

Hydro-Climatic Factors and Health Problems in the Town of Ouéllé (Central-Eastern Côte d'Ivoire)

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ABSTRACT: This article deals with hydro-climatic factors and their health impacts in the town of Ouéllé in a context of climate change. The aim of this study is to show the impact of hydro-climatic determinants on the spatial distribution of pathologies in the town of Ouéllé. The methodological approach used was based on data collection techniques ranging from documentary research to field surveys. Interviews were conducted with experts, while questionnaires were administered to 100 people living in the urban area of Ouéllé. In addition, photographs of the spatial units were taken using a Redmi 9A smartphone, followed by the collection of geospatial data using the UTM Geo map mobile application for data collected in KML (Keyhole Markup Language) format on the Android operating system. We also used statistical data analysis techniques to process the data.

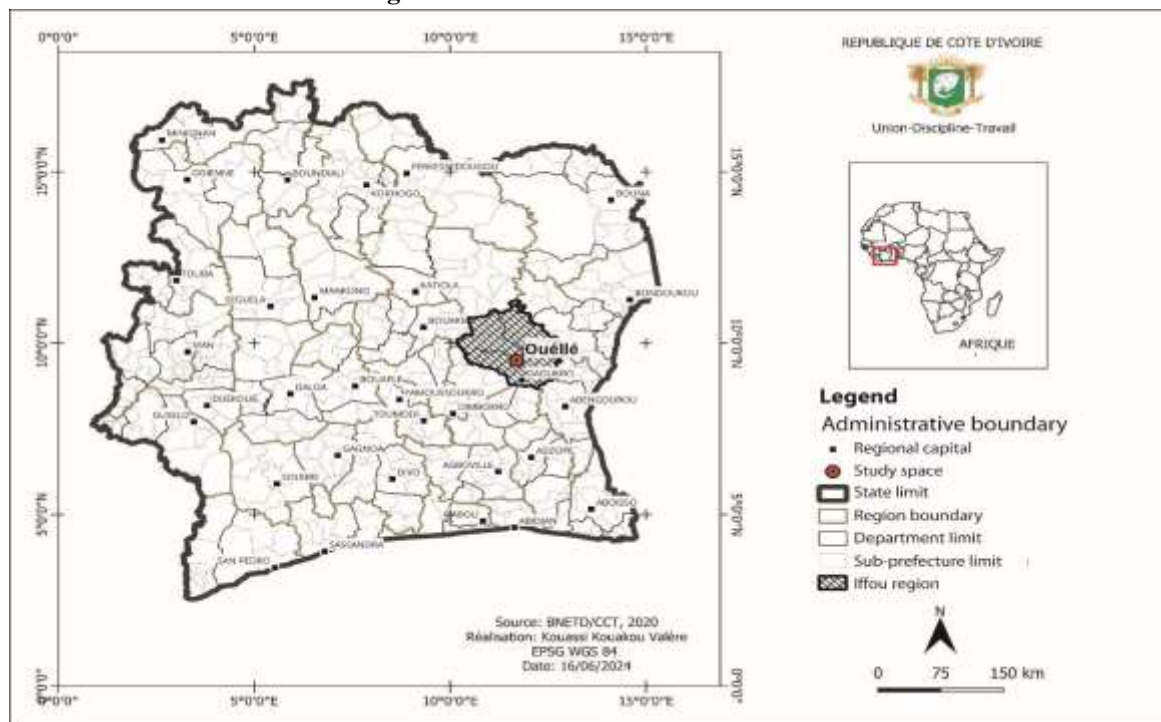
The results showed that the main hydro-climatic factors in Ouéllé are rainfall, temperature and wind. The diseases linked to these hydro-climatic factors are malaria, which is the main health risk, accounting for 63% of consultations in 2023, followed by typhoid fever (8%) and acute respiratory infections (ARI) (3%).

KEYWORDS: Ouéllé, Factor hydro-climatic, Health problems

I. INTRODUCTION

Urbanisation is a fast-growing phenomenon throughout the world, particularly in the least developed countries. Cities continue to expand exponentially from city centres to the outskirts, with ever larger populations. Unfortunately, in most cases in the least developed countries, this growth does not go hand in hand with urban planning standards. "This poorly controlled growth is increasingly generating needs in terms of decent housing, access to drinking water, sanitation and healthcare" (Tapé S. P., 2023, p 250). Today, the quality of the urban environment leaves much to be desired, with the existence of liquid waste, household refuse and water and air pollution. These urban problems are tending to increase with the effects of climate variability, the current and future consequences of which are worrying a large number of political and institutional players. West Africa is one of the regions most vulnerable to climate change because of its economic, social and demographic structures (Ardoine-Bardin S., 2004, p11). The consequences can be seen in the water cycles through long periods of drought or excess water (Afouda and al., 2007; Goula and al., 2006, cited by Kouamassi H., 2014, p11). The periodic and spatial variability of these two (02) factors, notably drought and the long rainy season, has an impact on the physical environment, populations, economic activities and particularly on human health. The towns of Côte d'Ivoire, and specifically Ouéllé, are not immune to this reality. Ouéllé, located in the central-east of Côte d'Ivoire, is subject to the effects of climate change at a time when it is already experiencing exceptional demographic growth.

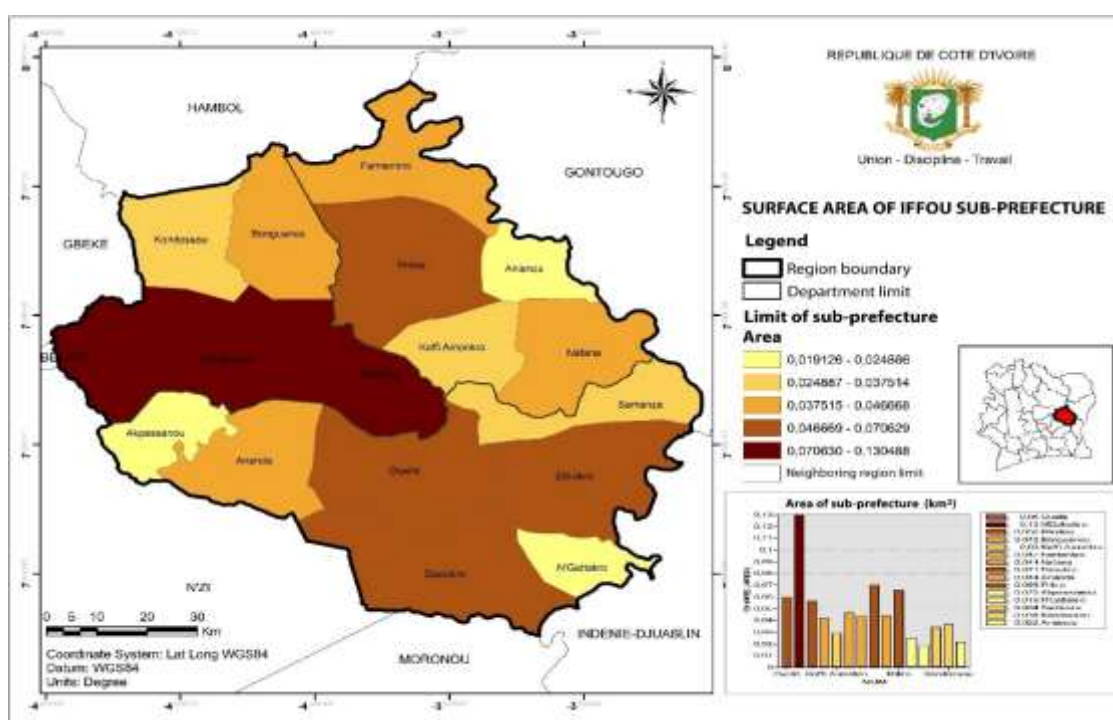
Figure 1: Location of the town of Ouéllé



The uncontrolled growth of this town is due to the intense gold panning activities of the last five (05) years, which have resulted in a large population and a shortage of water. These problems are experienced on a daily basis by the town's inhabitants, causing serious damage to the health of the population, particularly the most disadvantaged. The aim of this study is to conduct a spatial analysis of hydro-climatic factors and their impact on health in Ouéllé. The town is built on a gently sloping site with hills and low-lying areas. The hydrographic network consists of small seasonal streams. The Baulean climate is composed of 04 seasons, 02 of which are rainy and 02 dry.

Location of the town of Ouéllé

The urban area of Ouéllé covers an area of 1558 m² with an estimated population of 37641 inhabitants (INS, RGPH 2021) made up of 20011 men, i.e. 53.2% and 17630 women, i.e. 46.8%. Part of the Iffou region, it lies at the crossroads of the Daoukro, Prikro and N'Bahiakro departments (Figure 1).



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II. DATA COLLECTION AND PROCESSING METHODOLOGY

A. Data collection

The research methodology is based on documentary research and data collection in the field.

The documentary research was based on theses, scientific articles and dissertations obtained online. The documents consulted relate to the various hydroclimatic factors in general and in the region, climate-related diseases, strategies implemented to combat diseases, endemic areas and factors in the distribution of climate-related diseases in cities. With regard to the field surveys, interviews were conducted with experts in public and private health care provision in the study town. These were 03 nurses, 02 doctors and the head doctor of the town's general hospital. Interviews were conducted with administrative officials and urban management experts, in particular those in charge of the municipality's technical department, the environment and drinking water distribution (SODECI). Questionnaires were also administered to 100 individuals selected on the basis of age (over 18), length of time in the town (having spent at least 5 years in Ouélé) and professional status. The data was collected using the snowball method, which consisted of sharing our questionnaire with people of similar characteristics, who in turn recommended other resource persons with similar profiles to respond to our document and circulate it to others, and so on. The purpose of these exchanges was to obtain information on pathologies, their distribution in the city, waste collection and treatment methods, unhealthy neighbourhoods, and spatial entities with difficult access to water.

Field observation consisted of visits to health establishments in different parts of the city, endemic areas, urban vegetation and unhealthy areas. Photographs of the spatial units were taken using a Redmi 9A smartphone, followed by the collection of geospatial data using the UTM Geo map mobile application for data collected in KML (Keyhole Markup Language) format on the Android operating system. The coordinates collected included wells, boreholes, health centres and clinics, pharmacies, illegal dumps and schools.

B. Data processing

The data collected was processed and analysed using statistical data analysis methods and the interface of various software packages: Microsoft Excel (Microsoft Office 365) for organising, processing and producing diagrams and tables, integration of the processed geospatial data into the GIS (Geographic Information System) software, ArcGIS version 10.8 for cartographic production, and Microsoft Word (Microsoft Office 365) for text input.

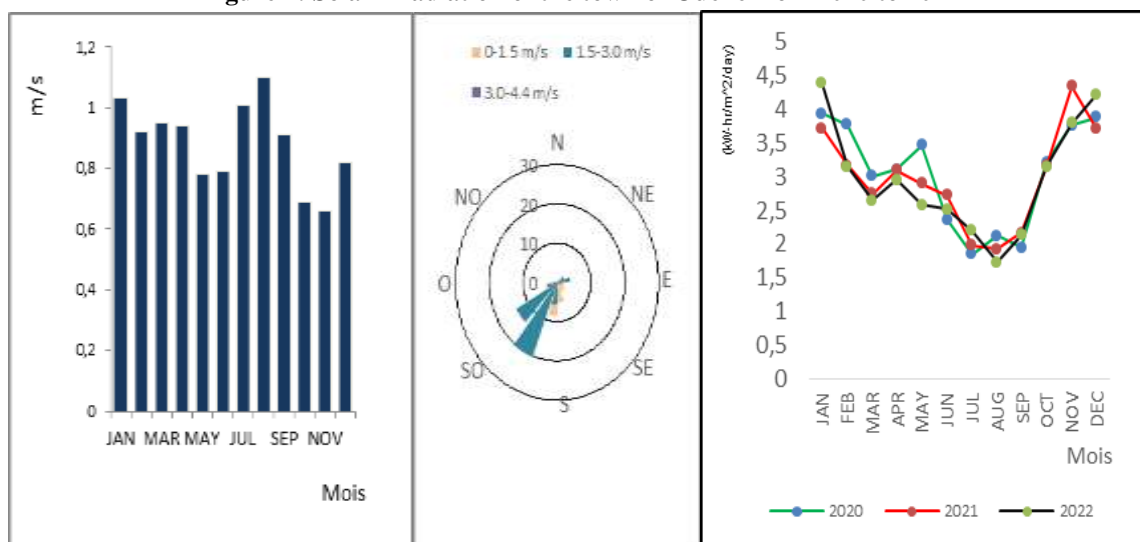
III. RESULTS

A. Identification of hydro-climatic factors

1) Wind direction and speed

The figure shows the monthly mean wind speed, the frequency of wind speeds in different ranges from 0-1.5 m/s to 3.0-4.4+ m/s, and the percentage contribution of each direction to the total observed wind speed. The highest average wind speed direction of 1.73 m/s is South-South-West (SSW) (Figures 2 and 3). The windiest seasons are the harmattan period (December to March) and the rainy season (June to September). The winds are stronger and favour rainfall.

Figure 2: Solar irradiation of the town of Ouélé from 2020 to 2022



Source: NASA/POWER CERES/MERRA2 Native Resolution Monthly and Annual

Dates (month/day/year): 01/01/2020 through 12/31/2022]

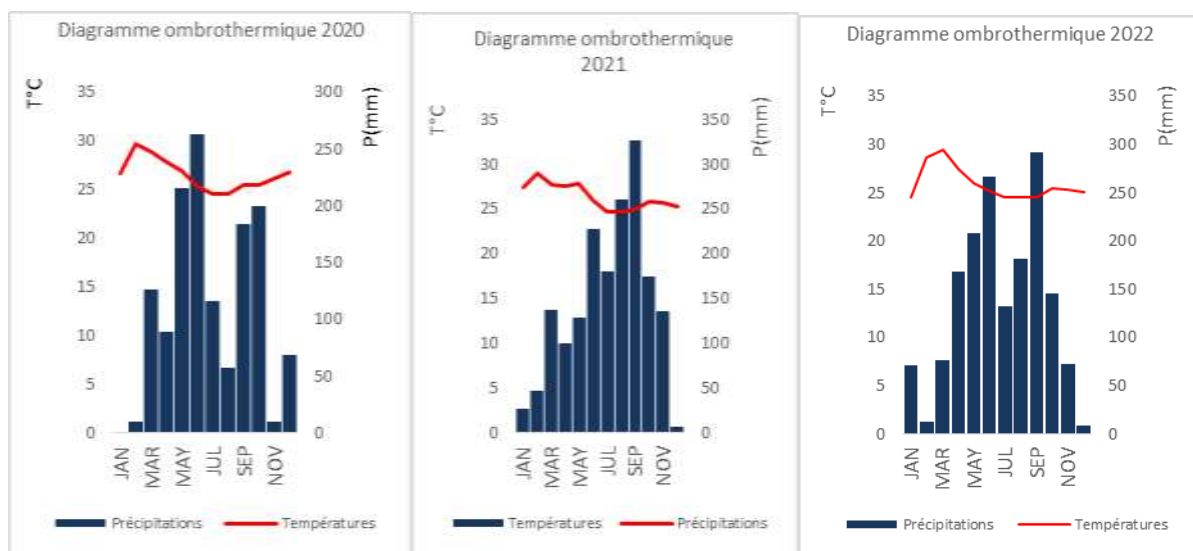
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Overall, sunshine is strong at the start of the year with 3.94 kW-hr/m² per day and gradually decreases, reaching its lowest point in July with 1.85 kW-hr/m². This could indicate the seasonal nature of the number of hours of sunshine. Thus, the months of June, July and August, corresponding to the rainy season, generally show the lowest values, followed by an increase at the end of the year, particularly in November and December, with an average of 4.34 kW-hr/m² per day.

2) Precipitation and temperature

The city is subject to seasonal rainfall variations, with average monthly rainfall of over 300 millimetres in the wet season (March to August). Temperatures vary according to rainfall parameters. The hottest months correspond to the dry season (December to March), with temperatures reaching 30°C. There is a correlation between rainfall and temperatures. Warmer months tend to have less rainfall, while colder months have higher rainfall (Figure 3).

Figure 3: Umbrothermal diagrams of average monthly rainfall and temperature in Ouéllé from 2020 to 2022



A detailed analysis of this figure shows that the rainiest months in the first diagram are May and June. In contrast to the first chart, the second shows August and September as the months with the most rainfall. In contrast to the first two diagrams, the last one shows that only June and September are the months with the most rainfall. The comment that follows from this analysis of the graphs is that the town of Ouéllé is subject to rainfall variability. Its seasonal profile is therefore no longer under control.

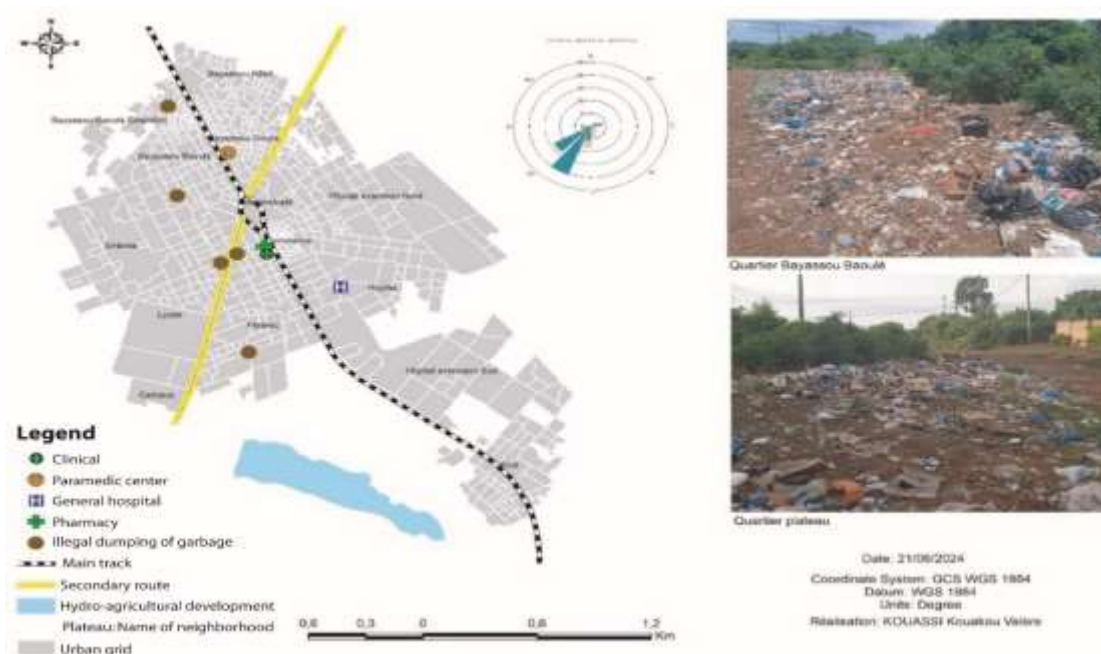
B. Impact of hydro-climatic factors on the urban environment and people's health

1) An unhealthy, damp urban environment

The city is exposed to household waste of all kinds. During the harmattan period (December to February) and at the start of the rainy season, the wind, blowing from north-north-east to south-south-west at an average speed of 1 metre per second, transports rubbish from the unauthorised dumps in the northern neighbourhoods to the spatial units in the south-south-west, thus increasing the volume of rubbish in these neighbourhoods. During the rainy seasons, this waste, combined with the humidity, creates an unhealthy urban environment, leading to the proliferation of mosquito breeding grounds.

Figure 4: Unauthorised dumping of rubbish and location of sanitary facilities in the town of Ouéllé

Photo: TAPE Sophie Pulchérie, June 2023



This map shows 5 open dumps. As can be seen from the photographs, these places where waste is dumped spontaneously pollute the town and, during the rainy season, provide shelter for the pathogenic vectors that cause health problems for the inhabitants of Ouéllé.

2) Ouéllé, near a hydro-agricultural development and forest cover

The primary objective of the hydro-agricultural scheme built by the local authorities was to develop food crops, particularly market gardening. However, the long periods of drought in 2016 and 2018 have led to considerable deterioration (Photo 1). It has now been abandoned by local people and is a breeding ground for mosquitoes because of its proximity to 02 urban neighbourhoods, which are generally unhealthy, particularly the Plateau and Hospital Extension Sud neighbourhoods. In general, these species of Anopheles, which carry malaria, bite at night between sunset and sunrise, and tend to stay close to their birthplace (around 400m away), although they can travel up to 3 kilometres (km) for a blood meal. In densely populated urban areas, for example, they will bite the nearest available individuals. Passive transport, on the other hand, can take Anopheles far from its original habitat. Natural conditions such as wind, as well as population movements by various means of transport, guide its movements (Mouchet and al., 2004; Carnevale & Robert, 2009, cited by Marion B., 2016, p24). These spatial units are located 350 metres from the study area. During rainy seasons, this water increases in volume and even overflows in places, extending the health risk zone close to the town. Residents living next to this development are therefore exposed to malaria.

Photo 1: A hydro-agricultural development in decline

Taken by: TAPE Sophie Pulchérie, May 2024



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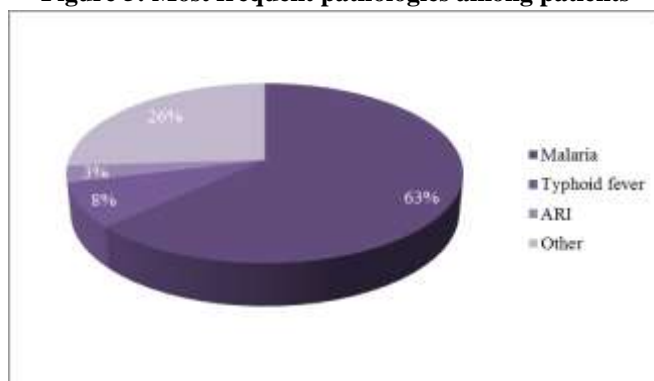
This image shows the Ouéllé hydro-agricultural dam. It is a degraded site, and has been abandoned by the local population because it no longer meets their farming requirements. The site is teeming with pathogens and is a breeding ground for anopheles. The few water points on the site are covered in these malaria vectors. Its proximity to the town poses a real health risk, especially during the rainy season. During the rainy season, children play in this area, exposing themselves to water-related diseases.

C. Distribution of illnesses in the town of Ouéllé

1) The predominance of malaria in the town

The town of Ouéllé suffers from three (03) main diseases: malaria, typhoid fever and acute respiratory infections (ARI). Statistics from consultations in 2023 at the general hospital show that out of a total population of 3,7641 (INS and RGPH, 2021), 30% of people suffer from malaria, 4% from typhoid fever and 2% from ARIs. Malaria and typhoid fever are more prevalent during the rainy season, particularly from March to August, while ARI is more prevalent during the harmattan period (December to March). The profusion and entrenchment of these diseases are exacerbated by a water shortage that dates back more than twenty years, and which is tending to worsen as the city sprawls.

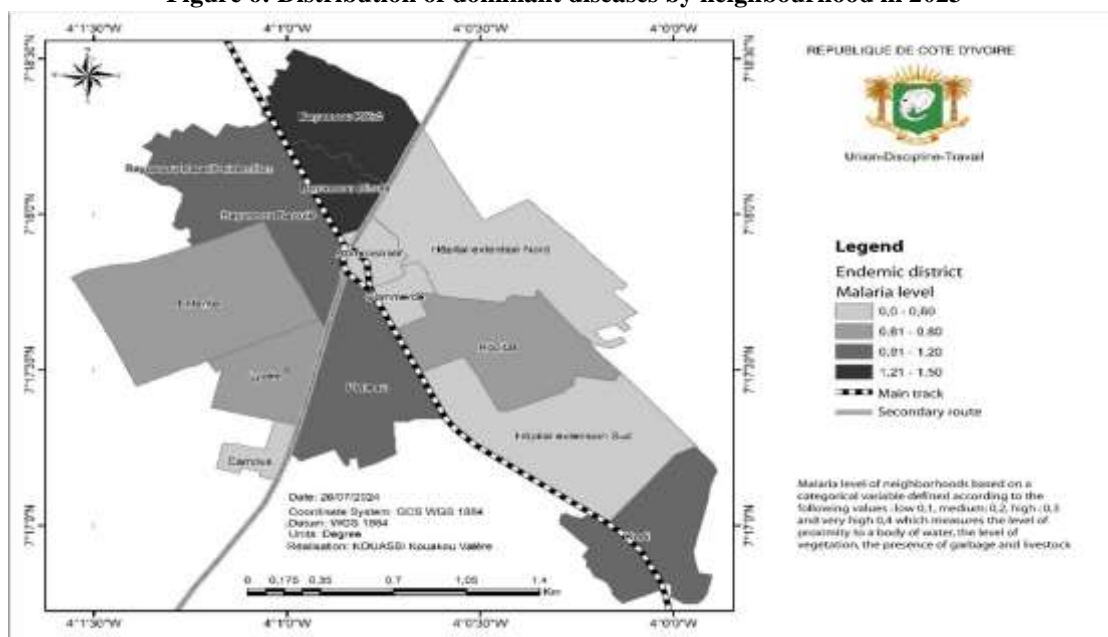
Figure 5: Most frequent pathologies among patients



Source: Ouéllé General Hospital, 2023

Analysis of this graph shows that malaria remains the leading cause of consultation in the town, accounting for 63% of medical visits. Although it appears to be under medical control, it is still a crucial health problem (Kerouedan, 2011). Moisture from rainfall, uncontrolled rubbish dumps, the presence of marshes and bodies of water and, above all, vegetation and livestock in certain parts of the city are key factors in the growth and entrenchment of the parasite. The endemic areas of the city according to these variables are the Bayassou Dioula and Bayassou Kôkô neighbourhoods, the Plateau, Kodi Bayassou Baoulé and Bayassou Baoulé extension neighbourhoods (Figure 6).

Figure 6: Distribution of dominant diseases by neighbourhood in 2023



Source: Our fieldwork, May 2024

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The health facilities available to the population are spread throughout the town along or around the main thoroughfare. Ouéllé has an Urban Health Centre (UHC), built in 1970, with a pharmacy and available services (Table 3) in the Hospital district, a paramedical centre in the Bayassou district, and a pharmacy and clinic in the Commerce district (Figure 4).

Table I: Services at Ouéllé General Hospital

n°	Service	Status
1	Maternity	Operational
2	General medicine	Operational
3	Pharmacy	Operational
4	Laboratory	Operational
5	Vaccination service	Operational
6	Nutrition service	Operational
7	Surgical block	Not Operational
8	Neonatology service	Not Operational

Source: Ouéllé General Hospital, May 2024

However, financial difficulties and the long chain from consultation to analysis to the prescription of medicines are leading people to self-medicate. In addition, health workers make recommendations to patients after they have been treated. These include cleaning up their environment, sleeping under impregnated mosquito nets, getting rid of tin cans, adopting intra-domiciliary spraying and cleaning the grass around their homes. These preventive measures are generally taken for malaria. For typhoid fever, it is advisable to wash hands regularly, wash raw food before eating it, use modern latrines and drink clean water. As for ARI, it is advisable to wear a nose plug during the harmattan period, and to get vaccinated against respiratory pneumonia and influenza.

IV. DISCUSSION

Malaria remains the dominant disease in Ivorian cities. It is the most frequent cause of medical consultations and hospitalisation in the country. It is also responsible for 33% of hospital deaths according to WHO (2010). Its link with hydrometeorological variables is unequivocal. Humidity, stagnant water, vegetation, livestock and, above all, the insalubrity of urban areas are conducive to the proliferation of Anopheles, the agent responsible for transmitting the parasite (Marion B., 2016, p16). Rainy seasons are favourable for malaria, while the so-called dry seasons are conducive to ARI and the insalubrity attributable to typhoid fever, hence its name "dirty hands disease". These last 02 diseases are not the only ones, as our results show. Other diseases linked to these hydro-climatic factors and the unhealthy environment exist in other regions. These include chronic diseases such as dermatitis, high blood pressure, sinusitis, rheumatism, ulcers and epilepsy; as well as clinical signs such as abdominal pain, anaemia and bloated bellies (Possylétia J. K. B. and al., 2019, p24). In addition, the rise in temperature encourages the evaporation of water, resulting in more latent heat in the atmosphere (Kodja D. J., 2018, p14). Intense heat is a vector for disease. The most common are those linked to the skin. Long years of drought are therefore the cause of epidemics of Cerebro Spinal Meningitis. The most severe epidemic of Cerebrospinal Meningitis was recorded in 2006 in the Savanes District, for example, following two (02) years of extreme drought in 2004 for a period running from 2005-2010 in the Korhogo health district (Tanoh A.S.R., 2014, p151). This is because the drop in average relative humidity (below 40%) and the increase in average air temperature (above 28°C) during the harmattan period (December, January, February and March) allow the vector to proliferate. Some urban diseases are linked to the dumping of wastewater in alleyways due to a lack of facilities and inadequate sanitation (WHO, 2000) (Dongo K. and al., 2008). In Ouéllé, it is the lack of drinking water that tends to amplify cases of disease, specifically those linked to the availability of drinking water. In Gagnoa, it is the inadequacy and mismatch between urban dynamics and the availability of health facilities in the urban area that is partly to blame for health problems (Coulibaly S. and al., 2022). Environmental diseases are also caused by flooding following heavy rainfall, with frequent landslides and mudslides leading to health risks such as typhoid fever, cholera and malaria (Kouassi K. D. and al., 2008, p35).

V. CONCLUSION

Diseases linked to hydro-climatic factors, and more specifically to water, are diverse. In the town of Ouéllé, the most frequent are malaria (63%), typhoid fever (8%), ARI (3%) and others (26%). Malaria is the leading cause of consultation in the town's various health centres. Throughout the year, there are peaks in these diseases during the rainy seasons (April, June and July). Recommendations made to patients, the distribution of impregnated mosquito nets, rubbish collection and the cleaning of vegetation are all part of the fight against these diseases.

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