
- Adequate electrification of health facilities to maintain the cold chain for medicines and vaccines, use alternative technologies such as solar panels, where appropriate;
- Construction or design of health care units with optimal air ventilation;
- Dissemination of storm-, rain- and heat-resistant housing techniques (such as white roofs) to rural populations through demonstrations and simple brochures;
- Improving the structures of school buildings, markets and other public infrastructure to prevent accidents in the event of high winds and heavy rain;
- Planting trees in the compounds of health facilities, schools and other public facilities to provide shade.

4.3 Adaptation Measures for Malaria, Respiratory Infections and Meningitis

Table 5: Adaptation Measures for Malaria, Respiratory Infections and Meningitis

Risk	Target Prefectures	Adaptation Measures for the Health Sector	
		At the Level of the Health Pyramid	at the Level of the Population
Malaria	Vo Lacs Moyen-Mono Kpélé Bas-Mono	Informing the staff and health workers about climate change and its impact on malaria Supplying LLINs taking into account the number of beds per household and storage Equipping peripheral health units with tricycle motorcycles for better coverage of remote and inaccessible areas Improving the conditions of health facilities to ensure a continuum of care for severe cases, so that patients can stay until the end of their treatment (drinking water, waste management, sanitary facilities, etc.). Controlling the sale of unauthorised drugs (such as chloroquine) Providing quality nets of different sizes and quality at all times in local markets and pharmacies so that people can choose quality and size without having to wait for distribution. Promoting the sale of mosquito repellents in local markets and pharmacies at an affordable price (possibly subsidised by the government)	Providing information on climate change and its impact on malaria Providing information and organising awareness campaigns on: - the proper use of mosquito nets; - the use of health facilities for testing and appropriate treatment of malaria; - Continuing the treatment as recommended by the health worker; - the discontinuation of self-medication or the use of unauthorised drugs (such as chloroquine); - the traditional use of mosquito repelling plants; - prevention of mosquito bites: clothing, peak hours and mosquito habitats Promoting environmental health through the destruction of mosquito breeding sites (stagnant water, sewers, etc.). Maintaining the universal distribution of LLINs in mass campaigns and routine household campaigns. Extending the SMC (Seasonal Malaria Chemo Prevention) to children aged five to ten years old. Spraying in markets and other public facilities Disseminating information on the availability and use of mosquito repellents

Risk	Target Prefectures	Adaptation Measures for the Health Sector	
		At the Level of the Health Pyramid	at the Level of the Population
Respiratory conditions/ **Infections**	Oti Kpendjal Tandjoaré Doufelgou Tône	Integrating adaptation measures programmes into health at all levels of the health pyramid (central, regional and prefecture) Strengthening the skills of the health staff in training and education on climate change, on the risks of air pollution and on appropriate protective measures (avoid walking nearby fires and burning garbage, keep children away from smoke, cover the mouth and nose in high-pollution areas, etc.). Equipping existing health facilities with medicines and Personal Protective Equipment (masks, disposable gloves, eye protection, gowns, etc.). Strengthening of health facilities with human resources Arranging wards in health facilities to ensure that they are airy and well ventilated (wide windows, fans, etc.)	Information campaigns on radio, television, social networks, etc. to draw the public's attention to days with high air pollution/peak pollution levels, combustion-related risks, as well as to appropriate protective measures, early warning and monitoring. Promoting improved cooking stoves for the reduction of carbon dioxide contributing to respiratory infections Information campaign on the adverse effects of the burning of household waste and residues, especially plastics Information campaign on personal hygiene and basic infection control measures (use of soap, etc.) targeting families with children in particular to prevent the spread of viruses and bacteria.
Meningitis	Kpendjal Oti Cinkassé Tchamba Tône	Strengthening the skills and increasing the number of staff to deal with health emergencies due to climate change and its impact on the spread of meningitis. Equipping peripheral health units with tricycle motorcycles for a better coverage of remote and inaccessible areas. Extending vaccination campaigns, to include the pastoralist population Improving the technical platform (equipment) and equipping PHUs laboratories to facilitate the identification of germs at the local level. Strengthening the cross-border epidemiological surveillance systems and reinforcing the exchange of information between Togo, Benin, Burkina Faso and Ghana for epidemiological early warning and a coordinated and effective response, using ICT	Informing communities about climate change and its impact on the spread of meningitis Information campaigns on modes of transmission, symptoms and health consequences, as well as possible treatment options Demonstrating and disseminating hygiene measures at the household level Disseminating early warning notifications on meningitis epidemics and the actions to be taken at the individual level Promoting the vaccination of vulnerable populations (people under 10 years of age, etc.)

Risk	Target Prefectures	Adaptation Measures for the Health Sector	
		At the Level of the Health Pyramid	at the Level of the Population
		(technology and tools for early warning by mobile phone and e-mail, possibly quarterly meetings of key health staff). Improving the availability of drugs and inputs for case management, especially in peripheral health units Improving the hygienic conditions of health facilities: drinking water, waste management, sanitary facilities Electrification of health facilities to maintain the cold chain for medicines and vaccines Improving the early warning system for epidemics	

4.4 Adaptation Measures to curb the Impact of Weather Events on Health

The table below shows changes in expected weather events, their impact on human health and corresponding adaptation measures.

Table 6: Impact of Weather Events and Adaptation Measures

Weather events/Signal	Potential Impact on Health	Multi-sectoral Adaptation Measures	Adaptation Measures for the Health Sector	
			At the level of the health pyramid	At the level of the population
Extreme Heat waves	Heatstroke, cardiovascular/circulatory collapse, dehydration, kidney infections Deficit of performance/ability to work, reduced capacity to support livelihoods, food insecurity	Protecting existing trees and reforestation for the creation of shaded areas Propagating and demonstrating heat-resistant/heat-resilient construction techniques based on locally available materials (e.g., white roofs) Improving and extending the early warning system	Information on future temperature rise and health impacts Protection and reforestation around the facilities to create shaded areas Improving the conditions of health facilities: air ventilation systems, drinking water, waste management, sanitary facilities, etc. Electrification of health facilities to maintain the cold chain for medicines and vaccines, with the possibility of night-time patient care. Providing tricycle motorcycles to peripheral health units for a better coverage of remote and inaccessible areas Improving the early warning system	Information on future temperature rise and health impacts Promoting the protection of existing trees and reforestation for the creation of shaded areas Information on the fluid needs of the human body Disseminating information on the need to avoid direct sunlight during peak hours Promoting the use of light cotton clothing Promoting personal/body hygiene Disseminating early warning notifications about heat waves and precautionary measures, especially for the most vulnerable groups
Prolonged Dry Seasons	Lack of balanced diet and food insecurity Lack of drinking water and strenuous walks to the wells	Promoting and introducing resilient/adapted crops and agricultural techniques Building improved wells for drinking water supply	Providing information on prolonged dry seasons and their impact on health Improving hygienic conditions in health facilities:	Providing information on prolonged dry seasons and their impact on health; Providing information on balanced diet; Demonstrating water storage and treatment techniques;

Weather events/Signal	Potential Impact on Health	Multi-sectoral Adaptation Measures	Adaptation Measures for the Health Sector	
			At the level of the health pyramid	At the level of the population
	Increase in diarrhoeal diseases and skin infections due to water scarcity	Improving and extending the early warning system	• Providing drinking water to health facilities, • Building incinerators for waste management, • Appropriate sanitary facilities Electrification of health facilities to maintain the cold chain for medicines and vaccines Dissemination of seasonal forecasts (early warning notifications)	Improving the positioning of drinking water supply points. Disseminating seasonal forecasts (early warning notifications) and adaptation measures (nutrition, agriculture, water management, etc.).
Heavy rains and storms	Stagnant waters and an increase in related diseases (diarrhoea, skin infections, malaria, etc.); Food insecurity caused by the destruction of food stocks and crops Damage to homes and absorption of family capital for reconstruction, which would otherwise be used for health care and food Destruction of access roads to health facilities Bodily injuries: trauma and injuries caused by the collapse of houses and	Demonstrating and propagating drainage systems Improving the drinking water supply system Implementing waste collection measures by the competent departments Demonstrating and disseminating resilient construction techniques using locally available materials Propagating or introducing adapted crops and agricultural techniques	Providing information on the increase and intensification of rainfall and storms in the future Equipping peripheral health structures with tricycle motorcycles for a better coverage of remote and inaccessible areas Increasing and improving mobile clinic staff and equipment Training and demonstration of first aid techniques to CHWs Regular inspection of health facilities for potential damage during rains and storms (premises, roofing, surrounding trees, etc.). Upgrading the buildings of health care facilities to prevent infiltration and collapse	Information on the increase and intensity of rainfall and storms in the future Demonstrating and disseminating hygiene precautions Demonstrating water treatment/chlorination techniques for drinking water purification, information and awareness of the population on the use of the technology Demonstrating the cleaning of wells and latrines Demonstration and training on first aid techniques to key members of the community (teachers, traditional healers, village chiefs, etc.). Establishing waste collection, evacuation and treatment systems

Weather events/Signal	Potential Impact on Health	Multi-sectoral Adaptation Measures	Adaptation Measures for the Health Sector	
			At the level of the health pyramid	At the level of the population
	buildings including falling trees and branches.	Improving and adequately maintaining access roads to health facilities Improving and extending the early warning system.	Improving the hygienic conditions of health care facilities regarding drinking water, waste management and sanitary facilities. Improvement of the equipment of Peripheral Health Care Units (PHUs) (laboratories, beds, sterilisation equipment, etc.). Electrification of health facilities to maintain the cold chain for medicines and vaccines Equipping PHUs with adequate equipment for the treatment of injuries Improving the early warning systems.	Building sewage channels, cleaning of drainage pipes before and after a rainy period to facilitate the outflow of wastewater. Disseminating early warning notifications and precautionary measures.

5 Conclusions and Courses of Action

The findings of the assessment confirm that climate change will have an impact on the welfare of the Togolese population, not only with respect to the three main health risks assessed, but also due to extreme weather events.

With regard to malaria, the situation will probably remain the same in the future, but the length of the transmission period could be reduced. In the case of respiratory infections and meningitis, there will probably be an increase in the risk, due to an increase in consecutive dry days, especially in the north. A general increase in maximum temperature will also contribute to this trend. This trend will be amplified especially in the north by the end of the century, according to the RCP 8.5 scenario.

A study of the Ministry of Environment and Forest Resources published in 2015 (MERF 2015 b) has already highlighted the effects of climate change on the proliferation of vector-borne, waterborne and infectious diseases. Another important finding of this report is that groups that are already considered vulnerable are likely to be even more so if immediate action is not taken.

Beyond the indications it provides through its findings, the added value of this assessment is that it confirms the main challenges identified in similar assessments. At least, there is no major contradiction with other studies. On the other hand, this assessment has revealed a number of additional elements:

1) The Policy Aspect of Data:

- There is still a strong need to build national capacity regarding the sharing and management of climate change data and knowledge across ministries.
- An integrated vision of climate risk – integrating climate and environmental issues as well as socio-economic and disease-specific factors – has emerged as a key consideration, but it requires openness and interdisciplinary collaboration.
- Data sharing has been successful, but it is time-consuming and is slowed down by bureaucracy. In addition, data quality problems in large databases (DHIS2), gaps and bottlenecks have been identified (see Table of missing data).
- The user of the report is also encouraged to use the information and results with the benefit of hindsight, i.e., to be able to discern relevant insights, while taking into account methodological uncertainties, data availability and the comprehensiveness of the approach.

2) The Content:

- The assessment used the new understanding of risk, in accordance with the AR5 concept. This has never been done before in Togo.
- In addition, the report integrated the quantitative and qualitative assessment approaches together, which is not the case in other assessments.
- It has established a good framework of quantitative indicators given the situation in an environment where data are scarce.
- It used the most recent climate projections for the region (CORDEX ensemble) and included a malaria-specific climate indicator (LTS).
- It revealed the uncertainty of future scenarios, especially since data on most vulnerability factors are not available. This is not specific to Togo, but a general challenge. It was therefore decided not to model future climate risk indices, even if trends could be identified.
- For the three diseases, an in-depth quantitative assessment was carried out, particularly for current conditions. This level of detail is new for Togo. In particular, this assessment can serve as a starting point for more in-depth assessments at indicator level. With the available results, it is possible to design (and monitor) adaptation options for each prefecture individually (see Bar Graphs). Hotspot maps provide information and 'key' areas to target.

Significant financial and human resources have already been invested in studies to assess the impact of climate change on certain sectors. This assessment helped to increase knowledge through the application of an integrated approach to risk, combining environmental, human and socio-economic factors. Ideally, this should facilitate the targeted identification of adaptation measures, i.e., what needs to be done, where and when, taking into account local needs and the socio-cultural context.

The climate risk assessment for the health sector in Togo is based on the methodology of the *Sourcebook* (GIZ 2014), which has been enriched by the adoption of qualitative methods – an addition that proved relevant to the assessment. It is therefore recommended that this experience be repeated in the future when quantitative and qualitative approaches are mutually informative.

Despite the difficulties experienced in accessing and acquiring data from national institutions, the indicator framework that has been developed is relatively robust compared to similar studies in this context. However, it should be recalled that such a quantitative assessment is only an approximation of the reality – like any modelling exercise. In the context of this study, quantitative modelling is even more complex, due to the multidimensional nature of health and climate risks, integrating societal, biological and environmental factors, where linkages and relationships are not always obvious. This needs to be taken into account when interpreting and using the results. Therefore, the integration of local, national and international expertise throughout the process is an important prerequisite for the validity and legitimacy of the results. This is particularly relevant for the development of impact chains, as they aim to integrate local conditions and current scientific knowledge.

Possible future actions could include: (i) monitoring and evaluating adaptation measures through updated risk assessment in a few years (3–5 years); (ii) taking steps to improve the quality of national datasets; (iii) further developing approaches to link quantitative and qualitative assessment methods; and (iv) considering the integration of dynamic disease-specific models (e.g., models for malaria).

All things considered, the outcomes of this assessment reinforce or complete the knowledge on the impact of climate change on health that already exists and is accessible in Togo (MERF 2015 b). Indeed, this knowledge is already being exploited and coordination mechanisms have been put in place to integrate interventions into strategic documents and sectoral policies (see Chapter 1). Despite efforts, there is still a long way to go in terms of implementation.

Adaptation measures to improve the health of the population are of paramount importance for Togo's economic development, particularly to prevent poverty from increasing and the workforce from leaving the country or region.

A series of adaptation measures have therefore been suggested in this report, designed to serve as a basis for the next steps. They include a multi-sectoral assessment of the physical condition, logistical, material and human capacities of health facilities, particularly at the peripheral level, in the prefectures that have been identified areas at risk. Based on a list of priority facilities and measures, financial support[11] should then be solicited. In addition, efforts must be made in the area of policy and governance, both in the management of health risks and in the context of adaptation to climate change, by adopting an integrated approach and encouraging cooperation between the various institutions.

As a matter of fact, health officials need to increase their efforts, particularly at the national level, to ensure coordination with other sectors and to guarantee the mainstreaming of health adaptation measures into respective policies. Stronger advocacy is needed to make it clear that the health of the Togolese people is an essential condition precedent for the country's development. In this regard, the dissemination of the results at central and regional level, by the target groups and according to the guidelines developed during the validation workshop in November 2019), will be of paramount importance.

Communication materials (posters, flyers, etc.) may be produced with target groups to be used in health centres. Also, the translation of this assessment into English should be considered, in order to share the results in international networks, with GIZ headquarters and key partners. In addition, the outcomes of the assessment can be integrated into the content of the training on the nexus between climate change and health dedicated to decision makers of the Ministry of Health and based on a WHO and GIZ training manual.

[11] In this regard, the following guide may be useful: the World Health Organisation (WHO) 2013: Climate Change and health: A tool to estimate health and adaptation costs. This tool is used to estimate the cost associated with climate change action, i.e., adaptation measures in the health sector, as well as in other related sectors. It is a practical guide describing all the steps required for this purpose.

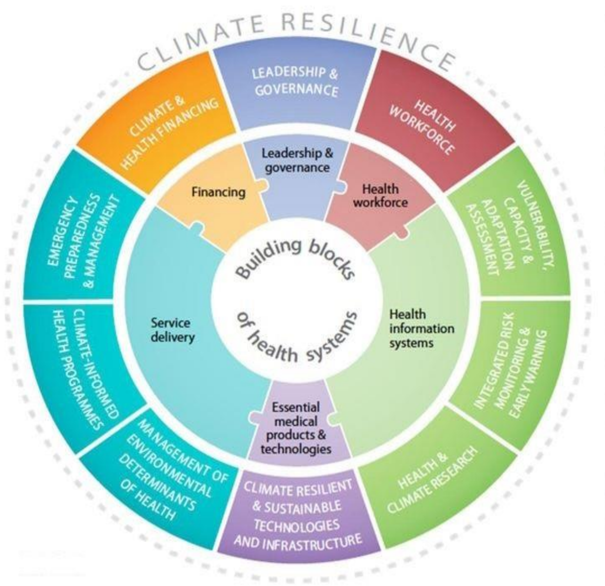

Figure 18: Key Elements of the WHO Operational Framework for Building Climate Resilient Health Systems

Adaptation is ultimately about building resilience. To this end, a strategy for the adaptation of the health sector to climate change needs to be developed based on WHO guidelines, and particularly the *WHO Guidance to protect health from climate change through health adaptation planning* (WHO 2015 a) or the *Operational framework for building climate-resilient health systems*, can serve as a basis for developing such a strategy.

It was developed by WHO (2016) to guide this quest for resilience. The framework provides guidance for public health professionals to systematically and effectively plan and implement interventions for a 'climate-resilient health system' to climate change. It also serves to guide actions in health-determining sectors (such as water and sanitation, food, nutrition, agriculture, energy, urban planning, etc.) to better understand and prepare for climate-related health risks.

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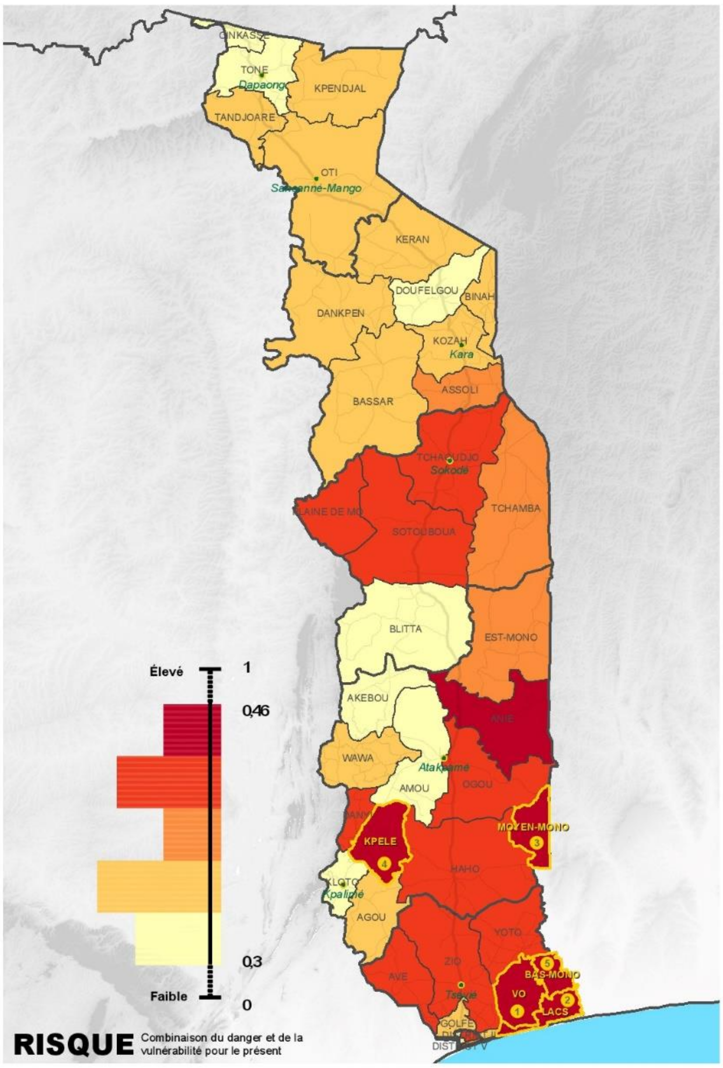
7 Annexes

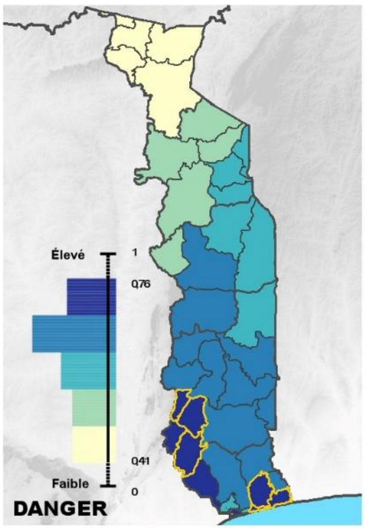
7.1 Annex 1: Maps

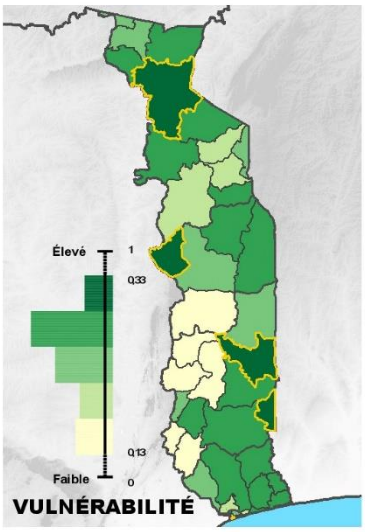
7.1.1 Maps of Climate Risks for Malaria, Respiratory Infections and Meningitis

TOGO

RISQUE, DANGER, VULNÉRABILITÉ RELATIFS AU PALUDISME







1 VO		2 LACS		3 MOYEN-MONO		4 KPELE		5 BAS-MONO	
Risque	*0,46*	*Risque*	*0,46*	*Risque*	*0,46*	*Risque*	*0,44*	*Risque*	*0,43*
Danger	*0,76*	*Danger*	*0,75*	*Danger*	*0,64*	*Danger*	*0,75*	*Danger*	*0,68*
Vulnérabilité	*0,28*	*Vulnérabilité*	*0,28*	*Vulnérabilité*	*0,33*	*Vulnérabilité*	*0,26*	*Vulnérabilité*	*0,28*

LOCALISATION

0 10 20 30 40
Kilomètres

Projection locale: UTM Zone 31N, Datum: WGS 84
Projection géographique: Lat/Lon, Datum: WGS 84
Echelle 1:4.500.000 format A3

Analyse et Cartographie: Spatial Services
14 novembre 2019 © adelphi / Z_GIS / Spatial Services

DESCRIPTION | LÉGENDE

Les indicateurs montrent le danger, la vulnérabilité et le risque relatifs au paludisme au niveau de la préfecture. Les cinq préfectures ayant le niveau le plus élevé sont marquées en jaune.

Région — Préfecture — Plus haut 5 Préfectures

Risque de paludisme
0,30 — 0,33 — 0,36 — 0,39 — 0,43 — 0,46

Danger de paludisme
0,41 — 0,48 — 0,55 — 0,62 — 0,69 — 0,76

Vulnérabilité au paludisme
0,13 — 0,17 — 0,21 — 0,25 — 0,29 — 0,33

SOURCES DES DONNÉES | RÉFÉRENCES

Données utilisées: DHIS2, INSEED, ISIMIP, Copernicus/Vito), Ensemble CORDEX AFRICA avec biais corrigés (SMHI)

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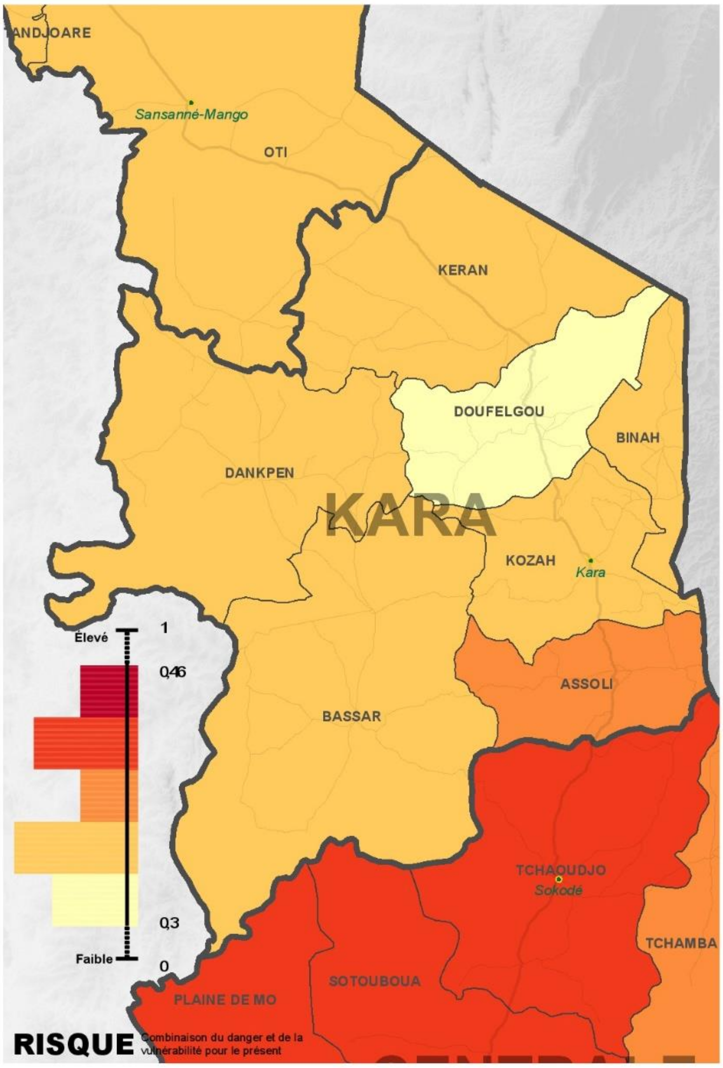
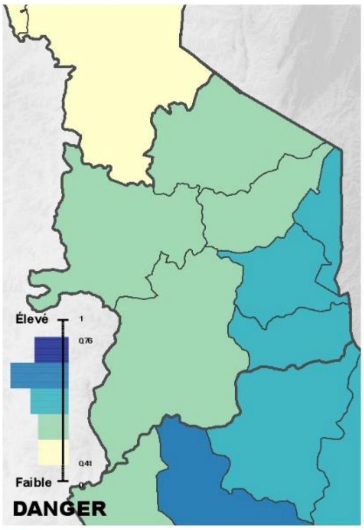
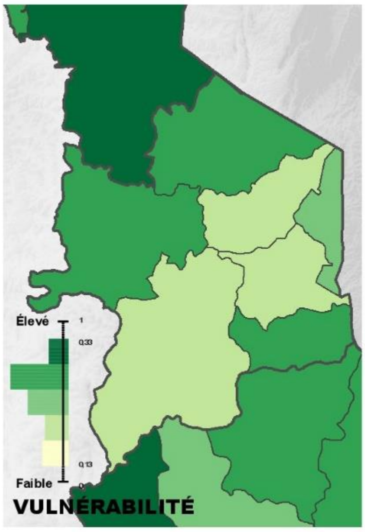
RISQUE, DANGER, VULNÉRABILITÉ RELATIFS AU PALUDISME



RISQUE Combinaison du danger et de la vulnérabilité pour le présent



DANGER



VULNÉRABILITÉ

	ASSOLI	BASSAR	BINAH	DANKPEN	DOUFELGOU	KERAN	KOZAH
Risque	0,38	0,33	0,36	0,35	0,31	0,36	0,33
Aléa	0,57	0,53	0,57	0,48	0,53	0,40	0,55
Vulnérabilité	0,25	0,21	0,22	0,26	0,19	0,26	0,20

LOCALISATION

0 5,5 11 16,5 22
Kilomètres

Projection locale: UTM Zone 31N, Datum: WGS 84
Projection géographique: Lat/Lon, Datum: WGS 84
Echelle 1:4.500.000 format A3

Analyse et Cartographie: Spatial Services
14 novembre 2019 © adelphi / Z_GIS / Spatial Services

DESCRIPTION | LÉGENDE

Les indicateurs montrent le danger, la vulnérabilité et le risque relatifs au paludisme au niveau de la préfecture. Les cinq préfectures ayant le niveau le plus élevé sont marquées en jaune.

Région — Préfecture

Risque de paludisme: 0,30 · 0,33 · 0,36 · 0,39 · 0,43 · 0,46

Danger de paludisme: 0,41 · 0,48 · 0,55 · 0,62 · 0,69 · 0,76

Vulnérabilité au paludisme: 0,13 · 0,17 · 0,21 · 0,25 · 0,29 · 0,33

SOURCES DES DONNÉES | RÉFÉRENCES

Données utilisées: DHIS2, INSEED, ISIMIP, Copernicus/Vito), Ensemble CORDEX AFRICA avec biais corrigés (SMHI)

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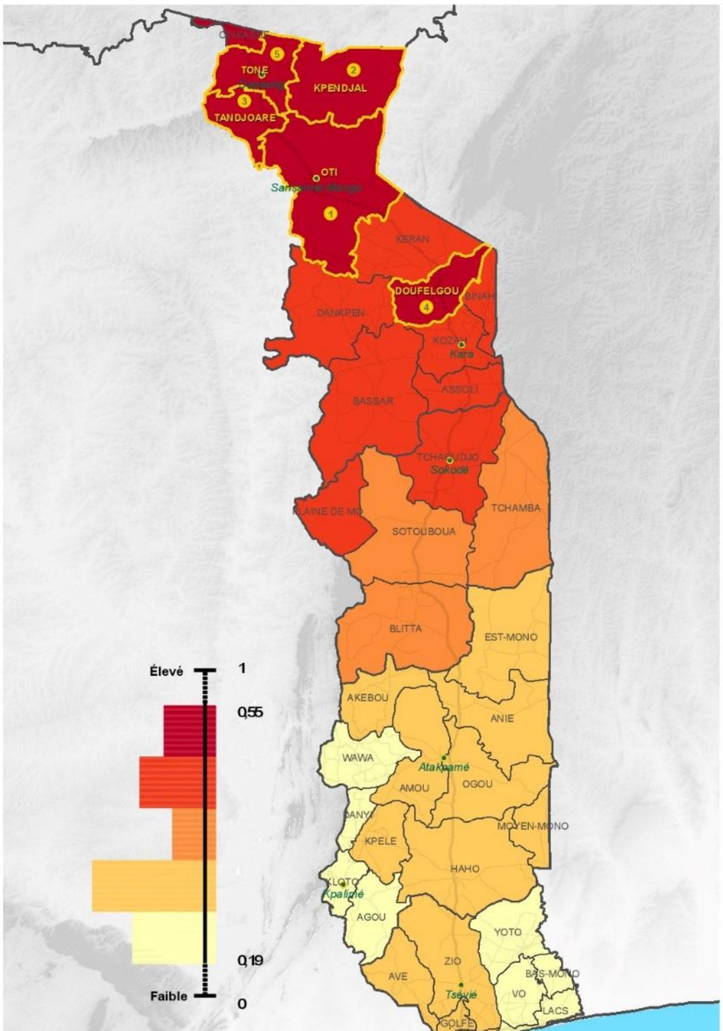
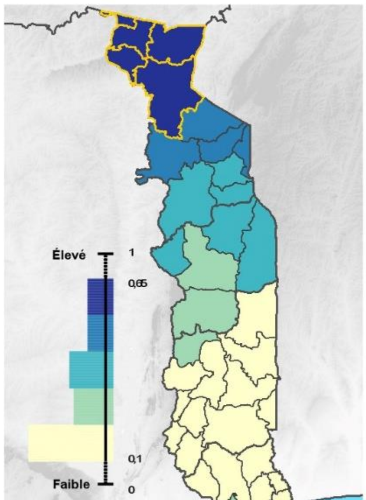
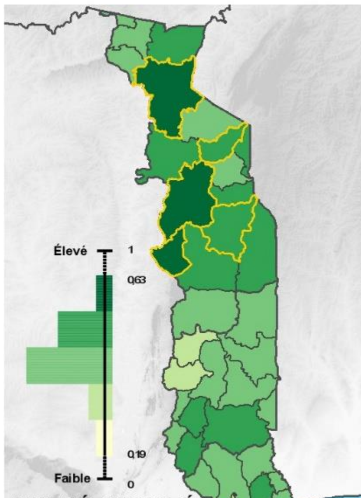
RISQUE, DANGER, VULNÉRABILITÉ RELATIFS AUX INFECTIONS RESPIRATOIRES



RISQUE Combinaison du danger et de la vulnérabilité pour le présent



DANGER



VULNÉRABILITÉ

	1 OTI	2 KPENDJAL	3 TANDJOARE	4 DOUFELGOU	5 TONE
Risque	0,55	0,55	0,53	0,51	0,50
Danger	0,56	0,61	0,65	0,49	0,60
Vulnérabilité	0,55	0,50	0,43	0,53	0,41

LOCALISATION

0 10 20 30 40
Kilomètres

Projection locale: UTM Zone 31N, Datum: WGS 84
Projection géographique: Lat/Lon, Datum: WGS 84
Echelle 1:4.500.000 format A3

Analyse et Cartographie: Spatial Services
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DESCRIPTION | LÉGENDE

Les indicateurs montrent le danger, la vulnérabilité et le risque relatifs aux infections respiratoires au niveau de la préfecture. Les cinq préfectures ayant le niveau le plus élevé sont marquées en jaune.

Région — Préfecture — Plus haut 5 Préfectures

Risque d'infection respiratoire: 0,19 — 0,27 — 0,34 — 0,41 — 0,48 — 0,55

Danger d'infection respiratoire: 0,10 — 0,21 — 0,32 — 0,43 — 0,54 — 0,65

Vulnérabilité aux infections respiratoires: 0,19 — 0,28 — 0,37 — 0,45 — 0,54 — 0,63

SOURCES DES DONNÉES | RÉFÉRENCES

Données utilisées: DHIS2, INSEED, ISIMIP, Copernicus/Vito), Ensemble CORDEX AFRICA avec biais corrigés (SMHI)

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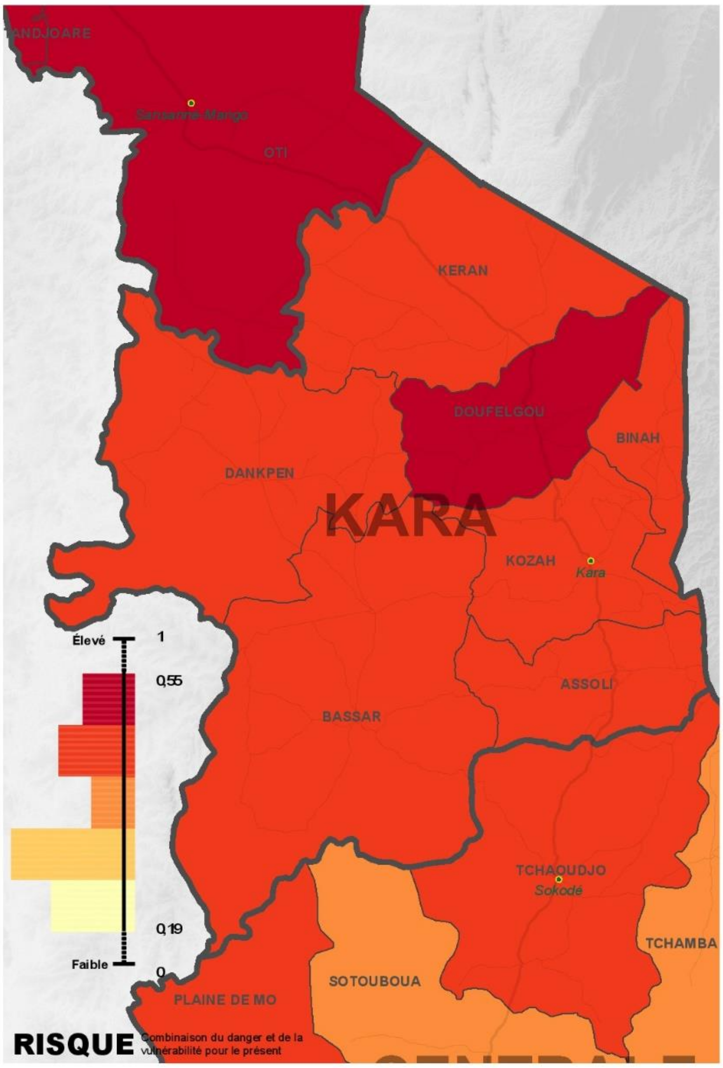
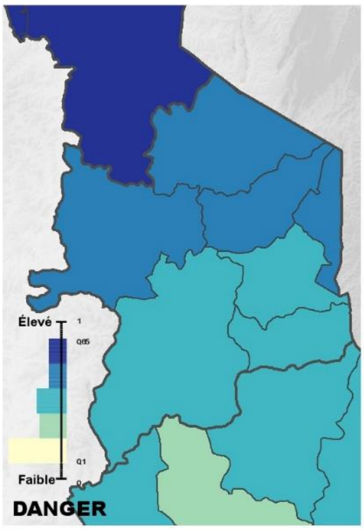
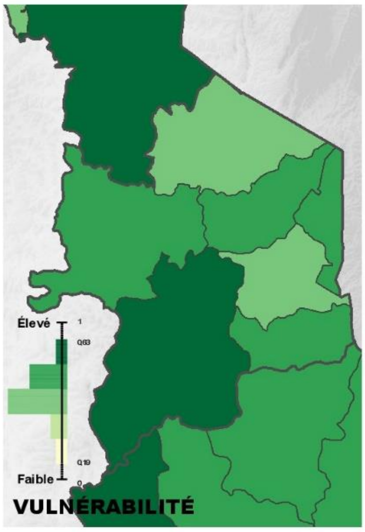
RISQUE, DANGER, VULNÉRABILITÉ
RELATIFS AUX INFECTIONS RESPIRATOIRES







	ASSOLI	BASSAR	BINAH	DANKPEN	DOUFELGOU	KERAN	KOZAH
Risque	0,45	0,46	0,46	0,47	0,51	0,44	0,43
Aléa	0,40	0,39	0,44	0,43	0,48	0,45	0,42
Vulnérabilité	0,50	0,55	0,47	0,51	0,53	0,44	0,44

LOCALISATION

0 5,5 11 16,5 22
Kilomètres

Projection locale: UTM Zone 31N, Datum: WGS 84
Projection géographique: Lat/Lon, Datum: WGS 84
Echelle 1:4.500.000 format A3

Analyse et Cartographie: Spatial Services
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DESCRIPTION | LÉGENDE

Les indicateurs montrent le danger, la vulnérabilité et le risque relatifs aux infections respiratoires au niveau de la préfecture. Les cinq préfectures ayant le niveau le plus élevé sont marquées en jaune.

Région   Préfecture

Risque d'infection respiratoire
0,19 0,27 0,34 0,41 0,48 0,55

Danger d'infection respiratoire
0,10 0,21 0,32 0,43 0,54 0,65

Vulnérabilité aux infections respiratoires
0,19 0,28 0,37 0,45 0,54 0,63

SOURCES DES DONNÉES | RÉFÉRENCES

Données utilisées: DHIS2, INSEED, ISIMIP, Copernicus/Vito), Ensemble CORDEX AFRICA avec biais corrigés (SMHI)

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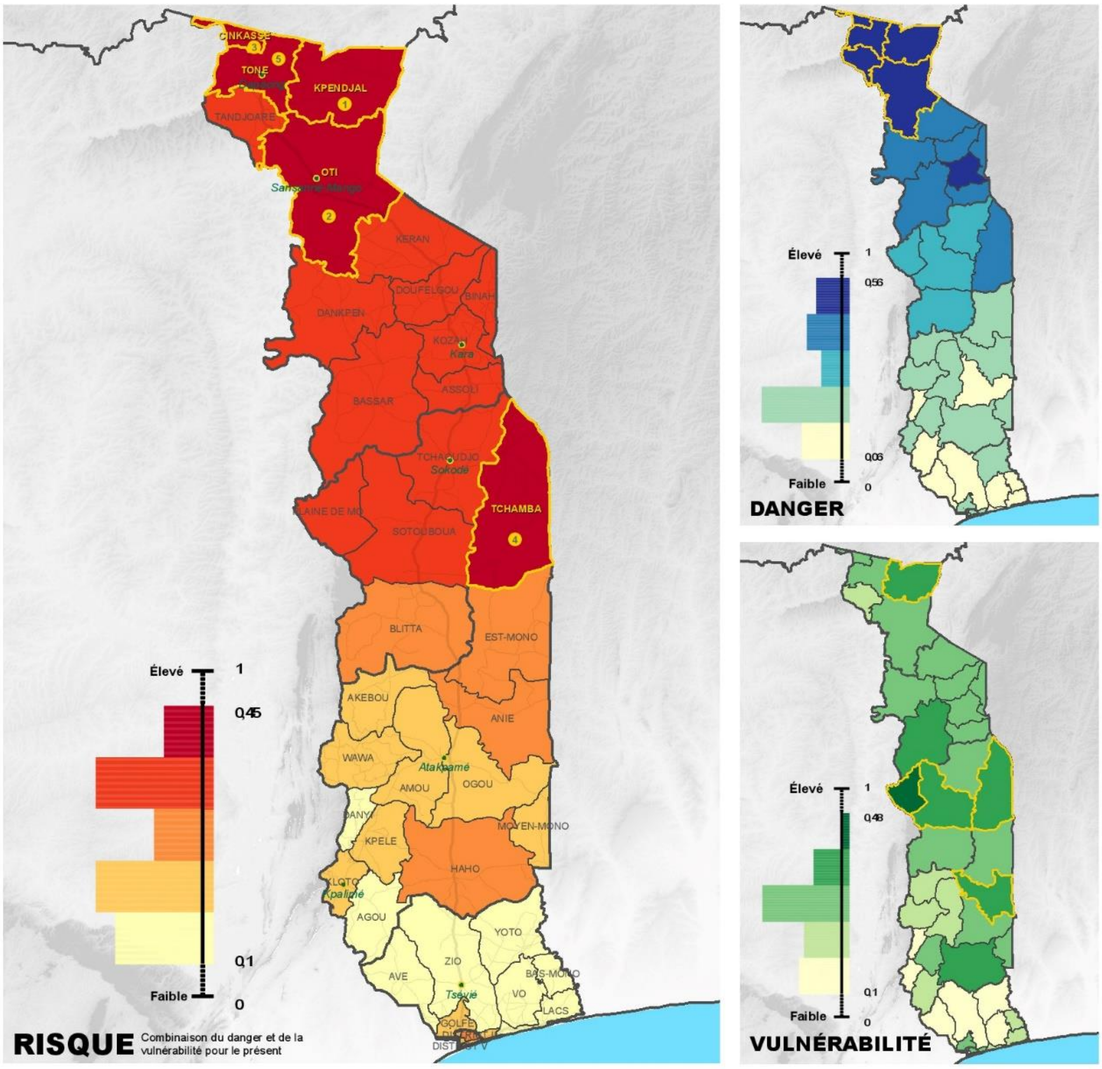
RISQUE, DANGER, VULNÉRABILITÉ RELATIFS A LA MÉNINGITE



	Risque	Danger	Vulnérabilité
1 KPENDJAL	0,45	0,55	0,37
2 OTI	0,42	0,56	0,31
3 CINKASSE	0,39	0,56	0,28
4 TCHAMBA	0,39	0,44	0,35
5 TONE	0,39	0,52	0,29

LOCALISATION

0 10 20 30 40
Kilomètres

Projection locale: UTM Zone 31N, Datum: WGS 84
Projection géographique: Lat/Lon, Datum: WGS 84
Echelle 1:4.500.000 format A3

Analyse et Cartographie: Spatial Services
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DESCRIPTION | LÉGENDE

Les indicateurs montrent le danger, la vulnérabilité et le risque relatifs à la méningite au niveau de la préfecture. Les cinq préfectures ayant le niveau le plus élevé sont marquées en jaune.

Région | Préfecture | Plus haut 5 Préfectures

Risque de méningite
0,10 | 0,17 | 0,24 | 0,31 | 0,38 | 0,45

Danger de méningite
0,06 | 0,16 | 0,26 | 0,36 | 0,46 | 0,56

Vulnérabilité à la méningite
0,10 | 0,18 | 0,25 | 0,32 | 0,40 | 0,48

SOURCES DES DONNÉES | RÉFÉRENCES

Données utilisées: DHIS2, INSEED, ISIMIP, Copernicus/Vito), Ensemble CORDEX AFRICA avec biais corrigés (SMHI)

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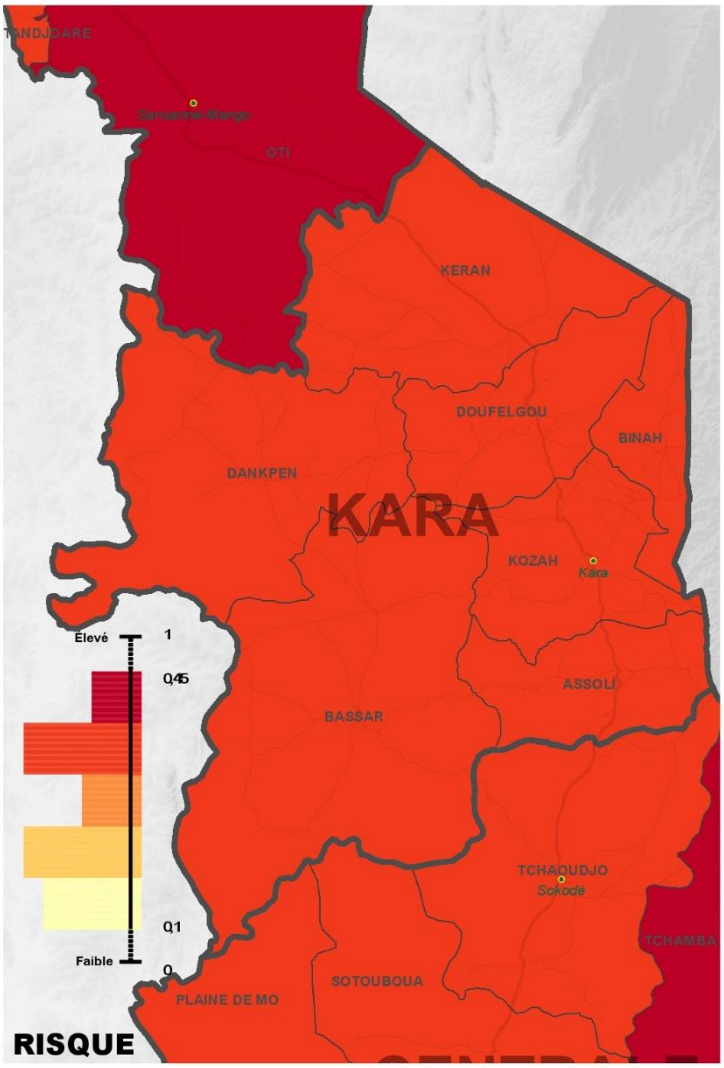
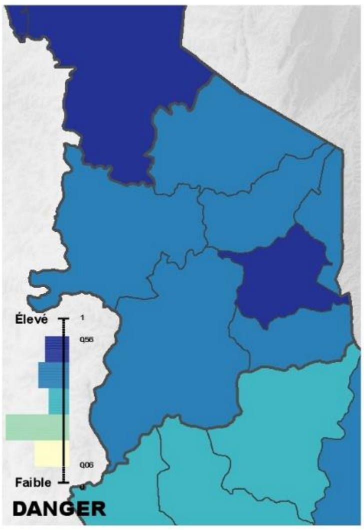
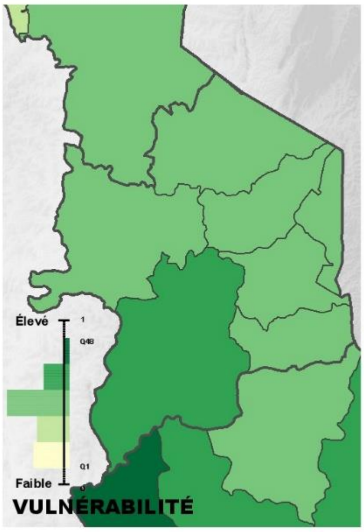
RISQUE, DANGER, VULNÉRABILITÉ RELATIFS A LA MÉNINGITE







	ASSOLI	BASSAR	BINAH	DANKPEN	DOUFELGOU	KERAN	KOZAH
Risque	0,37	0,37	0,35	0,33	0,34	0,33	0,37
Aléa	0,46	0,42	0,44	0,37	0,43	0,42	0,49
Vulnérabilité	0,31	0,33	0,28	0,30	0,26	0,26	0,27

LOCALISATION

0 5,5 11 16,5 22
Kilomètres

Projection locale: UTM Zone 31N, Datum: WGS 84
Projection géographique: Lat/Lon, Datum: WGS 84
Echelle 1:4.500.000 format A3

Analyse et Cartographie: Spatial Services
14 novembre 2019 © adelphi / Z_GIS / Spatial Services

DESCRIPTION | LÉGENDE

Les indicateurs montrent le danger, la vulnérabilité et le risque relatifs à la méningite au niveau de la préfecture. Les cinq préfectures ayant le niveau le plus élevé sont marquées en jaune.

Région | Préfecture | Plus haut 5 Préfectures

Risque de méningite: 0,10 – 0,17 – 0,24 – 0,31 – 0,38 – 0,45

Danger de méningite: 0,06 – 0,16 – 0,26 – 0,36 – 0,46 – 0,56

Vulnérabilité à la méningite: 0,10 – 0,18 – 0,25 – 0,32 – 0,40 – 0,48

SOURCES DES DONNÉES | RÉFÉRENCES

Données utilisées: DHIS2, INSEED, ISIMIP, Copernicus/Vito), Ensemble CORDEX AFRICA avec biais corrigés (SMHI)

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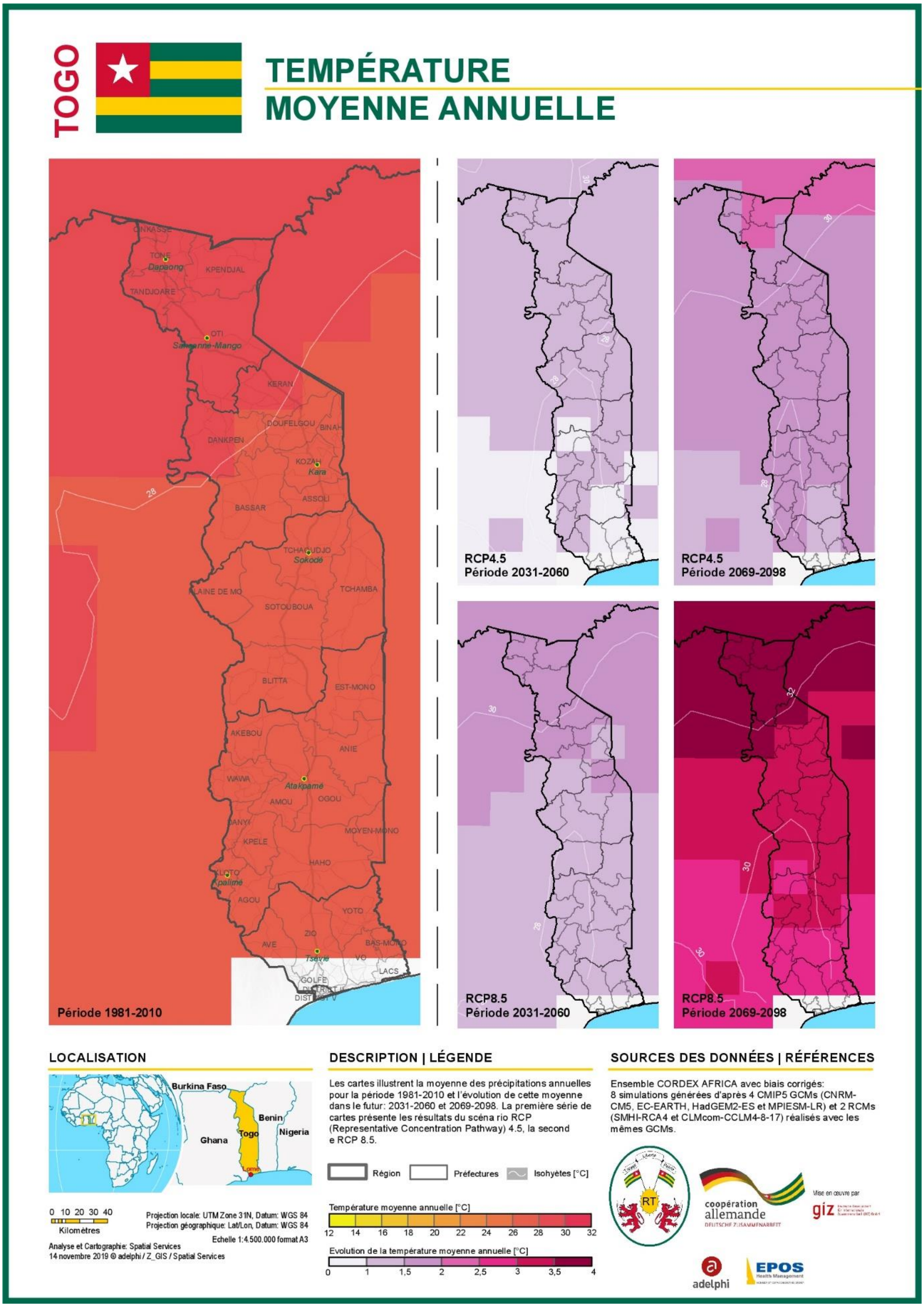
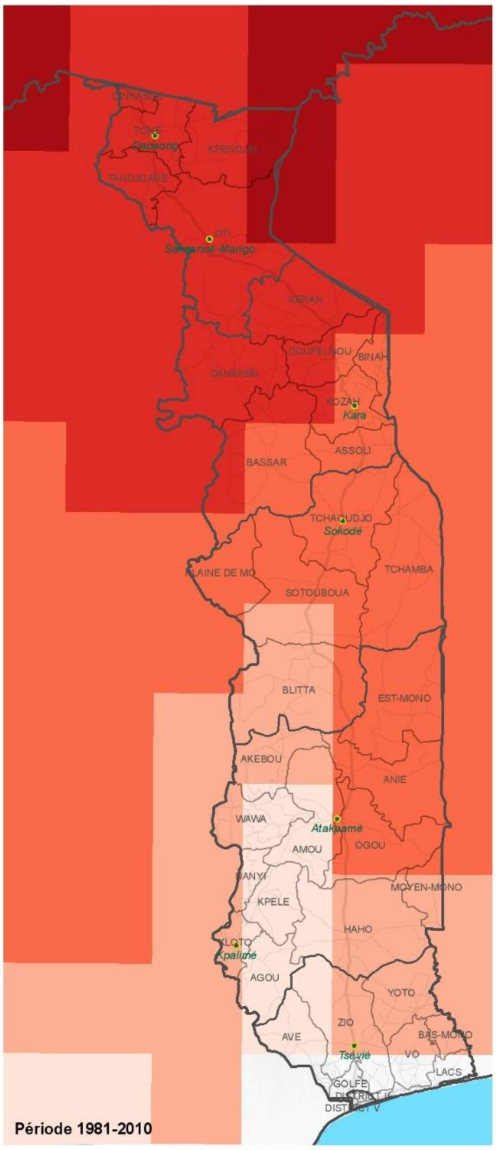
0,48

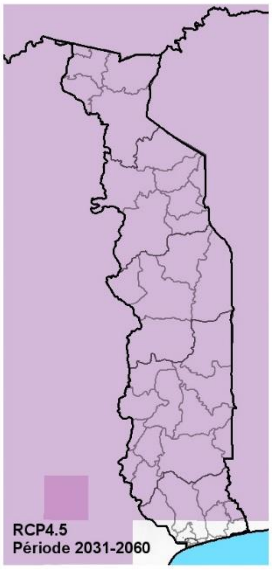
7.1.2 Additional Maps on Climate Change

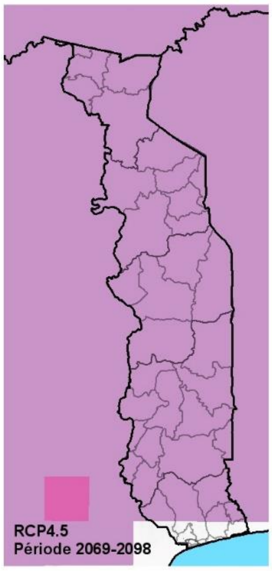


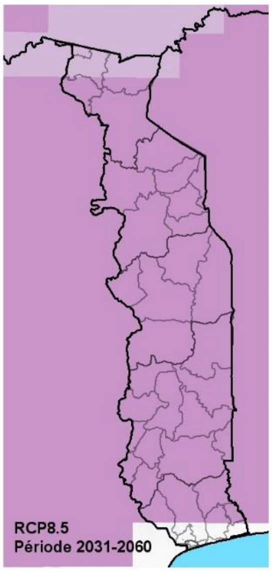
TOGO

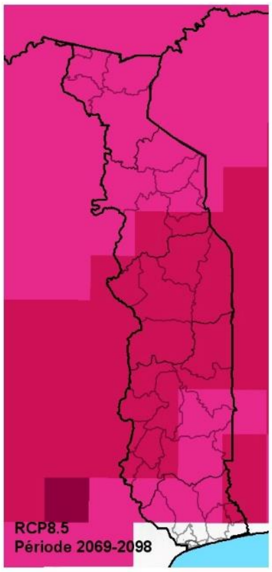
TEMPÉRATURE MAXIMALE ANNUELLE MOYENNE











LOCALISATION

0 10 20 30 40
Kilomètres

Projection locale: UTM Zone 31N, Datum: WGS 84
Projection géographique: Lat/Lon, Datum: WGS 84
Echelle 1:4.500.000 format A3

Analyse et Cartographie: Spatial Services
14 novembre 2019 © adelphi / Z_GIS / Spatial Services

DESCRIPTION | LÉGENDE

Les cartes montrent la moyenne des températures maximales annuelles 1981-2010 et l'évolution de ce nombre à l'avenir: 2031-2060 et 2069-2098. La première série de cartes présente Résultats du scénario RCP (concentration représentative) Pathway) 4.5, le deuxième RCP 8.5.

Région   Préfectures

Température maximale moyenne (°C)
31 32 33 34 35 36

Evolution de la température maximale moyenne (°C)
0 1 2 3 4 5 6 7

SOURCES DES DONNÉES | RÉFÉRENCES

Ensemble CORDEX AFRICA avec biais corrigés:
8 simulations générées d'après 4 CMIP5 GCMs (CNRM-CM5, EC-EARTH, HadGEM2-ES et MPIESM-LR) et 2 RCMs (SMHI-RCA4 et CLMcom-CCLM4-8-17) réalisés avec les mêmes GCMs.

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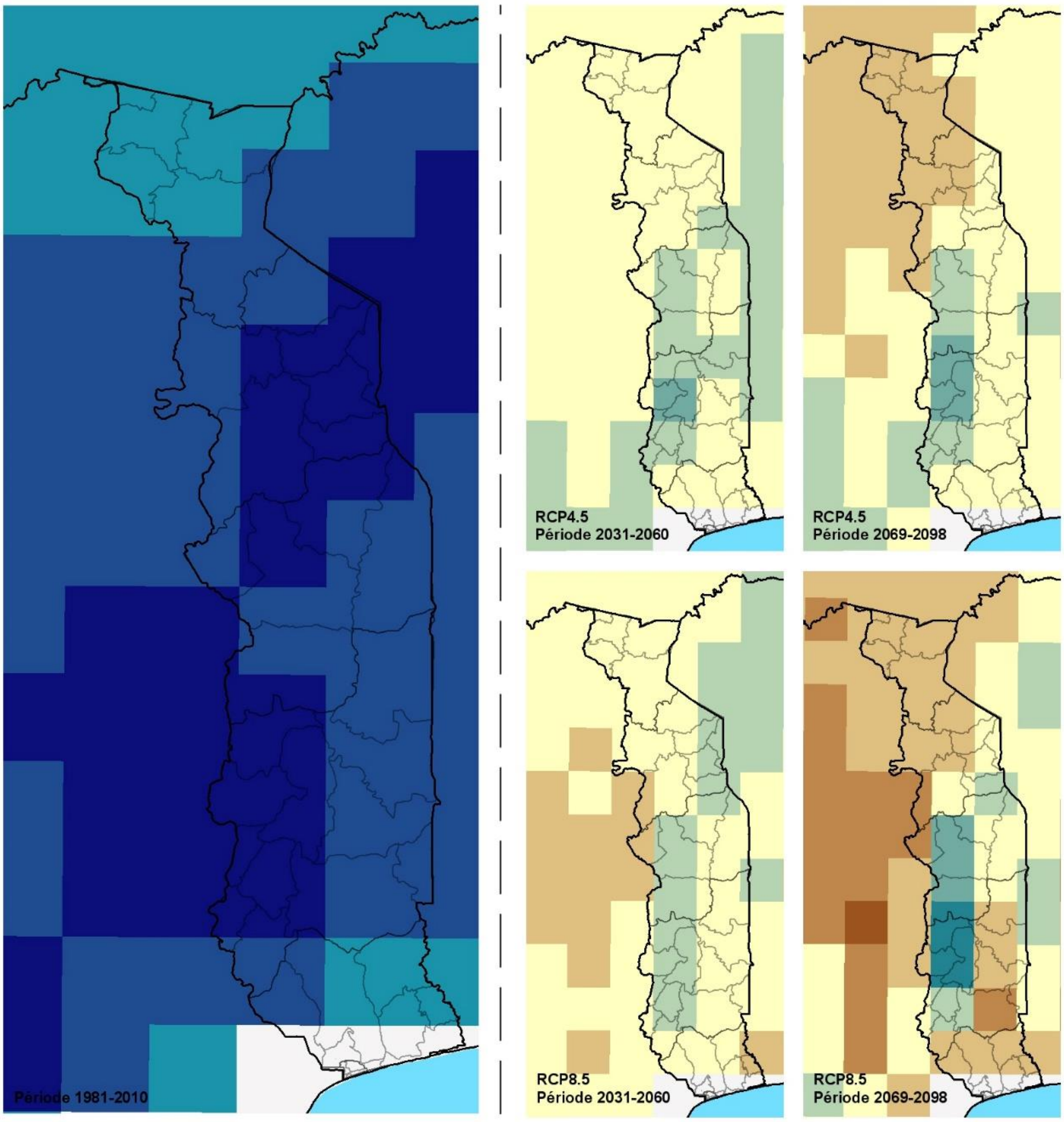
PRÉCIPIATIONS MOYENNES ANNUELLES



LOCALISATION

0 10 20 30 40
Kilomètres

Projection locale: UTM Zone 31N, Datum: WGS 84
Projection géographique: Lat/Lon, Datum: WGS 84
Echelle 1:4.500.000 format A3

Analyse et Cartographie: Spatial Services
14 novembre 2019 © adelphi / Z_GIS / Spatial Services

DESCRIPTION | LÉGENDE

Les cartes illustrent la moyenne des précipitations dans l'intervalle temporel avec présence d'épisodes pluvieux (de septembre à mai) pour la période 1981-2010 et l'évolution de cette moyenne dans le futur: 2031-2060 et 2069-2098. La première série de cartes présente les résultats du scénario RCP (Representative Concentration Pathway) 4.5, la seconde RCP8.5.

Région | Préfectures

Précipitations par jour [mm]
0 | 200 | 400 | 600 | 800 | 1000 | 1200 | 1400

Evolution du nombre par jour [mm]
-0,4 | -0,3 | -0,2 | -0,1 | 0 | 0,1 | 0,2 | 0,3

SOURCES DES DONNÉES | RÉFÉRENCES

Ensemble CORDEX AFRICA avec biais corrigés: 8 simulations générées d'après 4 CMIP5 GCMs (CNRM-CM5, EC-EARTH, HadGEM2-ES et MPI-ESM-LR) et 2 RCMs (SMHI-RCA4 et CLMcom-CCLM4-8-17) réalisés avec les mêmes GCMs.

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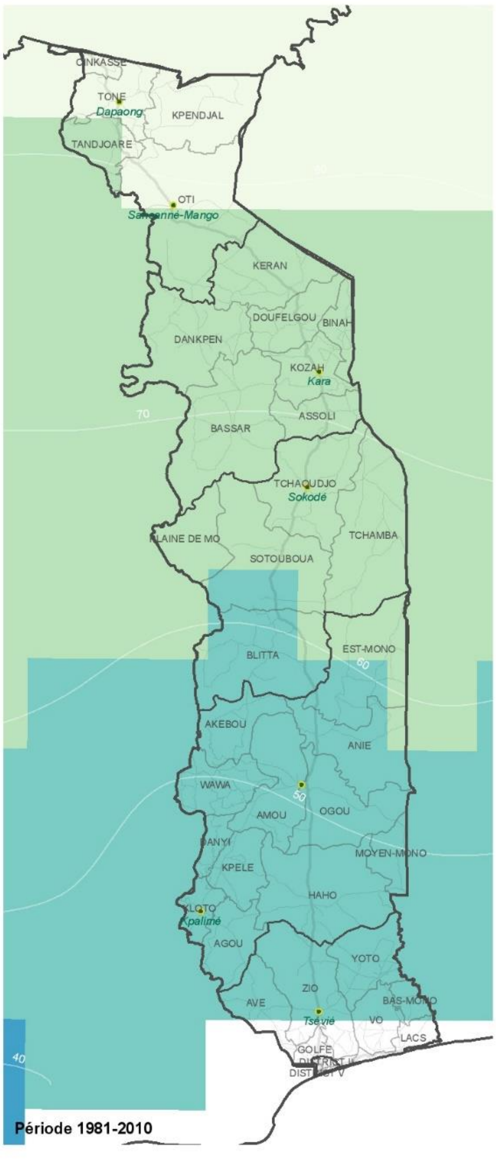
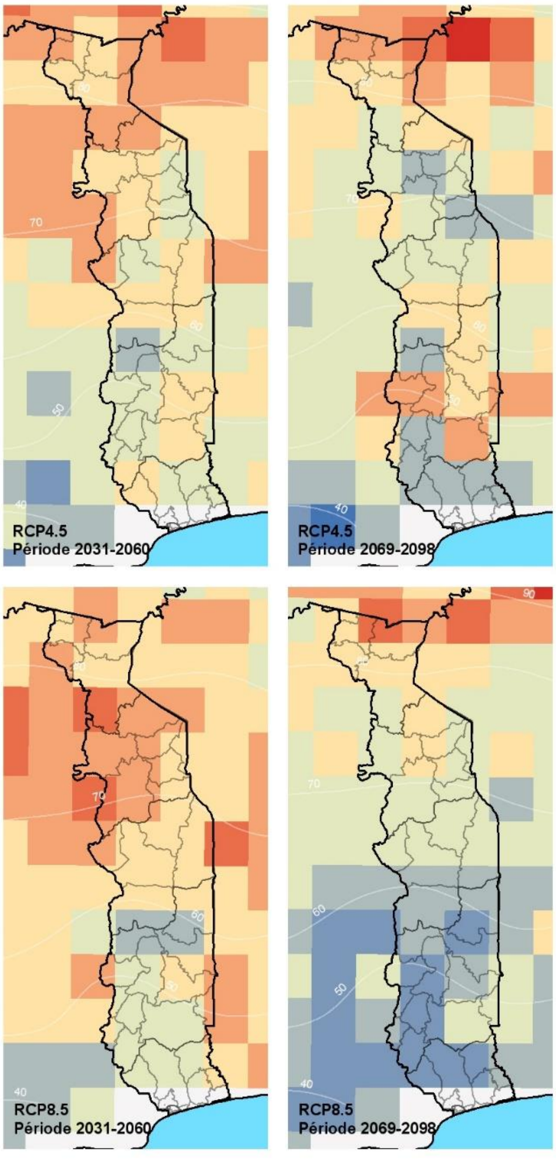
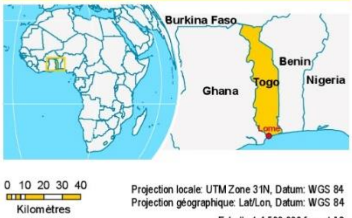
DURÉE MAXIMALE
PÉRIODES DE SÉCHERESSE





LOCALISATION



0 10 20 30 40
Kilomètres

Projection locale: UTM Zone 31N, Datum: WGS 84
Projection géographique: Lat/Lon, Datum: WGS 84
Echelle 1:4.500.000 format A3

Analyse et Cartographie: Spatial Services
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DESCRIPTION | LÉGENDE

Les cartes illustrent le nombre maximal de jours consécutifs avec un seuil de précipitations journalier <1 mm pour la période 1981-2010 et l'évolution de ce nombre dans le futur: 2031-2060 et 2069-2098. La première série de cartes présente les résultats du scénario RCP (Representative Concentration Pathway) 4.5, la seconde RCP 8.5.

Région | Préfectures | Isohyètes [d]

Nombre de jours secs consécutifs [d]
0 20 40 60 80 100

Evolution du nombre de jours secs consécutifs [d]
-4 -3 -2 -1 0 1 2 3 4

SOURCES DES DONNÉES | RÉFÉRENCES

Ensemble CORDEX AFRICA avec biais corrigés: 8 simulations générées d'après 4 CMIP5 GCMs (CNRM-CM5, EC-EARTH, HadGEM2-ES et MPIESM-LR) et 2 RCMs (SMHI-RCA4 et CLMcom-CCLM4-8-17) réalisés avec les mêmes GCMs.

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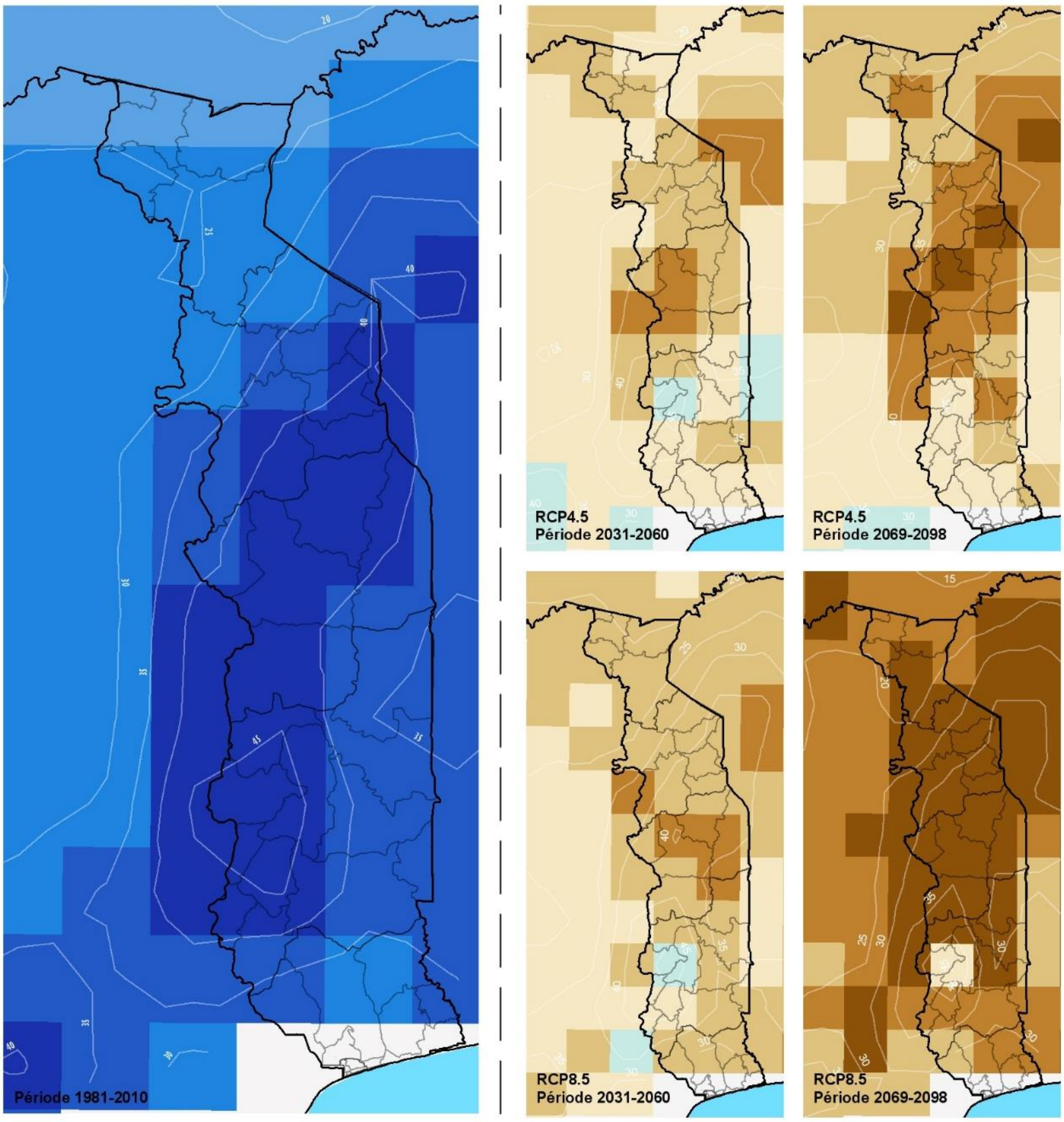
DURÉE MAXIMALE DES PÉRIODES HUMIDES



LOCALISATION

0 10 20 30 40
Kilomètres

Projection locale: UTM Zone 31N, Datum: WGS 84
Projection géographique: Lat/Lon, Datum: WGS 84
Echelle 1:4.500.000 format A3

Analyse et Cartographie: Spatial Services
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DESCRIPTION | LÉGENDE

Les cartes illustrent le nombre maximal de jours consécutifs avec un seuil de précipitations journalier >1mm pour la période 1981-2010 et l'évolution de ce nombre dans le futur: 2031-2060 e t 2069-2098. La première série de cartes présente les résultats du scénario RCP (Representative Concentration Pathway) 4.5, la seconde du scénario RCP 8.5.

Région   Préfectures   Isohyètes [d]

Nombre de jours humides consécutifs [d]
0 8 16 24 32 40 48 56

Evolution du nombre de jours humides consécutifs [d]
-8 -6 -4 -2 0 2

SOURCES DES DONNÉES | RÉFÉRENCES

Ensemble CORDEX AFRICA avec biais corrigés:
8 simulations générées d'après 4 CMIP5 GCMs (CNRM-CM5, EC-EARTH, HadGEM2-ES et MPIESM-LR) et 2 RCMs (SMHI-RCA4 et CLMcom-CCLM4-8-17) réalisés avec les mêmes GCMs.

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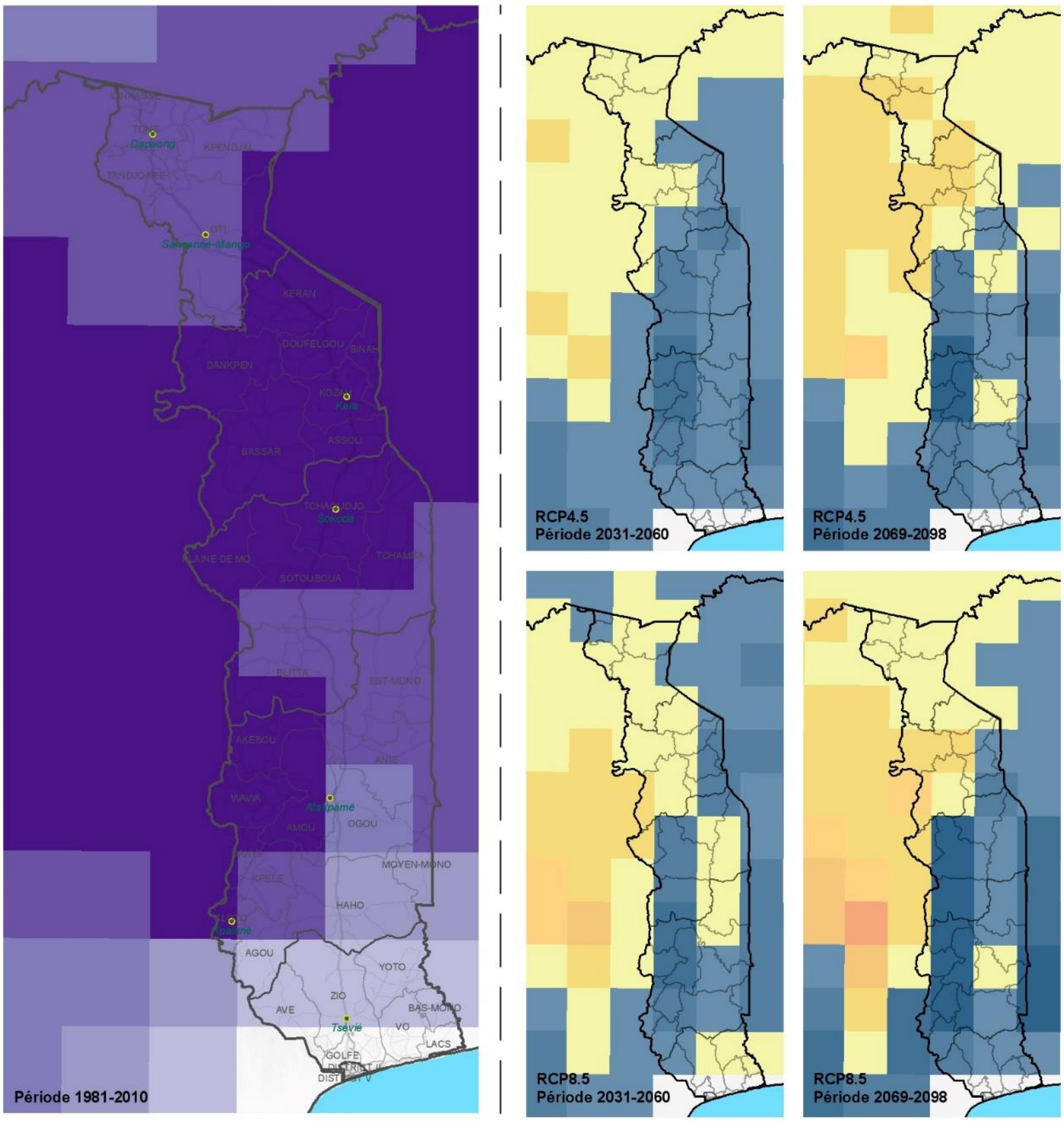
NOMBRE DE JOURS HUMIDES (PRÉCIPITATION >10 MM)



LOCALISATION

0 10 20 30 40
Kilomètres

Projection locale: UTM Zone 31N, Datum: WGS 84
Projection géographique: Lat/Lon, Datum: WGS 84
Echelle 1:4.500.000 format A3

Analyse et Cartographie: Spatial Services
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DESCRIPTION | LÉGENDE

Les cartes illustrent le nom b re d e jours avec des précipitations >10mm / jour pour la période 1981-2010 et l'évolution de ce nombre dans le futur: 2031-2060 et 2069-2098.
La première série de cartes p résente les résultats du scénario RCP (Representative Concentration Pathway) 4.5, la seconde RCP 8.5.

Région Préfectures Isohyètes [mm]

Nombre de jours humides [mm]
0 1 2 3 4 5 6 7 8

Evolution du nombre de jours humides [mm]
-5 -4 -3 -2 -1 0 1 2 3 4

SOURCES DES DONNÉES | RÉFÉRENCES

Ensemble CORDEX AFRICA avec biais corrigés:
8 simulations générées d'après 4 CMIP5 GCMs (CNRM-CM5, EC-EARTH, HadGEM2-ES et MPIESM-LR) et 2 RCMs (SMHI-RCA4 et CLMcom-CCLM4-8-17) réalisés avec les mêmes GCMs.

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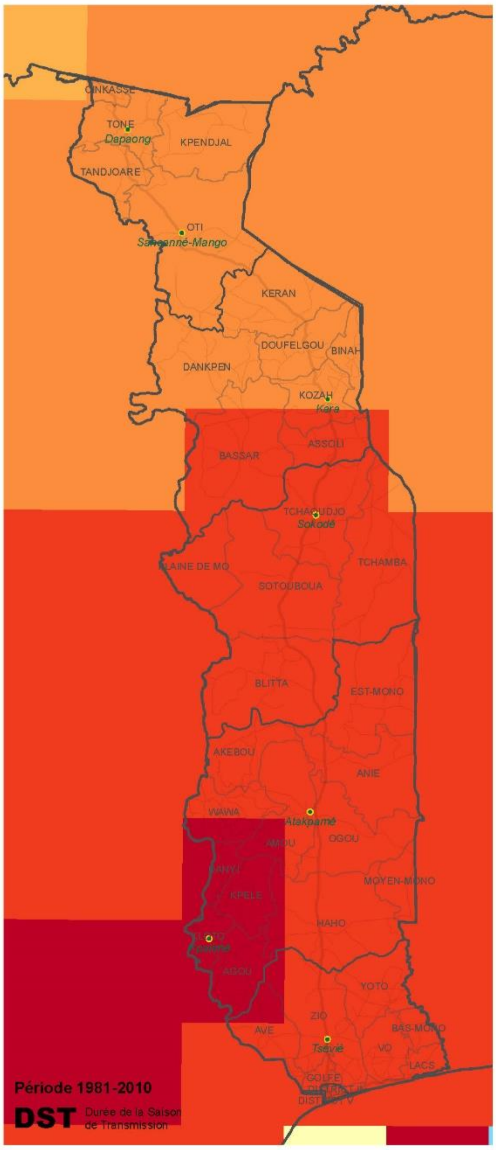
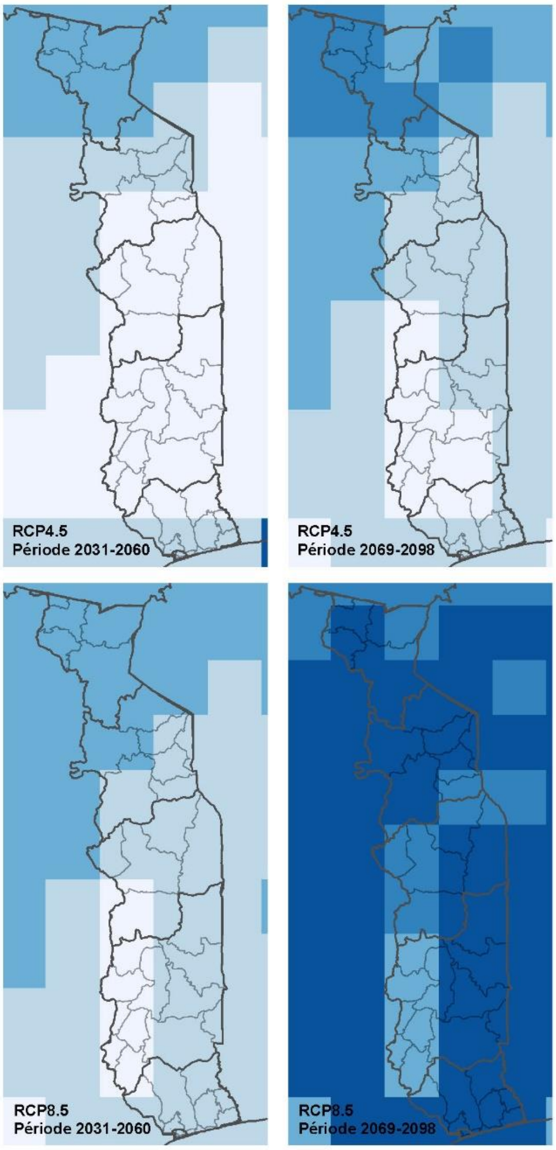
SCÉNARIOS FUTURS DE LA DURÉE DE LA SAISON DE TRANSMISSION DU PALUDISME





LOCALISATION

0 25 50 75 100
Kilomètres

Projection locale: UTM Zone 31N, Datum: WGS 84
Projection géographique: Lat/Lon, Datum: WGS 84
Echelle 1:4.500.000 format A3

Analyse et Cartographie: Spatial Services
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DESCRIPTION | LÉGENDE

Les cartes montrent l'évolution de la durée de la saison de transmission du paludisme. Les modèles montrent une diminution constante du LTS simulé pour le 21ème siècle.

Payes — Région — Préfecture

Durée récente de la saison de transmission du paludisme
0 2 4 6 8 10 12

Changement de la durée de la saison de transmission du paludisme
-2,5 -2,0 -1,5 -1,0 -0,5 0,0

SOURCES DES DONNÉES | RÉFÉRENCES

Données utilisées: DHIS2, INSEED, ISIMIP, Copernicus/Vito), Ensemble CORDEX AFRICA avec biais corrigés (SMHI)

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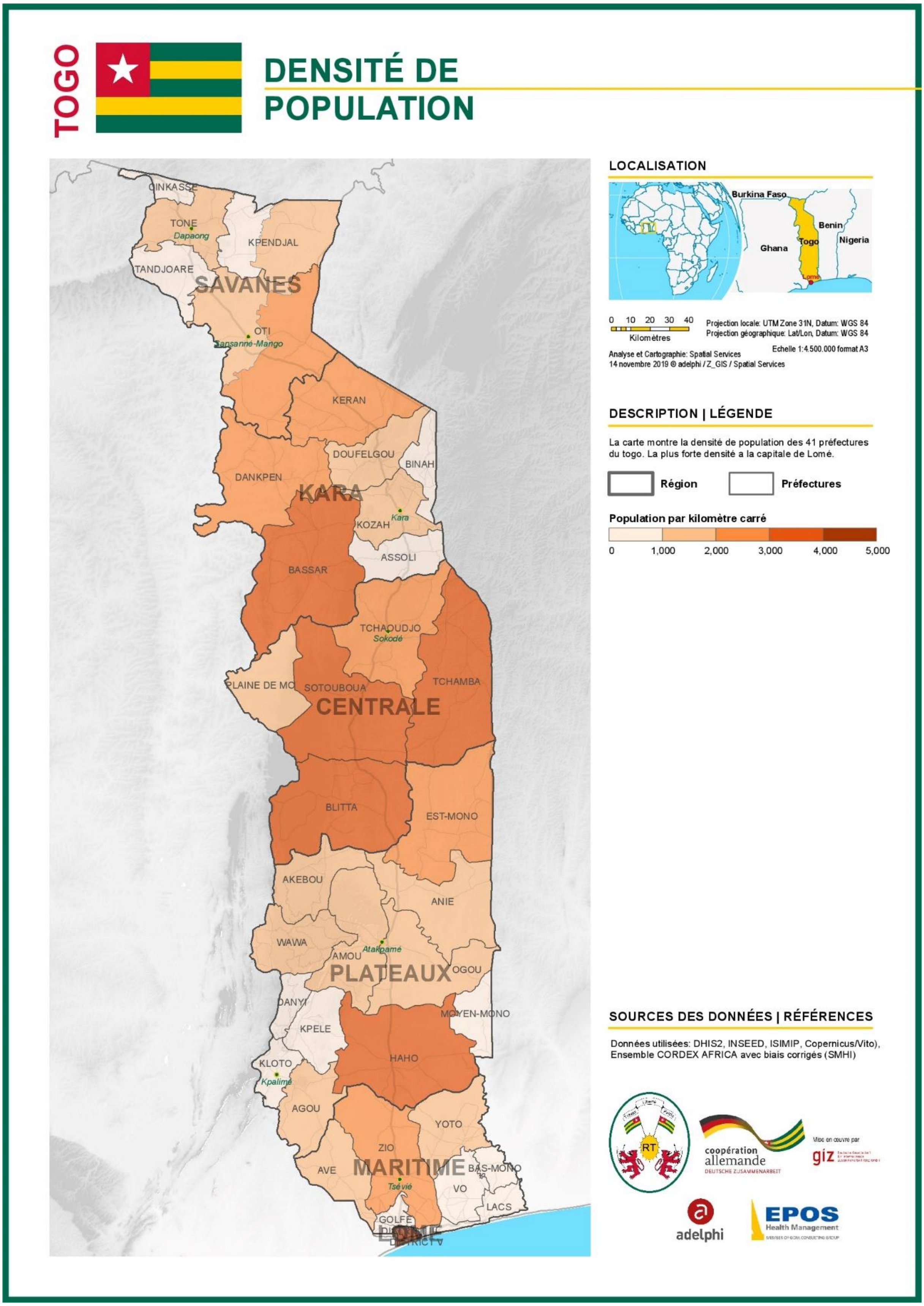
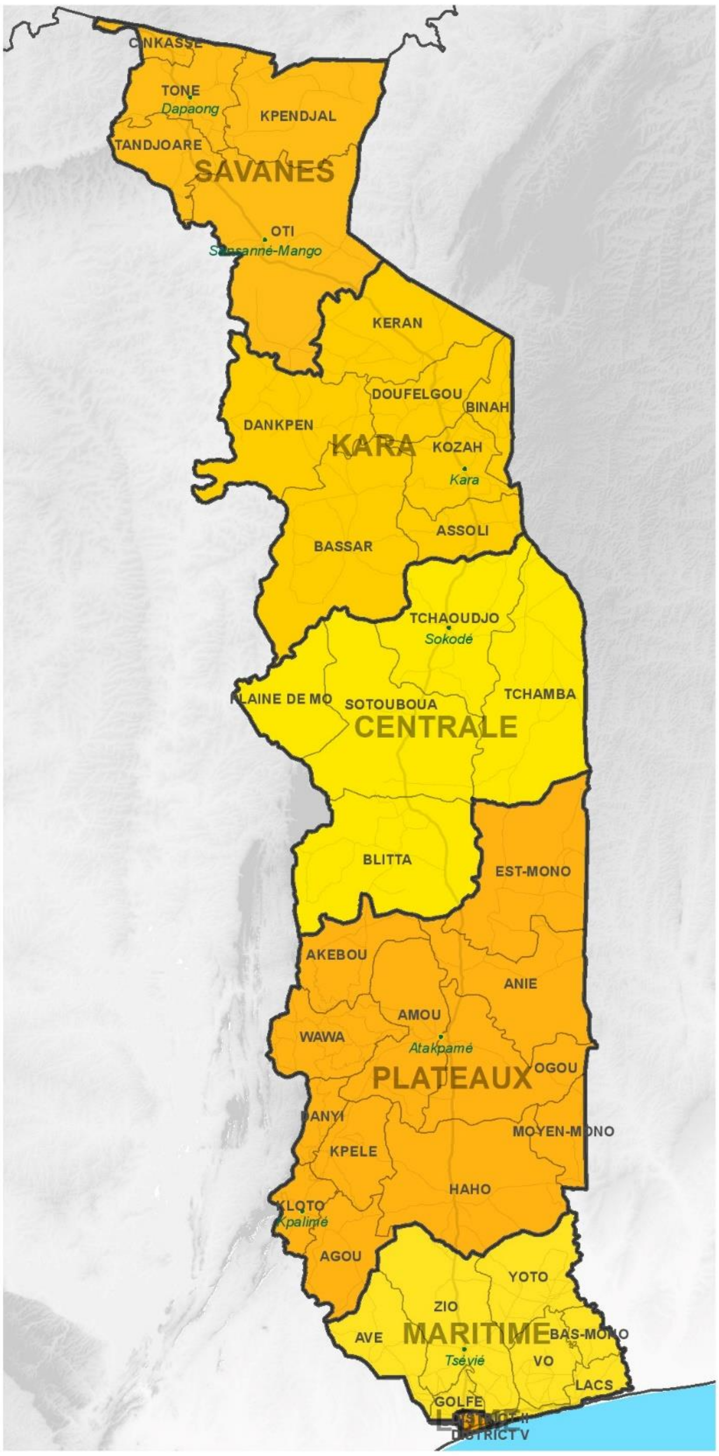
7.1.3 Maps of Togo



TOGO

CARTE GÉNÉRALE
RÉGIONS ET PRÉFECTURES



LOCALISATION

0 10 20 30 40
Kilomètres

Projection locale: UTM Zone 31N, Datum: WGS 84
Projection géographique: Lat/Lon, Datum: WGS 84
Echelle 1:4.500.000 format A3

Analyse et Cartographie: Spatial Services
14 novembre 2019 © adelphi / Z_GIS / Spatial Services

DESCRIPTION | LÉGENDE

Le Togo est divisé en cinq régions. Les régions sont divisées en 41 préfectures. Les préfectures sont subdivisées en communes. Dans l'ensemble le Togo compte 116 communes.

Région Préfectures

SOURCES DES DONNÉES | RÉFÉRENCES

Données utilisées: DHIS2, INSEED, ISIMIP, Copernicus/Vito), Ensemble CORDEX AFRICA avec biais corrigés (SMHI)

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7.2 Annex 2: List of Monitoring Indicators for the Three Climate-sensitive Diseases (Malaria, Respiratory Infections and Meningitis)

MALARIA - List of indicators and data for the monitoring of climate risks

Risk Area	Sub-area	Factor - Impact chain	Indicator used	Direction	Weighting	Acronym	Attribute used	Justification	Data source	URL	Surveillance Update Cycle	Spatial Resolutio	Date of data
Hazard (Probability of infected mosquito bites)		Proliferation of mosquitoes	Days per year /Length of Tranmission Season/LTS	+	0,5	PALTS0	LTS_mean	Climate-based indicator developed specifically to characterize the malaria cycle	ISIMIP/Caminade et al (2014)	https://www.pnas.org/content/pnas/111/9/3286.full.pdf	depending on the model used but normally updated after a few years	~55x55km'	2014
		Contaminated persons	% of cases in total population	+	0,1	PAPCO	Uncomplicated malaria confirmed ; Nb cases of severe malaria referred to PHU	The contaminated people are hosts for the parasite	District Health Information System 2 (DHIS2) Togo; 2018 MSHP	https://togo.dhis2.org/	continuous	Prefecture level	2018
		Floods	% seasonal inland water total area of prefecture	+	0,1	PAINO	"Seasonal Inland Water (Fractional cover layer)"	Stagnant water is the preferred breeding ground for mosquitoes.	Global Land Cover/Copernicus/Vito	https://lcviewer.vito.be/	continuous ; depends on the availability of	100x100m'	2015
		Stagnant waters	% seasonal and permanent inland water /total area of the prefecture	+	0,1	PAEST	"Seasonal + Permanent Inland Water (Fractional cover layer)"	Stagnant water is the preferred breeding ground for mosquitoes.	Global Land Cover/Copernicus/Vito	https://lcviewer.vito.be/	continuous ; depends on the availability of	100x100m'	2015
		Insufficient sewage disposal	% houses without drainage	+	0,1	PAEVE	Table 1.28: In the courtyard , plot , in the open	The lack of drainage favours the presence of stagnant water in the vicinity or in the plot and thus the presence of mosquitoes.	General Census of Population and Housing (RGPH), INSEED	http://www.stat-togo.org/	decennial	Prefecture level	2012
		Water conservation method	% houses without drinking water	+	0,1	PACOE	Table 1.23: Well, Rainwater River, backwater, reservoir , lake	Households without running water store water in large open containers, allowing mosquitoes to breed in them.	General Census of Population and Housing (RGPH), INSEED	http://www.stat-togo.org/	decennial	Prefecture level	2012
Vulnerability	Generic Susceptibility/ Sensitivity	People working outdoors	% people working outdoors	+	0,0769	PVSGPTE	Table 4.4: Agriculture, hunting and related activities, forestry, logging and related activities, Fisheries , Fish farming, aquaculture , Extraction of coal, lignite and peat, Extraction of crude oil and natural gas and related services, Extraction of uranium and thorium ores, Mining of metal ores Other extractive activities	People working outdoors are more exposed to mosquito bites.	General Census of Population and Housing (RGPH), INSEED	http://www.stat-togo.org/	decennial	Prefecture level	2012
		People on low income	% unemployed people	+	0,0769	PVSGPFR	Table 4.1: Unemployed, First job seeker, Housewife, Retired, Student/student, Pensioner, Other non-working people	Poverty is a generic factor of vulnerability because it implies an overall lack of resources and less favourable living conditions.	General Census of Population and Housing (RGPH), INSEED	http://www.stat-togo.org/	decennial+M11:M12	Prefecture level	2012
	Biological susceptibility/ Sensibility inherent to persons	Pregnant and nursing women	% female population between 15 and 49 years old	+	0,0769	PVSBFEA	Table 2.3.	Pregnant and nursing women and their children under 5 years of age are particularly vulnerable.	General Census of Population and Housing (RGPH), INSEED	http://www.stat-togo.org/	decennial	Prefecture level	2012
		Children < 5 years	% population between 0 and 5 years old	+	0,0769	PVSBE5A	Table 2.3.	Young children are particularly vulnerable	General Census of Population and Housing (RGPH), INSEED	http://www.stat-togo.org/	decennial	Prefecture level	2012
		Elderly people (> 50)	% population over 50 years of age	+	0,0769	PVSBP50	Table 2.3.	Elderly people are particularly vulnerable	General Census of Population and Housing (RGPH), INSEED	http://www.stat-togo.org/	decennial	Prefecture level	2012
		Chronic diseases	% population with chronic diseases	+	0,0769	PVSBCHR	Cardiovascular, tumours, heart disease, diabetes, high blood pressure	People with chronic diseases have a weakened immune system.	District Health Information System 2 (DHIS2) Togo; 2018 MSHP	https://togo.dhis2.org/	decennial	Prefecture level	2018
		Low immunity	% Plasmodium falciparum parasite in 2-10 year old age group in Africa	+	0,0769	PVSBFIM	"Plasmodium falciparum parasite rate in 2-10 year old in Africa"	Testifies to the level of immunity to malaria	Malaria Atlas Project (MAP)/Bhatt et al (2015)	https://map.ox.ac.uk/	a few years; depends on data availability	~4,5x4,5km'	2000-2015
		Haemoglobulopathy (sickle cell disease, thalassaemia etc.)	% Mean estimates of the frequency of sickle cell hemoglobin alleles	+	0,0769	PVSBSIC	"Mean estimates of sickle haemoglobin alleles frequency"	Patients with SS hemoglobinosis are at risk of complicated forms of malaria.	Malaria Atlas Project (MAP)/Piel et al (2013)	https://map.ox.ac.uk/	a few years; depends on data availability		2010
	Lack of resilience – (Lack of) anticipation capacity	Level of education	% illiterate population	+	0,0769	PVRAEDU	Table 3.3	The level of general awareness of risk and how to protect oneself from it is linked to the level of education.		http://www.stat-togo.org/	decennial	Prefecture level	2012
		Availability of mosquito nets in households	% people with access to an insecticide-treated net (ITN)	-	0,0769	PVRAMOU	"Persons with access to an insecticide-treated mosquito net (ITN)"	The use of mosquito nets reduces the probability of bites.	Demographic and Health Survey (DHS)	https://spatialdata.dhsprogram.com/modeled-	a few years; depends on data availability	~4,5x4,5km'	2013
	Lack of resilience – (Lack) of coping /recovery capacity	uman resources	Average distance from health care facilities	+	0,0769	PVRRAHS	USP, HD, CHR	Accessibility to health services for treatment	Own modelling ("Cost Surface"); Health Sites : DHIS2; Land cover : Global Land Cover/Copernicus/Vito	togo.dhis2.org, https://lcviewer.vito.be/	continuous	860x860km'	2018
		Health staff human resources	Number of qualified staff per 10,000 inhabitants	-	0,0769	PVRRRHU	Nb Registered nurses, Nb General practionneers , Nb permanant nurses	Availability of staff to take care of patients	DHIS2	https://togo.dhis2.org/	continuous	Prefecture level	2018
		Accessibility of inputs	Total number of days of treatment interruption in 2018 for instant diagnostic test / health centre Average over the annual break days of the 3 chosen treatments / health centre	-	0,0769	PVRRIN1/2	Nb days of interruption AM-LM6, AS-AQ 6, AS-MF + Nb days of interruption TDR	Availability of drugs needed to treat patients	DHIS2	https://togo.dhis2.org/	continuous	Prefecture level	2018

Data Reference:

Caminade, Cyril, Sari Kovats, Joacim Rocklov, et al (2014): Impact of climate change on global malaria distribution. Proceedings of the National Academy of Sciences Mar 2014, 111 (9) 3286-3291; DOI: 10.1073/pnas.1302089111

Bhatt S., Weiss DJ., Cameron E., et al. The effect of malaria control on Plasmodium falciparum in Africa between 2000 and 2015 Nature. October 2015 526(7572): 207-211.

Piel FB., Patil AP., Howes RE., Nyangiri OA., Gething PW., Dewi M., Temperley WH., Williams TN., Weatherall DJ., Hay SI., Global epidemiology of sickle haemoglobin in neonates: a contemporary geostatistical model-based map and population estimates Lancet. January 2013 381(9861): 142-151.

RESPIRATORY INFECTIONS List of indicators and data for the monitoring of climate risks													
Risk Areas	**Sub-area**	**with**	**Indicator used**	**Direction**	**Weighting**	**Acronym**	**Attribute used**	**Justification**	**Data Source**	**URL**	**Surveillance Update Cycle**	**Spatial Resoluti**	**of data**
Hazard (probability of respiratory illnesses/infections)		Dry periods	Number of Consecutive Dry Days	+	0,25	CDD0	"Consecutive Dry Days (CDD)"	A dry climate induces dusty and polluted air.	Sveriges meteorologiska och hydrologiska institut (SMHI)	no link	depending on the model used but normally updated after a few years	~55x55km'	2014
		High temperature amplitudes	Maximum temperature	+	0,25	TMX0	"Maximum Temperature (Tmax)"	High temperatures contribute to a dry environment	Sveriges meteorologiska och hydrologiska institut (SMHI)	no link	depending on the model used but normally updated after a few years	~55x55km'	2014
		Contaminated persons	Sum of influenza-like illness and respiratory infections per 100,000 population	+	0,083	RAPCO	Flu Syndrom + IRAS	The infected people being hosts for the parasite	MSHP - base de données Surveillance Epidemiologique		continuous	prefecture level	2018
		Land cover /Land use	Classified land use categories	+	0,083	RASOL	"Forests (70), Shrubland (35), Herbaceous vegetation (75), Herbaceous wetlands (0), Moss & lichen (0), Bare/sparse vegetation (30), Cropland (40), Built-up (75), Snow & ice (0), Permanent water bodies (0)"	Certain classes of soil cover contribute to air pollution.	Global Land Cover/Copernicus/Vito	https://lcviewer.vito.be/	continuous ; depends on data availability	100x100m'	2015
		Exhaust gas	Average proximity to roads and industrial areas	+	0,083	RAGAZ	"Roads, Industrial Areas (Buffer 500m); ('WHO 2013)"	Roads and industrial areas contribute to air pollution	Open Street Map	https://www.openstreetmap.org	continuous	Vector	2019
		Bush fire	Fires (2003 - 2016) per km2 per prefecture	+	0,083	RAFEU	"Fires per sqkm per year"	Fire contribute to air pollution	Global Fire Atlas	https://www.globalfiredata.org	continuous , annual		2003 - 2016
		Waste burning	% of households that burn waste directly in the household's neighbourhood	+	0,083	RABDD	Table 1.25 (Burnt)	Waste burning produces harmful smoke in direct contact with the inhabitants and promotes IR	Recensement Général de la Population et de l'Habitat (RGPH), INSEED	http://www.stat-togo.org/	decennial	prefecture level	2012
		Urban and industrial particulate matters	Average estimates of satellite-derived PM2.5 (2007 - 2016)	+	0,083	RAP25	"Mean Satellite-Derived PM2.5 estimates"	Aerosols and small particles are a measure of air pollution.	WHO/University of Delasie	http://fizz.phys.dal.ca/~atmos/martin/?page_id=140#V4.GL.02	continuous, annual	0,01'x0,01'	2007 - 2016
Vulnerability	Generic susceptibility/sensitivity	Child < 5 years	% population between 0 and 5 years old	+	0,125	RVSGE5A	Table 2.3.	Young children are particularly vulnerable	General Census of Population and Housing (RGPH), INSEED	http://www.stat-togo.org/	decennial	prefecture level	2012
		Elderly people (> 50)	% population over 50 years of age	+	0,125	RVSGP50	Table 2.3.	Elderly people are particularly vulnerable	General Census of Population and Housing (RGPH), INSEED	http://www.stat-togo.org/	decennial	prefecture level	2012
		People with low income	% unemployed people	+	0,125	RVSGPFR	Table 4.1: Unemployed, First job seeker, Housewife, Retired, Student/student, Pensioner, Other non-working people	Poverty is a generic factor of vulnerability because it implies an overall lack of resources and less favourable living conditions.	Table 4.1. Distribution of the resident population aged 15 and over by age group and occupation status	http://www.stat-togo.org/	decennial	prefecture level	2012
	Biological susceptibility/	People with asthma	% of asthma consultations	+	0,125	RVSBAST		Asthma patients are more affected by IR	District Health Information System 2 (DHIS2) Togo; 2018 MSHP population	https://togo.dhis2.org/	continuous	prefecture level	2018
	Lack of resilience – (Lack of) anticipation capacity	Knowledge or education on pollutants	% illiterate people	+	0,125	RVRAEDU	Table 3.3	The level of general awareness of risk and how to protect oneself from it is linked to the level of education.	General Census of Population and Housing (RGPH), INSEED	http://www.stat-togo.org/	decennial	prefecture level	2012
		Hygiene	% of homes without proper sewage systems	+	0,125	RVRAEVE	Table 1.28: Nb plot without drainage systems (in the courtyard, in the plot, in the street, in the open)	Lack of evacuation reduces the level of hygiene in the dealership, putting a strain on the immune system and making the body more vulnerable to other attacks.	General Census of Population and Housing (RGPH), INSEED	http://www.stat-togo.org/	decennial	prefecture level	2012
	Lack of resilience – (Lack of) coping and recovery capacity	Accessibility to health services and care	Average distance from health care facilities	+	0,125	RVRRAHS	PHU, HD, CHR	Accessibility to health services for treatment	Own modelling ('Cost Surface'); Health sites: DHIS2; Land Cover: Global Land Cover/Copernicus/Vito	togo.dhis2.org, https://lcviewer.vito.be/	continuous	860x860km'	2018
		Health staff human resources	Number of qualified staff per 10,000 inhabitants	+	0,125	RVRRRHU	Nb Registered nurses, Nb General practionneers , Nb permanant nurses	Availability of staff to take care of patients	District Health Information System 2 (DHIS2) Togo; 2018 MSHP population	https://togo.dhis2.org/	continuous	prefecture level	2018

Data Reference :

WHO Regional Office for Europe. Review of evidence on health aspects of air pollution – REVIHAAP Project: Technical Report [Internet]. Copenhagen: WHO Regional Office for Europe; 2013. C, Proximity to roads, NO2, other air pollutants and their mixtures. Available from: https://www.ncbi.nlm.nih.gov/books/NBK361807/

MENINGITIS - List of indicators and data for the monitoring of climate risks													
Risk Area	**Sub-area**	**Factor - Impact Chains**	**Indicator used**	**Direction**	**Weighting**	**Acronym**	**Attribute used**	**Justification**	**Data Source**	**URL**	**Surveillance update cycle**	**spatial resolutio**	**Date of data**
Hazard (probability of contamination)		Temperature rise	Maximum temperature	+	0,25	TMX0	Maximum Temperature (Tmax)	High temperatures contribute to a dry environment and a dry climate induces dusty and polluted air.	Sveriges meteorologiska och hydrologiska institut (SMHI)	no link	depending on the model used but normally updated after a few years	~55x55km'	2014
		Drought	Number of Consecutive Dry Days	+	0,25	CDD0	Consecutive Dry Days (CDD)	A dry climate induces dusty and polluted air.	Sveriges meteorologiska och hydrologiska institut (SMHI)	no link	depending on the model used but normally updated after a few years	~55x55km'	2014
		Land cover/land use	Classified land use categories	+	0,125	MASOL	Forests (70), Shrubland (50), Herbaceous vegetation (75), Herbaceous wetlands (0), Moss & lichen (0), Bare/sparse vegetation (70), Cropland (60), Built-up (80), Snow & ice (0), Permanent water bodies (0); Molesworth et al. (2003)	Certain classes of soil cover contribute to air pollution.	Global Land Cover/Copernicus/Vito	https://lcviewer.vito.be/	continuous; depends on data availability	100x100m'	2015
		Presence aerosols / dusts	Average estimates of satellite-derived PM2.5 (2007 - 2016)	+	0,125	MAP25	Mean Satellite-Derived PM2.5 estimates	Aerosols and small particles are a measure of air pollution.	WHO/University of Delasie	http://fizz.phys.dal.ca/~atmos/martin/?page_id=140#V4.GL.02	continuous, annual	0,01°x0,01°	2007 - 2016
		Deforestation	Average loss of forest cover (2000 - 2018)	+	0,125	MADEF	Forest Loss	Deforestation is a source of air pollution	Global Forest Change/University of Maryland	https://earthenginepartners.appspot.com/science-2013-global-forest	continuous, annual	~30x30m'	2000 - 2018
		Infected persons	Number of cases of meningitis per 100,000 people	+	0,125	MAPCO	Nb of annual cases	Gives an indication of the number of infected persons	MSHP - Epidemiological Surveillance database		continuous	prefecture level	2018
Vulnerability	Generic susceptibility/Sensitivity	Migration dynamics /population movement	% of the population who have resided in the district for 2 years or less	+	0,1666	MVSGMIG	Table 5.6.	Population flows (potential carriers) increase the spread of the disease.	General Census of Population and Housing (RGPH), INSEED	http://www.stat-togo.org/	decennial	prefecture level	2012
		People with low income	% unemployed people	+	0,1666	MVSGPFR	Table 4.1: Unemployed, First job seeker, Housewife, Retired, Student/student, Pensioner, Other non-working people	Poverty is a generic factor of vulnerability because it implies an overall lack of resources and less favourable living conditions.	General Census of Population and Housing (RGPH), INSEED	http://www.stat-togo.org/	decennial	prefecture level	2012
	Biologic susceptibility/ Sensitivity Inherent	Young children <10 years	% population between 0 and 10 years old	+	0,1666	MVSBJ10	Table 2.3.	Young children are particularly vulnerable	General Census of Population and Housing (RGPH), INSEED	http://www.stat-togo.org/	decennial	prefecture level	2012
	Lack of resilience – (Lack of) anticipation capacity	Health immunization programmes targeted much more at children	Vaccination coverage on targets (child 0-18 months)	-	0,1666	MVRAVC1/2	DTC-HepB-Hib3 Coverage, RR-1 Coverage	Vaccination is an important risk reduction strategy	District Health Information System 2 (DHIS2) Togo; 2018 MSHP population	https://togo.dhis2.org/	continuous	prefecture level	2018
		Education	% illiterate people	+	0,1666	MVRAEDU	Table 3.3	The level of general awareness of risks and ways to protect oneself from them is linked to the level of education.	General Census of Population and Housing (RGPH), INSEED	http://www.stat-togo.org/	continuous	prefecture level	2012
	Lack of resilience – (Lack of) coping /recovery capacity	Accessibility to health services and care	Average distance from health care facilities	+	0,1666	MVRRAHS	PHU, HD, CHR	Accessibility to health services for treatment	Own modeling ('Cost Surface'); Health sites: DHIS2; Land Cover: Global Land Cover/Copernicus/Vito	togo.dhis2.org, https://lcviewer.vito.be/	continuous	860x860km'	2018

Data Reference

Molesworth, A. M., Cuevas, L. E., Connor, S. J., Morse, A. P., & Thomson, M. C. (2003). Environmental risk and meningitis epidemics in Africa. *Emerging infectious diseases* , *9* (10), 1287–1293. doi:10.3201/eid0910.030182

Factors for which data are missing

MALARIA

Risk area	Factor - Impact Chains	Data Challenges
Hazard	Insalubrity	Difficulty in finding an existing dataset that could represent this indicator. Potentially RGPH/DHS
	Ecosystem change/vector behaviour	No existing data, requires field studies
Vulnerability	People living in unventilated or poorly ventilated homes	Difficulty in finding an existing dataset that could represent this indicator. Potentially RGPH/DHS
	Use of mosquito repellent lights	Localised factor difficult to generalise for Togo
	Anti-malaria funding, programmes and campaigns	No existing spatialised data, data only available at national level
	Automedication	Difficulty in finding an existing dataset that could represent this indicator. Potentially DHIS2
	Incomplte treatment	Difficulty in finding an existing dataset that could represent this indicator. Potentially DHIS2

RESPIRATORY ILLNESSES/INFECTIONS

Risk area	Factor - Impact Chains	Data Challenges
Haza rd	Winds	Not included in standard climate models.
	Thermal inversions	No existing data for large areas such as regions, but only for specific points (city).
Vulnerability	Immunocompromised persons	Data available in DHIS2 but platform configuration issue makes it difficult to get the actual figures in time
	Environmental Awareness raising	Difficult to quantify; Considered already partially reflected by the level of education
	Environmental Institutions	Difficult to quantify; Requires qualitative survey of facilities
	Automedication	Difficulty in finding an existing data set that could represent this indicator. Potentially DHIS2

MENINGITIS

Risk area	Factor - Impact chains	Data Challenges
Hazard	Decrease in precipitation	Not necessary , already taken into account by the consecutive dry days indicator
	Violent wind	Not included in standard climate models.
	Air pollution	Already partially taken into account, no other indicators
	Long dry seasons	Not necessary , already taken into account by the consecutive dry days indicator
	Presence of new germs as a result of the vaccination campaign in old risk areas	No data available; requires a specific study with the epidemiological unit.
	Displacement of the meningitis belt towards forest and then coastal areas	No data available, requires meningitis-specific models
	Increased humidity	Not included in standard climate models.
Vulnerability	Promiscuity	Difficulty in finding an existing data set that could represent this indicator. Potentially DHIS2
	Poorly ventilated homes	Difficulty in finding an existing data set that could represent this indicator. Potentially RGPH/DHS
	Loss of herd immunity	Difficulty in finding an existing data set that could represent this indicator. Potentially DHIS2
	Vaccine financing	No spatialised data available, data only available at national level
	Availability/accessibility of medicines/inputs	Data not available; Potentially DHIS2
	Vaccination campaigns for adults	Data not available; Potentially DHIS2

7.3 Annex 3: Descriptive Statistics and Correlation Analysis

PALUDSIME

STATISTIQUES DESCRIPTIVES - DANGER

Attribute	*NoData#*	*NoData%*	*Mean*	*Min*	*Max*	*Sum*	*StdDev*	*Median*	*Kurtosis*	*Skewness*
PALTS0	0	0	8,72189355	6,17567028	10,178	357,597635	1,06829157	9,14004554	-0,07106655	-0,87402357
*PAPCO**	0	0	0,20710188	0,04833654	0,35380144	8,49117691	0,07397924	0,19899611	-0,71222732	-0,12670602
*PAINO**	0	0	0,00259846	0	0,0177186	0,10653696	0,00513822	0,00067057	4,71014708	2,4646588
*PAEST**	0	0	0,0058481	0	0,0517618	0,23977209	0,01548206	0	4,94515725	2,53613161
PAEVE	0	0	0,91952448	0,6009741	0,98999431	37,7005039	0,11059743	0,96200814	3,57656251	-2,17715245
PACOE	0	0	0,57131424	0,01649509	0,94744122	23,4238838	0,26123404	0,63630174	-0,52965606	-0,64539663
PALTS1	0	0	8,15577001	4,98825611	9,86064574	334,386571	1,29613874	8,57118285	0,26434314	-1,00220645
PALTS2	0	0	7,93339718	4,57205163	9,735807	325,269284	1,41224473	8,41997861	0,14037742	-0,99493983
PALTS3	0	0	7,91482796	4,84247676	9,68806499	324,507946	1,29772518	8,32561161	0,10346395	-0,92493097
PALTS4	0	0	6,61654722	4,24045726	8,71817255	271,278436	1,17112268	6,68719653	-0,25590481	-0,20566564

CORRÉLATION - DANGER

Attribute	*PALTS0*	*PAPCO*	*PAINO*	*PAEST*	*PAEVE*	*PACOE*	*PALT1A*	*PALT2A*	*PALT3A*	*PALT4A*
PALTS0	1	-0,2866	0,1641	0,1389	-0,26	-0,1001	0,9891	0,994	0,993	0,9549
PAPCO	-0,2866	1	-0,5838	-0,3335	0,505	0,4613	-0,21	-0,2307	-0,2178	-0,1222
PAINO	0,1641	-0,5838	1	0,4541	-0,7725	-0,6158	0,0789	0,1162	0,099	0,0268
PAEST	0,1389	-0,3335	0,4541	1	-0,2393	-0,1812	0,072	0,0999	0,0848	-0,0011
PAEVE	-0,26	0,505	-0,7725	-0,2393	1	0,7385	-0,1722	-0,2126	-0,1975	-0,1477
PACOE	-0,1001	0,4613	-0,6158	-0,1812	0,7385	1	-0,0262	-0,0576	-0,0439	0,0303
PALT1A	0,9891	-0,21	0,0789	0,072	-0,1722	-0,0262	1	0,9982	0,9985	0,9652
PALT2A	0,994	-0,2307	0,1162	0,0999	-0,2126	-0,0576	0,9982	1	0,9993	0,9637
PALT3A	0,993	-0,2178	0,099	0,0848	-0,1975	-0,0439	0,9985	0,9993	1	0,972
PALT4A	0,9549	-0,1222	0,0268	-0,0011	-0,1477	0,0303	0,9652	0,9637	0,972	1

STATISTIQUES DESCRIPTIVES - VULNÉRABILITÉ

Attribute	*NoData#*	*NoData%*	*Mean*	*Min*	*Max*	*Sum*	*StdDev*	*Median*	*Kurtosis*	*Skewness*
PVSGPTE	0	0	0,51213874	0,0049462	0,85943633	20,9976883	0,25684068	0,58227598	-0,37039682	-0,82606952
PVSGPFR	0	0	0,31549637	0,18911649	0,481447	12,9353513	0,06770414	0,31068708	-0,14523144	0,14692111
PVSBFEA	0	0	0,24135734	0,20892895	0,32037409	9,89565103	0,03006094	0,23240286	1,21533	1,51461904
PVSBE5A	0	0	0,11762917	0,07856701	0,16505894	4,82279577	0,02127972	0,11429624	-0,27234513	0,29995013
PVSBP50	0	0	0,10861955	0,07201117	0,16035226	4,45340138	0,02328012	0,10475647	-1,04512975	0,25001217
*PVSBCHR**	0	0	0,01148478	0,00104184	0,03379619	0,47087592	0,00891177	0,00843251	1,07295137	1,40993483
PVSBFIM	0	0	0,52114702	0,188443	0,676583	21,367028	0,14822289	0,542757	0,55482044	-1,10578105
PVSBSI1	0	0	0,0839014	0,0504974	0,129376	3,4399576	0,02522586	0,0837777	-1,30911055	0,17423558
PVRAEDU	0	0	0,28474459	0,05210209	0,68769919	11,6745282	0,17341231	0,25093633	-0,52999801	0,62124669
PVRAMOU	0	0	0,5384318	0,260849	0,740159	22,075704	0,10830994	0,535889	-0,42923125	-0,18264821
*PVRRAHS**	0	0	0,04647228	0	0,159259	1,90536333	0,04275404	0,034164	0,43602433	1,03322176
PVRRRHU	0	0	1,78556275	0	5,85898863	73,2080727	1,33367954	1,6480588	1,31103977	1,18886444
PVRRIN1	0	0	68,3739643	4	181,9	2803,33254	52,5239515	56,9375	-0,75856925	0,61453112
*PVRRIN2**	0	0	7,84804142	0	42,5	321,769698	11,2627049	2,89830508	2,81618317	1,86767526

CORRÉLATION - VULNÉRABILITÉ

Attribute	*PVSGPTE*	*PVSGPFR*	*PVSBFEA*	*PVSBE5A*	*PVSBP50*	*PVSBCHR*	*PVSBFIM*	*PVSBSI1*	*PVRAEDU*	*PVRAMOU*	*PVRRAHS*	*PVRRRHU*	*PVRRIN1*	*PVRRIN2*
PVSGPTE	1	-0,6109	-0,8617	0,24	-0,0795	-0,5545	0,6651	-0,4156	0,6916	0,3587	0,589	-0,1032	0,4499	0,1096
PVSGPFR	-0,6109	1	0,2802	-0,4374	0,189	0,4596	-0,0688	-0,0915	-0,4211	0,1534	-0,2507	0,3124	-0,1746	-0,0176
PVSBFEA	-0,8617	0,2802	1	0,0327	-0,1646	0,4698	-0,8645	0,5119	-0,6238	-0,5037	-0,48	0,083	-0,4292	-0,0867
PVSBE5A	0,24	-0,4374	0,0327	1	-0,4458	-0,3106	-0,1149	-0,1632	0,2354	-0,3262	0,3911	-0,1075	0,1777	0,0728
PVSBP50	-0,0795	0,189	-0,1646	-0,4458	1	0,2839	0,0898	0,2727	-0,3412	0,4883	-0,428	0,2299	-0,0047	0,0155
PVSBCHR	-0,5545	0,4596	0,4698	-0,3106	0,2839	1	-0,5006	0,3788	-0,5463	0,0398	-0,4665	0,2116	-0,2947	0,0717
PVSBFIM	0,6651	-0,0688	-0,8645	-0,1149	0,0898	-0,5006	1	-0,6444	0,656	0,375	0,4238	-0,0834	0,3894	0,0991
PVSBSI1	-0,4156	-0,0915	0,5119	-0,1632	0,2727	0,3788	-0,6444	1	-0,6087	-0,1538	-0,4429	-0,0787	-0,3619	0,1168
PVRAEDU	0,6916	-0,4211	-0,6238	0,2354	-0,3412	-0,5463	0,656	-0,6087	1	-0,1564	0,6567	-0,2206	0,3286	-0,0907
PVRAMOU	0,3587	0,1534	-0,5037	-0,3262	0,4883	0,0398	0,375	-0,1538	-0,1564	1	-0,0384	0,383	0,2968	0,0483
PVRRAHS	0,589	-0,2507	-0,48	0,3911	-0,428	-0,4665	0,4238	-0,4429	0,6567	-0,0384	1	-0,0867	0,308	0,1359
PVRRRHU	-0,1032	0,3124	0,083	-0,1075	0,2299	0,2116	-0,0834	-0,0787	-0,2206	0,383	-0,0867	1	0,2891	0,0763
PVRRIN1	0,4499	-0,1746	-0,4292	0,1777	-0,0047	-0,2947	0,3894	-0,3619	0,3286	0,2968	0,308	0,2891	1	0,2304
PVRRIN2	0,1096	-0,0176	-0,0867	0,0728	0,0155	0,0717	0,0991	0,1168	-0,0907	0,0483	0,1359	0,0763	0,2304	1

** indicateurs modifiés avec winsorisation*

INFECTIONS RESPIRATOIRES

STATISTIQUES DESCRIPTIVES - DANGER

Attribute	*NoData#*	*NoData%*	*Mean*	*Min*	*Max*	*Sum*	*StdDev*	*Median*	*Kurtosis*	*Skewness*
RACDD0	0	0	54,1049854	42,1292	82,3958	2218,3044	14,9949577	43,8833	-0,9642549	0,74250835
RACDD1	0	0	54,3231756	42,2667	84,1375	2227,2502	15,3843138	43,475	-0,82638212	0,79221262
RACDD2	0	0	53,2547854	40,8042	84,3333	2183,4462	15,8046656	42,3875	-0,74688195	0,81164373
RACDD3	0	0	54,7416707	43,0333	82,4917	2244,4085	14,5931041	44,9417	-0,93126717	0,74743665
RACDD4	0	0	54,832622	42,9333	83,35	2248,1375	14,8713469	44,8667	-0,88720884	0,76309948
RATMX0	0	0	32,4367415	31,4264	34,8342	1329,9064	1,13077396	32,2334	-0,10101239	0,97595215
RATMX1	0	0	34,131022	33,0288	36,3405	1399,3719	1,09471718	33,8445	-0,49342383	0,81077633
RATMX2	0	0	35,0401488	33,8844	37,1649	1436,6461	1,0856858	34,7068	-0,691474	0,72364889
RATMX3	0	0	32,4367829	31,4267	34,8343	1329,9081	1,13082232	32,2335	-0,10118609	0,97587859
RATMX4	0	0	34,6934561	33,5753	36,7907	1422,4317	1,06267029	34,3797	-0,64160721	0,7431407
RAPCO	0	0	374,587761	0,8853099	1889,40169	15358,0982	455,636954	226,235361	3,09853727	1,86666148
RASOL	0	0	49,1025512	30,4189	80	2013,2046	13,8083097	47,1458	-0,04594765	0,77716183
RAGAZ	0	0	22,5579572	0,095797	100	924,876247	27,1412036	12,4146	2,97098774	2,0636853
RAFEU	0	0	0,69951218	0	1,564	28,6799993	0,42095369	0,781122	-0,75330017	-0,16077357
*RABDD**	0	0	0,0333905	0,00065088	0,14322144	1,36901063	0,03772546	0,02108255	1,8234221	1,56746765
RAP25	0	0	35,0650244	29,947	37,789	1437,666	1,83179212	35,368	0,6627882	-0,86005185

CORRÉLATION - DANGER

Attribute	*RACDD0*	*RACDD1*	*RACDD2*	*RACDD3*	*RACDD4*	*RATMX0*	*RATMX1*	*RATMX2*	*RATMX3*	*RATMX4*	*RAPCO*	*RASOL*	*RAGAZ*	*RAFEU*	*RABDD*	*RAP25*
RACDD0	1	0,9995	0,9985	0,9998	0,9997	0,9663	0,9789	0,9823	0,9663	0,9815	0,0666	0,043	-0,3069	0,2364	0,2555	0,274
RACDD1	0,9995	1	0,9996	0,9996	0,9998	0,9675	0,9789	0,9815	0,9675	0,981	0,0522	0,0397	-0,3158	0,2355	0,2676	0,2799
RACDD2	0,9985	0,9996	1	0,9992	0,9995	0,9696	0,9806	0,9828	0,9696	0,9825	0,0451	0,0462	-0,3101	0,2267	0,2739	0,2826
RACDD3	0,9998	0,9996	0,9992	1	1	0,9677	0,9802	0,9834	0,9677	0,9827	0,0628	0,0462	-0,3038	0,2316	0,2585	0,276
RACDD4	0,9997	0,9998	0,9995	1	1	0,9688	0,9809	0,9838	0,9688	0,9832	0,0594	0,0485	-0,3032	0,229	0,2625	0,2766
RATMX0	0,9663	0,9675	0,9696	0,9677	0,9688	1	0,9956	0,9898	1	0,9913	0,0608	0,2536	-0,1053	0,0631	0,3307	0,2172
RATMX1	0,9789	0,9789	0,9806	0,9802	0,9809	0,9956	1	0,9988	0,9956	0,9993	0,0847	0,1954	-0,1441	0,1056	0,2847	0,2556
RATMX2	0,9823	0,9815	0,9828	0,9834	0,9838	0,9898	0,9988	1	0,9898	0,9999	0,0979	0,1635	-0,1648	0,1287	0,2593	0,2749
RATMX3	0,9663	0,9675	0,9696	0,9677	0,9688	1	0,9956	0,9898	1	0,9913	0,0608	0,2536	-0,1053	0,063	0,3307	0,2171
RATMX4	0,9815	0,981	0,9825	0,9827	0,9832	0,9913	0,9993	0,9999	0,9913	1	0,0939	0,1709	-0,1598	0,1227	0,2654	0,2713
RAPCO	0,0666	0,0522	0,0451	0,0628	0,0594	0,0608	0,0847	0,0979	0,0608	0,0939	1	0,0411	0,2206	-0,1253	-0,2104	0,2554
RASOL	0,043	0,0397	0,0462	0,0462	0,0485	0,2536	0,1954	0,1635	0,2536	0,1709	0,0411	1	0,775	-0,5314	0,2112	-0,3114
RAGAZ	-0,3069	-0,3158	-0,3101	-0,3038	-0,3032	-0,1053	-0,1441	-0,1648	-0,1053	-0,1598	0,2206	0,775	1	-0,7425	-0,0469	-0,3379
RAFEU	0,2364	0,2355	0,2267	0,2316	0,229	0,0631	0,1056	0,1287	0,063	0,1227	-0,1253	-0,5314	-0,7425	1	-0,1904	0,3269
RABDD	0,2555	0,2676	0,2739	0,2585	0,2625	0,3307	0,2847	0,2593	0,3307	0,2654	-0,2104	0,2112	-0,0469	-0,1904	1	-0,2489
RAP25	0,274	0,2799	0,2826	0,276	0,2766	0,2172	0,2556	0,2749	0,2171	0,2713	0,2554	-0,3114	-0,3379	0,3269	-0,2489	1

STATISTIQUES DESCRIPTIVES - VULNÉRABILITÉ

Attribute	*NoData#*	*NoData%*	*Mean*	*Min*	*Max*	*Sum*	*StdDev*	*Median*	*Kurtosis*	*Skewness*
RVSGE5A	0	0	0,11762917	0,07856701	0,16505894	4,82279577	0,02127972	0,11429624	-0,27234512	0,29995014
RVSGP50	0	0	0,10861955	0,07201117	0,16035226	4,45340138	0,02328012	0,10475647	-1,04512975	0,25001217
RVSGPFR	0	0	0,31549637	0,18911649	0,481447	12,9353513	0,06770414	0,31068708	-0,14523144	0,14692111
*RVSBAST**	0	0	0,00123718	0,00026226	0,00316003	0,0507242	0,00079661	0,00101651	0,35346207	1,09490862
RVRAEDU	0	0	0,28474459	0,05210209	0,68769919	11,6745282	0,17341231	0,25093633	-0,52999801	0,62124669
*RVRAEVE**	0	0	0,91650291	0,4770897	0,98999431	37,5766195	0,12074472	0,96200814	4,75822547	-2,36034139
*RVRRAHS**	0	0	0,0464838	0,00014754	0,159259	1,9058356	0,04274123	0,034164	0,43754121	1,03431679
RVRRRHU	0	0	1,78556275	0	5,85898863	73,2080727	1,33367954	1,6480588	1,31103977	1,18886444

CORRÉLATION - VULNÉRABILITÉ

Attribute	*RVSGE5A*	*RVSGP50*	*RVSGPFR*	*RVSBAST*	*RVRAEDU*	*RVRAEVE*	*RVRRAHS*	*RVRRRHU*
RVSGE5A	1	-0,4223	-0,5606	-0,7068	0,9215	0,6579	0,6855	-0,2852
RVSGP50	-0,4223	1	0,189	0,1824	-0,3412	-0,0002	-0,4282	0,2299
RVSGPFR	-0,5606	0,189	1	0,3623	-0,4211	-0,2876	-0,2506	0,3124
RVSBAST	-0,7068	0,1824	0,3623	1	-0,612	-0,7021	-0,556	0,1811
RVRAEDU	0,9215	-0,3412	-0,4211	-0,612	1	0,5047	0,6565	-0,2206
RVRAEVE	0,6579	-0,0002	-0,2876	-0,7021	0,5047	1	0,4751	-0,1745
RVRRAHS	0,6855	-0,4282	-0,2506	-0,556	0,6565	0,4751	1	-0,0866
RVRRRHU	-0,2852	0,2299	0,3124	0,1811	-0,2206	-0,1745	-0,0866	1

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MÉNINGITE

STATISTIQUES DESCRIPTIVES - DANGER

Attribute	*NoData#*	*NoData%*	*Mean*	*Min*	*Max*	*Sum*	*StdDev*	*Median*	*Kurtosis*	*Skewness*
MATMX0	0	0	32,4367412	31,4263992	34,8342018	1329,90639	1,13077426	32,2333984	-0,10100697	0,97595425
MATMX1	0	0	34,1310225	33,028801	36,3404999	1399,37192	1,09471636	33,8445015	-0,49342034	0,8107775
MATMX2	0	0	35,0401491	33,8843994	37,1649017	1436,64611	1,0856864	34,7067986	-0,69147355	0,72364921
MATMX3	0	0	34,693456	33,5752983	36,790699	1422,43169	1,0626699	34,3796997	-0,64160683	0,74314042
MATMX4	0	0	37,3902439	36	39	1533	0,89101203	37	-0,63929651	0,22290574
MACDD0	0	0	54,1049849	42,1292	82,3957977	2218,30438	14,9949569	43,8833008	-0,96425494	0,74250833
MACDD1	0	0	54,3231753	42,2667007	84,1374969	2227,25019	15,384313	43,4749985	-0,82638234	0,79221256
MACDD2	0	0	53,2547843	40,8041992	84,3332977	2183,44616	15,8046648	42,3875008	-0,74688187	0,81164375
MACDD3	0	0	54,8326217	42,9333	83,3499985	2248,13749	14,8713467	44,8666992	-0,887209	0,76309943
MACDD4	0	0	53,0469413	40,4832993	83,2249985	2174,92459	15,7787271	42,2916985	-0,89918766	0,76247251
MASOL	0	0	40,435702	30,3829994	75	1657,86378	12,70599	36,4766998	2,37456891	1,87875362
MAP25	0	0	35,0650243	29,9470005	37,7890015	1437,66599	1,83179205	35,368	0,66278825	-0,86005166
MADEF	0	0	2,16234744	0	7,69086981	88,656245	1,97617683	1,61930001	0,00839069	0,86057098
MAPCO	0	0	9,95619712	0	49,3626653	408,204082	12,615046	4,11109948	1,82517179	1,46749175

CORRÉLATION - DANGER

Attribute	*MATMX0*	*MATMX1*	*MATMX2*	*MATMX3*	*MATMX4*	*MACDD0*	*MACDD1*	*MACDD2*	*MACDD3*	*MACDD4*	*MASOL*	*MAP25*	*MADEF*	*MAPCO*
MATMX0	1	0,9956	0,9898	0,9913	0,9097	0,9663	0,9675	0,9696	0,9688	0,9678	0,0511	0,2172	-0,536	0,4187
MATMX1	0,9956	1	0,9988	0,9993	0,9381	0,9789	0,9789	0,9806	0,9809	0,9799	0,0068	0,2556	-0,5005	0,4528
MATMX2	0,9898	0,9988	1	0,9999	0,9494	0,9823	0,9815	0,9828	0,9838	0,9829	-0,0176	0,2749	-0,481	0,4716
MATMX3	0,9913	0,9993	0,9999	1	0,9476	0,9815	0,981	0,9825	0,9832	0,9823	-0,0117	0,2713	-0,4845	0,4655
MATMX4	0,9097	0,9381	0,9494	0,9476	1	0,9172	0,9183	0,9221	0,9207	0,9192	-0,1179	0,4379	-0,333	0,4698
MACDD0	0,9663	0,9789	0,9823	0,9815	0,9172	1	0,9995	0,9985	0,9997	0,9998	-0,1618	0,274	-0,4201	0,5136
MACDD1	0,9675	0,9789	0,9815	0,981	0,9183	0,9995	1	0,9996	0,9998	0,9998	-0,17	0,2799	-0,4148	0,5029
MACDD2	0,9696	0,9806	0,9828	0,9825	0,9221	0,9985	0,9996	1	0,9995	0,9993	-0,1636	0,2826	-0,413	0,4897
MACDD3	0,9688	0,9809	0,9838	0,9832	0,9207	0,9997	0,9998	0,9995	1	1	-0,1572	0,2766	-0,419	0,5023
MACDD4	0,9678	0,9799	0,9829	0,9823	0,9192	0,9998	0,9998	0,9993	1	1	-0,1616	0,2767	-0,4183	0,5059
MASOL	0,0511	0,0068	-0,0176	-0,0117	-0,1179	-0,1618	-0,17	-0,1636	-0,1572	-0,1616	1	-0,3283	-0,5097	-0,2785
MAP25	0,2172	0,2556	0,2749	0,2713	0,4379	0,274	0,2799	0,2826	0,2766	0,2767	-0,3283	1	0,1459	0,0838
MADEF	-0,536	-0,5005	-0,481	-0,4845	-0,333	-0,4201	-0,4148	-0,413	-0,419	-0,4183	-0,5097	0,1459	1	-0,0592
MAPCO	0,4187	0,4528	0,4716	0,4655	0,4698	0,5136	0,5029	0,4897	0,5023	0,5059	-0,2785	0,0838	-0,0592	1

STATISTIQUES DESCRIPTIVES - VULNÉRABILITÉ

Attribute	*NoData#*	*NoData%*	*Mean*	*Min*	*Max*	*Sum*	*StdDev*	*Median*	*Kurtosis*	*Skewness*
MVSGMIG	0	0	0,11759882	0,03773242	0,31649791	4,82155159	0,06294924	0,10468594	2,09730089	1,54344575
MVSGPFR	0	0	0,31549637	0,18911649	0,481447	12,9353513	0,06770414	0,31068708	-0,14523144	0,14692111
MVSBJ10	0	0	0,15874232	0,09445046	0,20574372	6,50843519	0,02799536	0,16134859	-0,21116545	-0,60544201
*MVRAVC1**	0	0	0,88168293	0,649	1,105	36,149	0,09156458	0,87	0,96204974	-0,18606115
*MVRAVC2**	0	0	0,7959878	0,545	1,212	32,6355	0,14861059	0,766	1,80444721	1,18868495
MVRAEDU	0	0	0,28474459	0,05210209	0,68769919	11,6745282	0,17341231	0,25093633	-0,52999801	0,62124669
*MVRRAHS**	0	0	0,04647228	0	0,15925901	1,90536334	0,04275404	0,034164	0,43602466	1,03322184

CORRÉLATION - VULNÉRABILITÉ

Attribute	*MVSGMIG*	*MVSGPFR*	*MVSBJ10*	*MVRAVC1*	*MVRAVC2*	*MVRAEDU*	*MVRRAHS*
MVSGMIG	1	0,4503	-0,8704	-0,3761	-0,2765	-0,6909	-0,5301
MVSGPFR	0,4503	1	-0,5658	-0,257	-0,0275	-0,4211	-0,2507
MVSBJ10	-0,8704	-0,5658	1	0,4402	0,2101	0,833	0,6508
MVRAVC1	-0,3761	-0,257	0,4402	1	0,637	0,5049	0,4302
MVRAVC2	-0,2765	-0,0275	0,2101	0,637	1	0,2296	0,1625
MVRAEDU	-0,6909	-0,4211	0,833	0,5049	0,2296	1	0,6567
MVRRAHS	-0,5301	-0,2507	0,6508	0,4302	0,1625	0,6567	1

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7.4 Annex 4: Health Risks and Seasonality in the Kara Region

The most important health problems as experienced and perceived by the population of the Kara region have been collected and captured in the following seasonal calendar. The seasonal calendar helps to understand the annual cycle of people living in a region – the occurrence of diseases and their possible connections to work, climate and other variables. It is a useful source when planning adaptation activities. Training and awareness campaigns, for example, should not be organised when a large proportion of the youth is out of the community because they have temporarily left for Nigeria.

Table 7: Seasonal Cycle of Health Issues in the Kara Region

Health	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Malaria			■	■	■	■	■	■	■	■	■	
Meningitis	■	■									■	■
Respiratory Conditions	■	■	■								■	■
Digestive diseases	■	■	■	■		■	■	■	■			
Water-related diseases (fungus, sores)	■	■										■
Variables	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Cropping season				■	■	■	■	■	■	■	■	
Harvest	■								■	■	■	■
Low income					■	■	■	■	■			
High income									■	■	■	■
Migration			■	■	■	■	■	■	■	■		
Weather events	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Thunderstorm									■	■		
Wildfire	■											■
Floods							■	■				
High temperature	■	■	■	■								
Drought	■	■	■	■							■	■

Source: Kanté, Bébéda and Koudjoukada community members

Explanation and analysis of the seasonal calendar:

- Health risks exist throughout the year. While malaria predominates from March to November, meningitis, respiratory infections and waterborne diseases are common from November to February.
- The high-risk season for malaria overlaps with the main planting and harvesting season. This has an impact on both male and female farming activities and therefore poses a threat to food security.
- 'Digestive diseases' are common from January to April and then from July to September. The main causes of this pattern in the first quarter of the year reported at the time of data collection are the consumption of unwashed mangoes and, from June to September, the use and consumption of unclean water.
- Concerning 'water-related diseases', the main explanation given for the months of December to February was the following: 'the Fulani herders come with their cows and pollute the fodder'. Whether this statement is true or not, it reveals the social frictions between socio-economic and ethnic groups that have already caused conflict in the past and are likely to increase further with climate change.
- Interviewees are particularly concerned about the temporary migration of young people, mainly to northern Nigeria from March to October, due to the 'lack of income' in their native villages. The interviewees could not really explain what the young people were doing there, but assumed that it was 'domestic work' and 'daily wages work in the field'. As a consequence, there is a lack of such labour in Togo during the sowing season, which probably has an impact on food security. At the same time, cross-border migration increases the risk of carrying diseases to villages, such as meningitis or new diseases. This requires special attention.

7.5 Annex 5: Bar Chart Visualization for Risk, Hazard and Vulnerability Indices and Indicators for the three Diseases

Bar charts showing risk, hazard and vulnerability indices and indicators for malaria.

PREFECTURE	REGION	Risk Index	Hazard Index	Vulnerability Index	Hazard Indicators: PALTO	PAPCO	PAINO	PAEST	PAEVE	PACOE
VO	MARITIME	0,46	0,76	0,28	0,84	0,54	0,06	1,00	0,94	0,83
LACS	MARITIME	0,46	0,75	0,28	0,81	0,49	0,16	1,00	0,95	0,79
MOYEN-MONO	PLATEAUX	0,46	0,64	0,33	0,83	0,23	0,22	0,00	0,93	0,85
KPELE	PLATEAUX	0,44	0,75	0,26	0,98	0,68	0,05	0,00	0,92	0,95
BAS-MONO	MARITIME	0,43	0,68	0,28	0,83	0,57	0,21	0,00	0,93	0,97
ANIE	PLATEAUX	0,43	0,63	0,30	0,80	0,36	0,02	0,03	0,95	0,93
HAHO	PLATEAUX	0,43	0,65	0,28	0,90	0,42	0,01	0,00	0,92	0,66
DANYI	PLATEAUX	0,42	0,74	0,24	0,98	0,60	0,00	0,00	0,97	0,92
AVE	MARITIME	0,42	0,70	0,25	0,94	0,73	0,04	0,00	0,95	0,56
DISTRICT II	LOME	0,41	0,70	0,24	0,86	0,10	1,00	1,00	0,50	0,15
PLAINE DE MO	CENTRALE	0,41	0,54	0,30	0,73	0,37	0,03	0,00	0,99	0,35
TCHAOUDJO	CENTRALE	0,40	0,59	0,28	0,70	0,87	0,03	0,00	0,86	0,69
YOTO	MARITIME	0,40	0,64	0,25	0,89	0,37	0,05	0,21	0,97	0,32
ZIO	MARITIME	0,40	0,62	0,26	0,89	0,31	0,03	0,01	0,94	0,45
SOTOUBOUA	CENTRALE	0,40	0,65	0,25	0,74	1,00	0,01	0,00	0,97	0,79
OGOU	PLATEAUX	0,40	0,62	0,25	0,85	0,41	0,02	0,02	0,85	0,70
TCHAMBA	CENTRALE	0,39	0,59	0,25	0,70	0,81	0,01	0,00	0,96	0,67
EST-MONO	PLATEAUX	0,39	0,61	0,24	0,76	0,75	0,02	0,00	0,97	0,58
DISTRICT III	LOME	0,38	0,63	0,23	0,86	0,00	1,00	1,00	0,00	0,06
ASSOLI	KARA	0,38	0,57	0,25	0,69	0,87	0,05	0,00	0,83	0,47
DISTRICT I	LOME	0,37	0,47	0,29	0,86	0,37	0,00	0,00	0,00	0,05
KERAN	KARA	0,36	0,49	0,26	0,53	0,48	0,02	0,00	1,00	0,75
DISTRICT IV	LOME	0,36	0,55	0,23	0,86	0,13	1,00	0,00	0,07	0,04
OTI	SAVANES	0,36	0,43	0,30	0,45	0,37	0,01	0,06	0,98	0,58
BINAH	KARA	0,36	0,57	0,22	0,61	0,84	0,07	0,00	0,93	0,78
DANKPEN	KARA	0,35	0,48	0,26	0,58	0,42	0,03	0,01	1,00	0,42
KPENDJAL	SAVANES	0,35	0,45	0,27	0,37	0,77	0,02	0,01	0,93	0,90
TANDJOARE	SAVANES	0,34	0,44	0,27	0,40	0,56	0,07	0,00	0,99	0,77
AGOU	PLATEAUX	0,34	0,73	0,16	1,00	0,75	0,04	0,00	0,82	0,67
GOLFE	MARITME	0,34	0,55	0,21	0,86	0,13	0,16	0,00	0,74	0,18
WAWA	PLATEAUX	0,33	0,66	0,17	0,91	0,42	0,00	0,00	0,86	0,82
KOZAH	KARA	0,33	0,55	0,20	0,64	0,68	0,06	0,22	0,86	0,47
BASSAR	KARA	0,33	0,53	0,21	0,66	0,70	0,01	0,00	0,96	0,34
AMOU	PLATEAUX	0,33	0,65	0,17	0,88	0,44	0,03	0,00	0,90	0,77
DISTRICT V	LOME	0,32	0,54	0,19	0,86	0,16	1,00	0,00	0,00	0,00
BLITTA	CENTRALE	0,32	0,63	0,16	0,79	0,52	0,01	0,00	0,97	0,83
AKEBOU	PLATEAUX	0,31	0,67	0,15	0,86	0,37	0,04	0,00	0,99	1,00
DOUFELGOU	KARA	0,31	0,53	0,19	0,61	0,70	0,04	0,00	0,95	0,62
TONE	SAVANES	0,31	0,41	0,23	0,39	0,46	0,04	0,08	0,88	0,76
CINKASSE	SAVANES	0,31	0,41	0,23	0,33	0,83	0,24	0,00	0,85	0,51
KLOTO	PLATEAUX	0,30	0,69	0,13	1,00	0,72	0,08	0,00	0,60	0,50

PREFECTURE	Vulnerability Indicators: PVSGPTE	PVSGPFR	PVSBFEA	PVSBE5A	PVSBP50	PVSBCHR	PVSBFIM	PVSBSIC	PVRAEDU	PVRAMOU	PVRRAHS	PVRRRHU	PVRRIN1	PVRRIN2
VO	0,66	0,31	0,10	0,31	1,00	0,32	0,73	0,95	0,31	0,33	0,08	0,31	0,80	0,99
LACS	0,30	0,45	0,32	0,34	0,74	0,39	0,73	0,95	0,18	0,49	0,06	0,14	0,88	0,78
MOYEN-MONO	0,88	0,00	0,33	0,64	0,34	0,13	0,58	0,78	0,66	0,70	0,59	0,07	0,46	0,98
KPELE	0,71	0,59	0,21	0,41	0,44	1,00	0,58	0,54	0,20	0,07	0,17	0,28	0,42	0,95
BAS-MONO	0,74	0,27	0,11	0,15	0,77	0,83	0,73	1,00	0,25	0,36	0,11	0,11	0,73	0,00
ANIE	0,70	0,13	0,25	0,63	0,12	0,12	0,58	0,42	0,56	0,70	0,79	0,13	0,97	1,00
HAHO	0,83	0,48	0,27	0,63	0,06	0,14	0,58	0,59	0,52	0,51	0,49	0,30	0,77	0,91
DANYI	0,78	0,41	0,12	0,63	0,70	0,43	0,58	0,43	0,07	0,23	0,08	0,29	1,00	0,97
AVE	0,69	0,26	0,27	0,19	0,77	0,29	0,73	0,76	0,23	0,26	0,13	0,29	0,93	0,93
DISTRICT II	0,01	0,48	0,82	0,50	0,05	0,66	0,00	0,72	0,03	1,00	0,00	0,00	0,99	0,85
PLAINE DE MO	0,87	0,60	0,06	0,31	0,20	0,11	0,87	0,16	0,92	0,33	1,00	0,38	0,87	0,98
TCHAOUDJO	0,31	0,85	0,26	0,32	0,49	0,88	0,87	0,22	0,31	0,29	0,25	0,39	0,96	0,95
YOTO	0,68	0,32	0,20	0,41	0,64	0,15	0,73	0,94	0,26	0,37	0,20	0,21	0,60	0,62
ZIO	0,59	0,31	0,37	0,34	0,54	0,13	0,73	0,75	0,24	0,32	0,24	0,08	0,87	0,88
SOTOUBOUA	0,58	0,69	0,21	0,86	0,37	0,18	0,87	0,17	0,17	0,28	1,00	0,38	0,25	0,19
OGOU	0,58	0,40	0,36	0,48	0,16	0,29	0,58	0,51	0,32	0,57	0,54	0,34	0,69	0,97
TCHAMBA	0,61	0,60	0,17	0,59	0,20	0,27	0,87	0,24	0,51	0,55	0,54	0,29	0,17	0,77
EST-MONO	0,83	0,33	0,18	0,66	0,06	0,15	0,58	0,45	0,49	0,62	0,47	0,22	0,62	0,48
DISTRICT III	0,03	0,47	0,85	0,57	0,23	0,18	0,00	0,71	0,09	0,82	0,00	0,00	1,00	1,00
ASSOLI	0,43	0,86	0,06	0,00	0,69	0,52	0,96	0,16	0,45	0,24	0,19	0,22	0,86	1,00
DISTRICT I	0,00	0,55	1,00	0,38	0,66	1,00	0,00	0,70	0,05	0,63	0,00	0,16	0,99	0,98
KERAN	0,92	0,19	0,07	0,90	0,29	0,05	0,96	0,00	0,72	0,43	0,36	0,03	0,10	1,00
DISTRICT IV	0,00	0,53	0,92	1,00	0,54	0,50	0,00	0,70	0,00	0,63	0,00	0,68	0,88	0,86
OTI	0,92	0,26	0,08	0,81	0,22	0,20	1,00	0,01	0,80	0,64	0,75	0,24	0,57	0,36
BINAH	0,52	0,56	0,07	0,02	0,83	0,22	0,96	0,07	0,46	0,49	0,11	0,24	0,70	1,00
DANKPEN	0,99	0,06	0,10	0,45	0,05	0,09	0,96	0,01	0,91	0,57	0,55	0,19	0,58	1,00
KPENDJAL	1,00	0,02	0,00	0,96	0,22	0,00	1,00	0,04	1,00	0,48	0,57	0,29	0,16	0,93
TANDJOARE	0,89	0,36	0,10	0,64	0,32	0,07	1,00	0,01	0,53	0,49	0,35	0,16	0,87	0,96
AGOU	0,78	0,25	0,20	0,34	0,79	0,27	0,58	0,65	0,24	0,17	0,14	0,65	0,10	0,49
GOLFE	0,03	0,64	0,79	0,22	0,00	0,21	0,55	0,79	0,03	0,66	0,01	0,05	0,81	0,83
WAWA	0,68	0,42	0,15	0,43	0,44	0,21	0,58	0,32	0,14	0,00	0,16	0,08	0,48	1,00
KOZAH	0,33	1,00	0,33	0,16	0,58	0,33	0,96	0,10	0,12	0,15	0,08	0,45	0,95	0,93
BASSAR	0,67	0,63	0,06	0,01	0,57	0,24	0,96	0,07	0,61	0,31	0,45	0,37	0,00	0,96
AMOU	0,76	0,33	0,21	0,36	0,53	0,26	0,58	0,40	0,15	0,08	0,31	0,54	0,56	0,88
DISTRICT V	0,00	0,73	0,96	0,31	0,24	1,00	0,00	0,72	0,01	0,63	0,00	0,87	0,78	0,68
BLITTA	0,75	0,42	0,22	0,36	0,23	0,20	0,87	0,28	0,33	0,22	0,27	0,31	0,51	0,00
AKEBOU	0,92	0,01	0,18	0,54	0,19	0,23	0,58	0,34	0,27	0,05	0,31	0,51	0,62	1,00
DOUFELGOU	0,70	0,59	0,15	0,42	0,74	0,23	0,96	0,05	0,40	0,26	0,24	0,76	0,14	0,72
TONE	0,74	0,33	0,14	0,65	0,27	0,03	1,00	0,05	0,59	0,56	0,21	0,22	0,48	0,81
CINKASSE	0,58	0,38	0,28	0,36	0,17	0,15	1,00	0,05	0,75	0,61	0,11	0,25	0,78	0,89
KLOTO	0,34	0,65	0,41	0,23	0,55	0,40	0,58	0,56	0,08	0,20	0,06	1,00	0,27	0,95

Bar charts representing risk, hazard and vulnerability indices and indicators for respiratory infections/conditions.

					Hazard Indicators								Vulnerability Indicators							
PREFECTURE	REGION	Risk Index	Hazard Index	Vulnerability Index	CDD0	TMX0	RAPCO	RASOL	RAGAZ	RAFEU	RABDD	RAP25	RVSGE5A	RVSGP50	RVSGPFR	RVSBAST	RVRAEDU	RVRAEVE	RVRRAHS	RVRRRHU
OTI	SAVANES	0,55	0,56	0,55	0,96	0,59	0,00	0,52	0,07	0,54	0,20	0,75	0,81	0,22	0,26	0,31	0,80	0,98	0,75	0,24
KPENDJAL	SAVANES	0,55	0,61	0,50	0,96	0,59	0,03	0,56	0,08	0,61	0,54	0,81	0,96	0,22	0,02	0,01	1,00	0,95	0,57	0,29
TANDJOARE	SAVANES	0,53	0,65	0,43	0,96	0,59	0,04	0,54	0,09	0,55	1,00	0,95	0,64	0,32	0,36	0,06	0,53	0,99	0,35	0,16
DOUFELGOU	KARA	0,51	0,49	0,53	0,65	0,33	1,00	0,29	0,11	0,58	0,14	0,77	0,42	0,74	0,59	0,16	0,40	0,96	0,24	0,76
TONE	SAVANES	0,50	0,60	0,41	0,96	0,59	0,12	0,56	0,12	0,22	1,00	0,52	0,65	0,27	0,33	0,12	0,59	0,91	0,21	0,22
CINKASSE	SAVANES	0,48	0,57	0,41	0,96	0,59	0,12	0,59	0,20	0,17	0,23	0,91	0,57	0,17	0,38	0,13	0,75	0,88	0,11	0,25
DANKPEN	KARA	0,47	0,43	0,51	0,65	0,33	0,15	0,46	0,09	1,00	0,00	0,54	1,00	0,05	0,06	0,29	0,91	1,00	0,55	0,19
BASSAR	KARA	0,46	0,39	0,55	0,65	0,33	0,06	0,16	0,09	0,79	0,02	0,57	0,63	0,57	0,63	0,16	0,61	0,97	0,45	0,37
BINAH	KARA	0,46	0,44	0,47	0,65	0,33	0,55	0,45	0,14	0,47	0,17	0,56	0,38	0,83	0,56	0,27	0,46	0,94	0,10	0,24
ASSOLI	KARA	0,45	0,40	0,50	0,65	0,33	0,27	0,07	0,12	0,50	0,03	0,91	0,36	0,69	0,86	0,37	0,45	0,87	0,19	0,22
PLAINE DE MO	CENTRALE	0,45	0,32	0,63	0,44	0,20	0,16	0,10	0,00	0,95	0,01	0,74	0,86	0,20	0,60	0,07	0,92	0,99	1,00	0,38
KERAN	KARA	0,44	0,45	0,44	0,65	0,33	0,53	0,38	0,11	0,70	0,11	0,61	0,90	0,29	0,19	0,02	0,72	1,00	0,36	0,03
KOZAH	KARA	0,43	0,42	0,44	0,65	0,33	0,11	0,34	0,18	0,42	0,39	0,64	0,16	0,58	1,00	0,26	0,12	0,90	0,08	0,45
TCHAOUDJO	CENTRALE	0,42	0,34	0,52	0,44	0,20	0,41	0,09	0,11	0,41	0,23	0,93	0,32	0,49	0,85	0,65	0,31	0,89	0,25	0,39
TCHAMBA	CENTRALE	0,39	0,32	0,48	0,44	0,20	0,29	0,22	0,08	0,46	0,06	0,85	0,59	0,20	0,60	0,18	0,51	0,97	0,54	0,29
SOTOUBOUA	CENTRALE	0,39	0,31	0,51	0,44	0,20	0,13	0,14	0,04	0,59	0,12	0,75	0,31	0,37	0,69	0,15	0,17	0,98	1,00	0,38
DISTRICT V	LOME	0,36	0,33	0,39	0,07	0,14	0,50	1,00	0,95	0,00	0,23	0,62	0,02	0,24	0,73	1,00	0,01	0,24	0,00	0,87
BLITTA	CENTRALE	0,34	0,29	0,40	0,44	0,20	0,04	0,16	0,09	0,51	0,03	0,69	0,50	0,23	0,42	0,18	0,33	0,98	0,27	0,31
DISTRICT IV	LOME	0,32	0,27	0,38	0,07	0,14	0,22	1,00	0,75	0,00	0,04	0,58	0,01	0,54	0,53	1,00	0,00	0,30	0,00	0,68
DISTRICT II	LOME	0,31	0,35	0,27	0,07	0,14	0,71	0,83	0,88	0,01	0,35	0,74	0,19	0,05	0,48	0,79	0,03	0,62	0,00	0,00
HAHO	PLATEAUX	0,30	0,20	0,46	0,03	0,01	0,03	0,38	0,08	0,85	0,13	0,84	0,63	0,06	0,48	0,26	0,52	0,94	0,49	0,30
DISTRICT I	LOME	0,30	0,29	0,30	0,07	0,14	0,20	1,00	1,00	0,00	0,04	0,58	0,00	0,66	0,55	1,00	0,05	0,00	0,00	0,16
AKEBOU	PLATEAUX	0,29	0,22	0,37	0,03	0,01	0,92	0,07	0,14	0,43	0,00	1,00	0,54	0,19	0,01	0,11	0,27	0,99	0,30	0,51
KPELE	PLATEAUX	0,28	0,17	0,47	0,03	0,01	0,26	0,11	0,15	0,73	0,03	0,64	0,41	0,44	0,59	0,71	0,20	0,94	0,16	0,28
AMOU	PLATEAUX	0,28	0,18	0,42	0,03	0,01	0,16	0,13	0,08	0,68	0,21	0,84	0,36	0,53	0,33	0,22	0,15	0,93	0,31	0,54
ZIO	MARITIME	0,28	0,20	0,38	0,03	0,00	0,01	0,45	0,13	0,60	0,73	0,46	0,34	0,54	0,31	0,30	0,24	0,96	0,24	0,08
ANIE	PLATEAUX	0,28	0,17	0,44	0,03	0,01	0,02	0,34	0,06	0,55	0,01	0,97	0,63	0,12	0,13	0,19	0,56	0,96	0,79	0,13
OGOU	PLATEAUX	0,27	0,17	0,43	0,03	0,01	0,07	0,36	0,08	0,60	0,11	0,74	0,48	0,16	0,40	0,29	0,32	0,88	0,54	0,34
AVE	MARITIME	0,27	0,16	0,45	0,03	0,00	0,00	0,28	0,12	0,61	0,37	0,49	0,36	0,77	0,26	0,62	0,23	0,96	0,13	0,29
MOYEN-MONO	PLATEAUX	0,27	0,18	0,41	0,03	0,01	0,09	0,30	0,10	0,60	0,05	0,89	0,64	0,34	0,00	0,00	0,66	0,95	0,59	0,07
EST-MONO	PLATEAUX	0,27	0,17	0,42	0,03	0,01	0,15	0,32	0,08	0,50	0,03	0,89	0,66	0,06	0,33	0,12	0,49	0,98	0,47	0,22
GOLFE	MARITME	0,27	0,23	0,31	0,07	0,14	0,04	0,70	0,41	0,11	0,69	0,17	0,22	0,00	0,64	0,73	0,03	0,80	0,01	0,05
YOTO	MARITIME	0,27	0,17	0,41	0,03	0,00	0,10	0,32	0,16	0,63	0,27	0,51	0,41	0,64	0,32	0,24	0,26	0,98	0,20	0,21
KLOTO	PLATEAUX	0,26	0,15	0,45	0,03	0,01	0,16	0,03	0,18	0,18	0,75	0,34	0,23	0,55	0,65	0,30	0,08	0,70	0,06	1,00
AGOU	PLATEAUX	0,25	0,13	0,48	0,03	0,01	0,01	0,07	0,11	0,61	0,17	0,53	0,34	0,79	0,25	0,57	0,24	0,86	0,14	0,65
LACS	MARITIME	0,25	0,15	0,41	0,03	0,00	0,00	0,40	0,27	0,18	0,30	0,52	0,34	0,74	0,45	0,43	0,18	0,96	0,06	0,14
BAS-MONO	MARITIME	0,25	0,14	0,42	0,03	0,00	0,02	0,38	0,12	0,47	0,27	0,36	0,45	0,77	0,27	0,47	0,25	0,95	0,11	0,11
DANYI	PLATEAUX	0,21	0,12	0,38	0,03	0,01	0,14	0,01	0,21	0,23	0,04	0,72	0,31	0,70	0,41	0,18	0,07	0,97	0,08	0,29
DISTRICT III	LOME	0,21	0,24	0,19	0,07	0,14	0,16	0,91	1,00	0,00	0,06	0,07	0,15	0,23	0,47	0,35	0,09	0,24	0,00	0,00
VO	MARITIME	0,21	0,10	0,46	0,03	0,00	0,02	0,45	0,18	0,17	0,25	0,00	0,31	1,00	0,31	0,41	0,31	0,95	0,08	0,31
WAWA	PLATEAUX	0,19	0,11	0,34	0,03	0,01	0,11	0,00	0,23	0,13	0,01	0,73	0,43	0,44	0,42	0,12	0,14	0,89	0,16	0,08

Bar charts representing risk, hazard and vulnerability indices and indicators for meningitis

PREFECTURE	REGION	Risk Index	Hazard Index	Vulnerability Index	TMX0	CDD0	MASOL	MAP25	MADEF	MAPCO
					Hazard Indicators					
KPENDJAL	SAVANES	0,45	0,55	0,37	0,59	0,96	0,23	0,81	0,02	0,25
OTI	SAVANES	0,42	0,56	0,31	0,59	0,96	0,20	0,75	0,03	0,42
CINKASSE	SAVANES	0,39	0,56	0,28	0,59	0,96	0,23	0,91	0,00	0,22
TCHAMBA	CENTRALE	0,39	0,44	0,35	0,20	0,44	0,08	0,85	1,00	0,28
TONE	SAVANES	0,39	0,52	0,29	0,59	0,96	0,21	0,52	0,00	0,34
PLAINE DE MO	CENTRALE	0,38	0,30	0,48	0,20	0,44	0,03	0,74	0,33	0,00
ASSOLI	KARA	0,37	0,46	0,31	0,33	0,65	0,02	0,91	0,20	0,56
BASSAR	KARA	0,37	0,42	0,33	0,33	0,65	0,06	0,57	0,22	0,55
KOZAH	KARA	0,37	0,49	0,27	0,33	0,65	0,18	0,64	0,16	1,00
SOTOUBOUA	CENTRALE	0,35	0,33	0,37	0,20	0,44	0,06	0,75	0,21	0,37
TANDJOARE	SAVANES	0,35	0,55	0,22	0,59	0,96	0,20	0,95	0,01	0,14
BINAH	KARA	0,35	0,44	0,28	0,33	0,65	0,30	0,56	0,03	0,65
DOUFELGOU	KARA	0,34	0,43	0,26	0,33	0,65	0,11	0,77	0,19	0,41
DANKPEN	KARA	0,33	0,37	0,30	0,33	0,65	0,17	0,54	0,05	0,25
KERAN	KARA	0,33	0,42	0,26	0,33	0,65	0,14	0,61	0,14	0,47
TCHAOUDJO	CENTRALE	0,32	0,34	0,30	0,20	0,44	0,03	0,93	0,34	0,15
BLITTA	CENTRALE	0,30	0,34	0,26	0,20	0,44	0,06	0,69	0,58	0,13
EST-MONO	PLATEAUX	0,27	0,24	0,31	0,01	0,03	0,11	0,89	0,71	0,10
ANIE	PLATEAUX	0,26	0,20	0,35	0,01	0,03	0,11	0,97	0,37	0,03
HAHO	PLATEAUX	0,26	0,20	0,34	0,01	0,03	0,15	0,84	0,21	0,31
DISTRICT II	LOME	0,25	0,25	0,26	0,14	0,07	0,73	0,74	0,09	0,01
AKEBOU	PLATEAUX	0,23	0,26	0,20	0,01	0,03	0,05	1,00	0,59	0,33
OGOU	PLATEAUX	0,22	0,16	0,31	0,01	0,03	0,12	0,74	0,23	0,08
MOYEN-MONO	PLATEAUX	0,22	0,17	0,28	0,01	0,03	0,11	0,89	0,23	0,00
KPELE	PLATEAUX	0,21	0,18	0,26	0,01	0,03	0,04	0,64	0,65	0,00
DISTRICT V	LOME	0,21	0,26	0,17	0,14	0,07	1,00	0,62	0,03	0,01
GOLFE	MARITIME	0,21	0,17	0,25	0,14	0,07	0,57	0,17	0,18	0,00
DISTRICT III	LOME	0,20	0,18	0,22	0,14	0,07	0,89	0,07	0,01	0,00
WAWA	PLATEAUX	0,19	0,19	0,20	0,01	0,03	0,00	0,73	0,63	0,08
DISTRICT IV	LOME	0,19	0,25	0,15	0,14	0,07	1,00	0,58	0,00	0,00
KLOTO	PLATEAUX	0,19	0,25	0,14	0,01	0,03	0,02	0,34	0,66	0,94
AMOU	PLATEAUX	0,19	0,19	0,18	0,01	0,03	0,05	0,84	0,55	0,03
DANYI	PLATEAUX	0,17	0,16	0,18	0,01	0,03	0,01	0,72	0,45	0,00
DISTRICT I	LOME	0,16	0,25	0,10	0,14	0,07	1,00	0,58	0,00	0,00
AGOU	PLATEAUX	0,16	0,13	0,19	0,01	0,03	0,03	0,53	0,33	0,08
ZIO	MARITIME	0,15	0,14	0,18	0,00	0,03	0,17	0,46	0,39	0,00
YOTO	MARITIME	0,15	0,19	0,12	0,00	0,03	0,14	0,51	0,80	0,03
BAS-MONO	MARITIME	0,15	0,12	0,18	0,00	0,03	0,16	0,36	0,39	0,00
LACS	MARITIME	0,14	0,11	0,19	0,00	0,03	0,21	0,52	0,08	0,03
AVE	MARITIME	0,13	0,10	0,17	0,00	0,03	0,10	0,49	0,17	0,00
VO	MARITIME	0,10	0,06	0,15	0,00	0,03	0,17	0,00	0,26	0,02

PREFECTURE	MVSGMIG	MVSGPFR	MVSBJ10	MVRAVC1	MVRAVC2	MVRAEDU	MVRRAHS
	Vulnerability Indicators						
KPENDJAL	0,10	0,02	1,00	0,43	0,61	1,00	0,57
OTI	0,10	0,26	0,90	0,00	0,12	0,80	0,75
CINKASSE	0,21	0,38	0,70	0,42	0,63	0,75	0,11
TCHAMBA	0,24	0,60	0,74	0,30	0,70	0,51	0,54
TONE	0,13	0,33	0,82	0,57	0,79	0,59	0,21
PLAINE DE MO	0,09	0,60	0,83	0,34	0,54	0,92	1,00
ASSOLI	0,24	0,86	0,60	0,39	0,62	0,45	0,19
BASSAR	0,15	0,63	0,70	0,34	0,54	0,61	0,45
KOZAH	0,40	1,00	0,34	0,80	0,59	0,12	0,08
SOTOUBOUA	0,27	0,69	0,52	0,44	0,68	0,17	1,00
TANDJOARE	0,07	0,36	0,79	0,43	0,00	0,53	0,35
BINAH	0,20	0,56	0,61	0,65	0,79	0,46	0,11
DOUFELGOU	0,17	0,59	0,54	0,52	0,75	0,40	0,24
DANKPEN	0,07	0,06	0,89	0,09	0,57	0,91	0,55
KERAN	0,11	0,19	0,81	0,25	0,49	0,72	0,36
TCHAOUDJO	0,28	0,85	0,48	0,64	0,54	0,31	0,25
BLITTA	0,22	0,42	0,64	0,63	0,79	0,33	0,27
EST-MONO	0,24	0,33	0,75	0,43	0,68	0,49	0,47
ANIE	0,22	0,13	0,72	0,58	0,83	0,56	0,79
HAHO	0,14	0,48	0,81	0,55	0,64	0,52	0,49
DISTRICT II	0,85	0,48	0,19	1,00	1,00	0,03	0,00
AKEBOU	0,11	0,01	0,90	0,52	0,72	0,27	0,31
OGOU	0,35	0,40	0,59	0,60	0,77	0,32	0,54
MOYEN-MONO	0,00	0,00	0,94	0,40	0,61	0,66	0,59
KPELE	0,27	0,59	0,54	0,67	0,90	0,20	0,17
DISTRICT V	0,85	0,73	0,04	0,29	0,53	0,01	0,00
GOLFE	1,00	0,64	0,24	0,49	0,71	0,03	0,01
DISTRICT III	0,63	0,47	0,13	1,00	1,00	0,09	0,00
WAWA	0,25	0,42	0,59	0,57	0,71	0,14	0,16
DISTRICT IV	0,58	0,53	0,08	0,65	0,75	0,00	0,00
KLOTO	0,40	0,65	0,32	0,52	0,17	0,08	0,06
AMOU	0,25	0,33	0,55	0,46	0,55	0,15	0,31
DANYI	0,29	0,41	0,50	0,53	0,87	0,07	0,08
DISTRICT I	0,59	0,55	0,00	0,36	0,47	0,05	0,00
AGOU	0,33	0,25	0,47	0,59	0,78	0,24	0,14
ZIO	0,37	0,31	0,53	0,20	0,53	0,24	0,24
YOTO	0,17	0,32	0,64	0,24	0,00	0,26	0,20
BAS-MONO	0,10	0,27	0,68	0,61	0,67	0,25	0,11
LACS	0,37	0,45	0,45	0,54	0,67	0,18	0,06
AVE	0,25	0,26	0,49	0,62	0,67	0,23	0,13
VO	0,09	0,31	0,63	0,43	0,59	0,31	0,08

7.6 Annex 6: Outcome of the Assessment for the Selection of Three Climate-Sensitive Diseases

Assessment by DHAB and GIZ:

CRITERIA / DISEASES ASSESSED	a) Gaps in funding, partner interventions and existing programmes	b) Availability of data to carry out the assessment	c) Priority of the MSPHS (Togolese Ministry of Health)	d) Impact: DALY, QUALY, morbidity, mortality	e) Existing capacity to respond	g) Impact of climate change (targets and degree of severity)	MEAN
	1= Existence of a programme coupled with a long-term (5 years) and sufficient funding agreement with partners	1= Data not available	1= Not included in any plan	1= g	1= No proven expertise	1= Minor relationship	
	2= Existence of a programme coupled with a funding agreement but insufficient (for the country or intervention)	2= Data collected sporadically	2= Included in operational plans	2= gh	2= Lack of expertise and technical facilities	2= Indirect impact on all targets	
	3= Existence of a programme with no funding agreement	3= Database available and accessible for 1 year	3= Included in the strategic plans of directorates/divisions	3= hg	3= Availability of expertise, but inadequate technical facilities	3= Direct impact on all targets	
	4= No programme but activities carried out	4= Database available and accessible for 1–10 years	4= In line with PNDS priorities	4= hj	4= Existence of a non-decentralised programme	4= Direct and temporary impact on vulnerable targets	
	5= No funding	5= Database available and accessible for at least 10 years	5= In line with PNDS priorities and international guidelines	5= jj	5= Existence of a programme (HR, Logistics, decentralised) with a proven track record	5= Direct and permanent impact on vulnerable targets (children, women)	
Malaria	1	5	5	5	5	5	4.20
Respiratory Infections	4	4	2	3	4	5	3.80
Meningitis	4	3	4	4	4	5	4.00

Malnutrition	2	3	3	3	4	3	3.00
Cholera	3	4	3	5	4	5	3.80
Diarrhoeal diseases	3	3	2	4	4	4	3.20
Cardiovascular diseases	4	2	2	1	2	2	2.40
Skin diseases	4	2	2	2	2	2	2.40
Accidents	5	2	1	3	1	1	2.00
HIV/AIDS	1	4	4	4	2	1	2.40
Hepatitis A	4	2	1	1	2	1	2.00
Rabies	5	2	1	1	2	1	2.20
Others (Lassa fever, etc.)	5	2	2	1	1	2	2.40

- **Evaluation by the consultants:**

CRITERIA / DISEASES ASSESSED	a) Gaps in funding, partner interventions and existing programmes	b) Availability of data to carry out the assessment	c) Priority of the MSPHS (Togolese Ministry of Health)	d) Impact: DALY, QUALY, morbidity, mortality	e) Existing capacity to respond	g) Impact of climate change (targets and degree of severity)	MEAN
	1= Existence of a programme coupled with a long-term (5 years) and sufficient funding agreement with partners	1= Data not available	1= Not included in any plan	1= g	1= No proven expertise	1= Minor relationship	
	2= Existence of a programme coupled with a funding agreement but insufficient (for the country or intervention)	2= Data collected sporadically	2= Included in operational plans	2= gh	2= Lack of expertise and technical facilities	2= Indirect impact on all targets	
	3= Existence of a programme with no funding agreement	3= Database available and accessible for 1 year	3= Included in the strategic plans of directorates/divisions	3= hg	3= Availability of expertise, but inadequate technical facilities	3= Direct impact on all targets	
	4= No programme but activities carried out	4= Database available and accessible for 1–10 years	4= In line with PNDS priorities	4= hj	4= Existence of a non-decentralised programme	4= Direct and temporary impact on vulnerable targets	
	5= No funding	5= Database available and accessible for at least 10 years	5= In line with PNDS priorities and international guidelines	5= jj	5= Existence of a programme (HR, Logistics, decentralised) with a proven track record	5= Direct and permanent impact on vulnerable targets (children, women)	
Malaria	3	5	5	5	5	5	4.71
Respiratory Infections	2	3	4	3	4	2.5	3.07
Meningitis	2	1.5	3	4	2	2	2.29
Malnutrition	2	3	3	3	4	4	3.14

Cholera	2	2.5	2	5	3	4	3.00
Diarrhoeal diseases	1	3.5	3	4	4	4	3.29
Cardiovascular diseases	5	1.5	1	1	1	2	1.86
Skin diseases	3	2.5	1	2	3	2	2.00
Accidents	5	1.5	2	3	3	2	2.43
HIV/AIDS	1	3	2	4	4	1	2.43
Hepatitis A	2	2	1	1	1	3	1.71
Rabies	4	1	1	1	1	2	1.57
Others (Lassa fever, etc.)	1	0.5	1	1	1	2	1.00