Climate Health in Africa
Integrated Risk Research

MALAWI

CHAIRR DISTRICT CLIMATE RISK VULNERABILITY ASSESSMENTS

SUMMARY FOR POLICYMAKERS

Working in partnership with Sightsavers

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Visit:

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https://www.sightsavers.org/news/2022/03/sightsavers-and-walker-institute-climate-study/

Full details of the analysis highlighted in the CHAIRR Summary for Policymakers may be found in the accompanying technical report:

Cornforth, R. J., Petty, E. C., Saidaliyeva, Z., Wells, C., Mardi, D., Ngoleka, S., Selby, R., (2025). *CHAIRR-Malawi: District Climate Risk Vulnerability Assessments – Technical Report*, WITR0125/13, Walker Institute, University of Reading, January 2025. https://doi.org/10.5281/zenodo.14996034/

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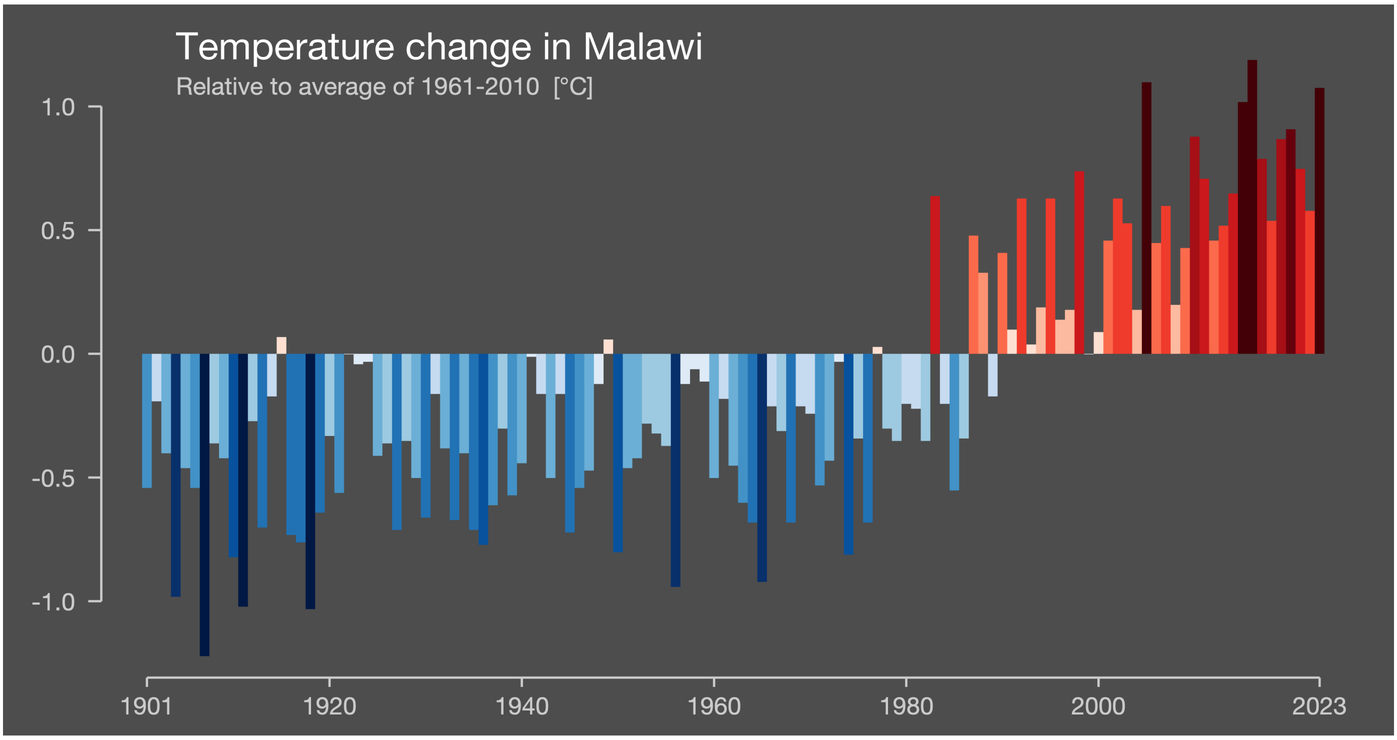

FIGURE 1: CLIMATE STRIPES FOR MALAWI.: https://showyourstripes.info/c/africa/malawi/all. ACCESSED DECEMBER 2024

1. INTRODUCTION

1.1 Wider Project Context

The primary aim of the **Climate Health in Africa Integrated Risk Research (CHAIRR)** project, a Sightsavers and Walker Institute collaboration, is to provide a comprehensive, fine resolution picture of climate effects that will have a bearing on the epidemiology of Neglected Tropical Diseases (NTD) in Malawi.

Funded by **Sightsavers** and implemented in partnership with the **Walker Institute** at the University of Reading, the initiative builds on cutting-edge climate science and stakeholder engagement to generate actionable insights for policymakers and practitioners. By generating district-level climate risk and vulnerability assessments to inform evidence-based adaptation strategies, the CHAIRR project seeks to enhance resilience and health outcomes across Malawi's diverse geographical and socio-economic settings.

The targeted outcomes include strengthened institutional and technical capacities for managing climate-related health risks and the development of **Inclusive Consultative Integrated Climate-Livelihood-Environment (ICICLE) storylines**. These are designed to guide policy and practitioner understanding on the future prevalence and spread of NTDs in Malawi, and to support evidence-based decision-making in monitoring and adapting to the impact of climate change on NTDs. The aim is to enhance planning to reduce health risks posed by NTDs to communities in Malawi - a critical action identified in the World Health Organisation 2030 NTD road map in 2020.

As such, CHAIRR is targeting 6 NTDs:

1. **Human African Trypanosomiasis (HAT)**
2. **Lymphatic Filariasis (LF)**
3. **Onchocerciasis (Oncho)**
4. **Schistosomiasis**
5. **Soil-transmitted Helminths (STH)**
6. **Trachoma**

The project has benefitted greatly from a strong synergistic partnership between Sightsavers and the Walker Institute. This has involved capacity building activities across both organisations, engagement with external local and international experts to support the research, joint PhD students, shared communications and conference/dialogue platforms, the district-specific climate risk assessment and the submission of a comprehensive technical report. Ongoing work includes the preparation of 2 peer-reviewed papers and planning for an Adaptation Planning workshop in Malawi which will also help to strengthen linkages between NTD researchers, climate scientists, health policymakers and practitioners, adaptation planners and key stakeholders – including at local levels, and with national, regional and international stakeholders.

1.2 Project Scope

In line with CHAIRR's objectives, the Walker Institute collaborated with key stakeholders, including Malawi's Department of Climate Change and Meteorological Services (DCCMS), Sightsavers UK and Malawi, and local experts, to conduct Climate Risk and Vulnerability Assessments (CRVAs) in ten districts. The aim was to develop district-specific ICICLE storylines, informed by downscaled climate projections and a robust analysis of vulnerabilities and risks associated with NTDs.

By creating ICICLE storylines for the focus districts in Malawi for each NTD noted, based on downscaled climate projections, the goal of CHAIRR is to better inform policy makers and enhance their planning of adaptation measures to reduce health risks posed by NTDs to communities in Malawi.

Ten districts were selected in consultation with the Sightsavers team in the UK and Malawi, and with the Malawi Department of Climate Change and Meteorological Services (DCCMS) for this analysis. From north to south these are:

1. **Karonga**: Vulnerable to temperature and precipitation changes, impacting health and agriculture
2. **Chitipa:** Altitude related health risks and agricultural practices.
3. **Nkhata Bay:** Water level fluctuations threatening fishing communities and health outcomes**.**
4. **Mchinji:** Transboundary health and climate challenges due to its border with Zambia.
5. **Lilongwe:** Urban health risks driven by population density and infrastructure limitations.
6. **Dedza:** Agricultural vulnerabilities tied to food security and rural health disparities.
7. **Mangochi:** Waterborne diseases particular impact here due to proximity of Lake Malawi.
8. **Zomba:** Environmental variations and health risks from Zomba Plateau's climate.
9. **Blantyre:** Urban-industrial health risks in Malawi's second-largest city.
10. **Nsanje:** High flood risks exacerbating health and livelihood vulnerabilities.

Each of the targeted districts is of interest for diverse geographic or socio-economic reasons.

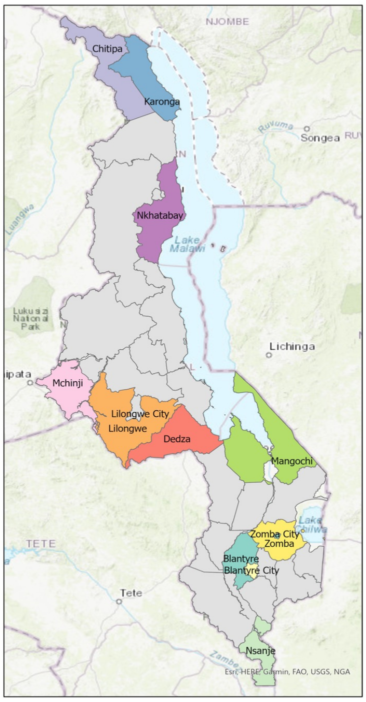

FIGURE 2: LOCATION OF THE DISTRICTS ANALYSED IN THIS REPORT

The district-level Climate Risk and Vulnerability analyses were developed in two stages. Firstly, downscaled climate projections for the districts were generated and analyzed. The results of this analysis are described in full in Part 2: Climate Change Storylines of the Technical Report on which this Summary for Policymakers is based. Secondly, the downscaled climate information was combined with information on local exposure and vulnerability to derive climate risks and high-level NTD interventions and adaptation options to mitigate the changing risks posed by NTDs.

The goal of CHAIRR is being achieved through **six outputs** related to the initial objectives. These are:

Output 1. Quantification of the projections of decision-relevant quantities from state-of-the-art climate models, and their uncertainties, relevant to district-level NTD planning in Malawi – the plausible climate storylines.

Output 2. Integration of socio-economic, environmental, and health data with local expert information and insight from the districts in order to assess future community vulnerability to NTDs

Output 3. Generation of ICICLE (Inclusive Consultative Integrated Climate, Livelihoods and Environment) storylines for each targeted district that combine the plausible climate storylines with the integrated data from Output 2.

Output 4. Translation of CHAIRR's new scientific understanding into appropriate NTD intervention and management planning tools for targeted climate-health adaptation action.

Output 5. Generation of cross-level interactions to foster engagement of key stakeholders/decision-makers throughout for validation of the research and for ensuring the contemporaneity of information and appropriate use of climate, disease, and livelihoods planning tools.

These outputs are being used to deliver on four significant outcomes for CHAIRR:

Outome 1: Building institutional and technical capacity for managing climate-related health risks through training and participatory planning processes.

Outome 2: Harnessing the evidence-based climate-health information for shaping national and regional health policies, in alignment with international frameworks such as the Kigali Declaration and the Sustainable Development Goals (SDGs).

Outome 3: Social and economic development in Malawi that integrates adaptation to climate change as part of a climate resilient health service and system.

Outome 4: Monitoring, reviewing and reporting on the impact of climate change on NTDs to reduce health risks posed by NTDs to communities in Malawi.

1.3 Science Approach and Key Innovations

The project has taken an interdisciplinary approach to bridge the gap between climate science, health policy, and local stakeholder knowledge and advance adaptive capacity in Malawi. It is expected that these outputs will not only support the development of district and national adaptation plans but also contribute to the global discourse on integrating climate risk and health resilience into sustainable development strategies.

Applying the **Implementation Centric Evolving Climate Change Adaptation Process (ICECCAP)**, we were able to focus specifically on NTDs to produce a set of **Inclusive Consultative Integrated Climate, Livelihoods and Environment (ICICLE) storylines** (Wells et al., 2023) which detail plausible climate futures, overlaid with the health and welfare effects that these could precipitate. These storylines serve as a foundation for identifying sector-specific vulnerabilities, adaptation needs, and opportunities for reducing risks to NTDs and other climate-sensitive health outcomes.

The science-based approaches used in CHAIRR build on the World Climate Research Programme "My Climate Risk" (MCR) science for assessing climate-health-livelihood impacts with compelling evidence and practical pathways to adaptive action for scaled-up interventions on Climate and NTDs.

The district-level CRVA analysis aims at providing a robust, evidence-based information that embeds state-of-the-art "My" Climate Risk (MCR) methodologies pioneered by the Walker Institute as one of the World Climate Research Programme (WCRP)-appointed global "My" Climate Risk hubs (https://www.wcrp-climate.org/my-climate-risk). These transdisciplinary research methodologies connect the local to national and regional scales, by **integrating complex data and local expert observations** to support the implementation of **science-based adaptation planning**. The innovative aspects of this MCR approach are:

- **Climate storylines:** The development of up to three plausible climate storylines for each district: one with more precipitation and one with less, and one with increasing humidity and one with less, reflecting the uncertainty in projections emerging from a detailed analysis of the CMIP6 statistically downscaled projections.
- **ICICLE storylines:** The climate storylines are integrated with province-specific environmental and socio-economic vulnerabilities, to construct ICICLE (Inclusive Consultative Climate-Livelihood-Environment) storylines. These are then used to derive plausible impacts affecting the ten districts.
- **Health sector specific vulnerabilities**: Here the vulnerability information remains disaggregated across districts. This allowed health-specific vulnerabilities to be identified and in time, linked with the most viable adaptation actions.
- **Long-term climate change risk complementing extreme weather events**: To complement a more traditional view of climate risk used in National Adaptation Plans (NAP) which is focused on disasters, such as floods, storms and landslides, this analysis examines the risks posed by long-term average changes in temperature and precipitation. These changes, while not resulting in extreme weather, pose risks to NTDs as well as to livelihood strategies and related sectors as agriculture.
- **Evidence-base review of adaptation options:** This report provides a high-level evidence-based assessment of a range of adaptation options for the health sector specific to each district. The extensive amount of peer-reviewed (176 papers) and grey (86 reports) literature reviewed for this report contributes a strong evidence base derived from regional, national and local adaptation insights and experience.
- **Cross-sectoral view of risk:** Finally, where possible, this report drew connections between health and other sectors, in terms of cascading risks and adaptation opportunities, to help identifying the most vulnerable communities in the

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provinces facing multi-dimensional risks. This also helped with identifying intervention points, i.e., adaptation actions that would benefit a range of sectors.

1.4 Generation of the Climate Storylines

To generate the climate storylines for each district, climate change projections for each district were generated using a robustly selected set of statistically downscaled climate models from CEDA for four separate twenty year periods from (1) 2021 to 2040, (2) 2041 to 2060, (3) 2061 to 2080, and (4) 2081-2100, as changes from values against the 1995-2014 baseline (anomalies). The district results focus on the near term, 2021-2040 in this report. The approach used was designed to simplify information from the substantial range of climate change projections used by the IPCC while retaining much of the information on the uncertainties involved.

Key climate variables for understanding changing risk to NTDs were analysed. These included:

- **Temperature: mean annual temperature anomaly**
- **Precipitation: total annual precipitation anomaly**
- **Humidity: mean annual near-surface relative humidity anomaly**

The climate storylines were identified for each district by analyzing mean anomaly values from the downscaled climate models of air temperature, precipitation and humidity, looking at the different evolutions of annual mean temperature, annual total precipitation and annual total humidity against the 1995-2014 baseline, for the SSP2-4.5 [Middle Road] with 'grouping' to generate a set of distinct but plausible climate storylines using 3D scatter plots.

The details of the model selection and storyline analysis are described in Parts 2 and 3 of the full CHAIRR Technical Report including details of the number of models used to generate the climate storylines for each district.

1.5 CHAIRR Stakeholder Engagement

Stakeholder engagement is recognized as a key component of the ICECCAP methodology. In the context of this work, stakeholder engagement activities covered three main groups, described below.

The Sightsavers Team – UK and Malawi: Throughout the project, the team worked in partnership with Sightsavers. Beyond regular updates and exchanges on progress, the communication with Sightsavers and their linked NTD expert networks was critical in steering the analysis work in the direction that best supported Sightsavers ongoing and future work in Malawi, and the wider region. The Walker team were able to share the technical work in progress (presentations, analysis, reports) and obtain rapid feedback and steer which played a key role in progressing the work.

National stakeholders: The joint project team communicated effectively with national stakeholders involved in NTD and climate research and information services, facilitated by established connections across the two teams. Thanks to this collaboration the team could obtain:

- a list of reports deemed important to support the CRVA analysis with clarification of methodologies used provided by the Malawi Red Cross Society;
- links to trusted databases (the reader is referred to Section 3. Data and sub-sections within, in the full CHAIRR Technical Report) such as: the Malawi Statistical Information Service, the USAID Famine Early Warning Systems Network (FEWS NET) for information on Agricultural Livelihoods and the World Health Organization (WHO), Expanded Special Project for the Elimination of Neglected Tropical Diseases (ESPEN) Portal;
- help on interpretation and comments on the reliability of information found by the team in the grey literature.

1.6 Limitations of the Current Analysis

The present analysis relies on the assumption that the limitations due to climate model biases (discussed in Section 3.4 Climate Model Validation in the full CHAIRR Technical Report) have been addressed by considering changes with respect to the model past to investigate the future.

The analysis carried out to identify climate storylines does not include the projections for the change risk of floods and hydrological drought that may impact on future reemergence of NTDs. It is important to bear in mind that the actual occurrence of floods and droughts will depend not only on the climate conditions, but also on environmental factors and resources management. In particular, water resources management can change the risk of floods and droughts, e.g., if dams and reservoirs are operated to prevent floods or store water for dry season use. Land use will also play a crucial role, e.g., determining how much water is used and for which types of agriculture and other activities. These aspects cannot be considered quantitatively in the present analysis. Hence, the risk of floods and drought discussed here must be interpreted with these caveats in mind. This limitation can be addressed by hydrological modelling as suggested in next steps, which would include such effects, for which the present work lays the foundation and describes qualitatively as anticipated impacts.

An attempt to collect additional and more contextual data on local livelihoods and key climate and environmental risk factors for the districts involved in this study, via interviews with local experts was not possible in this study. The present work relied solely on open-source information validated by Stella Ngoleka, Malawi Livelihoods Practitioner and Walker Associate, the Malawi Sightsavers country team, and some engagement with the Malawi Red Cross Society.

The environmental and socio-economic analysis carried out in this report is, as mentioned, based on open-source data available in peer reviewed and grey literature and it provides a provisional guide to the detailed and quantitative analysis that would be carried out in a second stage and would meaningfully quantify impacts and risks by involving a combination of:

- local expert knowledge, via key informant stakeholder interviews, on area-specific household economy and associated key aspects of the local environment;
- hydrological and epidemiological modelling to quantify the effect of the climate storylines on water resources and NTD re/emergence;
- a socio-economic model and appraisal, to translate the hydrological and epidemiological projections into livelihood impacts and assessment of treatment interventions.

Finally, the analysis of future conditions using the scenario-based methodologies and storylines focuses on mid-century changes, as agreed with Sightsavers and due to time constraints developed storylines using the SSP2-4.5, moderate emission scenario. However, in subsequent analysis, the downscaled results might be integrated under all three emissions scenarios i.e., *SSP1-2.6* (low emissions), SSP2-4.5 (moderate emissions) and *SSP5-8.5* (high emissions).

The work undertaken by Walker Institute does not offer a perfect solution but aims to present information on climate projections, risk and vulnerability in a way that reduces complexities while retaining aspects of uncertainty through the use of statistically downscaled climate projections and quantitative clustering to generate a set of plausible climate storylines that will support ongoing and future decision making of NTD health practitioners and policymakers.

2. CLIMATE PROJECTIONS AND CLIMATE STORYLINES

2.1 Summary of the Climate Change Analysis

Over the historical period (1951-2020), there has been an observable warming trend in Malawi with southern regions typically warmer than the northern areas (not shown). This trend is clear from the heat plot in Figure 3 (LH panel) which displays the monthly anomalies for various 10-year periods, relative to the monthly average over the historical recent period (1995-2014) in the left hand panel. For example, the value shown under 1980-1990 for March represents the difference between the average March temperature during 1980-1990 and the average March temperature across the reference period (1995-2014).

Malawi is also experiencing a marked increase in temperature extremes. Observational data indicate that both the frequency and intensity of hot days have risen significantly in recent years (Figure 4, RH Panel), posing serious implications for the country's agriculture, water resources, and public health sectors.

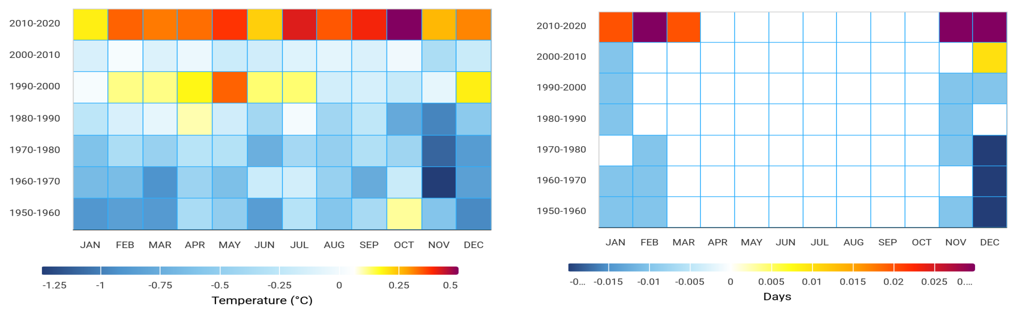


FIGURE 3: LH PANEL: AVERAGE MEAN SURFACE AIR TEMPERATURE MONTHLY TRENDS FROM 1951-2020; RH PANEL: NUMBER OF DAYS WITH HEAT INDEX > 35°C MONTHLY TRENDS FROM 1951-2020. BOTH PANELS ARE RELATIVE TO THE MONTHLY AVERAGE OVER THE HISTORICAL RECENT PERIOD (1995-2014). SOURCE: WORLD BANK (2024B). ACCESSED DECEMBER 2024.

Analysis of the rainfall trends are less striking (see Figure 4) with no significant trends across the whole country, but highlight the irregularity of rainfall patterns, leading to increased unpredictability in seasonal water availability. Amosi et al. (2023) examined decadal trends using monthly and seasonal mean precipitation across different regions of Malawi. The seasonal mean precipitation trends showed consistent decade-to-decade drying over north-eastern region (using CHIRPS data), whereas CRU data showed patches of dry conditions across their entire study domain, including southern parts despite increased frequency of tropical cyclones and associated floods during recent decades. The variability across the country poses not only agricultural challenges but also has implications for the spread of schistosomiasis and lymphatic filariasis, which are closely linked to environmental conditions.

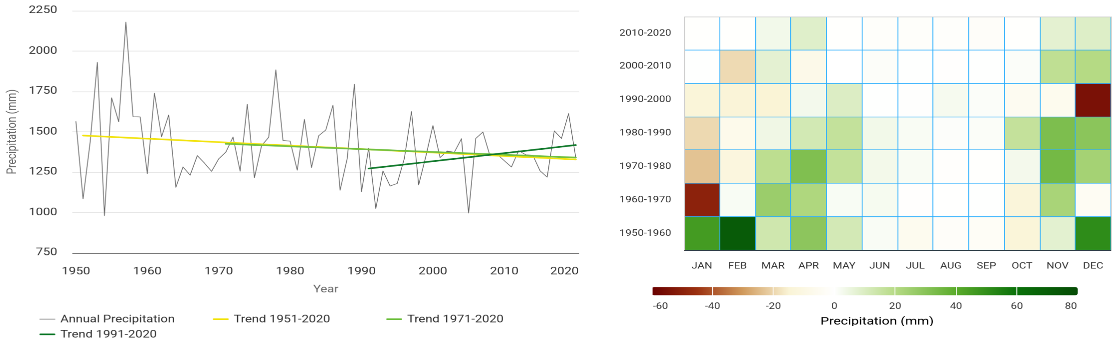


FIGURE 4: LH PANEL: PRECIPITATION ANNUAL TRENDS WITH SIGNIFICANCE OF TRENDS PER DECADE FROM 1951-2020; RH PANEL: PRECIPITATION MONTHLY TRENDS FROM 1951-2020 RELATIVE TO THE MONTHLY AVERAGE OVER THE HISTORICAL RECENT PERIOD (1995-2014). SOURCE: WORLD BANK (2024B). ACCESSED DECEMBER 2024.

Throughout the 21st century, the annual average temperature across the ten focus districts is expected to rise significantly compared to today. Under an intermediate greenhouse gas (GHG) emissions scenario—where CO2 emissions remain near current levels until 2050 before declining, but not reaching net zero by 2100—temperature increases are projected as follows: 0.8–1.4ºC in the near term (2021–2040), 1.5–2.3ºC in the mid-term (2041–2060), 2.0–3.0ºC later in the century (2061–2080), and a substantial rise of 2.3–3.5ºC by the century's end (2081–2100). This steady increase in temperatures underscores the pressing need to address climate change, as noticeable warming is anticipated even under optimistic scenarios.

In contrast, precipitation trends display far greater variability, with possibilities for both increases and decreases across all districts. To address this uncertainty, three distinct climate storylines have emerged, with one emphasizing changes in humidity. Unlike the clear upward trajectory of temperature changes, precipitation patterns could range from a 6% decrease to a 10% increase in the near term (2021–2040) and from a 10% decrease to a 20% increase by the century's end (2081–2100). Northern districts are more likely to see increases in total rainfall, while southern districts may experience declines.

2.2 Summary of the District Climate Storylines

For each of the ten districts (see Figure 5), **up to three climate storylines were identified for each district by analysing mean anomaly values from the downscaled climate models of air temperature, precipitation and humidity, and looking at the combined *changes* in mean annual temperature and total annual rainfall and mean annual humidity against the 1995-2014 baseline, for the SSP2-4.5 [Middle Road] with 'grouping' to generate a set of distinct but plausible climate storylines using 3D scatter plots.**

The districts experience three primary climate futures—hotter and drier, hotter and wetter with decreasing humidity, and hotter and much wetter with increasing humidity—each influencing disease risks, food security, and livelihoods in distinct but interconnected ways. The uncertainty remains largely on the magnitude of these changes, which can nevertheless be critical for NTD transmission, water security, food security and ecosystems.

It is not possible to compute changes in other climate variables that may be relevant to NTD risk, such as number of hot days or length of dry spells, for each storyline to provide a more complete picture of these future climates, as this information is not available in the literature of from expert insights. This is also a topic for future research.

These three primary climate storylines have been developed to account for the variability and uncertainty in future rainfall and humidity patterns, noting that the wetter climate storylines generally create conditions that are more conducive to flooding in the wet season, particularly when higher rainfall coincides with longer dry spells. In these scenarios, rainfall becomes more concentrated, occurring over fewer days, which increases the risk of intense and potentially hazardous flood events.

The drier climate storylines generally create conditions that are more conducive to meteorological droughts in the dry season, particularly when lower seasonal rainfall coincides with longer dry spells.

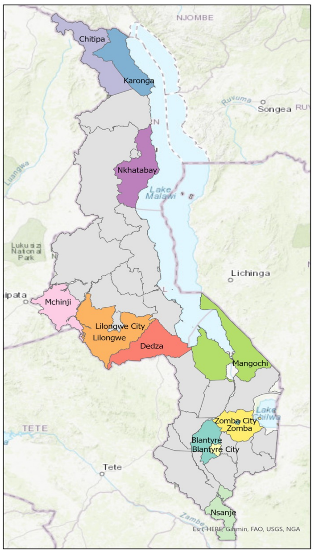


FIGURE 5: CHAIRR-MALAWI DISTRICT MAP

It is also possible that total seasonal rainfall may remain relatively unchanged, as suggested by some models. However, even in such scenarios, droughts and floods will still occur, as they do today, but could be exacerbated by higher temperatures. Elevated temperatures increase water evaporation from the soil and accelerate transpiration from plants, particularly when rainfall and relative humidity are low. This, in turn, heightens the risk of both hydrological and agricultural droughts. Simultaneously, hotter air can hold more moisture, which means that rainfall events during the wet season could become more intense, increasing the likelihood of flooding.

A summary of the climate storylines for all ten district is shown below for the SS2-4.5 emission scenario in the near-term (2021-2040), as changes (anomalies) from values across 1995 to 2014.

District-Specific Climate Storylines (CS) (SS2-4.5 and 2021-2040) as changes from values across 1995 to 2014 CS that have a higher number of models clustered are shown in bold. *Cell colours mirror map in Figure 5 for ease of reference.*	
CHITIPA **CS1. Hotter – Drier – Decreasing Humidity** Temperature Increase (T↑): 0.7°C (3.6%) Precipitation Decrease (P↓): -45 mm (3.4%) Humidity Decrease (H↓): -0.8% (0.9%) **CS2. Hotter – Wetter – Decreasing Humidity** **Temperature Increase (T↑): 0.8°C (3.9%)** **Precipitation Increase (P↑): 36 mm (2.7%)** **Humidity Decrease (H↓): -0.7% (0.9%)** **CS3. Hotter – Wetter – Increasing Humidity** Temperature Increase (T↑): 0.4°C (2.1%) Precipitation Increase (P↑): 43 mm (3.3%) Humidity Increase (H↑): 0.5% (0.7%)	**KARONGA** **CS1. Hotter – Drier – Decreasing Humidity** Temperature Increase (T↑): 0.7°C (3.4%) Precipitation Decrease (P↓): -51 mm (3.7%) Humidity Decrease (H↓): -20% (26.3%) **CS2. Hotter – Wetter – Decreasing Humidity** **Temperature Increase (T↑): 0.7°C (3.4%)** **Precipitation Increase (P↑): 33 mm (2.4%)** **Humidity Decrease (H↓): -13% (17.1%)** **CS3. Cooler – Wetter – Decreasing Humidity** Temperature Decrease (T↓): -4.8°C (22%) Precipitation Increase (P↑): 44 mm (3.2%) Humidity Decrease (H↓): -19% (25%)
NKHATA BAY **CS1. Hotter – Drier – Decreasing Humidity** **Temperature Increase (T↑): 0.8°C (3.6%)** **Precipitation Decrease (P↓): -31 mm (5.3%)** **Humidity Decrease (H↓): -0.9% (1.2%)** **CS2. Hotter – Wetter – Decreasing Humidity** Temperature Increase (T↑): 0.9°C (4.1%) Precipitation Increase (P↑): 37 mm (3.1%) Humidity Decrease (H↓): -0.9% (1.2%) **CS3. Hotter – Wetter – Increasing Humidity** Temperature Decrease (T↑): 0.5°C (2.3%) Precipitation Increase (P↑): 37 mm (3.1%) Humidity Decrease (H↑): 0.3% (0.4%)	**DEDZA** **CS1. Hotter – Drier – Decreasing Humidity** **Temperature Increase (T↑): 0.9°C (4.1%)** **Precipitation Decrease (P↓): -34 mm (3.3%)** **Humidity Decrease (H↓): -1.4% (2.0%)** **CS2. Hotter – Wetter – Decreasing Humidity** Temperature Increase (T↑): 0.7°C (3.2%) Precipitation Increase (P↑): 45 mm (4.4%) Humidity Decrease (H↓): -0.6% (0.9%) **CS3. Hotter – Wetter – Increasing Humidity** Temperature Decrease (T↑): 0.4°C (1.8%) Precipitation Increase (P↑): 74 mm (7.6%) Humidity Decrease (H↑): 0.3% (0.4%)

MCHINJI

CS1. Hotter – Drier – Decreasing Humidity
Temperature Increase (T↑): 0.8°C (3.9%)
Precipitation Decrease (P↓): -41 mm (4.3%)
Humidity Decrease (H↓): -1.1% (1.7%)

CS2. Hotter – Wetter – Decreasing Humidity
Temperature Increase (T↑): 0.9°C (4.2%)
Precipitation Increase (P↑): 31 mm (3.2%)
Humidity Decrease (H↓): -1.2% (2.4%)

CS3. Hotter – Wetter – Increasing Humidity
Temperature Decrease (T↑): 0.4°C (1.9%)
Precipitation Increase (P↑): 57mm (5.9%)
Humidity Decrease (H↑): 0.4% (0.6%)

MANGOCHI

CS1. Hotter – Drier – Decreasing Humidity
Temperature Increase (T↑): 0.8°C (3.5%)
Precipitation Decrease (P↓): -43 mm (4.2%)
Humidity Decrease (H↓): -1.3% (1.9%)

CS2. Hotter – Wetter – Decreasing Humidity
Temperature Increase (T↑): 0.9°C (3.9%)
Precipitation Increase (P↑): 34 mm (3.3%)
Humidity Decrease (H↓): -1.1% (1.6%)

CS3. Hotter – Wetter – Increasing Humidity
Temperature Decrease (T↑): 0.5°C (2.2%)
Precipitation Increase (P↑): 75mm (7.3%)
Humidity Decrease (H↑): 0.3% (0.4%)

LILONGWE

CS1. Hotter – Drier – Decreasing Humidity
Temperature Increase (T↑): 0.8°C (4.1%)
Precipitation Decrease (P↓): -34 mm (3.5%)
Humidity Decrease (H↓): -1.2% (1.6%)

CS2. Hotter – Wetter – Decreasing Humidity
Temperature Increase (T↑): 0.8°C (4.1%)
Precipitation Increase (P↑): 19 mm (1.9%)
Humidity Decrease (H↓): -1.1% (1.6%)

CS3. Hotter – Wetter – Increasing Humidity
Temperature Decrease (T↑): 0.4°C (2.0%)
Precipitation Increase (P↑): 62mm (6.7%)
Humidity Decrease (H↑): 0.3% (0.5%)

ZOMBA

CS1. Hotter – Drier – Decreasing Humidity
Temperature Increase (T↑): 0.9°C (3.9%)
Precipitation Decrease (P↓): -54 mm (5.3%)
Humidity Decrease (H↓): -1.5% (2.1%)

CS2. Hotter – Wetter – Decreasing Humidity
Temperature Increase (T↑): 0.7°C (3.1%)
Precipitation Increase (P↑): 65 mm (6.4%)
Humidity Decrease (H↓): -0.3% (0.4%)

CS3. Hotter – Wetter – Increasing Humidity
Temperature Decrease (T↑): 0.3°C (3.1%)
Precipitation Increase (P↑): 104mm (10.2%)
Humidity Decrease (H↑): 0.7% (1.0%)

BLANTYRE

CS1. Hotter – Drier – Decreasing Humidity
Temperature Increase (T↑): 0.9°C (3.9%)
Precipitation Decrease (P↓): -51 mm (5.1%)
Humidity Decrease (H↓): -1.6% (2.3%)

CS2. Hotter – Wetter – Decreasing Humidity
Temperature Increase (T↑): 0.7°C (3.1%)
Precipitation Increase (P↑): 53 mm (5.3%)
Humidity Decrease (H↓): -0.4% (0.6%)

CS3. Hotter – Wetter – Increasing Humidity
Temperature Decrease (T↑): 0.4°C (1.7%)
Precipitation Increase (P↑): 97mm (9.7%)
Humidity Decrease (H↑): 0.5% (0.7%)

NSANJE

CS1. Hotter – Drier – Decreasing Humidity
Temperature Increase (T↑): 0.9°C (3.6%)
Precipitation Decrease (P↓): -51 mm (6.0%)
Humidity Decrease (H↓): -1.5% (2.2%)

CS2. Hotter – Wetter – Decreasing Humidity
Temperature Increase (T↑): 0.7°C (2.8%)
Precipitation Increase (P↑): 71 mm (8.3%)
Humidity Decrease (H↓): -0.5% (0.7%)

CS3. Hotter – Wetter – Increasing Humidity
Temperature Decrease (T↑): 0.4°C (1.5%)
Precipitation Increase (P↑): 36mm (4.2%)
Humidity Decrease (H↑): 0.7% (1.1%)

3. DISTRICT CLIMATE RISK VULNERABILITY ASSESSMENT – ICICLE STORYLINES

The **ICICLE storylines** have been generated by combining the district-level climate storylines with district information on environmental and socio-economic vulnerabilities (e.g., land degradation, poverty) and trends (e.g., population growth) considering the livelihood zones present in each district (Figure 6). To derive possible impacts, the methodological choice is to assume that current vulnerabilities will persist in the future and that no additional adaptation measures will be implemented. Additionally, *it is assumed that current trends —specifically population growth, increased urbanisation, and a transition from subsistence to commercial agriculture—will continue and will keep influencing the exposure and vulnerability of all the districts.*

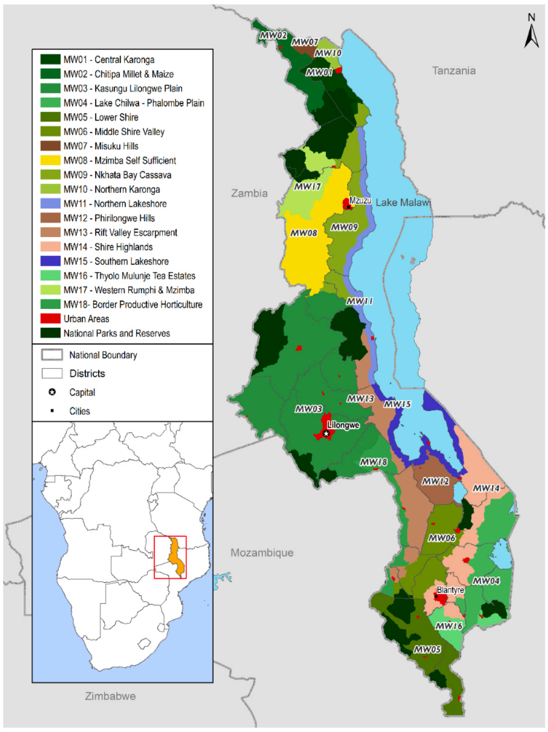


FIGURE 6: MALAWI LIVELIHOOD BASELINE PROFILES (2016). SOURCE: FEWS NET. HTTPS://FEWS.NET/SOUTHERN-AFRICA/MALAWI/LIVELIHOOD-BASELINE/MARCH-2016.

The integrated quantitative information associated with each climate storyline for each District have been presented in the form of a "narrative" which helps to communicate the climate storylines and summarise the differences and similarities to non-technical stakeholders – they offer a foundation for understanding potential future risks and identifying opportunities for building resilience in Malawi's districts.

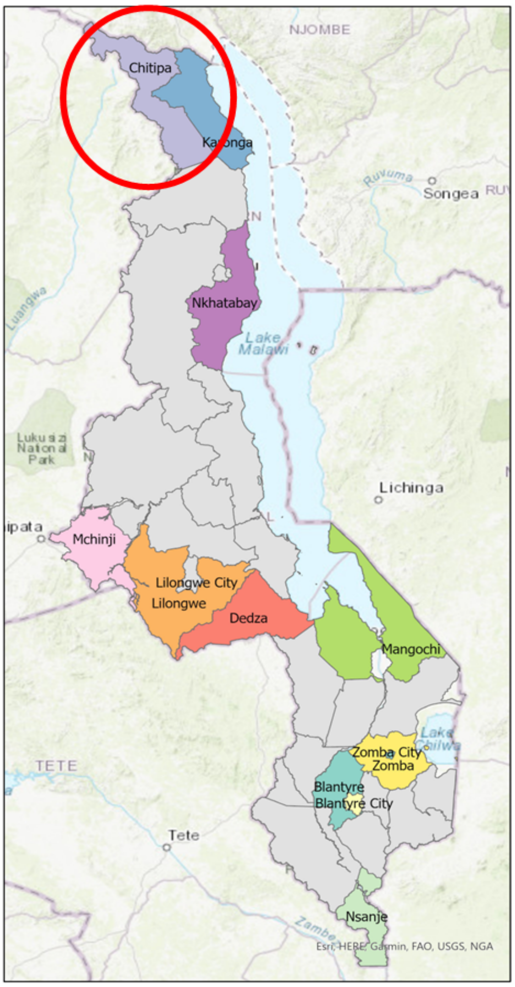
It is essential to note that the actual occurrence of floods and droughts will depend not only on climatic conditions but also on environmental factors and resource management practices. Effective water resource management and land-use planning can significantly mitigate these risks, highlighting the importance of integrating climate adaptation strategies into national and district-level planning processes.

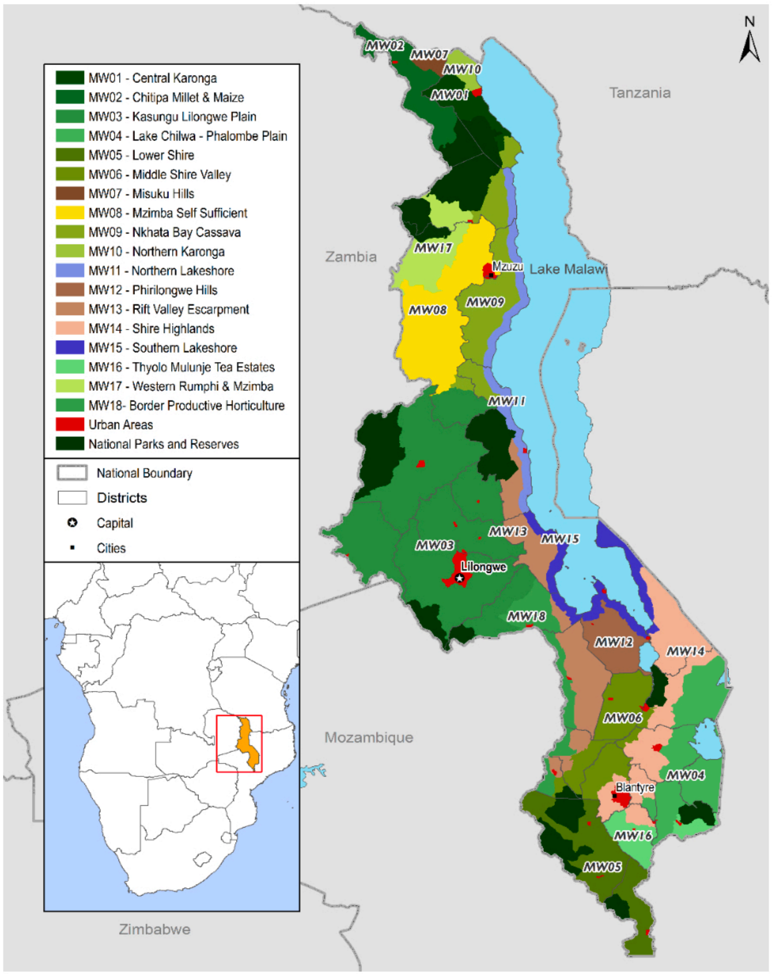
Although a set of interventions and adaptation options have been suggested to mitigate against these NTD risks, but this is pending expert insight from the stakeholder workshop in Spring 2025.

Districts are presented in discrete sections to facilitate reading and distribution.

The district ICICLES are followed by a short synthesis section outlining commonalities across key change areas and recommendations.

4. CHITIPA ICICLE STORYLINES





Chitipa District, located in Northern Malawi, supports over 234,000 people, with agriculture as the dominant livelihood activity. Its topography and climatic diversity expose it to a range of specific climate change impacts on NTDs, including schistosomiasis, lymphatic filariasis, soil-transmitted helminthiasis (STH), trachoma, onchocerciasis, and human African trypanosomiasis (HAT) (Red Cross, District Councils and the Malawi Office of Statistics). The district's reliance on natural water sources and sanitation challenges amplifies vulnerabilities to vector-borne disease.

The district is mainly covered by Livelihood Zone **MW02 'Chitipa Millet and Maize.'**

Chitipa Climate storylines (CS) for SSP2-4.5 Emission Scenario

CS1. Hotter – Drier – Decreasing Humidity
Temperature Increase (T↑): 0.7°C (3.6%)
Precipitation Decrease (P↓): -45 mm (3.4%)
Humidity Decrease (H↓): -0.8% (0.9%)

CS2. Hotter – Wetter – Decreasing Humidity
Temperature Increase (T↑): 0.8°C (3.9%)
Precipitation Increase (P↑): 36 mm (2.7%)
Humidity Decrease (H↓): -0.7% (0.9%)

CS3. Hotter – Wetter – Increasing Humidity
Temperature Increase (T↑): 0.4°C (2.1%)
Precipitation Increase (P↑): 43 mm (3.3%)
Humidity Increase (H↑): 0.5% (0.7%)

4.1 Chitipa ICICLE Storyline Narratives

Projections indicate that Chitipa's future climate will likely be hotter and wetter with decreasing humidity. However, a hotter and wetter future is also possible with increasing humidity, as well as a hotter and drier future with decreasing humidity.

The narratives, based on the Climate Storylines for Chitipa are:

Chitipa ICICLE Storyline 1: Hotter – Drier – Decreasing Humidity

Chitipa's vulnerability to NTDs is evolving as water availability declines, potentially reducing habitats for schistosomiasis-transmitting snails. Whilst initially lowering Schistosomiasis transmission rates, the increasing reliance on limited and potentially contaminated water sources is heightening people's exposure risks. Trachoma is exacerbated by dry and dusty conditions that are worsen eye irritation for people, especially in areas lacking clean water for sanitation. However, Soil-Transmitted Helminths are experiencing survival challenges due to their reduced viability in drier soils, though dust-borne transmission is a concern where hygiene practices are inadequate. The stretched public health infrastructure is struggling with the ongoing sanitation challenges and limited water resources. This is further straining services. In agriculture, the moisture stress is hindering staple crops such as maize, though people growing drought-resistant millet are faring slightly better. Livestock health is suffering with inadequate forage and water availability, and the reduced crop yields are decreasing labour opportunities to supplement income for the poorer households dependent on casual (any) work (RCRC, 2021).

Chitipa ICICLE Storyline 2: Hotter – Wetter – Decreasing Humidity

Increasing rainfall is creating new breeding grounds for vectors like mosquitoes and blackflies, which is elevating the risk of lymphatic filariasis and onchocerciasis. However, the reduced humidity is limiting mosquito survival outside the principal waterlogged areas. Schistosomiasis risks are fluctuating with the changing water levels in freshwater habitats. Unfortunately, public health facilities are struggling as they face damage and access issues due to the increased rainfall exacerbating soil erosion in hilly areas. This is compounding the challenge of managing the heightened disease rates. On the agricultural front, crops like rice are benefitting from increased water availability though this may be short-lived. Fluctuating moisture conditions continues to challenge crop health, especially for bananas and rice that require stable humidity. The increased rainfall on steep slopes that is leading to soil erosion, is straining resources for farmers who only have basic tools to manage their crops. Livestock health risks are also rising due to the muddy conditions, necessitating veterinary support. This is further impacting poorer households who are finding it difficult to sell healthy animals.

Chitipa Storyline 3: Hotter – Wetter – Increasing Humidity

The now optimal conditions for vector and snail reproduction, are seriously exacerbating transmission risks for Schistosomiasis, LF, and Onchocerciasis. Fortunately, trachoma risks are decreasing slightly with improved water access, though sanitation challenges are persisting. The increased disease prevalence is straining health infrastructure further, and communities continue to face challenges to accessing health facilities due to waterlogged routes and/or eroded pathways. Agricultural outcomes are rather mixed: beans and groundnuts are facing increased mould and fungal risks from the high humidity. This is complicating storage and post-harvest handling for farmers. Pests are also thriving under these warmer, humid conditions, which is leading to reduced yields and spending money on costly pest control efforts. This is aggravated by the increased fungal diseases also being experienced by the high-value cash crops, such as tobacco and coffee. Livestock health is declining due to humid conditions promoting disease spread. People are struggling with heat stress under these conditions which is impacting productivity and health with older and younger people in the community most affected.

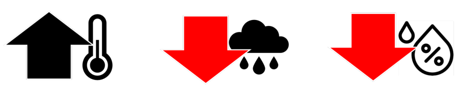
4.2 Summary of Impacts for Chitipa under each Climate Storyline

The table below considers the climate impacts likely to affect the six selected NTDs and public health infrastructure and related to these the likely impacts on key crops, livestock, and livelihoods in Chitipa. Impacts result from the changing climate condition (hazards), the exposure of these systems, and the intrinsic crop and animal vulnerabilities to, e.g., specific temperature thresholds, and of broader environmental vulnerabilities (e.g., soil erosion) and socio-economic vulnerabilities (e.g., poverty).

The impacts are derived considering all the climate storylines by considering the implications that each may have on NTDs, crops, livestock, and livelihoods. The impacts are visually presented in a table, to allow a more immediate access to this extensive information. For more details on the methodology used for the impact, see the full Technical Report (Methods Section).

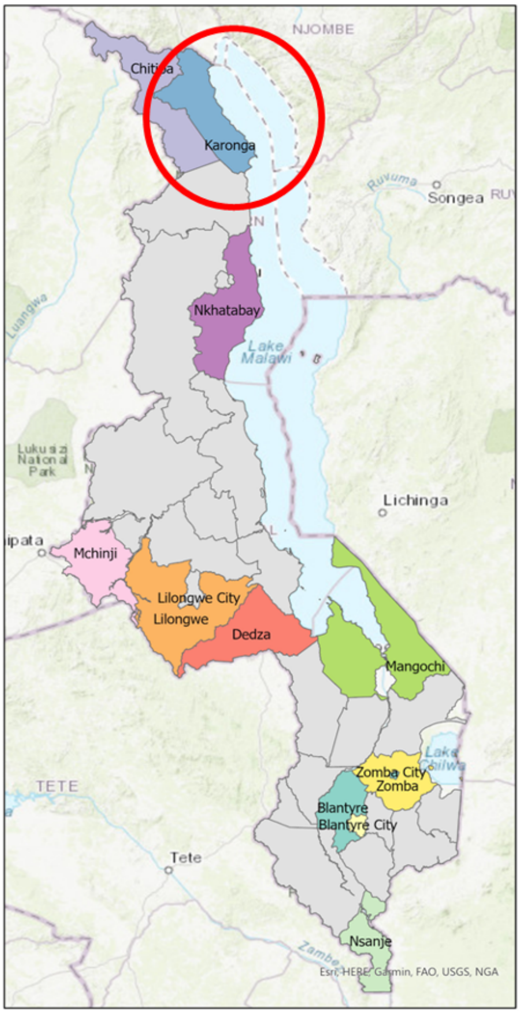
The hazards and vulnerabilities determining the ICICLE storylines specific to Chitipa and the resulting potential impacts in the relevant sectors (health, agriculture and livelihoods) are expressed in Table 1. The impacts are based on input from local stakeholders (LE) and integrated with the most pertinent impacts identified in the literature review. The research team has further refined these to focus on those most relevant to Chitipa according to expert judgment.

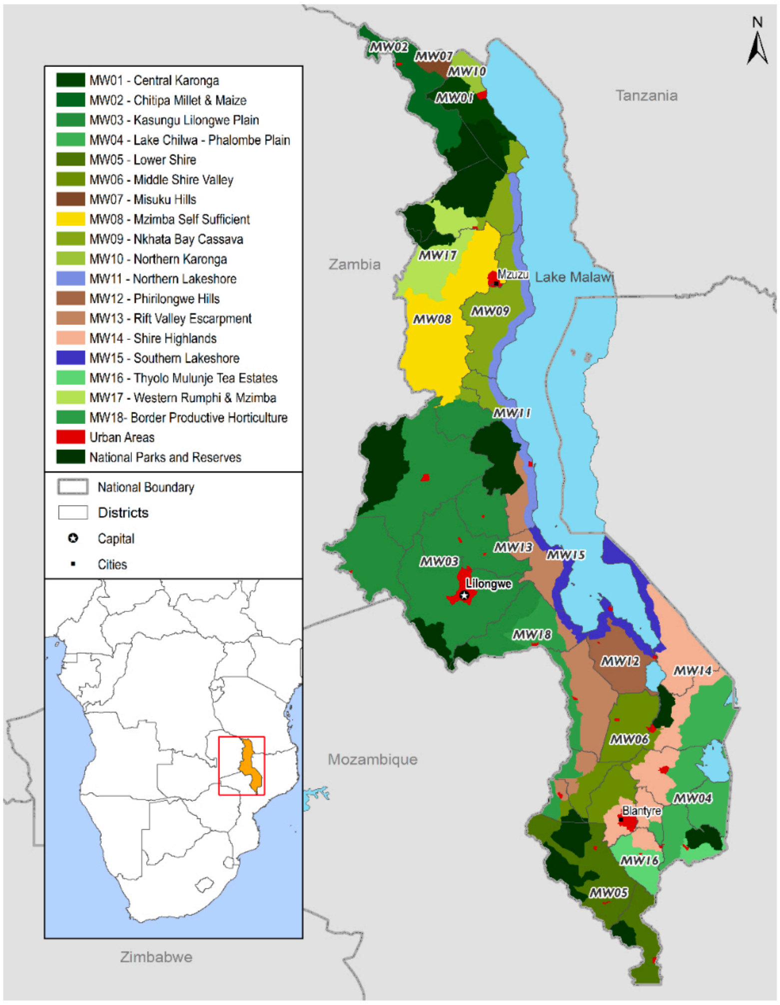
TABLE 1: KEY CLIMATE IMPACTS ON TARGETED NTDS, PUBLIC HEALTH INFRASTRUCTURE AND AGRICULTURE IN CHITIPA WITH THE ASSOCIATED CLIMATE STORYLINE (CS) AND RELEVANT LOCAL VULNERABILITIES. KEY: BLACK ARROWS ARE INCREASING; RED ARROWS = DECREASING; THERMOMETER = TEMPERATURE; CLOUD = RAINFALL; DROP/PERCENTAGE = RELATIVE HUMIDITY

Sector	Climate Storyline 1 	Climate Storyline 2 	Climate Storyline 3 
Neglected Tropical Diseases 	• **Schistosomiasis Risk:** Reduced water sources concentrate human activity around remaining water bodies, heightening exposure risks. • **Vector Survival:** Mosquito breeding cycles accelerate during brief rain events, increasing lymphatic filariasis risks. • **Trachoma:** Dry, dusty conditions promote bacterial transmission, exacerbating eye health challenges.	• **Snail Habitats:** Increased rainfall supports snails, raising schistosomiasis risks. • **Mosquito Expansion:** More standing water facilitates mosquito breeding, increasing filariasis cases. • **Onchocerciasis:** Blackflies thrive in fast-flowing water, escalating disease risks.	• **Widespread Disease:** Humidity and waterlogging amplify schistosomiasis and filariasis transmission. • **Waterborne Illnesses:** Stagnant water fosters outbreaks of cholera and dysentery. • **Infrastructure Strain:** Rising cases overwhelm health facilities, limiting treatment capacity.

Public Health Infrastructure 	• **Water Scarcity:** Limited rainfall affects clean water availability for health facilities, reducing hygiene standards. • **Heat Stress:** Rising temperatures increase dehydration cases, straining health systems. • **Access Gaps:** Drought isolates rural communities, limiting health service delivery.	• **Flood Damage:** Heavy rains disrupt health facilities, damaging equipment and infrastructure. • **Disease Burden:** Vector-borne diseases, such as malaria, spike, overwhelming health systems. • **Isolated Communities:** Flooded roads hinder vulnerable populations' access to health services.	• **Infrastructure Decay:** High humidity damages facilities through mould and corrosion. • **Disease Load:** Rising cases of vector and waterborne diseases overburden health systems. • **Sanitation Challenges:** Compromised water sanitation and hygiene systems exacerbate cholera and dysentery outbreaks.
Livelihoods 	• **Economic Strain:** Reduced crop yields diminish ganyu (labour) opportunities, affecting poorer households. Market prices for staples may rise due to poor yields nationally. • **Livestock Health Decline:** Drought reduces water and forage availability, impacting milk and meat production with associated increase in market prices.	• **Livestock Risks:** Muddy conditions increase livestock diseases, raising veterinary costs and reducing farm income. • **Market Disruptions:** Flooded roads hinder access to markets, reducing income for farmers. • **Short-Term Gains:** Improved pastures from rainfall may benefit livestock for farmers who have access to better drained land and veterinary services.	• **Disease Outbreaks:** Tick and parasite infestations rise, reducing livestock productivity. • **Cash Crop Challenges:** Increased fungal disease heighten costs for smallholder farmers. • **Widening Inequality:** Wealthier households adopt adaptive measures, deepening socioeconomic divides.
Agriculture 	• **Crop Yield Reductions:** Maize and millet experience declines due to prolonged drought and increased heat stress. • **Soil Degradation:** Reduced rainfall accelerates soil erosion and nutrient loss, further lowering productivity. • **Pest Dynamics:** Heat stress and sporadic rainfall promote the emergence of drought-tolerant pests.	• **Flooding Risks:** Heavy rainfall leads to waterlogging and crop loss, particularly for maize and rice. • **Disease Pressure:** Fluctuating moisture creates favourable conditions for fungal diseases in groundnuts and bananas. • **Growth Variability:** Irregular rainfall distribution disrupts planting and harvesting cycles.	• **Crop Diseases:** High humidity increases fungal infections in bananas and groundnuts, reducing market value. • **Soil Erosion:** Intense rainfall washes away topsoil, undermining long-term soil fertility. • **Mixed Outcomes:** Cassava may benefit from higher moisture, although still risks waterlogging,, while maize faces risks of high risk of waterlogging.

5. KARONGA ICICLE STORYLINES





Karonga District, located along the northern shore of Lake Malawi, is home to 365,000 people, with an annual growth rate of 3.0% (Malawi Office of Statistics). The district is characterised by two primary livelihood zones (FEWS NET USAID, 2024): **MW01 (Central Karonga**) - primarily agricultural, focusing on rice, maize, and cassava production; and **MW10 (Northern Karonga) - c**ombines agriculture and fishing, with Lake Malawi serving as a critical resource for food security and income.

The district is highly vulnerable to NTDs such as schistosomiasis, lymphatic filariasis, onchocerciasis, trachoma, and soil-transmitted helminths (STH). Climate variations exacerbate these vulnerabilities by altering vector habitats, water availability, and sanitation conditions**.**

Karonga Climate storylines (CS) for SSP2-4.5 Emission Scenario

CS1. Hotter – Drier – Decreasing Humidity
Temperature Increase (T↑): 0.7°C (3.4%)
Precipitation Decrease (P↓): -51 mm (3.7%)
Humidity Decrease (H↓): -20% (26.3%)

CS2. Hotter – Wetter – Decreasing Humidity
Temperature Increase (T↑): 0.7°C (3.4%)
Precipitation Increase (P↑): 33 mm (2.4%)
Humidity Decrease (H↓): -13% (17.1%)

CS3. Cooler – Wetter – Decreasing Humidity
Temperature Decrease (T↓): -4.8°C (22%)
Precipitation Increase (P↑): 44 mm (3.2%)
Humidity Decrease (H↓): -19% (25%)

5.1 Karonga ICICLE Storyline Narratives

Projections indicate that Karonga's future climate will likely be hotter and wetter with decreasing humidity. However, a hotter and drier future is also possible with decreasing humidity, as is a cooler and wetter future with decreasing humidity.

The narratives, based on the near-term Climate Storylines for Karonga follow below.

Karonga ICICLE Storyline 1: Hotter – Drier – Decreasing Humidity
NTD transmission seems to be shifting; although schistosomiasis risks are initially decreasing with the reduced snail habitats, more people are accessing the limited water sources which is increasing disease spread (Roswati et al., 2021). With the dry and dustier conditions, the incidence of trachoma is worsening (RCRC IFRC, 2021). Public health infrastructure is strained due to the intensified water scarcity, affecting hygiene and care provision (RCRC IFRC, 2021 and Malawi Red Cross Society, 2020). Rising temperatures are accelerating the vector breeding cycles, increasing the prevalence of diseases such as lymphatic filariasis and malaria (Roswati et al., 2021). Karonga's agricultural sector is also suffering with severe moisture stress particularly for maize, resulting in stunted growth, reduced flowering, and lower yields. The effects are being experienced particularly in MW01, where soil moisture deficits are also exacerbating heat stress (Malawi Office of Statistics, 2021; FEWS NET, USAID, 2024). Rice cultivation which depends on an adequate water supply is struggling in MW01's floodplains. Farmers are relying on additional irrigation to mitigate their losses (FEWS NET, USAID, 2024). Despite its drought resistance, farmers growing cassava are noticing that the root size and quality are reducing due to the prolonged dry spells they are seeing. This is raising concerns about food security (Malawi Office of Statistics, 2021) for the national government. The much lower humidity is increasing disease susceptibility for cash crops like bananas and groundnuts. This is in turn, lowering the market value and profitability of cash crops (FEWS NET, USAID, 2024). With these declining crop yields reducing the demand for ganyu labour, livelihoods are now at risk, particularly for the poorer households which depend on seasonal employment (FEWS NET, USAID, 2024). The lower water levels in Lake Malawi is reducing fish stocks, further threatening incomes and food security for small-scale fishers in MW10 (Malawi Office of Statistics, 2021). Livestock health is deteriorating due to reduced water availability and degraded grazing land.
Karonga ICICLE Storyline 2: Hotter – Wetter – Decreasing Humidity
The increase in surface water sources is expanding the mosquito breeding sites and increasing vector-borne disease transmission (Malawi Office of Statistics, 2021; RCRC IFRC, 2021). NTDs are seeing a resurgence as a result, including for lymphatic filariasis, and schistosomiasis with increases in the availability of snail habitats (Roswati et al., 2021). The increase in rainfall around Lake Malawi is leading to an increase in flood risk and the government is concerned about the potential impacts on public health infrastructure, isolating communities and damaging facilities. Agricultural productivity is experiencing some temporary improvements with the increased soil moisture, boosting maize and rice yields in MW01 (Malawi Office of Statistics, 2021). However, humidity is fluctuating though on a downward trend which is introducing new pest and disease challenges, and affecting crop health (FEWS NET, USAID, 2024). Although the cash crops grown in Karonga such as bananas and groundnuts are benefitting from more rain, concerns are being raised about the quality of the post-harvest storage which may be compromised due to humidity-related pests (FEWS NET, USAID, 2024). Livelihoods in Karonga are improving with some short-term benefits arising from improved crop yields and better pasture conditions for the livestock. However, the increased rainfall is also leading to waterlogging and livestock disease outbreaks (Malawi Office of Statistics, 2021). Similarly for fisher communities, the higher water levels in Lake Malawi due to the increased rainfall has improved fish stocks, but flooding is damaging infrastructure, limiting market access and reducing local incomes (RCRC IFRC, 2021).
Karonga ICICLE Storyline 3: Cooler – Wetter – Decreasing Humidity
NTD transmission risks for schistosomiasis and lymphatic filariasis are increasing due to favourable breeding conditions, while sustained soil moisture is promoting the incidence of soil-transmitted helminthiasis (Roswati et al., 2021). Under the cooler, wetter conditions and decreasing humidity agriculture is experiencing mixed effects. Rice cultivation in MW01 is benefitting from the higher rainfall and soil moisture, but cooler temperatures is slowing the rice growth cycles. Meanwhile, maize and groundnuts are facing challenges with waterlogging, root rotting and fungal diseases. The demand for enhanced pest and disease management is exacerbating socio-economic disparities, as the wealthier farmers are finding it easier to adapt their farm practices (FEWS NET, USAID, 2024; Malawi Office of Statistics, 2021). People whose livelihoods are dependent on agriculture and fishing are facing fluctuating water levels and heightened livestock disease risks and are having to invest more in veterinary care and adaptive practices (Malawi Office of Statistics, 2021). Temporary opportunities for ganyu labour in pest and disease control are emerging, but they bring elevated health risks and unstable employment (Malawi Office of Statistics, 2021). Rising disease burdens, including vector-borne and waterborne illnesses, are further straining public health infrastructure with the increased rainfall contributing to a more rapid degrading of public health facilities through mould and corrosion, requiring rapid investments in more climate-resilient infrastructure (RCRC IFRC, 2021).

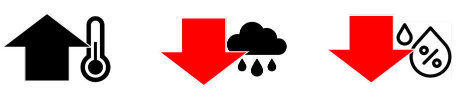
5.2 Summary of Impacts for Karonga under each Climate Storyline

The table below considers the climate impacts likely to affect the six selected NTDs and public health infrastructure and related to these the likely impacts on key crops, livestock, and livelihoods in Karonga. Impacts result from the changing climate condition (hazards), the exposure of these systems, and the intrinsic crop and animal vulnerabilities to, e.g., specific temperature thresholds, and of broader environmental vulnerabilities (e.g., soil erosion) and socio-economic vulnerabilities (e.g., poverty).

The impacts are derived considering all the climate storylines by considering the implications that each may have on NTDs, crops, livestock, and livelihoods. The impacts are visually presented in a table, to allow a more immediate access to this extensive information. For more details on the methodology used for the impact, see the full Technical Report (Methods Section).

The hazards and vulnerabilities determining the ICICLE storylines specific to Karonga and the resulting potential impacts in the relevant sectors (health, agriculture and livelihoods) are expressed in Table 2Table 1. The impacts are based on input from local stakeholders (LE) and integrated with the most pertinent impacts identified in the literature review. The research team has further refined these to focus on those most relevant to Karonga according to expert judgment.

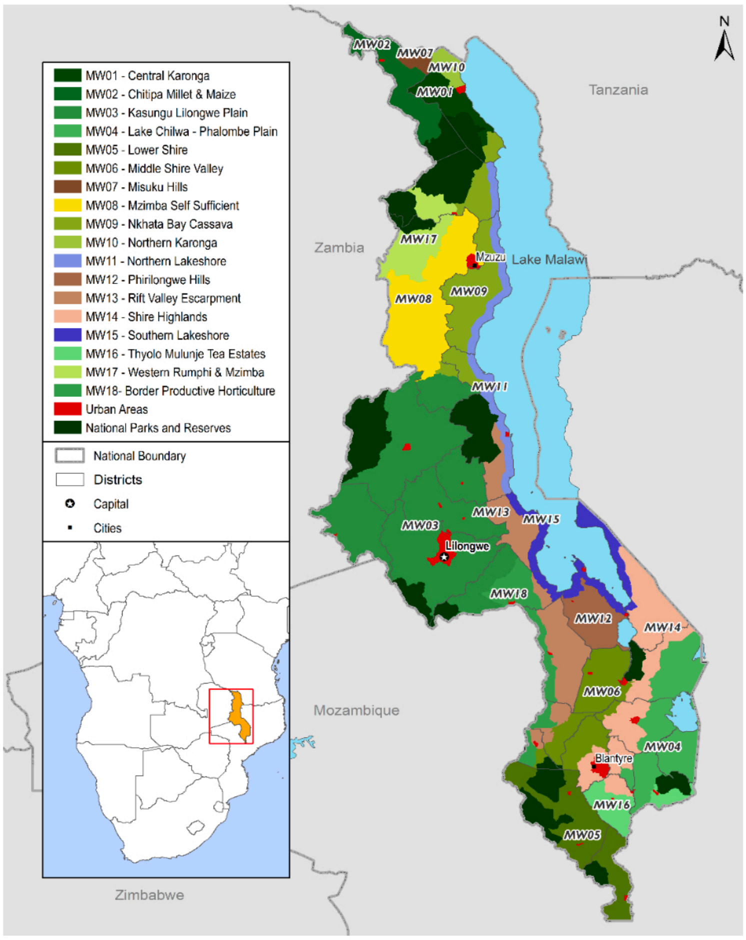
TABLE 2: KEY CLIMATE IMPACTS ON TARGETED NTDS, PUBLIC HEALTH INFRASTRUCTURE AND AGRICULTURE IN KARONGA WITH THE ASSOCIATED CLIMATE STORYLINE (CS) AND RELEVANT LOCAL VULNERABILITIES. KEY: BLACK ARROWS ARE INCREASING; RED ARROWS = DECREASING; THERMOMETER = TEMPERATURE; CLOUD = RAINFALL; DROP/PERCENTAGE = RELATIVE HUMIDITY

Sector	Climate Storyline 1 	Climate Storyline 2 	Climate Storyline 3 
Neglected Tropical Diseases 	• **Schistosomiasis Decline:** Reduced water bodies limit snail habitats but increase human exposure near limited sources. • **Lymphatic Filariasis Surge:** Isolated rainfall and rising temperatures accelerate mosquito breeding cycles. • **Trachoma Worsens:** Dry and dusty conditions exacerbate bacterial infections, increasing eye health challenges.	• **Increased Waterborne Diseases:** Rising water levels encourage schistosomiasis transmission as snails thrive in temporary water pools. • **Mosquito Breeding Surge:** Increased rainfall results in stagnant water pools, supporting lymphatic filariasis transmission. • **Onchocerciasis Risk Expansion:** Higher river flow supports blackfly breeding, heightening onchocerciasis risks.	• **Waterborne Risks:** Prolonged wet conditions amplify cholera and schistosomiasis outbreaks. • **Vector-Borne Diseases:** Cooler conditions reduce mosquito activity. However, sustained water sources maintain transmission risks. • **Sanitation Challenges:** Limited access to clean water exacerbates outbreaks of dysentery and waterborne infections.

Public Health Infrastructure 	• **Water Scarcity:** Reduced rainfall affects clean water availability for health facilities, impacting hygiene and care. • **Heat-Related Illness:** Rising temperatures strain health systems with cases of heat stress and dehydration. • **Access Limitations:** Isolated rural communities face heightened challenges in reaching health services.	• **Flood Damage to Facilities:** Excess rainfall damages buildings and disrupts medical service availability. • **Vector-Borne Disease Surges:** Malaria and lymphatic filariasis threaten to overwhelm already strained health services. • **Isolated Populations:** Damaged roads and infrastructure hinder healthcare access, particularly in remote communities.	• **Rising burden of disease**, including vector-borne and waterborne illnesses, are straining public health infrastructure. • Increased rainfall contributes to a **more rapid degrading of public health facilities** due to mould and corrosion.
Livelihoods 	• **Safe Water Shortages:** Reduced rainfall lowers access to safe drinking water, increasing disease risks and higher expenditure on health • **Livestock Vulnerability:** Limited pasture and water availability negatively impact livestock production. • **Fishing Industry Decline:** Lower Lake Malawi water levels reduce fish stocks, threatening fishing livelihoods and local economies linked to the fishing industry.	• **Temporary Grazing Benefits:** Short-term rainfall increases pasture growth, improving livestock health but risks to health from excessive rainfall unless preventive action is taken. • **Market Disruptions:** Flooded roads limit farmer and fisher access to markets, reducing income opportunities. • **Casual Labour Instability:** Fluctuations in agricultural output impact ganyu (casual labour) availability, affecting poorer households.	• **Fishing Uncertainty:** Changing water temperatures may alter fish migration, reducing catches. • **Livestock Disease Risks:** Wetter conditions create ideal breeding grounds for bacterial infections. • **Economic Uncertainty:** Inconsistent growing conditions create financial instability for farmers and traders.
Agriculture 	• **Crop Yield Decline:** Reduced precipitation and lower humidity exacerbate soil moisture loss, leading to significant yield reductions for bananas and groundnuts. • **Soil Erosion & Degradation:** Decreased rainfall weakens soil structure, increasing vulnerability to erosion and nutrient loss.	• **Waterlogging & Crop Loss:** Heavy rainfall leads to root rot and fungal infections. • **Soil Instability:** Intense rainfall events increase soil erosion, damaging arable land. • **Harvest Challenges:** Uneven moisture levels disrupt harvesting schedules and increase post-harvest losses.	• **Mixed Crop Performance:** Cooler temperatures could reduce heat stress but slow crop growth. • **Flooding Impacts:** Excess water negatively affects root crops, particularly cassava and groundnuts. • **Lower Disease Pressure:** Cooler conditions reduce vector and pest activity, benefiting overall crop health.

	• **Pest & Disease Risks:** Lower humidity may reduce fungal diseases but could favor drought-tolerant pests. • **Livestock Stress:** Decreased pasture availability leads to lower milk production and overall herd health deterioration.	• **Livestock Hoof Diseases:** Muddy conditions promote bacterial and fungal infections, increasing veterinary costs.	

6. NKHATA BAY ICICLE STORYLINES



Nkhata Bay District, located along the northern shores of Lake Malawi, has a population of approximately 284,681, as recorded in the 2018 Population and Housing Census (Malawi Office of Statistics, 2018). The district's socio-economic structure is defined by two primary livelihood zones—**MW09 (Nkhata Bay Cassava) and MW11 (Northern Lakeshore),** each playing a unique role in supporting household food security and income through a blend of upland farming and lakeshore fishing activities (FEWS NET, USAID, 2024). MW11 benefits from fertile soils and proximity to Lake Malawi, supporting both agriculture and fishing. Maize and cassava are staple crops, with cassava gaining importance due to its resilience to climate variability. Fishing plays a central role in the local economy, serving as a primary income source through the sale of fresh and dried fish both within and outside the district.

Nkhata Bay Climate storylines (CS) for SSP2-4.5 Emission Scenario

CS1. Hotter – Drier – Decreasing Humidity
Temperature Increase (T↑): 0.8°C (3.6%)
Precipitation Decrease (P↓): -31 mm (5.3%)
Humidity Decrease (H↓): -0.9% (1.2%)

CS2. Hotter – Wetter – Decreasing Humidity
Temperature Increase (T↑): 0.9°C (4.1%)
Precipitation Increase (P↑): 37 mm (3.1%)
Humidity Decrease (H↓): -0.9% (1.2%)

CS3. Hotter – Wetter – Increasing Humidity
Temperature Decrease (T↑): 0.5°C (2.3%)
Precipitation Increase (P↑): 37 mm (3.1%)
Humidity Decrease (H↑): 0.3% (0.4%)

6.1 Nkhata Bay ICICLE Storyline Narratives

Projections indicate that Nkhata Bay's future climate will likely be hotter and drier with slightly decreasing humidity. However, a hotter and wetter future is also possible with decreasing humidity, as is a hotter and wetter future but with slightly increasing humidity.

The narratives, based on the near-term Climate Storylines for Nkhata Bay follow below.

Nkhata Bay ICICLE Storyline 1: Hotter – Drier – Decreasing Humidity
Public health infrastructure is struggling with water scarcity, hindering sanitation and infection control whilst increasing temperatures are accelerating vector breeding cycles, and elevating people's risk of disease from malaria and LF (RCRC IFRC, 2021; Roswati et al., 2021). Agricultural and livelihood systems in Nkhata Bay are facing significant challenges due to water scarcity and rising temperatures. Cassava yields are declining as moisture stress becomes a persistent issue, reducing root size and quality, while maize and groundnuts are experiencing reduced productivity and heightened susceptibility to pests and diseases (Malawi Office of Statistics, 2018; FEWS NET, USAID, 2024). The declining water levels in Lake Malawi are continuing to threaten fish stocks, thereby impacting fishing livelihoods and reducing household incomes around the lake. This is exacerbated by reducing ganyu (casual labour) opportunities and poorer households are becoming increasingly vulnerable without alternative income sources (FEWS NET, USAID, 2024).
Nkhata Bay ICICLE Storyline 2: Hotter – Wetter – Decreasing Humidity
The expansion of mosquito breeding sites due to the increased rainfall are leading to increases in vector-borne and waterborne diseases, placing additional strain on public health facilities (Roswati et al., 2021). Sanitation systems are also becoming overwhelmed, through the surge in waterborne diseases such as cholera (RCRC IFRC, 2021). Although the higher rainfall in the Nkhata Bay district is temporarily supporting crop growth, improving cassava and maize yields, the fluctuating humidity is introducing challenges such as fungal diseases and pest infestations (FEWS NET, USAID, 2024). Increased water availability is benefitting fishing livelihoods, but fluctuating water levels are disrupting fish breeding cycles and damaging trade infrastructure (Malawi Office of Statistics, 2018). Ganyu labour opportunities are rising but their distribution remains uneven, benefiting wealthier households more and deepening socio-economic disparities (Malawi Office of Statistics, 2018; FEWS NET, USAID, 2024).
Nkhata Bay ICICLE Storyline 3: Hotter – Wetter – Increasing Humidity
Public health facilities are facing higher disease burdens from vector-borne and waterborne diseases, while infrastructure resilience is being compromised due to water-related damage, mould, and corrosion (RCRC IFRC, 2021; Roswati et al., 2021). The combination of increased rainfall and humidity is creating much more favourable conditions for cassava and other moisture-dependent crops, boosting yields (FEWS NET, USAID, 2024). However, the increased moisture is also heightening the risk of fungal diseases and pest infestations, and farmers are having to invest more in disease-resistant crop varieties and improved storage facilities (Malawi Office of Statistics, 2018). Fishing livelihoods are benefitting from increased fish stocks, but preservation and drying challenges are emerging due to the increasing humidity, which is affecting trade and income (FEWS NET, USAID, 2024).

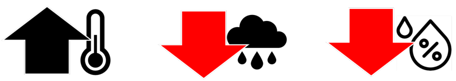
6.2 Summary of Impacts for Nkhata Bay under each Climate Storyline

The table below considers the climate impacts likely to affect the six selected NTDs and public health infrastructure and related to these the likely impacts on key crops, livestock, and livelihoods in Nkhata Bay. Impacts result from the changing climate condition (hazards), the exposure of these systems, and the intrinsic crop and animal vulnerabilities to, e.g., specific temperature thresholds, and of broader environmental vulnerabilities (e.g., soil erosion) and socio-economic vulnerabilities (e.g., poverty).

The impacts are derived considering all the climate storylines by considering the implications that each may have on NTDs, crops, livestock, and livelihoods. The impacts are visually presented in a table, to allow a more immediate access to this extensive information. For more details on the methodology used for the impact, see the full Technical Report (Methods Section).

The hazards and vulnerabilities determining the ICICLE storylines specific to Nkhata Bay and the resulting potential impacts in the relevant sectors (health, agriculture and livelihoods) are expressed in Table 3Table 1. The impacts are based on input from local stakeholders (LE) and integrated with the most pertinent impacts identified in the literature review. The research team has further refined these to focus on those most relevant to Nkhata Bay according to expert judgment.

TABLE 3: KEY CLIMATE IMPACTS ON TARGETED NTDS, PUBLIC HEALTH INFRASTRUCTURE AND AGRICULTURE IN NKHATA BAY WITH THE ASSOCIATED CLIMATE STORYLINE (CS) AND RELEVANT LOCAL VULNERABILITIES. KEY: BLACK ARROWS ARE INCREASING; RED ARROWS = DECREASING; THERMOMETER = TEMPERATURE; CLOUD = RAINFALL; DROP/PERCENTAGE = RELATIVE HUMIDITY

Sector	Climate Storyline 1	Climate Storyline 2	Climate Storyline 3
			
Neglected Tropical Diseases 	• **Schistosomiasis:** Declining water bodies may reduce snail habitats, potentially lowering transmission. However, human reliance on limited stagnant water sources could increase exposure risk. • **Lymphatic Filariasis (LF):** Lower water availability may initially limit mosquito breeding sites, but rising temperatures accelerate mosquito larval cycles, increasing outbreak risks during isolated rainfall events. • **Onchocerciasis:** Reduced precipitation may lower blackfly breeding areas, but	• **Schistosomiasis:** Increased rainfall expands snail habitats, raising transmission risks, but reduced humidity limits snail reproduction. • **Lymphatic Filariasis (LF):** Additional mosquito breeding sites emerge due to higher rainfall, accelerating transmission risks in areas with weak vector control. • **Onchocerciasis:** Higher rainfall supports blackfly breeding, increasing transmission risk near rivers. • **Soil-Transmitted Helminths (STH):** Increased soil moisture supports	• **Schistosomiasis:** Optimal breeding conditions for snails increase prevalence and transmission rates, requiring enhanced water and snail control. • **Lymphatic Filariasis (LF):** Favourable mosquito breeding conditions (high rainfall, humidity, and temperatures) increase the transmission risks of this disease. • **Onchocerciasis:** Warm temperatures and increased water flow promote blackfly populations, raising exposure risks.

	higher temperatures could sustain blackfly activity in existing water sources. • **Soil-Transmitted Helminths (STH):** Drier soils and lower humidity may reduce helminth egg survival, but transmission could persist in poor sanitation conditions. • **Trachoma:** Dry, dusty conditions heighten transmission risks due to increased eye irritation and poor hygiene access.	helminth eggs and larvae, heightening transmission risks in areas with inadequate sanitation. • **Trachoma:** Increased water availability improves hygiene access, but fluctuating humidity could sustain transmission risks.	• **Soil-Transmitted Helminths (STH):** Sustained soil moisture maintains helminth survival, increasing transmission risk in areas with poor sanitation. • **Trachoma:** Higher humidity may mitigate eye irritation, potentially lowering transmission, but hygiene improvements remain essential.
Public Health Infrastructure 	• **Water Scarcity:** Public health facilities struggle with maintaining hygiene and infection control due to limited water availability. • **Heat-Related Illnesses:** Rising temperatures increase dehydration cases, straining health systems. • **Infrastructure Degradation:** Heat stress accelerates the deterioration of buildings and equipment, affecting healthcare delivery.	• **Flooding Risks:** Localised flooding damages roads and facilities, restricting healthcare access. • **Vector-Borne Disease Burden:** Rising mosquito-borne illnesses, including malaria and LF, overwhelm facilities. • **Sanitation Challenges:** Heavy rainfall strain sanitation systems, increasing the risk of cholera and diarrheal diseases.	• **Structural Damage:** Persistent humidity and rainfall cause mould growth, corrosion, and water-related damage to health facilities. • **Disease Surge:** Increased malaria transmission, schistosomiasis, and LF overburden public health services. • **Emergency Preparedness:** More frequent extreme weather events necessitate stronger disaster response strategies.

Livelihoods 	• **Reduced Ganyu Labor:** Reduced crop productivity limits employment for poorer households. • **Fishing Industry Struggles:** Declining Lake Malawi water levels reduce fish stocks, impacting fishing-dependent livelihoods. • **Market Disruptions:** Lower maize and groundnut yields decrease market activity and economic resilience.	• **Fluctuating Ganyu Opportunities:** Higher yields temporarily boost labour demand, but benefits remain uneven between better off and poorer households • **Fishing Livelihoods Benefit:** Increased water availability stabilises fish stocks but disrupts breeding cycles. • **Infrastructure Limitations:** Flood-damaged roads restrict market access for fish and crop trade.	• **Higher Demand for Labour:** Increased harvests require more workers. Labour migration to areas with work opportunities increasing disease risk and exposure • **Fishing Challenges:** Humidity affects fish drying and preservation, reducing trade efficiency and fishing incomes. • **Wealth Disparities:** Wealthier households can invest in adaptation measures, deepening socioeconomic divides.
Agriculture 	• **Cassava and Maize Stress:** Moisture stress reduces root size in cassava and yields in maize. • **Groundnut and Bean Declines:** Increased pest pressure due to dry conditions affects yields and market value. • **Livestock Productivity Loss:** Reduced water and grazing land negatively impact cattle and goat production	• **Improved Cassava and Maize Growth:** Higher rainfall benefits staple crops but increases fungal disease risks. • **Pest Infestations:** Humidity fluctuations encourage pest outbreaks in bananas and groundnuts. • **Waterlogged Fields:** Inconsistent moisture conditions damage root crops like potatoes.	• **Crop Yield Boosts:** Increased precipitation and humidity support cassava and maize growth. • **Fungal Disease Risks:** Moisture-dependent crops face greater threats from cassava mosaic and bacterial blight. • **Storage Challenges:** High humidity complicates drying and post-harvest storage.

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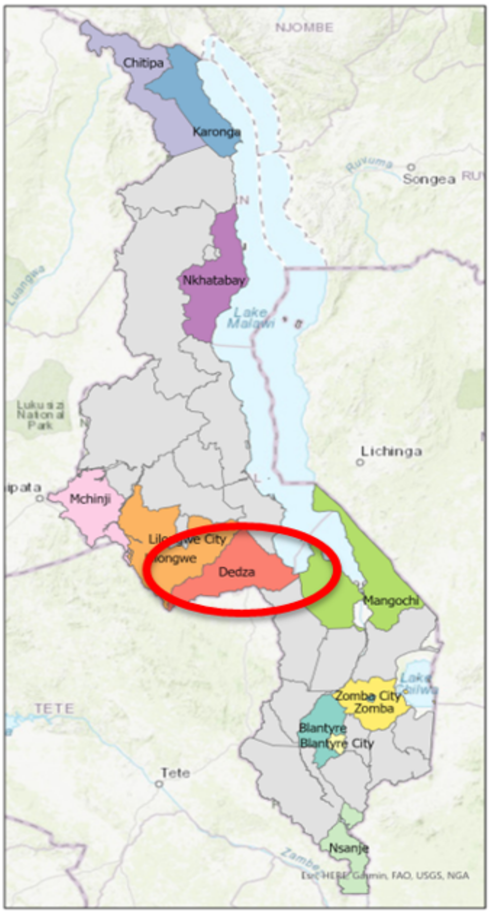
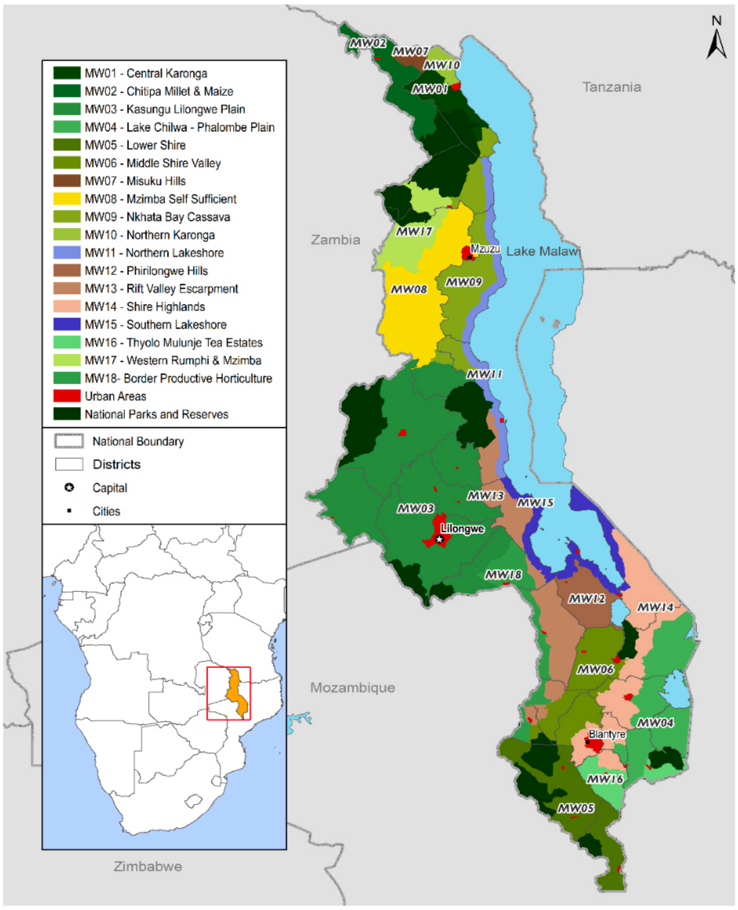
7. DEDZA ICICLE STORYLINES





Dedza, a district in central Malawi located just south of the capital, Lilongwe, has a diverse topography and a population of 830,512, contributing approximately 4.7% to Malawi's total population. The district spans four distinct livelihood zones**: MW03 (Kasungu-Lilongwe Plain Livelihood Zone), MW18 (Border Productive Horticulture Livelihood Zone)**, along with smaller sections **of MW13 (Rift Valley Escarpment Livelihood Zone)** and **ML15 (Southern Lakeshore Livelihood Zone**) (FEWS NET, USAID, 2024; see Figure 3). Dedza also shares a border with Mozambique. The district's demographics are notably youthful, with a large proportion of school-age individuals, signalling both growth potential and a significant dependency ratio. Dedza's economy is primarily agriculture-based, with most households engaged in staple crop farming. In relation to off farm employment, men are largely employed in the construction and energy sectors, while women are well-represented in health, social work, and education. This gendered division of labour highlights Dedza's dependence on primary industries, complemented by small-scale trade, which together provide employment diversity and support economic stability (Red Cross, District Councils, and the Malawi Office of Statistics).

Dedza Climate storylines (CS) for SSP2-4.5 Emission Scenario

CS1. Hotter – Drier – Decreasing Humidity
Temperature Increase (T↑): 0.9°C (4.1%)
Precipitation Decrease (P↓): -34 mm (3.3%)
Humidity Decrease (H↓): -1.4% (2.0%)

CS2. Hotter – Wetter – Decreasing Humidity
Temperature Increase (T↑): 0.7°C (3.2%)
Precipitation Increase (P↑): 45 mm (4.4%)
Humidity Decrease (H↓): -0.6% (0.9%)

CS3. Hotter – Wetter – Increasing Humidity
Temperature Decrease (T↑): 0.4°C (1.8%)
Precipitation Increase (P↑): 74 mm (7.6%)
Humidity Decrease (H↑): 0.3% (0.4%)

7.1 Dedza ICICLE Storyline Narratives

Projections indicate that Dedza future climate will likely be hotter and drier with slightly decreasing humidity. However, a hotter and wetter future is also possible with decreasing humidity, as is a hotter and much wetter future but with slightly increasing humidity.

The narratives, based on the near-term Climate Storylines for Dedza follow below.

Dedza ICICLE Storyline 1: Hotter – Drier – Decreasing Humidity
Vector-borne diseases such as lymphatic filariasis are seeing localised spikes as mosquito breeding cycles accelerate during isolated rainfall events (RCRC IFRC, 2021) across Dedza. Reduced productivity due to the higher temperature is also limiting ganyu (casual labour) opportunities, deepening socio-economic inequalities (FEWS NET, USAID, 2024). The reduced water levels are affecting sanitation and water availability for public health facilities, increasing risks of waterborne diseases and compromising infection control (Malawi Office of Statistics, 2018). Dedza's agricultural and livelihood systems are facing pronounced challenges due to moisture stress and rapidly rising temperatures. The Maize yields, a staple crop in MW03 and MW18, are reducing and affecting food security and household incomes. Cassava, known for its drought resistance, is declining in root size and quality during the prolonged dry spells that keep hitting the district. Cash crops such as soybeans and bananas are suffering from the decreased water availability, impacting farmers' market value and income potential (FEWS NET, USAID, 2024).
Dedza ICICLE Storyline 2: Hotter – Wetter – Decreasing Humidity
Expanded mosquito breeding sites are increasing vector-borne diseases like malaria and lymphatic filariasis, necessitating robust vector control measures (Roswati et al., 2021). The increased rainfall and related flooding is threatening to overwhelm sanitation provision leading to an increase in water-borne diseases and pressure on public health infrastructure. Increased water availability is however, helping to reduce the dry conditions linked to trachoma, and Dedza’s agricultural sector is seeing a temporary boost with improved soil moisture increasing maize and cassava yields. However, the lower and more variable humidity is introducing challenges such as increased pest infestations and fungal diseases, which are requiring proactive management strategies (FEWS NET, USAID, 2024 Fishing communities continue to experience fluctuating water levels which is challenging livelihoods and infrastructure resilience (Malawi Office of Statistics, 2018). The rise in ganyu labour opportunities is helping to offer economic relief, but wealth disparities are skewing the benefits towards wealthier households.
Dedza ICICLE Storyline 3: Hotter – Wetter – Increasing Humidity
Dedza is facing a higher disease burden with the change in environmental conditions favouring the prevalence of disease vectors from both vector-borne and waterborne diseases and putting strain on public health infrastructure. Health facilities must be adapted to prevent mould, corrosion, and water-related damage, to ensure continued service provision during the adverse weather conditions (RCRC IFRC, 2021; Roswati et al., 2021). The combination of higher rainfall and higher humidity offers favourable conditions for maize, cassava, and vegetable crops in MW03 and MW18, with farmers seeing increasing yields and improved food security. However, the heightened humidity is also raising the risks of fungal diseases and pest infestations, requiring investments in disease-resistant crop varieties and storage solutions (Malawi Office of Statistics, 2018). Increased water availability is bolstering fishing livelihoods through improved fish stocks, but high humidity is causing preservation challenges for fish products (FEWS NET, USAID, 2024).

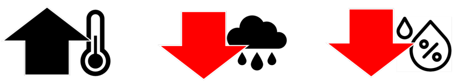
7.2 Summary of Impacts for Dedza under each Climate Storyline

The table below considers the climate impacts likely to affect the six selected NTDs and public health infrastructure and related to these the likely impacts on key crops, livestock, and livelihoods in Dedza. Impacts result from the changing climate condition (hazards), the exposure of these systems, and the intrinsic crop and animal vulnerabilities to, e.g. specific temperature thresholds, and of broader environmental vulnerabilities (e.g. soil erosion) and socio-economic vulnerabilities (e.g. poverty).

The impacts are derived considering all the climate storylines by considering the implications that each may have on NTDs, crops, livestock, and livelihoods. The impacts are visually presented in a table, to allow a more immediate access to this extensive information. For more details on the methodology used for the impact, see the full Technical Report (Methods Section).

The hazards and vulnerabilities determining the ICICLE storylines specific to Dedza and the resulting potential impacts in the relevant sectors (health, agriculture and livelihoods) are expressed in Table 4Table 1. The impacts are based on input from local stakeholders (LE) and integrated with the most pertinent impacts identified in the literature review. The research team has further refined these to focus on those most relevant to Dedza according to expert judgment.

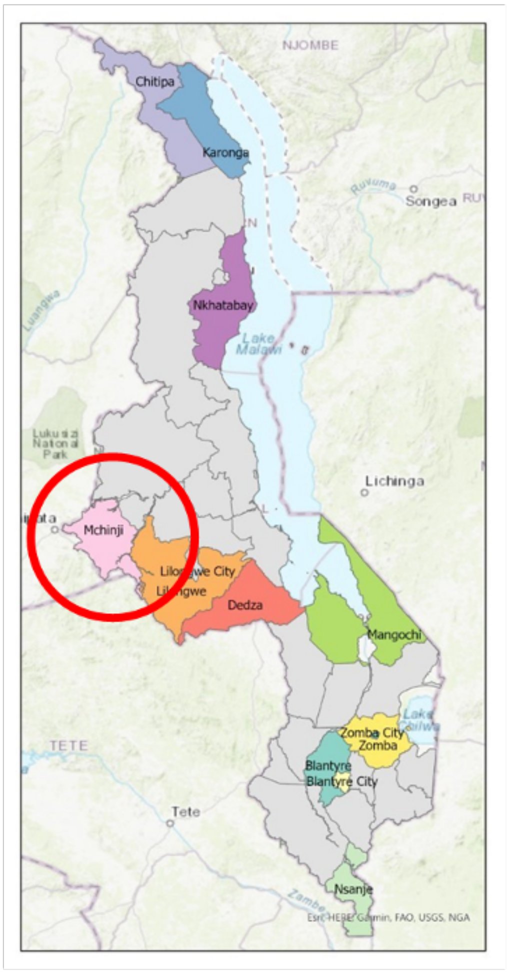
TABLE 4: KEY CLIMATE IMPACTS ON TARGETED NTDS, PUBLIC HEALTH INFRASTRUCTURE AND AGRICULTURE IN DEDZA WITH THE ASSOCIATED CLIMATE STORYLINE (CS) AND RELEVANT LOCAL VULNERABILITIES. KEY: BLACK ARROWS ARE INCREASING; RED ARROWS = DECREASING; THERMOMETER = TEMPERATURE; CLOUD = RAINFALL; DROP/PERCENTAGE = RELATIVE HUMIDITY

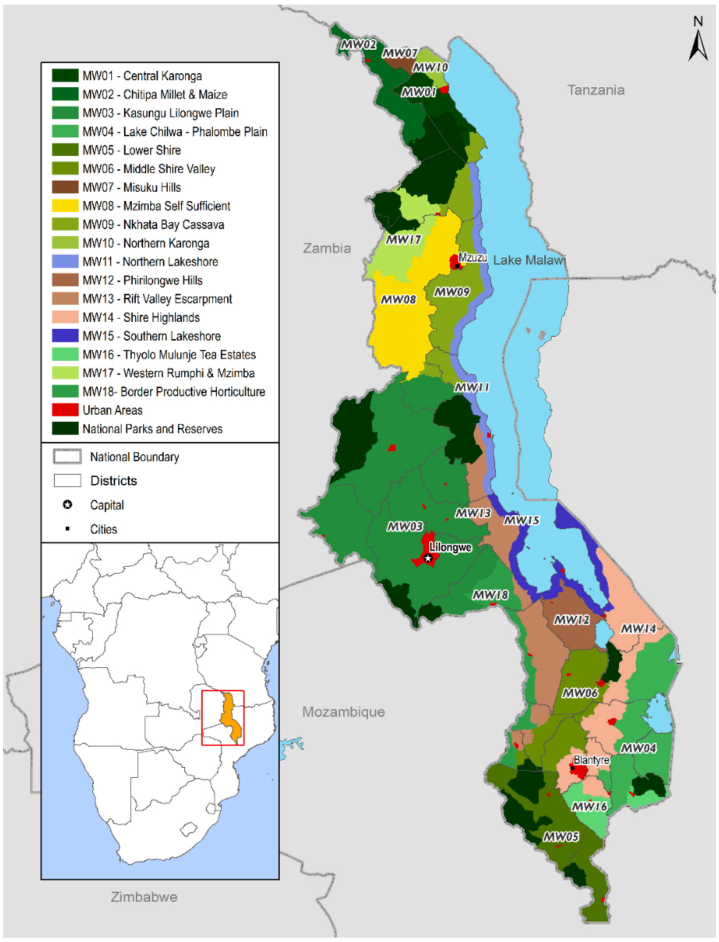
Sector	Climate Storyline 1 	Climate Storyline 2 	Climate Storyline 3 
Neglected Tropical Diseases 	• **Schistosomiasis:** Shrinking water bodies reduce snail habitats, lowering transmission risks, but reliance on stagnant water increases exposure in vulnerable areas. Accelerated larval development due to higher temperatures may counteract habitat reductions. • **Lymphatic Filariasis:** Limited rainfall initially restricts mosquito breeding, but sporadic rainfall and rising temperatures accelerate mosquito reproductive cycles, increasing transmission risk during isolated outbreaks.	• **Schistosomiasis:** Increased rainfall expands snail habitats, raising risks although reduced humidity disrupts snail reproduction cycles. • **Lymphatic Filariasis:** Higher rainfall creates more mosquito breeding sites, with elevated transmission risks from accelerated mosquito life cycles. • **Trachoma:** Water availability alleviates dryness, reducing risks slightly, but low humidity sustains some transmission potential.	• **Schistosomiasis:** Combined rainfall and humidity provide optimal conditions for snail populations, amplifying transmission risks. • **Lymphatic Filariasis:** Ideal breeding conditions for mosquitoes drive significant transmission risks, necessitating comprehensive vector control. • **Trachoma:** Higher humidity mitigates dryness, reducing risks but necessitating ongoing hygiene interventions.

	• **Trachoma:** Dry, dusty conditions elevate transmission risks due to poor hygiene and limited water access. • **Soil-Transmitted Helminths (STH):** Drier soils decrease egg and larval survival rates, slightly reducing risks in areas with adequate sanitation.	• **Soil-Transmitted Helminths (STH):** Improved soil moisture enhances egg survival, increasing infection potential in poorly sanitised areas.	• **Soil-Transmitted Helminths (STH):** Sustained soil moisture supports helminth viability, heightening risks where sanitation infrastructure is inadequate.
Public Health Infrastructure 	• **Water Scarcity:** Reduced precipitation limits clean water access, impacting hygiene and infection control in health facilities. • **Heat-Related Illnesses:** Higher temperatures increase cases of dehydration and heat stress, straining already limited health services. • **Structural Integrity:** Dry and hot conditions exacerbate infrastructure degradation, leading to cracks and equipment failures.	• **Flooding Risks:** Localised flooding damages health facilities and isolates communities, limiting access to essential services. • **Vector-Borne Diseases:** Increased mosquito breeding from standing water burdens health facilities with malaria and Lymphatic Filariasis cases. • **Sanitation Challenges:** Overwhelmed water sanitation and hygiene systems lead to waterborne disease outbreaks, such as cholera.	• **Facility Degradation:** High humidity promotes mould and corrosion, compromising infrastructure and equipment. • **Disease Burden:** Rising cases of vector and waterborne diseases overwhelm health systems. • **Emergency Preparedness:** Frequent extreme weather events require stockpiling and disaster response plans to ensure service continuity.
Livelihoods 	• **Agriculture:** Reduced yields lower incomes, especially for subsistence farmers. Declining productivity deepens poverty and limits ganyu (casual labour) opportunities. • **Fishing:** Falling Lake Malawi water levels disrupt fish stocks, reducing incomes and food security. • **Livestock:** Degraded pastures and water scarcity weaken livestock health, impacting income for poorer households.	• **Agriculture:** Increased rainfall boosts ganyu opportunities and short-term income, but benefits are uneven, favouring wealthier households. • **Fishing:** Higher rainfall stabilises fish stocks, but fluctuating water levels disrupt breeding cycles and infrastructure. • **Livestock:** Improved pastures temporarily benefit livestock, but muddy conditions raise disease risks, requiring veterinary care.	• **Agriculture:** Increased rainfall boosts ganyu opportunities and short-term income, but benefits are uneven, favouring wealthier households. • **Fishing:** Higher rainfall stabilises fish stocks, but fluctuating water levels disrupt breeding cycles and infrastructure. • **Livestock:** Improved pastures temporarily benefit livestock, but muddy conditions raise disease risks, requiring veterinary care.

Agriculture 	• **Maize and Cassava:** Moisture stress reduces yields, threatening food security. Cassava, although drought-resistant, suffers reduced root size during prolonged dry spells. • **Soybeans and Bananas:** Lower productivity due to reduced water availability and increased pest infestations. • **Vegetables:** Yield declines limit income diversification and negatively affect local markets.	• **Maize and Cassava:** Improved soil moisture temporarily boosts yields, but pest and fungal disease risks rise with fluctuating humidity. • **Soybeans and Bananas:** Rainfall supports growth, but low humidity challenges crop health, requiring pest and disease management. • **Vegetables:** Higher yields from increased rainfall, however inconsistent humidity creates disease management challenges.	• **Maize and Cassava:** Improved soil moisture temporarily boosts yields, but pest and fungal disease risks rise with fluctuating humidity. • **Soybeans and Bananas:** Rainfall supports growth, but low humidity challenges crop health, requiring pest and disease management. • **Vegetables:** Higher yields from increased rainfall however, inconsistent humidity creates disease management challenges.

8. MCHINJI ICICLE STORYLINES





Mchinji District, situated in Malawi's Central Region, has a population of 602,305, constituting approximately 3.4% of the national total (Malawi Office of Statistics, 2018). The district's population is predominantly youthful, with individuals aged 10-35 accounting for nearly half, highlighting significant potential for workforce development. However, this also reflects a high dependency ratio, underscoring the critical need for targeted investments in education and job creation to support sustainable development.

Mchinji Climate storylines (CS) for SSP2-4.5 Emission Scenario

CS1. Hotter – Drier – Decreasing Humidity
Temperature Increase (T↑): 0.8°C (3.9%)
Precipitation Decrease (P↓): -41 mm (4.3%)
Humidity Decrease (H↓): -1.1% (1.7%)

CS2. Hotter – Wetter – Decreasing Humidity
Temperature Increase (T↑): 0.9°C (4.2%)
Precipitation Increase (P↑): 31 mm (3.2%)
Humidity Decrease (H↓): -1.2% (2.4%)

CS3. Hotter – Wetter – Increasing Humidity
Temperature Decrease (T↑): 0.4°C (1.9%)
Precipitation Increase (P↑): 57mm (5.9%)

The district is primarily agrarian, relying on livelihood zone **MW03 (Kasungu-Lilongwe Plain)**, where maize remains the staple crop anchoring food security. Climate change adaptations in agriculture include the introduction of drought-tolerant maize varieties and shifts from volatile cash crops like tobacco to more stable options such as soybeans and bananas. Livestock ownership—including cattle, goats, and chickens—complements crop production, offering households nutritional and financial resilience (FEWS NETUSAID, 2024). Labour patterns reveal socio-economic stratification, with wealthier households hiring additional labour for farming while poorer households depend on ganyu (casual labour) opportunities during peak agricultural seasons. Access to basic services varies across the district. Boreholes are the primary water source, but sanitation is limited, with many households lacking access to improved toilet facilities. Firewood remains the predominant cooking fuel, while kerosene and battery-powered torches are common for lighting, indicating an urgent need for sustainable energy solutions. Public health infrastructure is constrained, posing challenges in managing both routine care and climate-sensitive health issues, particularly neglected tropical diseases (NTDs).

8.1 Mchinji ICICLE Storyline Narratives

Projections indicate that Mchinji's future climate will likely be hotter and drier with slightly decreasing humidity. However, a hotter and wetter future is also possible with decreasing humidity, as is a hotter and wetter future but with slightly increasing humidity.

The narratives, based on the near-term Climate Storylines for Mchinji follow below.

Mchinji ICICLE Storyline 1: Hotter – Drier – Decreasing Humidity
The reduction of water bodies due to declining rainfall and humidity are decreasing Schistosomiasis prevalence by limiting snail habitats. In contrast, the warmer temperatures are accelerating snail reproduction and maintaining transmission hotspots where water is available. Lymphatic filariasis risks is shifting as mosquito breeding sites shrink due to water scarcity, but the higher temperatures are speeding up mosquito life cycles, posing episodic outbreak risks. Onchocerciasis transmission is decreasing with a reduction in blackfly habitats but residual transmission risks persist due to prolonged blackfly activity in limited water bodies. Soil-transmitted helminthiasis transmission is dropping due to the drier soil, but poor sanitation may sustain the infection rates. Trachoma risks are increasing as dry, dusty conditions heighten eye irritation in areas with limited water access (World Health Organization, n.d.; Malawi NTD Master Plan 2023-2030). Public health facilities are impacted by the water scarcity hitting the district with challenging hygiene and sanitation services, increasing risks of waterborne diseases. Heat-related illnesses such as dehydration and heat exhaustion are becoming more prevalent. Farmers are dealing with significant declines in agricultural yields due to moisture stress, reducing staple crop productivity (maize) with implications for food security among poorer households. Better off households may be able to mitigate this by adopting alternative crops (e.g., soya) . Tobacco producers may also benefit from improved curing conditions for tobacco. For households dependent on agriculture and livestock this will be exacerbated by a possible deterioration in livestock health and pasture conditions.
Mchinji ICICLE Storyline 2: Hotter – Wetter – Decreasing Humidity
The increased rainfall is expanding water bodies and increasing schistosomiasis risks by enhancing snail host habitats, while the reducing humidity seems to be destabilising snail populations. Lymphatic filariasis transmission risks are rising with the expansion of mosquito breeding sites with the rising temperatures. Blackfly reproduction is also increasing with greater water availability, elevating onchocerciasis risks, especially in the riverine areas of Mchinji. Soil-transmitted helminthiasis transmission is increasing due to the improved soil moisture supporting egg and larval survival, while trachoma transmission risks persist due to the decreasing humidity despite the increased water availability (World Health Organization, n.d.; Malawi NTD Master Plan 2023-2030). Flooding and accessibility issues are creating challenges for public health infrastructure, necessitating contingency planning and proactive disease prevention strategies. Agricultural productivity is temporarily improving, increasing food security and ganyu labour opportunities. However, all crops are being impacted by fluctuating humidity levels and in addition, waterlogging risks are introducing new pest and disease challenges for crops. Better off households with access to improved seed varieties are more resilient to these conditions than households that cannot afford these seeds. Although livestock are benefitting from improved pastures, they are also facing new disease threats (FEWS NET, USAID), with implications for production costs including veterinary fees.
Mchinji ICICLE Storyline 3: Hotter – Wetter – Increasing Humidity
The increasing temperature, rainfall, and humidity are creating optimal conditions for snail proliferation, intensifying schistosomiasis risks and necessitating robust water and snail control measures. Mosquito breeding is flourishing, raising lymphatic filariasis risks, while blackfly populations and associated onchocerciasis transmission are also increasing. Soil-transmitted helminths are thriving due to the sustained soil moisture. Fortunately, the higher humidity combined with increased water access is helping to reduce trachoma risks when paired with effective hygiene interventions (World Health Organization, n.d.; Malawi NTD Master Plan 2023-2030). With the changes above, public health infrastructure faces a significantly increased disease burden from vector- and waterborne diseases, which is stressing poorly-resourced health systems. The resilience of health facilities is increasingly compromised due to infrastructure degradation from humidity and water-related damage. Farmers are obtaining higher yields from crops like maize and cassava, but fungal diseases, pests, and waterlogging risks persist. Better off households are better able to manage these conditions where improved crop management and post-harvest storage is proving critical. Whilst there is some increase in productivity as a result, investments in disease management, resilient transport infrastructure, and a capacity to diversify income streams is required (FEWS NET, USAID).

8.2 Summary of Impacts for Mchinji under each Climate Storyline

The table below considers the climate impacts likely to affect the six selected NTDs and public health infrastructure and related to these the likely impacts on key crops, livestock, and livelihoods in Mchinji. Impacts result from the changing climate condition (hazards), the exposure of these systems, and the intrinsic crop and animal vulnerabilities to, e.g., specific temperature thresholds, and of broader environmental vulnerabilities (e.g., soil erosion) and socio-economic vulnerabilities (e.g., poverty).

The impacts are derived considering all the climate storylines by considering the implications that each may have on NTDs, crops, livestock, and livelihoods. The impacts are visually presented in a table, to allow a more immediate access to this extensive information. For more details on the methodology used for the impact, see the full Technical Report (Methods Section).

The hazards and vulnerabilities determining the ICICLE storylines specific to Mchinji and the resulting potential impacts in the relevant sectors (health, agriculture and livelihoods) are expressed in Table 5Table 1. The impacts are based on input from local stakeholders (LE) and integrated with the most pertinent impacts identified in the literature review. The research team has further refined these to focus on those most relevant to Mchinji according to expert judgment.

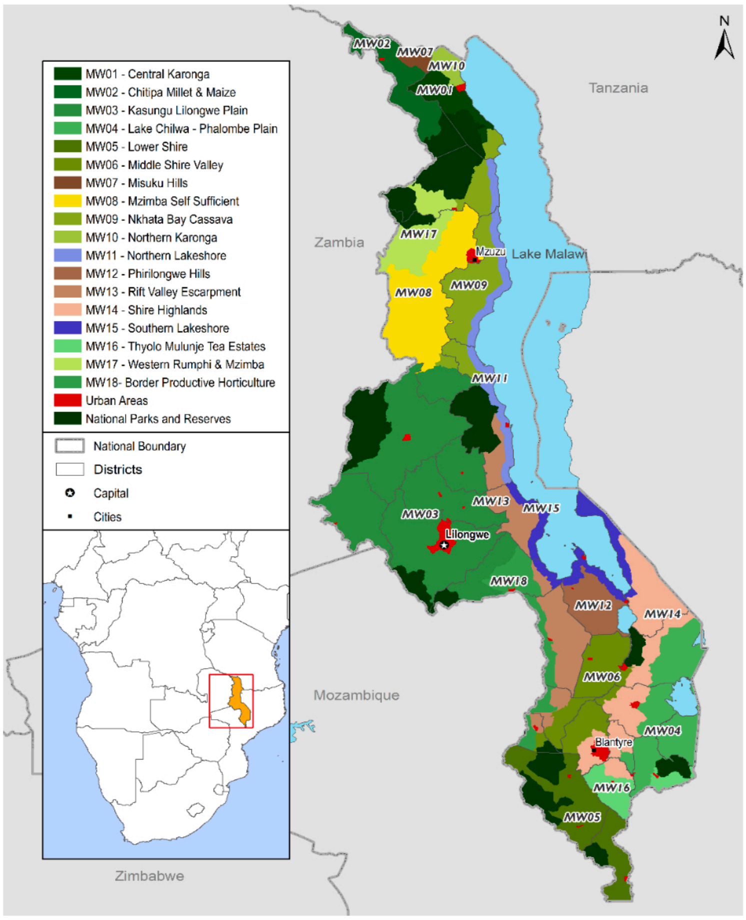
TABLE 5: KEY CLIMATE IMPACTS ON TARGETED NTDS, PUBLIC HEALTH INFRASTRUCTURE AND AGRICULTURE IN MCHINJI WITH THE ASSOCIATED CLIMATE STORYLINE (CS) AND RELEVANT LOCAL VULNERABILITIES. KEY: BLACK ARROWS ARE INCREASING; RED ARROWS = DECREASING; THERMOMETER = TEMPERATURE; CLOUD = RAINFALL; DROP/PERCENTAGE = RELATIVE HUMIDITY

Sector	Climate Storyline 1	Climate Storyline 2	Climate Storyline 3
Neglected Tropical Diseases 	• **Schistosomiasis Decline:** Fewer water bodies limit snail habitats, potentially reducing transmission. • **Lymphatic Filariasis Risks:** Mosquitoes breed faster in isolated rain events, leading to localised outbreaks. • **Trachoma Surge:** Dry and dusty conditions increase eye irritation, exacerbating transmission. • **Soil-Transmitted Helminths Decline:** Reduced soil moisture limits egg and larval survival, reducing transmission.	• **Schistosomiasis Expansion:** Increased water availability supports snail habitats; however, fluctuating humidity destabilises populations. • **Lymphatic Filariasis Spike:** Standing water expands mosquito breeding sites, escalating transmission. • **Onchocerciasis Increase:** More blackfly habitats form along rivers, heightening risks. • **Persistent Trachoma Threat:** Despite better water access, declining humidity sustains disease transmission.	• **Widespread Disease Outbreaks:** High temperatures, rainfall, and humidity create ideal conditions for NTD transmission. • **Schistosomiasis Intensification:** Snail populations thrive, increasing human exposure. • **Lymphatic Filariasis and Onchocerciasis Risk:** Expanded vector habitats support sustained transmission. • **Reduced Trachoma Transmission:** Improved hygiene access due to higher water availability could lower cases.

Public Health Infrastructure 	• **Water Scarcity Crisis:** Health facilities struggle to maintain hygiene and infection control. • **Heat-Related Illness Surge:** Dehydration and heat exhaustion cases increase among vulnerable populations. • **Service Disruptions:** Inadequate water supply affects sanitation, increasing disease transmission risks. • **Limited Disease Control Capacity:** Reduced water availability hampers response to vector-borne diseases.	• **Flood Risks to Health Facilities:** Infrastructure damage limits medical service provision. • **Vector-Borne Disease Spike:** Expanded mosquito and blackfly habitats increase malaria and filariasis burdens. • **Sanitation System Overload:** Increased rainfall strains Water, Sanitation, and Hygiene infrastructure. • **Inconsistent Healthcare Access:** Flooded roads and damaged facilities disrupt healthcare delivery.	• **Hospital Infrastructure Damage:** High moisture accelerates building deterioration and mould growth. • **Overburdened Health System:** Surge in waterborne and vector-borne diseases strains resources. • **Disease Transmission Hotspots:** Increased humidity sustains mosquito and snail populations, worsening outbreaks. • **Supply Chain Disruptions:** Flooding affects medicine and equipment distribution, limiting emergency response capacity.
Livelihoods 	• **Economic Decline:** Reduced agricultural productivity including tobacco and maize yields limits income from farming. • **Reduced Ganyu (Casual Labor):** Lower crop yields reduce hiring opportunities for poorer households. • **Water Scarcity:** Declining water levels impact fishing livelihoods and small-scale irrigation. • **Increased Vulnerability:** Fewer income diversification options exacerbate rural poverty.	• **Short-Term Gains in Ganyu:** Higher rainfall initially creates employment opportunities. • **Infrastructure Challenges:** Floods disrupt transport and trade, limiting income sources. • **Livestock and Fisheries Uncertainty:** Improved water access benefits fishing but increases disease risks for livestock. • **Growing Inequality:** Wealthier households benefit more from productivity gains than poorer ones.	• **Income Volatility:** Agriculture sees mixed results, with both increased yields and higher losses from pests and disease. • **Labour Market Shifts: Increased demand for labou**r in pest control and crop protection but more health-related absenteeism. • **Food Security Risks:** Post-harvest losses and market fluctuations threaten long-term household stability. • **Increased Disease Burden:** Rising vector-borne diseases among the workforce reduce economic productivity.
Agriculture	• **Crop Yield Decline:** Maize and cassava yields fall due to increased heat stress and declining soil moisture.	• **Short-Term Gains in Ganyu:** Higher rainfall creates temporary employment opportunities.	• **Pest and Disease Pressure:** Fungal diseases and pest infestations increase, lowering yields.

	• **Soil Degradation:** Drought accelerates land degradation, reducing long-term agricultural productivity. • **Livestock Stress:** Reduced pasture availability and water scarcity lead to poorer livestock health. • **Cash Crop Impact:** Tobacco curing may improve with lower humidity, but reduced irrigation threatens overall productivity.	• **Infrastructure Challenges:** Floods disrupt transport and trade, limiting income sources. • **Livestock and Fisheries Uncertainty:** Improved water access benefits fishing but increases disease risks for livestock. • **Growing Inequality:** Wealthier households benefit more from productivity gains than poorer ones.	• **Waterlogging Damage:** Maize and other staple crops suffer from excess soil moisture. • **Post-Harvest Challenges:** Increased humidity accelerates spoilage, reducing storage capacity. • **Livestock Disease Outbreaks:** Higher temperatures and moisture promote the spread of livestock diseases.

9. MANGOCHI ICICLE STORYLINES



Mangochi District, located along the southern shores of Lake Malawi and bordering Mozambique, has a population of 1,148,611 (Malawi Office of Statistics, 2018). Three key livelihood zones shape the district's economy: **MW15** (**Southern Lakeshore Zone**): Fishing, maize, and cassava farming are key activities, though overfishing and seasonal fluctuations threaten livelihoods. **MW12** (**Phirilongwe Hills Zone):** Maize and groundnuts dominate, with groundnuts valued for drought tolerance. Labour-intensive practices adapt to the hilly terrain, with drought-resistant crops like soybeans being introduced. **MW14** (**Shire Highlands Zone**): Tea production provides stable employment and income, with maize as the staple crop. Most households depend on boreholes for water and firewood for cooking, highlighting limited access to clean water and energy. Climate variability and population growth exacerbate pressures on agriculture, fishing, and infrastructure, increasing vulnerabilities to neglected tropical diseases (NTDs).

Mangochi Climate storylines (CS) for SSP2-4.5 Emission Scenario

CS1. Hotter – Drier – Decreasing Humidity
Temperature Increase (T↑): 0.8°C (3.5%)
Precipitation Decrease (P↓): -43 mm (4.2%)
Humidity Decrease (H↓): -1.3% (1.9%)

CS2. Hotter – Wetter – Decreasing Humidity
Temperature Increase (T↑): 0.9°C (3.9%)
Precipitation Increase (P↑): 34 mm (3.3%)
Humidity Decrease (H↓): -1.1% (1.6%)

CS3. Hotter – Wetter – Increasing Humidity
Temperature Decrease (T↑): 0.5°C (2.2%)
Precipitation Increase (P↑): 75mm (7.3%)
Humidity Decrease (H↑): 0.3% (0.4%)

9.1 Mangochi ICICLE Storyline Narratives

Projections indicate that Mangochi's future climate will likely be hotter and drier with slightly decreasing humidity. However, a hotter and wetter future is also possible with decreasing humidity, as is a hotter and much wetter future but with slightly increasing humidity.

The narratives, based on the near-term Climate Storylines for Mangochi follow below.

Mangochi ICICLE Storyline 1: Hotter – Drier – Decreasing Humidity
The decrease in rainfall and humidity alongside rising temperatures is generating difficult conditions for NTD transmission in Mangochi although for LF the reduced mosquito breeding sites is helping to limit transmission. That said, the rising temperatures are accelerating the mosquito reproduction cycles during isolated rainfall events, necessitating targeted vector control strategies such as insecticide-treated net distribution and larvicidal interventions (Malawi NTD Master Plan 2023-2030; FEWS NET, USAID, 2024). Onchocerciasis transmission risks are reducing as blackfly habitats shrink due to lower water flow, although the rising temperatures are sustaining their reproductive activity in limited areas, requiring sustained vector control (World Health Organization, n.d.; Malawi NTD Master Plan 2023-2030). For Soil-Transmitted Helminths (STH), decreasing soil moisture is reducing the viability of helminth eggs and larvae, but persistent poor sanitation is likely to continue to sustain infections within vulnerable communities (FEWS NET, USAID, 2024; Malawi Red Cross Society, 2020). The district's public health infrastructure continues to face challenges related to water scarcity, which affects hygiene and infection control measures (World Health Organization, 2023). All major crops grown in Mangochi which covers 3 different livelihood zones are experiencing reduced yields with major implications for the food security of poorer households who are suffering from both reduced yields and less agricultural labour. Lakeshore communities are also seeing a loss of income from fishing as fish stocks are affected by the falling lake levels. However, better off households in all livelihood zones across Mangochi are benefitting from the use of drought tolerant seeds and opportunities to invest in small businesses. Income inequalities are increasing. Successful diversification into new market opportunities will depend on post-harvest handling, disease management, and infrastructural support to stabilise incomes and build economic resilience (FEWS NET, USAID, 2024; Malawi Red Cross Society, 2020).
Mangochi ICICLE Storyline 2: Hotter – Wetter – Decreasing Humidity
A moderate increase in precipitation is temporarily expanding mosquito breeding habitats for LF, raising transmission risks, especially in areas prone to water accumulation. The rising temperatures are further accelerating the mosquito life cycles, necessitating comprehensive vector control measures, including mass drug administration and community-based larvicide application (Malawi NTD Master Plan 2023-2030; World Health Organization, n.d.). Onchocerciasis risks are increasing in Mchinji as increased water flows support the blackfly habitats, particularly in the riverine areas. Local government is calling for sustained monitoring and vector control interventions (Roswati et al., 2021). The improved soil moisture is also enhancing the survival of helminth eggs and larvae, thereby heightening STH transmission risks, especially in regions lacking adequate sanitation infrastructure (FEWS NET, USAID, 2024). The increased rainfall is also leading to localised flooding, damaging public health infrastructure and limiting access to healthcare services, emphasising the importance of resilient health systems (EM-DAT, 2023). Agricultural yields are improving with the increased rainfall leading to more ganyu for poorer households and greater food security . However, crop damage due to waterlogging and pests is offsetting the benefits for those households that are not able to invest in disease resistant seeds or improved post-harvest management. Income inequalities are increasing as better off households benefit from better yields and are capitalising on new marketing opportunities. Similarly, livestock is benefitting from improved pasture but higher expenditure is required on disease control. Fish stocks need careful monitoring as fluctuating conditions are affecting the fish breeding patterns, with subsequent losses of income for fishing communities. Successful diversification into new market opportunities will depend on post-harvest handling, disease management, and infrastructural support to stabilise incomes and build economic resilience (FEWS NET, USAID, 2024; Malawi Red Cross Society, 2020).

Mangochi ICICLE Storyline 3: Hotter – Wetter – Increasing Humidity
In this wetter future, the higher temperatures combined with increased rainfall and humidity is creating optimal conditions for vector proliferation and NTD transmission. For LF, expanded mosquito breeding sites, coupled with warmer temperatures, are driving higher transmission risks, emphasising the need for strengthened vector control and community engagement (Malawi NTD Master Plan 2023-2030; World Health Organization, n.d.). Onchocerciasis risks are also elevated due to favourable conditions for blackfly reproduction, especially in areas with high water flow, requiring comprehensive vector control and habitat management (Roswati et al., 2021). STH transmission is also rising as higher humidity and soil moisture promotes egg and larval survival, necessitating improved sanitation and hygiene practices to limit community spread (FEWS NET, USAID, 2024). The increased water availability and higher humidity is straining public health infrastructure through disease outbreaks and vector-borne disease management challenges (Malawi Office of Statistics). The greatest threat to agricultural incomes is coming from pests and diseases due to increased waterlogging and humidity. This is affecting root crops such as cassava, legumes and bananas, potentially off setting any benefits from higher rainfall. Conditions are benefitting fishing communities, but investment is needed to support drying and rapid access to markets. Successful diversification into new market opportunities will depend on post-harvest handling, disease management, and infrastructural support to stabilise incomes and build economic resilience (FEWS NET, USAID, 2024; Malawi Red Cross Society, 2020).

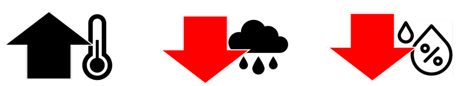
9.2 Summary of Impacts for Mangochi under each Climate Storyline

The table below considers the climate impacts likely to affect the six selected NTDs and public health infrastructure and related to these the likely impacts on key crops, livestock, and livelihoods in Mangochi. Impacts result from the changing climate condition (hazards), the exposure of these systems, and the intrinsic crop and animal vulnerabilities to, e.g., specific temperature thresholds, and of broader environmental vulnerabilities (e.g., soil erosion) and socio-economic vulnerabilities (e.g., poverty).

The impacts are derived considering all the climate storylines by considering the implications that each may have on NTDs, crops, livestock, and livelihoods. The impacts are visually presented in a table, to allow a more immediate access to this extensive information. For more details on the methodology used for the impact, see the full Technical Report (Methods Section).

The hazards and vulnerabilities determining the ICICLE storylines specific to Mangochi and the resulting potential impacts in the relevant sectors (health, agriculture and livelihoods) are expressed in Table 6Table 5Table 1. The impacts are based on input from local stakeholders (LE) and integrated with the most pertinent impacts identified in the literature review. The research team has further refined these to focus on those most relevant to Mangochi according to expert judgment.

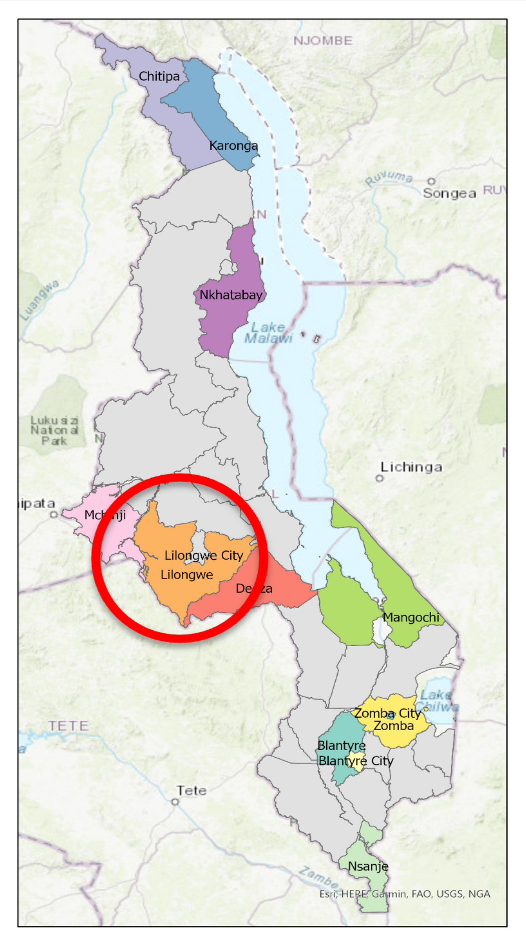
TABLE 6: KEY CLIMATE IMPACTS ON TARGETED NTDS, PUBLIC HEALTH INFRASTRUCTURE AND AGRICULTURE IN MANGOCHI WITH THE ASSOCIATED CLIMATE STORYLINE (CS) AND RELEVANT LOCAL VULNERABILITIES. KEY: BLACK ARROWS ARE INCREASING; RED ARROWS = DECREASING; THERMOMETER = TEMPERATURE; CLOUD = RAINFALL; DROP/PERCENTAGE = RELATIVE HUMIDITY

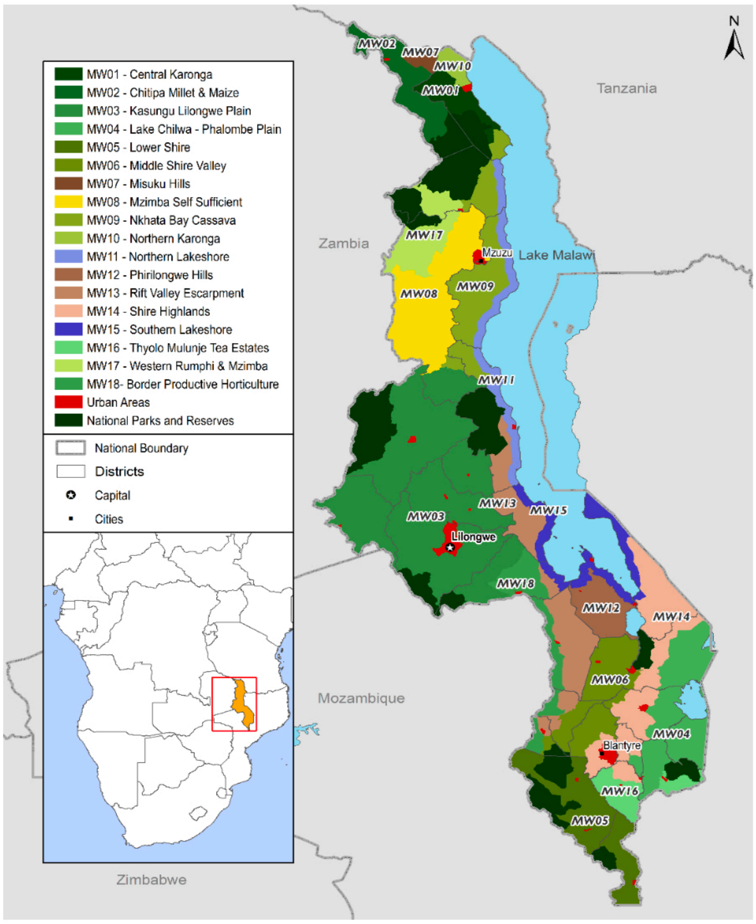
Sector	Climate Storyline 1 	Climate Storyline 2 	Climate Storyline 3 
Neglected Tropical Diseases 	• **Reduced Mosquito and Blackfly Breeding Sites:** Lower water availability limits LF and onchocerciasis transmission in some areas. • **Heat-Accelerated Vector Cycles:** High temperatures may speed up mosquito life cycles during sporadic rainfall events, maintaining disease hotspots. • **Soil-Transmitted Helminths (STH) Decline:** Drier soils reduce egg and larval survival, but sanitation issues sustain transmission in high-risk areas.	• **Expanded Breeding Sites:** Increased rainfall supports mosquito and blackfly populations, raising LF and onchocerciasis risks. • **Higher STH Transmission:** Moist soil supports helminth survival, necessitating better sanitation to prevent outbreaks. • **Flooding-Related Disease Risks:** Contaminated water sources increase the spread of schistosomiasis and diarrheal diseases. • **Trachoma Uncertainty:** Water access improves hygiene but lower humidity	• **Significant Disease Surge:** Ideal conditions for mosquitoes, black flies and snails heighten transmission risks for LF, onchocerciasis, and schistosomiasis. • **STH Persistence:** Increased humidity enhances helminth egg viability, sustaining high transmission levels. • **Waterborne Disease Risk:** Increased flooding heightens exposure to contaminated water sources, amplifying cholera and diarrhoea cases.

	• **Trachoma Risk Increase:** Dry, dusty conditions worsen eye irritation, raising trachoma prevalence in water-scarce communities.	may sustain eye irritation-related infections.	• **Trachoma Risk Decrease:** Higher humidity reduces dust, potentially lowering transmission rates if paired with improved hygiene measures.
Public Health Infrastructure 	• **Water Scarcity:** Limited rainfall affects sanitation and hygiene in healthcare facilities, raising infection risks. • **Heat-Related Illness Burden:** Increased temperatures heighten cases of dehydration and heat exhaustion, straining public health resources. • **Vector Control Gaps:** Decreased breeding sites limit mosquito and blackfly populations, but sporadic outbreaks remain a concern.	• **Flooding Impacts on Healthcare Access:** Increased precipitation isolates rural health facilities, reducing access for vulnerable populations. • **Waterborne Disease Burden:** Flood-related contamination of water sources leads to higher cholera and diarrheal disease outbreaks. • **Infrastructure Damage:** Persistent moisture weakens building structures, requiring climate-resilient health infrastructure investment.	• **Severe Disease Burden:** Health facilities face overwhelming demand due to simultaneous outbreaks of malaria, schistosomiasis, and waterborne diseases. • **Infrastructure Degradation:** High humidity accelerates mould growth and equipment damage, compromising healthcare service delivery. • **Sanitation and Hygiene Pressure:** Increased rainfall and humidity overburden waste management and sanitation systems, raising cross-contamination risks.
Livelihoods 	• **Economic Strain on Poorer Households:** Limited agricultural output reduces opportunities for ganyu labour, worsening income inequality. • **Fishing Decline:** Reduced lake water levels decrease fish catch volumes, negatively impacting households reliant on fishing for food and income. • **Diversification into Trade:** Wealthier households invest in small businesses, while poorer households have limited adaptation options. • **Fishing Decline:** Lower Lake Malawi water levels impact fish stocks, reducing	• **Short-Term Economic Gains:** Increased agricultural activity boosts ganyu labour availability, temporarily supporting poorer households. • **Infrastructure Challenges:** Flooding disrupts access to markets, reducing trade opportunities and increasing post-harvest losses. • **Fishing Volatility:** While lake levels support fish stocks, unpredictable conditions hinder sustainable income generation for fishing communities. • **Livestock Benefits and Costs:** Improved pastures increase productivity, but	• **Expansion of Agricultural Work:** Increased yields create more work opportunities, although humidity-induced crop losses offset some financial gains. • **Disease Burden Limits Livelihood Gains:** Increased vector-borne diseases such as malaria and LF reduce labour capacity, particularly among poorer households unable to afford health care.

	fishing incomes for lakeshore communities.	disease outbreaks strain household income through higher veterinary costs.	
Agriculture 	• **Crop Productivity Loss:** Maize, cassava, tea and groundnuts face significant yield reductions due to moisture stress and declining soil fertility. • **Drought-Tolerant Crops:** Wealthier households invest in drought-resistant seeds, while poorer households struggle with declining harvests. • **Livestock Stress:** Reduced pasture quality leads to deteriorating livestock health, affecting milk and meat production. • **Post-Harvest Losses:** Dry conditions facilitate better crop storage but increase pest infestations in stored grains.	• **Improved Soil Moisture:** Rainfall boosts maize and cassava yields temporarily, but variable humidity introduces pest and disease pressures. • **Waterlogging Issues:** Some crops, such as bananas, are impacted by root rot and fungal infections. • **Livestock Health Risks:** Increased rainfall improves pastures but raises the likelihood of waterborne diseases affecting cattle and goats. • **Fishing Volatility:** Fluctuating lake levels disrupt fish breeding cycles, leading to unstable income for fishing households. • **Ganyu Labour Expansion:** Higher yields and expanded farming activities temporarily increase casual labour opportunities for poorer households.	• **Increased Disease Pressure:** High humidity leads to widespread fungal infections in maize, bananas, and cassava, reducing market value. • **Fishing Income Growth:** Better fish stocks provide more economic opportunities, but inadequate storage solutions limit long-term profitability.

10. LILONGWE ICICLE STORYLINES





Lilongwe District, situated in Malawi's central region, is the most populous area and serves as the nation's political and economic hub. With a population of 1,830,619 (2023) spread across 5,808 km², the district balances urban dynamism with rural livelihoods (Malawi Office of Statistics, 2018). Urban areas are dominated by formal employment, government operations, and commerce, while rural regions, primarily in the **Kasungu-Lilongwe Plain (MW03**) livelihood zone, depend on agriculture for survival (FEWS NET USAID, 2024). Rural areas face significant challenges, including low literacy rates (38.5%), poor sanitation, and reliance on boreholes for water and firewood for energy. Agriculture in Lilongwe revolves around maize as the staple crop, complemented by efforts to adopt drought-resistant varieties due to climate challenges. Cash crops like tobacco are declining in favour of soybeans and bananas, which offer greater market stability. Labour systems feature ganyu (casual labour), which poorer households depend on, while livestock ownership provides a safety net for economic resilience. However, disparities between urban and rural areas persist, particularly in access to infrastructure, education, and healthcare services.

Lilongwe Climate storylines (CS) for SSP2-4.5 Emission Scenario

CS1. Hotter – Drier – Decreasing Humidity
Temperature Increase (T↑): 0.8°C (4.1%)
Precipitation Decrease (P↓): -34 mm (3.5%)
Humidity Decrease (H↓): -1.2% (1.6%)

CS2. Hotter – Wetter – Decreasing Humidity
Temperature Increase (T↑): 0.8°C (4.1%)
Precipitation Increase (P↑): 19 mm (1.9%)
Humidity Decrease (H↓): -1.1% (1.6%)

CS3. Hotter – Wetter – Increasing Humidity
Temperature Decrease (T↑): 0.4°C (2.0%)
Precipitation Increase (P↑): 62mm (6.7%)
Humidity Decrease (H↑): 0.3% (0.5%)

10.1 Lilongwe ICICLE Storyline Narratives

Projections indicate that Lilongwe's future climate will likely be hotter and drier with slightly decreasing humidity. However, a hotter and wetter future is also possible with decreasing humidity, as is a hotter and wetter future but with slightly increasing humidity.

The narratives, based on the near-term Climate Storylines for Lilongwe follow below.

Lilongwe ICICLE Storyline 1: Hotter – Drier – Decreasing Humidity

The decline in precipitation and humidity is reducing mosquito and snail habitats, potentially lowering transmission rates of lymphatic filariasis (LF) and schistosomiasis. However, the increased temperatures are accelerating the mosquito life cycles during isolated rainfall events, leading to localised outbreaks (Malawi NTD Master Plan 2023-2030; ESPEN, 2024). There is reduced transmission of Soil-transmitted helminths (STH) due to drier soil conditions, but water scarcity is exacerbating hygiene-related risks (ESPEN, 2024). Public health infrastructure is struggling with the water scarcity due to the impacts on hygiene and sanitation capabilities. Waterborne diseases are increasing and complicating infection control measures (FEWS NET, USAID, 2024; Malawi Red Cross Society, 2020). Lower rainfall and higher temperatures are severely stressing staple crops like maize, leading to crop failures and increasing food insecurity (FEWS NET, USAID, 2024). Farmers are turning to drought-resistant varieties where they can as access is not guaranteed (Malawi Office of Statistics). Casual labour (ganyu) opportunities are declining due to the reduced agricultural productivity. This is disproportionately affecting poorer households (FEWS NET, USAID, 2024). Livestock health is also compromised by the water scarcity, reducing milk and meat yields and undermining household economic resilience (Malawi NTD Master Plan, ESPEN, 2024).

Lilongwe ICICLE Storyline 2: Hotter – Wetter – Decreasing Humidity

The increased rainfall is increasing the number of mosquito and snail breeding sites, heightening risks for LF and schistosomiasis (ESPEN, 2024). The combination of warmer temperatures and increased rainfall is also accelerating mosquito and snail reproduction cycles, resulting in higher disease transmission risks (Malawi NTD Master Plan 2023-2030). Public health infrastructure is facing flooding and water contamination, disrupting health services and increasing the prevalence of waterborne diseases. Flood response measures and improved water management are proving critical to maintaining health service delivery and deliver effective vector control efforts (Malawi NTD Master Plan, ESPEN, 2024; Malawi Red Cross Society, 2020). Although the Increased rainfall is temporarily improving soil moisture, boosting short-term crop yields for maize, soybeans, and bananas (FEWS NET, USAID, 2024), waterlogging, soil erosion and fungal disease outbreaks remain risks due to rainfall variability. Improved pasture conditions is benefitting the livestock productivity, though some disease outbreaks reman for livestock due to the erratic rainfall (Malawi Office of Statistics; Malawi Red Cross Society, 2020). Higher agricultural productivity is providing increased ganyu labour opportunities, though benefits are unevenly distributed creating inequality across households. Effective crop and pest management practices are crucial for sustainable gains (FEWS NET, USAID, 2024).

Lilongwe ICICLE Storyline 3: Hotter – Wetter – Increasing Humidity

The combination of higher temperatures, much more rainfall and increasing humidity is creating optimal conditions for mosquito and snail populations, significantly raising transmission risks for LF, schistosomiasis and STH (ESPEN, 2024). The prolonged wet and humid conditions are also leading to stable vector breeding habitats, demanding robust disease monitoring and vector control interventions (Malawi NTD Master Plan 2023-2030; ESPEN, 2024). However, public health infrastructure is facing increased strain due to the heightened disease transmission and structural risks from water and humidity damage, requiring climate-resilient infrastructure improvements (FEWS NET, USAID, 2024). The wetter conditions and increased humidity is boosting maize, soybeans, and horticultural crop yields, helping to stabilise incomes (FEWS NET, USAID, 2024). However, these conditions are also increasing the risks of fungal diseases, pest infestations, and waterlogging, threatening long-term stability. Livestock productivity is improving with enhanced pasture conditions, but vector-borne diseases are increasing necessitating comprehensive veterinary care (Malawi Office of Statistics). Economic gains from increased agricultural productivity are helping to provide more ganyu labour opportunities but there are fluctuations in the productivity and increased disease risks due to crop pests and diseases which require more resilience strategies built in to sustain livelihoods (Malawi NTD Master Plan, ESPEN, 2024).

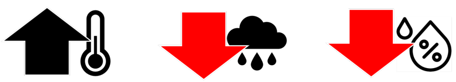
10.2 Summary of Impacts for Lilongwe under each Climate Storyline

The table below considers the climate impacts likely to affect the six selected NTDs and public health infrastructure and related to these the likely impacts on key crops, livestock, and livelihoods in Lilongwe. Impacts result from the changing climate condition (hazards), the exposure of these systems, and the intrinsic crop and animal vulnerabilities to, e.g., specific temperature thresholds, and of broader environmental vulnerabilities (e.g., soil erosion) and socio-economic vulnerabilities (e.g., poverty).

The impacts are derived considering all the climate storylines by considering the implications that each may have on NTDs, crops, livestock, and livelihoods. The impacts are visually presented in a table, to allow a more immediate access to this extensive information. For more details on the methodology used for the impact, see the full Technical Report (Methods Section).

The hazards and vulnerabilities determining the ICICLE storylines specific to Lilongwe and the resulting potential impacts in the relevant sectors (health, agriculture and livelihoods) are expressed in Table 7. The impacts are based on input from local stakeholders (LE) and integrated with the most pertinent impacts identified in the literature review. The research team has further refined these to focus on those most relevant to Lilongwe according to expert judgment.

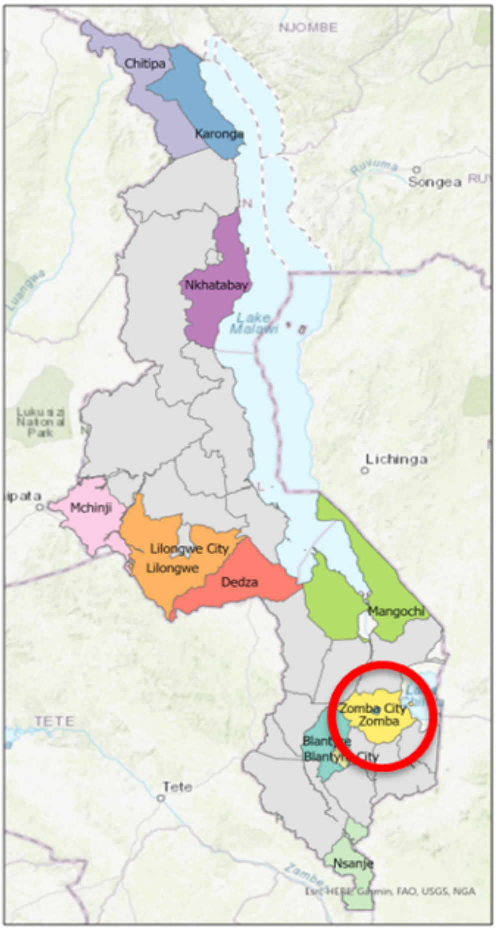
TABLE 7: KEY CLIMATE IMPACTS ON TARGETED NTDS, PUBLIC HEALTH INFRASTRUCTURE AND AGRICULTURE IN LILONGWE WITH THE ASSOCIATED CLIMATE STORYLINE (CS) AND RELEVANT LOCAL VULNERABILITIES. KEY: BLACK ARROWS ARE INCREASING; RED ARROWS = DECREASING; THERMOMETER = TEMPERATURE; CLOUD = RAINFALL; DROP/PERCENTAGE = RELATIVE HUMIDITY

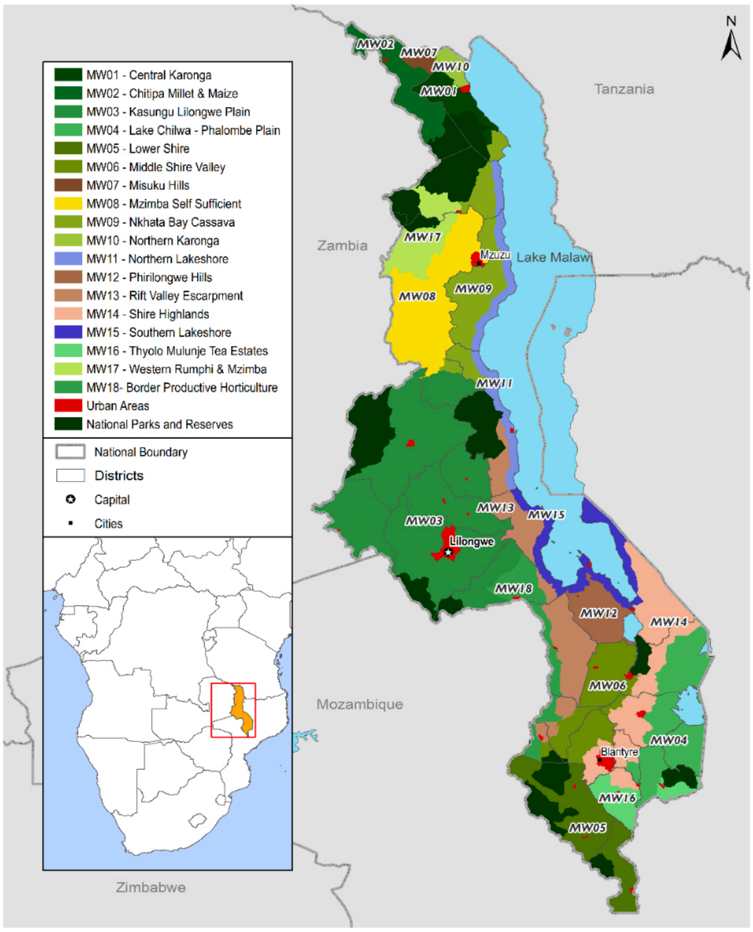
Sector	Climate Storyline 1 	Climate Storyline 2 	Climate Storyline 3 
Neglected Tropical Diseases 	• **Reduced LF and Schistosomiasis Risk:** Dry conditions limit mosquito and snail habitats, leading to lower transmission rates. • **Localised Outbreaks:** Isolated rainfall events create temporary breeding conditions, causing periodic disease spikes. • **STH Decline but Hygiene Risks Increase:** Drier soil reduces helminth egg viability, but poor sanitation exacerbates transmission risks.	• **Expanded Vector Habitats:** Higher rainfall increases mosquito and snail breeding sites, elevating LF and schistosomiasis risks. • **Disease Transmission Intensifies:** Warmer temperatures accelerate vector reproduction cycles, requiring stronger control measures. • **STH Risks Increase:** Enhanced soil moisture extends helminth survival, leading to increased transmission rates.	• **Severe NTD Burden:** Optimal conditions for mosquitoes, snails, and helminths lead to sustained high transmission rates of LF, schistosomiasis, and STH. • **Longer Breeding Cycles:** Persistent wet conditions prolong vector reproduction seasons, intensifying disease outbreaks. • **Urgent Vector Control Needs:** Expanded disease monitoring and intervention efforts are required to mitigate health risks.

Public Health Infrastructure 	• **Water Shortages:** Health facilities struggle with sanitation and infection control due to water scarcity. • **Increased Disease Risks:** Poor hygiene exacerbates the spread of waterborne diseases like cholera. • **Heat-Related Illnesses:** Rising temperatures increase cases of dehydration and heatstroke, particularly among vulnerable populations.	• **Flood-Related Disruptions:** Increased rainfall damages health facilities and roads, limiting healthcare access. • **Vector-Borne Disease Burden:** Expanded mosquito breeding sites increase malaria and LF prevalence, straining health services. • **Infrastructure Strain:** Increased moisture leads to mould growth and structural damage, requiring climate-resilient health facility investments.	• **Public Health System Overload:** Higher disease burden from vector- and waterborne diseases overwhelms healthcare capacity. • **Infrastructure Degradation:** Increased humidity accelerates facility deterioration, demanding urgent upgrades. • **Sanitation System Collapse:** Overburdened waste management systems contribute to cholera and diarrheal outbreaks, intensifying public health risks.
Livelihoods 	• **Ganyu Labour Decline:** Lower crop productivity reduces demand for casual agricultural labour, disproportionately affecting food security among poorer households. • **Livestock Health Decline:** Limited water availability and poor pasture conditions result in reduced milk and meat production, impacting household income.	• **Seasonal Job Growth:** Increased agricultural activity boosts ganyu labour demand, though benefits remain unevenly distributed. • **Improved Pasture Conditions:** Livestock health and productivity temporarily improve, but erratic rainfall increases the risk of disease outbreaks.	• **Economic Disparities Widen:** Wealthier households benefit from increased crop yields, while poorer households struggle with pest management and storage challenges. • **Higher Demand for Labour:** Increased agricultural productivity generates more ganyu opportunities, but also exposes workers to greater disease risks. • **Livestock Health Risks:** Improved grazing conditions support higher productivity, but humidity-driven vector-borne diseases threaten herd health.
Agriculture 	• **Crop Failures:** Maize and other staple crops experience significant declines due to moisture stress and rising temperatures, increasing food insecurity. • **Soil Degradation:** Reduced rainfall accelerates soil degradation, leading to nutrient loss and long-term fertility issues.	• **Short-Term Yield Boost:** Increased rainfall temporarily improves soil moisture, benefiting maize and soybean crops. • **Pest and Disease Risk:** Waterlogging and soil erosion heighten fungal diseases and pest infestations, threatening sustained crop productivity.	• **Increased Crop Productivity:** Maize, soybean, and horticultural crop yields rise due to higher water availability and stable soil moisture. • **Fungal Outbreaks:** Excess moisture heightens the risk of fungal infections in staple and high-value crops, requiring

	• **Limited Adaptation:** Farmers struggle to access drought-resistant seed varieties, with poorer households particularly vulnerable.	• **Market Disruptions:** Variable rainfall patterns create instability in production cycles, affecting food prices and supply chains.	improved disease management strategies. • **Post-Harvest Challenges:** Humid conditions complicate storage, leading to increased post-harvest losses and reduced marketability.

11. ZOMBA ICICLE STORYLINES





Zomba District, located in southern Malawi, is bordered by Lake Chilwa to the east and Mozambique to the southeast. The district's economy is shaped by three key livelihood zones: **MW04 (Lake Chilwa–Phalombe Plain), MW14 (Shire Highlands)**, and **MW06 (Middle Shire Valley)**. These zones support diverse economic activities, including agriculture, fishing, and horticulture.

Agriculture dominates livelihoods, with maize and rice as staple crops in MW04. Tea production in MW14 provides stable employment, while MW06 focuses on sorghum and maize. However, widespread poverty remains a critical challenge, with 95% of households living below the national poverty line. Infrastructure constraints are significant, as only 15% of households have electricity access, while digital connectivity and sanitation facilities are similarly limited (Malawi Office of Statistics, 2018). These conditions exacerbate vulnerabilities to climate change and neglected tropical diseases (NTDs).

Zomba Climate storylines (CS) for SSP2-4.5 Emission Scenario

CS1. Hotter – Drier – Decreasing Humidity
Temperature Increase (T↑): 0.9°C (3.9%)
Precipitation Decrease (P↓): -54 mm (5.3%)
Humidity Decrease (H↓): -1.5% (2.1%)

CS2. Hotter – Wetter – Decreasing Humidity
Temperature Increase (T↑): 0.7°C (3.1%)
Precipitation Increase (P↑): 65 mm (6.4%)
Humidity Decrease (H↓): -0.3% (0.4%)

CS3. Hotter – Wetter – Increasing Humidity
Temperature Decrease (T↑): 0.3°C (3.1%)
Precipitation Increase (P↑): 104mm (10.2%)
Humidity Decrease (H↑): 0.7% (1.0%)

11.1 Zomba ICICLE Storyline Narratives

Projections indicate that Zomba's future climate will likely be hotter and drier with slightly decreasing humidity. However, a hotter and wetter future is also possible with decreasing humidity, as is a hotter and wetter future but with slightly increasing humidity.

The narratives, based on the near-term Climate Storylines for Zomba follow below.

Zomba ICICLE Storyline 1: Hotter – Drier – Decreasing Humidity
The contraction of mosquito and blackfly breeding habitats due to lower water levels are reducing vector-borne disease transmission, such as LF and Onchocerciasis. However, isolated rainfall events and stagnant water bodies are sustaining localised transmission, necessitating continuous vector control interventions, such as insecticide-treated nets (ITNs) and larvicides (Malawi NTD Master Plan 2023-2030; Roswati et al., 2021). Water scarcity is heightening vulnerability to hygiene-related NTDs, including Schistosomiasis and Soil-Transmitted Helminths (STH), as people are forced to rely on stagnant and contaminated water sources. Limited water access is also straining public health infrastructure, impairing the capacity of health facilities to maintain basic hygiene standards (FEWS NET, USAID, 2024; WHO, 2018; Malawi Red Cross Society, 2020). Agricultural livelihoods, particularly for staple crops like maize and rice, are facing substantial moisture stress due to reduced rainfall and increased evapotranspiration. This continues to threaten food security, increasing socio-economic vulnerabilities and reducing the ability of households to afford essential health interventions. Wealthier households are adapting through securing greater access to drought-resistant varieties and advanced irrigation techniques, while the poorer households, relying on subsistence farming, are facing increasing poverty and rely on supplementing their income through more casual labour (Ganyu). Reduced agricultural productivity is impacting nutrition, weakening immunity and increasing susceptibility to NTDs such as Lymphatic Filariasis (LF) (Malawi Office of Statistics; Malawi Red Cross Society, 2020).
Zomba ICICLE Storyline 2: Hotter – Wetter – Decreasing Humidity
The expansion of mosquito and blackfly habitats with increased water flow is raising the risk of vector-borne NTDs, including LF and Onchocerciasis, particularly in riverine areas. Warmer temperatures are further accelerating the reproductive cycles of vectors, underscoring the need for robust vector control measures, community health engagement, and infrastructure improvements to manage disease outbreaks (EM-DAT, 2023; Malawi Red Cross Society, 2020; Malawi NTD Master Plan 2023-2030). Additionally, public health infrastructure is facing significant strain from flooding, which is damaging facilities, disrupting service delivery, and contaminating water supplies, exacerbating the transmission of waterborne diseases like cholera and increasing public health risks (WHO, 2018). The higher rainfall and warmer temperatures are creating a complex set of risks and opportunities for Zomba. The increased soil moisture is boosting short-term agricultural productivity for crops such as maize and rice, helping to stabilise food security. However, variability in rainfall patterns is increasing the risk of flooding with damage to crops and soil erosion, destabilising agricultural livelihoods. Wealthier households, with access to resilient crop varieties and pest control measures, are in a better position to cope with these changes, while poorer households are struggling (FEWS NET, USAID, 2024). The socio-economic impact of flooding extend to the fishing industry along Lake Chilwa, where fluctuating water levels are disrupting fish breeding cycles and impacting livelihoods. Whilst improved fish stock availability during periods of increased rainfall is offering temporary relief, the high humidity complicates fish drying and preservation processes, necessitating investments in drying technologies and improved market infrastructure (FEWS NET, USAID, 2024).
Zomba ICICLE Storyline 3: Hotter – Wetter – Increasing Humidity
Optimal conditions for vector proliferation due to much more rainfall, higher temperatures, and increased humidity are significantly increasing the risk of vector-borne NTDs such as LF and Onchocerciasis. Enhanced mosquito and blackfly reproduction needs comprehensive public health interventions, including mass drug administration (MDA), ITN distribution, and environmental management of vector habitats. Sustained public health campaigns targeting high-risk areas, alongside integrated disease management, are proving critical in mitigating health risks (Malawi Red Cross Society, 2020; Malawi NTD Master Plan 2023-2030; Roswati et al., 2021). Public health infrastructure is facing significant challenges from the high humidity and much wetter conditions, with mould growth and structural degradation requiring much more maintenance of health facilities across Zomba. These demands are putting a heavy strain on already limited resources and really needs climate-resilient infrastructure designs to be actioned to ensure uninterrupted health service delivery (WHO, 2018; FCFA, 2017). Socio-economic disparities are widening as wealthier households are able to access improved health services and adaptive measures, while the poorer populations remain vulnerable to the increased disease outbreaks and economic shocks. Agricultural productivity is benefitting from the increase in rainfall and water availability, helping to improve yields for maize, rice, and horticultural crops. However, waterlogging is a challenge and the high humidity is increasing the prevalence of fungal infections and pest infestations. Together these are threatening crop stability and economic livelihoods. Integrated crop management practices, pest-resistant varieties, and effective drainage systems are essential to minimise productivity losses and stabilise incomes (FEWS NET, USAID, 2024).

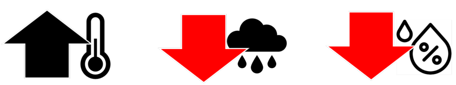
11.2 Summary of Impacts for Zomba under each Climate Storyline

The table below considers the climate impacts likely to affect the six selected NTDs and public health infrastructure and related to these the likely impacts on key crops, livestock, and livelihoods in Zomba. Impacts result from the changing climate condition (hazards), the exposure of these systems, and the intrinsic crop and animal vulnerabilities to e.g., specific temperature thresholds, and of broader environmental vulnerabilities (e.g., soil erosion) and socio-economic vulnerabilities (e.g., poverty).

The impacts are derived considering all the climate storylines by considering the implications that each may have on NTDs, crops, livestock, and livelihoods. The impacts are visually presented in a table, to allow a more immediate access to this extensive information. For more details on the methodology used for the impact, see the full Technical Report (Methods Section).

The hazards and vulnerabilities determining the ICICLE storylines specific to Zomba and the resulting potential impacts in the relevant sectors (health, agriculture and livelihoods) are expressed in Table 8. The impacts are based on input from local stakeholders (LE) and integrated with the most pertinent impacts identified in the literature review. The research team has further refined these to focus on those most relevant to Zomba according to expert judgment.

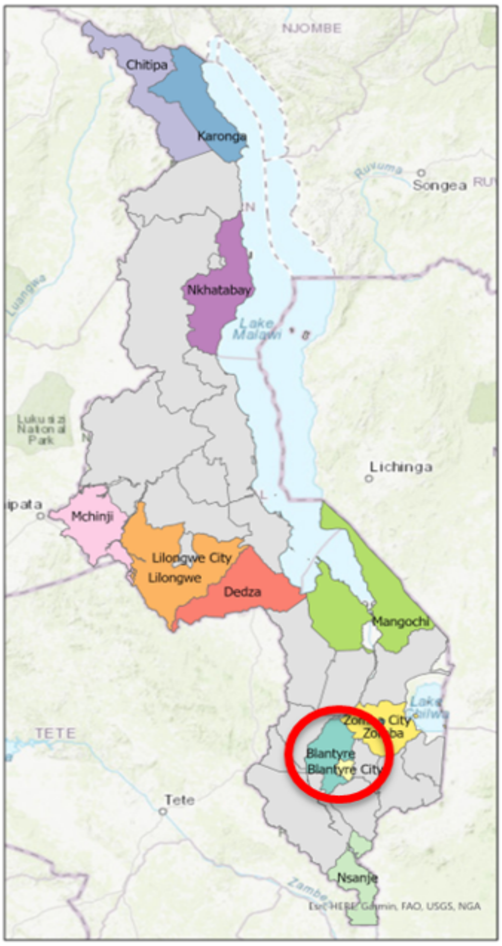
TABLE 8: KEY CLIMATE IMPACTS ON TARGETED NTDS, PUBLIC HEALTH INFRASTRUCTURE AND AGRICULTURE IN ZOMBA WITH THE ASSOCIATED CLIMATE STORYLINE (CS) AND RELEVANT LOCAL VULNERABILITIES. KEY: BLACK ARROWS ARE INCREASING; RED ARROWS = DECREASING; THERMOMETER = TEMPERATURE; CLOUD = RAINFALL; DROP/PERCENTAGE = RELATIVE HUMIDITY

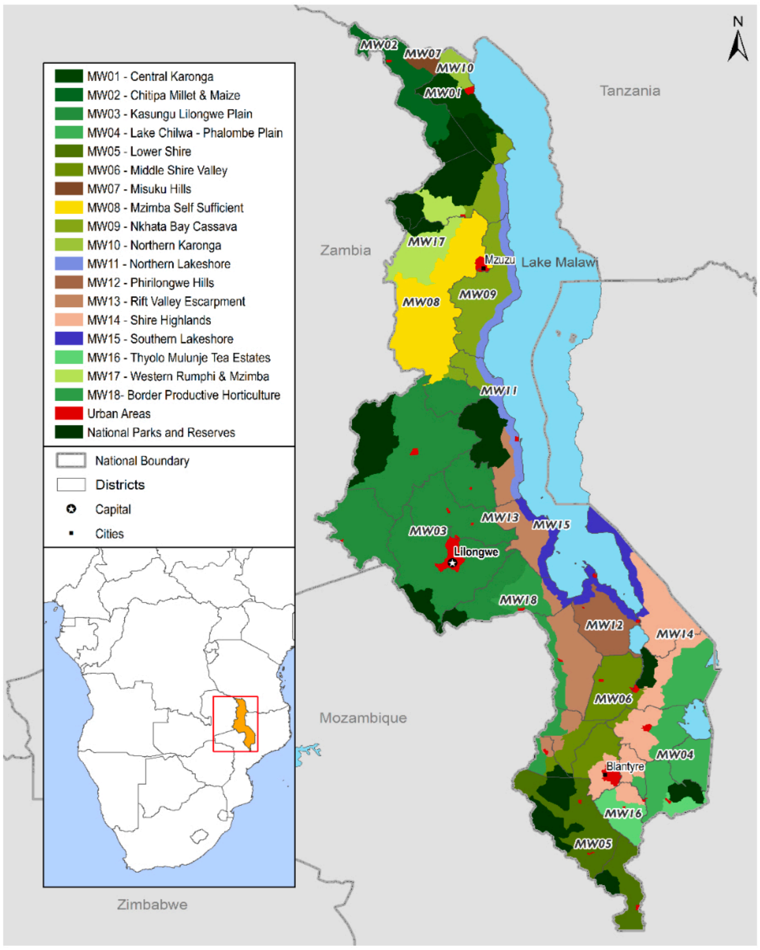
Sector	Climate Storyline 1	Climate Storyline 2	Climate Storyline 3
			
Neglected Tropical Diseases 	• **Lymphatic Filariasis (LF):** Reduced precipitation and humidity limit mosquito breeding habitats, lowering transmission risks but isolated rainfall events sustain localised transmission • **Onchocerciasis:** Declining water levels reduce blackfly populations and lower transmission risks. However, the remaining water bodies sustain some reproductive cycles, requiring ongoing vector control. • **Schistosomiasis & Soil-Transmitted Helminths (STH):** Reduced rainfall limits	• **Lymphatic Filariasis (LF):** Increased rainfall expands mosquito breeding habitats, heightening transmission risks. Higher temperatures accelerate mosquito reproductive cycles, necessitating ITN distribution and breeding site management. • **Onchocerciasis:** Greater water flow supports blackfly reproduction, increasing transmission risks, especially in riverine areas. Sustained vector control is required to mitigate disease expansion.	• **Lymphatic Filariasis (LF):** The combination of increased rainfall, temperature, and humidity creates optimal mosquito breeding conditions, significantly raising transmission risks. Control strategies such as mass drug administration (MDA) and ITN distribution are critical. • **Onchocerciasis:** Rising water levels and humidity further enhance blackfly populations, increasing transmission risks. Comprehensive vector control must focus on high-risk riverine areas.

	snail habitats, decreasing transmission risk, but reliance on stagnant water sources increases exposure and persistent sanitation challenges sustain infections.	• **Schistosomiasis & Soil-Transmitted Helminths (STH):** Increased rainfall supports snail and helminth survival, enhancing transmission risks. Expanded snail habitats and soil moisture create conditions for disease spread, requiring robust sanitation and water management strategies.	• **Schistosomiasis & Soil-Transmitted Helminths (STH):** Enhanced humidity and precipitation support snail and helminth populations, intensifying disease transmission. Water and sanitation improvements are crucial to control outbreaks.
Public Health Infrastructure 	• **Water Scarcity & Hygiene:** Limited precipitation and humidity exacerbate water shortages, reducing public health facilities' capacity to maintain sanitation and hygiene and increasing waterborne disease risks such as cholera. • **Vector-Borne Disease Management:** Lower mosquito populations reduce transmission risks, but localised rain events sustain some breeding grounds, necessitating continuous ITN use and larvicidal measures. • **Infrastructure Degradation:** High temperatures and reduced humidity accelerate the deterioration of public health infrastructure.	• **Flooding & Access Issues:** Increased rainfall raises flood risks, damaging health infrastructure, limiting service accessibility and contaminating water supplies, exacerbating cholera outbreaks. • **Vector-Borne Disease Expansion:** More mosquito and blackfly breeding sites lead to heightened disease burdens. Public health facilities must scale up vector control programs. • **Strain on Sanitation & Waste Systems:** Increased rainfall overwhelms sanitation systems, leading to water contamination and disease outbreaks.	• **Increased Risk of Mould & Infrastructure Degradation:** Higher humidity fosters mould growth, corrosion, and water damage in health facilities, necessitating climate-resilient upgrades. • **Public Health Service Strain:** Increased disease burdens from vector-borne diseases and waterborne illnesses require enhanced emergency preparedness and expanded healthcare capacity. • **Emergency Flood Response:** The risk of extreme flooding events may disrupt healthcare operations, necessitating robust preparedness measures such as improved drainage and stockpiling medical supplies.

Livelihoods 	• **Agricultural Livelihoods:** Reduced productivity for maize, rice, tea and horticultural crops increases food insecurity and poverty. • **Fishing Livelihoods (Lake Chilwa):** Decreasing water levels threaten fish stocks, impacting livelihoods. • **Livestock Health (MW14, MW06):** Reduced pasture quality lowers milk and meat yields, negatively affecting household incomes.	• **Agricultural Livelihoods:** Temporary yield improvements support food security, but fluctuating rainfall creates challenges for crop stability. • **Fishing Livelihoods:** Increased water availability stabilises fish stocks, but humidity complicates fish drying and preservation. • **Livestock Productivity:** Pasture improvements support livestock health, but erratic rainfall increases disease risks.	• **Agricultural Livelihoods:** Increased rainfall improves productivity, but waterlogging and fungal diseases remain challenges. • **Livestock Health:** Higher rainfall benefits pasture but raises disease risks, requiring disease management investments.
Agriculture 	• **Maize** Reduced rainfall and humidity lead to severe moisture stress, reducing maize yields, increasing food insecurity, and worsening economic strain for smallholder farmers • **Rice:** Declining precipitation threatens rice production in the Lake Chilwa–Phalombe Plain, reducing food security. Efficient water management and irrigation diversification are crucial. • **Tea:** Reduced rainfall could stress tea production in the Shire Highlands, lowering yields and impacting employment opportunities (Malawi Office of Statistics). • **Horticulture (All Zones):** Water scarcity negatively impacts small-scale horticulture, reducing food availability and incomes.	• **Maize (MW04, MW14, MW06):** Higher rainfall improves soil moisture and maize yields, but fluctuating humidity increases fungal diseases and waterlogging risks. • **Rice (MW04):** Additional rainfall stabilises irrigation but raises flood risks, requiring flood control measures. • **Tea (MW14):** Increased precipitation benefits tea growth, but humidity fluctuations increase disease risks. • **Horticulture (All Zones):** Increased rainfall may support horticultural crops but raises risks of disease outbreaks and soil degradation.	• **Maize (MW04, MW14, MW06):** Excessive moisture leads to fungal infections, pest infestations, and crop losses, requiring improved drainage and disease-resistant varieties. • **Rice (MW04):** Stable water availability boosts rice yields, but increased humidity heightens disease threats, requiring improved management strategies. • **Tea (MW14):** Enhanced rainfall and humidity may boost yields, but risks of blight and root diseases increase, requiring intensive pest control. • **Horticulture (All Zones):** The combination of excess moisture and humidity benefits crops but raises disease challenges, requiring climate-resilient practices.

12. BLANTYRE ICICLE STORYLINES





Blantyre District, located in southern Malawi, covers 1,785 square kilometres with a population density of 252.8 people per square kilometre. The population exceeds 451,000, concentrated primarily in Traditional Authorities Kapeni (103,742), Kuntaja (84,765), and Somba (82,668) (Malawi Office of Statistics, 2018). Blantyre's demographics highlight a youthful population, with 41.9% under 14 years and 53.9% within the working-age group. These figures underscore a high dependency ratio, demanding robust investments in education, healthcare, and employment. Despite urbanisation, rural areas within **MW06 and MW14** face significant development challenges, including limited access to electricity, water, and quality education. These disparities highlight the need for targeted policy interventions to address both urban and rural needs.

Blantyre Climate storylines (CS) for SSP2-4.5 Emission Scenario

CS1. Hotter – Drier – Decreasing Humidity
Temperature Increase (T↑): 0.9°C (3.9%)
Precipitation Decrease (P↓): -51 mm (5.1%)
Humidity Decrease (H↓): -1.6% (2.3%)

CS2. Hotter – Wetter – Decreasing Humidity
Temperature Increase (T↑): 0.7°C (3.1%)
Precipitation Increase (P↑): 53 mm (5.3%)
Humidity Decrease (H↓): -0.4% (0.6%)

CS3. Hotter – Wetter – Increasing Humidity
Temperature Decrease (T↑): 0.4°C (1.7%)
Precipitation Increase (P↑): 97mm (9.7%)
Humidity Decrease (H↑): 0.5% (0.7%)

Blantyre's economy integrates two key livelihood zones: **Middle Shire Valley (MW06) -** Focuses on maize and sorghum as staple crops, complemented by growing horticultural production. Shifts toward drought-tolerant varieties and diversification have enhanced climate resilience (FEWS NETM USAID, 2024). **Shire Highlands (MW14) -** This zone, renowned for its tea estates, benefits from reliable rainfall, established infrastructure, and formal employment opportunities. Maize remains the primary staple crop, while tea provides economic stability.

12.1 Blantyre ICICLE Storyline Narratives

Projections indicate that Blantyre's future climate will likely be hotter and drier with slightly decreasing humidity. However, a hotter and wetter future is also possible with decreasing humidity, as is a hotter and much wetter future but with slightly increasing humidity.

The narratives, based on the near-term Climate Storylines for Blantyre follow below.

Blantyre ICICLE Storyline 1: Hotter – Drier – Decreasing Humidity
Blantyre faces a critical combination of increased temperatures and reduced rainfall, with significant implications for Neglected Tropical Diseases (NTDs), public health infrastructure, agriculture, and livelihoods. The reduction in precipitation is decreasing the mosquito and blackfly breeding habitats, helping to lower the transmission risk of vector-borne diseases such as Lymphatic Filariasis (LF) and Onchocerciasis. However, isolated rainfall events, coupled with higher temperatures, can accelerate the life cycles of these vectors, sustaining localised transmission risks. Effective vector control strategies, such as insecticide-treated nets (ITNs) and larvicidal interventions, are critical for mitigating these risks (Malawi NTD Master Plan 2023-2030; ESPEN, 2024). For waterborne diseases like schistosomiasis and soil-transmitted helminths (STH), the reduced water availability is limiting snail and helminth habitats and reducing transmission. However, water scarcity is exacerbating sanitation challenges, increasing infection risks through poor hygiene and limited water access (FEWS NET, USAID, 2024). The strain on public health infrastructure under this climate future is considerable. Limited water resources are hindering health facilities' capacity to maintain hygiene standards, impairing efforts to control hygiene-related NTDs such as STH and increasing the risk of waterborne diseases like cholera. Communities relying on communal water sources are particularly vulnerable, highlighting the need for robust water management strategies and resilient public health infrastructure (WHO, 2018). The agricultural impacts are similarly concerning, as reduced water availability is significantly stressing staple crops such as maize, leading to lower yields and increased food insecurity. Sorghum, which is more drought-tolerant, is offering some resilience but sorghum growers are facing challenges due to the persistent heat and limited water access. Poorer households are being hardest hit due to limited resource access and alternative livelihood options. Livestock productivity is declining due to degraded pasture conditions, further exacerbating poverty and economic disparities (FEWS NET, USAID, 2024).
Blantyre ICICLE Storyline 2: Hotter – Wetter – Decreasing Humidity
The increase in both temperature and rainfall is presenting a mixed picture for Blantyre's health, agriculture, and livelihoods. The expanded availability of water resources is creating new mosquito and blackfly breeding habitats, increasing the transmission of vector-borne diseases such as LF and Onchocerciasis. The combination of warmer temperatures and increased rainfall is accelerating mosquito reproductive cycles, emphasising the need for community-based vector control measures (Malawi NTD Master Plan 2023-2030; EM-DAT, 2023). Similarly, schistosomiasis and STH transmission risks are rising due to the expansion of snail habitats and improved soil moisture conditions for helminth eggs. Effective water management and sanitation measures are crucial to mitigate these public health risks (FEWS NET, USAID, 2024). Regarding public health infrastructure, the increased rainfall is increasing flooding, damaging health facilities, disrupting service delivery, and contaminating water sources, leading to disease outbreaks. Implementation of flood control measures, improved drainage systems, and resilient public health planning is vital (Malawi NTD Master Plan 2023-2030; EM-DAT, 2023). The agricultural and livelihood impacts reflect the complexities of this scenario. While higher rainfall is improving soil moisture and enhancing crop yields for maize, sorghum, and horticultural crops, the associated variability in rainfall patterns is posing risks of waterlogging, soil erosion, and pest infestations, potentially undermining productivity gains. Livestock are benefitting temporarily from improved pasture conditions. However, they are facing heightened disease risks due to erratic water availability. The resulting economic uncertainty and potential for crop loss is driving temporary migration and increasing socio-economic stress (FEWS NET, USAID, 2024).

Blantyre ICICLE Storyline 3: Hotter – Wetter – Increasing Humidity
The combined increase in temperature, rainfall, and humidity is creating both opportunities and challenges for Blantyre. Optimal mosquito and blackfly proliferation conditions are increasing vector-borne diseases such as LF and Onchocerciasis. Similarly, increased moisture and humidity is supporting the proliferation of snail and helminth populations, raising transmission risks for schistosomiasis and STH (ESPEN, 2024; Roswati et al., 2021). Integrated public health measures focusing on water safety, snail control, and improved sanitation are critical to managing these health risks. However, public health infrastructure is under significant strain as vector proliferation is driving a higher disease burden, increasing the demand for disease management services and overwhelming health systems. Increased humidity and rainfall is posing risks to facility infrastructure, including mould growth, water damage, and overloaded sanitation systems, requiring regular maintenance and climate-resilient facility designs (WHO, 2018; FEWS NET, USAID, 2024). On the agricultural front, increased water availability is enhancing crop yields, particularly for moisture-dependent crops such as maize and tea. However, the high humidity is introducing risks of fungal diseases, pest infestations, and waterlogging, threatening crop stability and productivity gains. Effective pest and disease management, improved storage facilities, and resilient crop practices are essential to maximise productivity. Livestock health is temporarily benefitting from improved pasture conditions but needs proactive disease management to address potential outbreaks related to high humidity (Malawi Office of Statistics, 2018; FEWS NET, USAID, 2024).

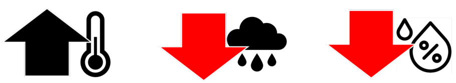
12.2 Summary of Impacts for Blantyre under each Climate Storyline

The table below considers the climate impacts likely to affect the six selected NTDs and public health infrastructure and related to these the likely impacts on key crops, livestock, and livelihoods in Blantyre. Impacts result from the changing climate condition (hazards), the exposure of these systems, and the intrinsic crop and animal vulnerabilities to, e.g. specific temperature thresholds, and of broader environmental vulnerabilities (e.g. soil erosion) and socio-economic vulnerabilities (e.g. poverty).

The impacts are derived considering all the climate storylines by considering the implications that each may have on NTDs, crops, livestock, and livelihoods. The impacts are visually presented in a table, to allow a more immediate access to this extensive information. For more details on the methodology used for the impact, see the full Technical Report (Methods Section).

The hazards and vulnerabilities determining the ICICLE storylines specific to Blantyre and the resulting potential impacts in the relevant sectors (health, agriculture and livelihoods) are expressed in Table 9. The impacts are based on input from local stakeholders (LE) and integrated with the most pertinent impacts identified in the literature review. The research team has further refined these to focus on those most relevant to Blantyre according to expert judgment.

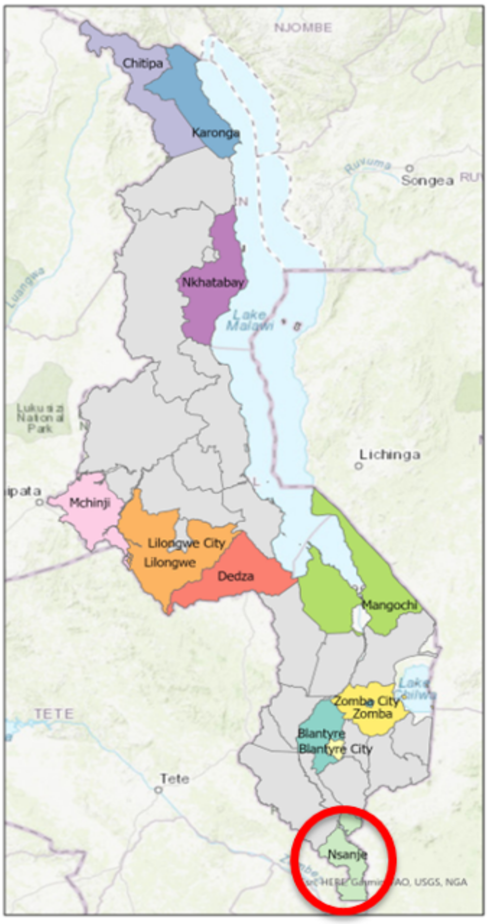
TABLE 9: KEY CLIMATE IMPACTS ON TARGETED NTDS, PUBLIC HEALTH INFRASTRUCTURE AND AGRICULTURE IN BLANTYRE WITH THE ASSOCIATED CLIMATE STORYLINE (CS) AND RELEVANT LOCAL VULNERABILITIES. KEY: BLACK ARROWS ARE INCREASING; RED ARROWS = DECREASING; THERMOMETER = TEMPERATURE; CLOUD = RAINFALL; DROP/PERCENTAGE = RELATIVE HUMIDITY

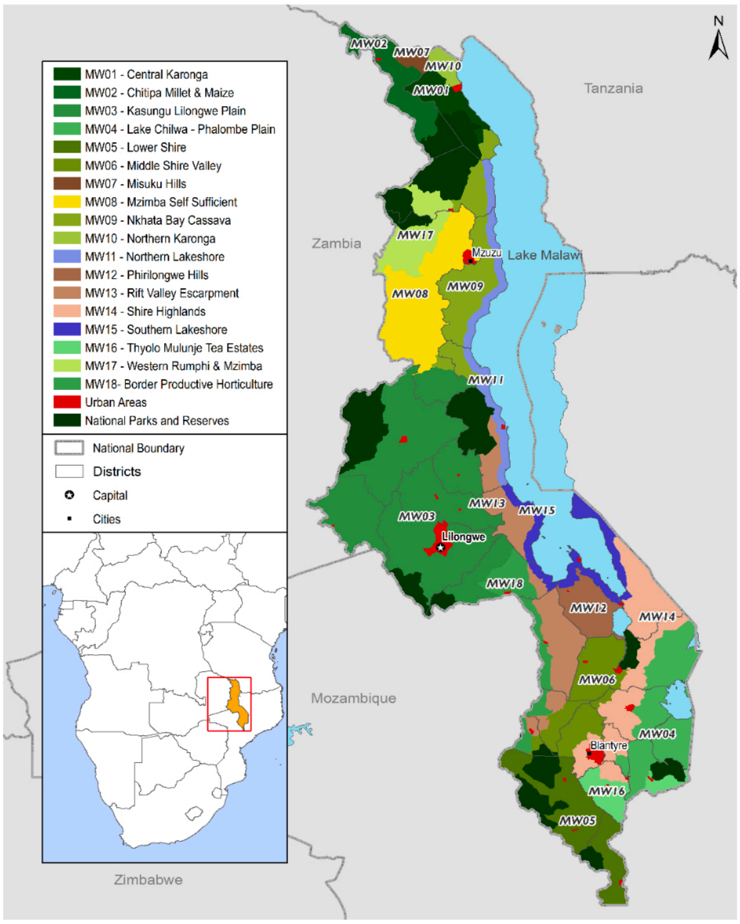
Sector	Climate Storyline 1	Climate Storyline 2	Climate Storyline 3
			
Neglected Tropical Diseases 	• **Lymphatic Filariasis (LF):** Reduced precipitation and humidity limits mosquito breeding habitats, lowering transmission risks but higher temperatures accelerate mosquito life cycles during isolated rain events. Effective vector control measures and environmental management remains essential. • **Onchocerciasis:** Reduced water levels decreases blackfly populations and lower transmission risks. However, stagnant water sources support blackfly	• **Lymphatic Filariasis (LF):** Increased precipitation creates new mosquito breeding grounds, raising transmission risks. Warmer temperatures accelerate mosquito reproductive cycles, requiring robust vector control strategies, community-based ITN distribution and environmental management. • **Onchocerciasis:** Greater water flow and expanded blackfly habitats increases transmission risks, particularly in riverine and water-rich areas. Elevated temperatures accelerate blackfly life	• **Lymphatic Filariasis (LF):** The combination of increased rainfall, temperature, and humidity creates optimal mosquito breeding conditions, significantly raising transmission risks. Control strategies such as mass drug administration (MDA) and ITN distribution are critical. • **Onchocerciasis:** Rising water levels and humidity further enhance blackfly populations, increasing transmission risks. Comprehensive vector control must focus on high-risk riverine areas.

	reproduction, necessitating ongoing vector control • **Schistosomiasis & Soil-Transmitted Helminths (STH):** Reduced rainfall and drier conditions may limit snail habitats, potentially decreasing schistosomiasis transmission. However, water scarcity can exacerbate sanitation challenges, increasing infection risks through contaminated water and poor hygiene practices.	cycles, requiring focused efforts on vector control in high-risk locations. • **Schistosomiasis & Soil-Transmitted Helminths (STH):** Increased rainfall promote the survival and expansion of snail habitats, heightening schistosomiasis risks. Similarly, higher soil moisture could support helminth egg survival, raising STH transmission risks.	• **Schistosomiasis and soil-transmitted Helminths (STH):** Enhanced humidity and precipitation support snail and helminth populations, intensifying disease transmission. Water and sanitation improvements are crucial outbreaks.
Public Health Infrastructure 	• **Water Scarcity and Hygiene:** Reduced precipitation and humidity exacerbate water scarcity, impacting public health facilities' ability to maintain hygiene standards and increasing risks for waterborne diseases such as cholera. • **Health Facility Operations:** Reduced water availability impacts infection control, sanitation, and patient care. Poor sanitation limits the effectiveness of disease control interventions. • **Heat-Related Health Strains:** Higher temperatures lead to an increase in heat-related illnesses, placing additional demand on public health services, particularly for vulnerable populations.	• **Flooding and Access Issues:** Increased rainfall raises the risk of flooding, damaging health facilities, disrupting healthcare services, and leading to water contamination, exacerbating outbreaks of waterborne diseases. • **Higher Disease Burden from Vector-Borne Diseases:** The combination of increased temperature, rainfall, and humidity fosters ideal conditions for vector proliferation, heightening the risks of transmission of malaria, lymphatic filariasis, and onchocerciasis. • **Sanitation and Hygiene Challenges:** Increased rainfall temporarily improves water availability but also leads to sanitation system overflow, water contamination, and disease outbreaks.	• **Flooding and Access Issues:** Increased rainfall raises the risk of flooding, damaging health facilities, disrupting healthcare services, and leading to water contamination, exacerbating outbreaks of waterborne diseases. • **Higher Disease Burden from Vector-Borne Diseases:** The combination of increased temperature, rainfall, and humidity fosters ideal conditions for vector proliferation, heightening the risks of transmission of malaria, lymphatic filariasis, and onchocerciasis. • **Sanitation and Hygiene Challenges:** Increased rainfall can temporarily improve water availability but may also lead to sanitation system overflow, water contamination, and disease outbreaks.

Livelihoods 	• **Agricultural Livelihoods:** Decreasing precipitation and increasing temperatures stress crop yields, reducing food security and income for subsistence farmers. • **Casual Labour (Ganyu):** As agricultural productivity declines, ganyu labour opportunities may dwindle, further stressing vulnerable households.	• **Agricultural Productivity and Livelihoods:** Increased precipitation temporarily boosts yields, particularly for maize and horticultural crops. However, flooding and soil degradation introduce uncertainty into household incomes. • **Livestock and Disease Burden:** Increased humidity promotes vector-borne diseases affecting livestock, requiring enhanced veterinary services. • **Casual Labour (Ganyu):** Increased agricultural productivity creates short-term ganyu opportunities but benefits are not evenly distributed, leading to persistent socio-economic disparities.	• **Livestock Health and Disease Risk:** Improved pasture conditions supports livestock productivity, but increased humidity also heightens the prevalence of vector-borne diseases affecting livestock. • **Migration and Adaptation:** Climate variability and crop losses drives temporary migration as households seek income opportunities in urban areas.
Agriculture 	• **Maize (MW06):** Reduced precipitation and increased temperatures lead to significant moisture stress, reducing yields and causing crop failures. Drought-resistant maize varieties may be necessary. • **Horticultural Crops:** The water-intensive nature of many horticultural crops makes them highly vulnerable to reduced water availability, leading to lower yields and crop losses. • **Livestock-Dependent Livelihoods:** Reduced water availability and pasture degradation negatively affect livestock health, leading to declines in milk and meat production.	• **Maize (MW06):** Increased rainfall enhances soil moisture, supporting crop growth in the short term. However, risks of waterlogging and soil erosion could negate these benefits. • **Tea (MW14):** Increased rainfall benefits tea production but also introduces new disease pressures, requiring enhanced disease management. • **Livestock Livelihoods:** Increased rainfall temporarily improves pasture conditions, enhancing livestock productivity. However, erratic rainfall and flooding leads to disease outbreaks among livestock.	• **Maize (MW06):** Higher precipitation and increased humidity creates optimal conditions for maize growth but also poses risks of fungal infections and pest infestations. • **Horticultural Crops:** Increased water and humidity boosts horticultural yields, but excess moisture may lead to higher disease and pest pressure. • **Tea (MW14):** Increased precipitation and humidity supports tea growth also leads to issues with leaf blight and root diseases, impacting quality and yield.

13. NSANJE ICICLE STORYLINES





Located in the far South of Malawi, Nsanje's agricultural system relies heavily on the Shire River, which supports both rain-fed and irrigated agriculture. Upland areas are used primarily for maize and sorghum, while winter production in the river-adjacent plots includes maize, rice, beans, sweet potatoes, and vegetables. Livelihood zone MW05 (Shire River) covers the whole district. Irrigated farming is practised on a limited scale, with some households using treadle pumps to supplement water supplies. The diversified agricultural system reflects efforts mitigate the impacts of recurrent droughts (FEWS NETM USAID, 2024). The district is reliant on agriculture, and access essential services, including electricity, clean water, and educational facilities is poor, is especially in remote parts of the district.

Nsanje Climate storylines (CS) for SSP2-4.5 Emission Scenario

CS1. Hotter – Drier – Decreasing Humidity
Temperature Increase (T↑): 0.9°C (3.6%)
Precipitation Decrease (P↓): -51 mm (6.0%)
Humidity Decrease (H↓): -1.5% (2.2%)

CS2. Hotter – Wetter – Decreasing Humidity
Temperature Increase (T↑): 0.7°C (2.8%)
Precipitation Increase (P↑): 71 mm (8.3%)
Humidity Decrease (H↓): -0.5% (0.7%)

CS3. Hotter – Wetter – Increasing Humidity
Temperature Decrease (T↑): 0.4°C (1.5%)
Precipitation Increase (P↑): 36mm (4.2%)
Humidity Decrease (H↑): 0.7% (1.1%)

13.1 Nsanje ICICLE Storyline Narratives

Projections indicate that Nsanje's future climate will likely be hotter and drier with slightly decreasing humidity. However, a hotter and wetter future is also possible with decreasing humidity, as is a hotter and wetter future but with slightly increasing humidity.

The narratives, based on the near-term Climate Storylines for Nsanje follow below.

Nsanje ICICLE Storyline 1: Hotter – Drier – Decreasing Humidity

The lower humidity levels are limiting mosquito breeding habitats, and reducing LF transmission, but localised outbreaks are possible during short bursts of rainfall. Snail populations are reducing due to a decline in water bodies, but limited snail populations will be present in stagnant water, sustaining the threat of Schistosomiasis. Similarly, reduced water availability is lessening the problem of Soil-Transmitted Helminths (STH) but it is hard to eliminate it due to continuing poor hygiene practices. Reduced river flow is lowering blackfly transmission rates. However, remaining stagnant water is still supporting limited blackfly breeding, necessitating continued vector control to remove the threat of Onchocerciasis: (ESPEN, 2024). Reduced water access is having serious public health implications with hygiene and sanitation challenges, leading to an increasing incidence of waterborne diseases and placing an additional burden on local and national health services. Agricultural workers are exposed to heat stress, which is also impacting on health care workers. Energy failures with pressure on air conditioning systems is additionally impacting on supply chains, including the critical cold chain required for national child vaccination programmes. Nsanje's reduced rainfall and higher temperatures are leading to moisture stress in crops such as maize and sorghum, which are foundational for food security and livelihoods. This moisture deficit is decreasing yields and crop failures for rain-fed systems, disproportionately affecting poorer households who are relying heavily on these staples. Additionally, reduced water availability for livestock will lead to diminished grazing quality and productivity, undermining household resilience and economic security (Malawi Red Cross Society, 2020;FEWS NET, USAID, 2024). Public health infrastructure is facing challenges as water scarcity affects hygiene, sanitation, and overall health services, with further risks of waterborne diseases (Malawi Office of Statistics, 2018).

Nsanje ICICLE Storyline 2: Hotter – Wetter – Decreasing Humidity

Increased rainfall will impact on LF, Schistosomiasis, Soil-Transmitted Helminths (STH) and Onchocerciasis, creating new breeding sites and habitats for disease vectors. Managing these diseases and preventing new outbreaks will require increased vector control measures. Public health systems are contending with flooding that is disrupting healthcare delivery and increasing disease outbreaks from water contamination (Malawi Office of Statistics, 2018). Structural damage of health facilities are also resulting in a reduced ability to respond to local health needs. In the agricultural sector, increases in rainfall are offering opportunities for improved crop yields due to enhanced soil moisture, benefitting maize and horticultural crops. However, excessive rainfall is leading to waterlogging, erosion, and the proliferation of fungal diseases, necessitating effective water management and drainage systems. Livelihoods are seeing temporary boosts in labour demand during periods of agricultural productivity but remain vulnerable to fluctuating output levels due to excess moisture (FEWS NET, USAID, 2024; Malawi Red Cross Society, 2020).

Nsanje ICICLE Storyline 3: Hotter – Wetter – Increasing Humidity

Increasing temperature, rainfall and humidity are creating ideal conditions for mosquito breeding, snail habitats, blackfly populations and STH. This is creating a heightened threat of LF, Schistosomiasis, Soil-Transmitted Helminths (STH) and Onchocerciasis requiring appropriate control measures and targeting of resources to the most critically affected areas. Public health infrastructure is struggling with flood damage, and water borne disease outbreaks are a problem due to a breakdown in sanitation systems. With respect to agriculture, increased rainfall, temperature, and humidity are helping to enhance the yields of moisture-dependent crops like maize, but are also increasing risks of fungal diseases, pest infestations, and waterlogging. Horticultural crops are experiencing increased productivity, but pest and disease pressure due to high humidity are causing significant challenges. The combination of improved pasture conditions and heightened disease risks calls for sustained livestock health management (Malawi Red Cross Society, 2020;FEWS NET, USAID, 2024). Public health infrastructure needs resilience-building measures to cope with potential sanitation system strain and vector-borne disease proliferation due to favourable breeding conditions (Malawi Office of Statistics, 2018).

13.2 Summary of Impacts for Nsanje under each Climate Storyline

The table below considers the climate impacts likely to affect the six selected NTDs and public health infrastructure and related to these the likely impacts on key crops, livestock, and livelihoods in Nsanje. Impacts result from the changing climate condition (hazards), the exposure of these systems, and the intrinsic crop and animal vulnerabilities to, e.g., specific temperature thresholds, and of broader environmental vulnerabilities (e.g., soil erosion) and socio-economic vulnerabilities (e.g., poverty).

The impacts are derived considering all the climate storylines by considering the implications that each may have on NTDs, crops, livestock, and livelihoods. The impacts are visually presented in a table, to allow a more immediate access to this extensive information. For more details on the methodology used for the impact, see the full Technical Report (Methods Section).

The hazards and vulnerabilities determining the ICICLE storylines specific to Nsanje and the resulting potential impacts in the relevant sectors (health, agriculture and livelihoods) are expressed in Table 10. The impacts are based on input from local stakeholders (LE) and integrated with the most pertinent impacts identified in the literature review. The research team has further refined these to focus on those most relevant to Nsanje according to expert judgment.

TABLE 10: KEY CLIMATE IMPACTS ON TARGETED NTDS, PUBLIC HEALTH INFRASTRUCTURE AND AGRICULTURE IN NSANJE WITH THE ASSOCIATED CLIMATE STORYLINE (CS) AND RELEVANT LOCAL VULNERABILITIES. KEY: BLACK ARROWS ARE INCREASING; RED ARROWS = DECREASING; THERMOMETER = TEMPERATURE; CLOUD = RAINFALL; DROP/PERCENTAGE = RELATIVE HUMIDITY

Sector	Climate Storyline 1	Climate Storyline 2	Climate Storyline 3
	Temperature increasing; Rainfall decreasing; Relative humidity decreasing	Temperature increasing; Rainfall increasing; Relative humidity decreasing	Temperature increasing; Rainfall increasing; Relative humidity increasing
Neglected Tropical Diseases 	• **Lymphatic Filariasis (LF):** Despite reduced precipitation, short bursts of rainfall sustain localised transmission risks, necessitating continued vector control strategies. • **Schistosomiasis:** The decline in water bodies due to decreased precipitation reduces snail population. However, stagnant water sources sustain limited snail populations, maintaining localised transmission risks. • **Soil-Transmitted Helminths (STH):** Reduced rainfall and drier soil conditions hinder helminth egg survival, reducing transmission risks. However, inadequate	• Increased rainfall creates new breeding sites and habitats for disease vectors impacting on LF, Schistosomiasis, Soil-Transmitted Helminths (STH) and Onchocerciasis. • Additional resources are required for increased vector control measures to manage these diseases and prevent new outbreaks.	• Increasing temperature, rainfall and humidity are creating ideal conditions for mosquito breeding, snail habitats, blackfly populations and STH. • Resulting threat of LF, Schistosomiasis, Soil-Transmitted Helminths (STH) and Onchocerciasis requires urgent control measures and targeting of resources to the most critically affected areas.

	access to water for sanitation exacerbates hygiene-related infections • **Onchocerciasis:** Reduced river flow decreases blackfly populations, lowering transmission risks. However, stagnant water in some areas supports limited blackfly breeding, necessitating continued control measures.		
Public Health Infrastructure 	• **Water Scarcity and Hygiene:** Reduced precipitation exacerbates existing water scarcity, increasing hygiene and sanitation challenges. This leads to higher incidences of waterborne diseases such as cholera, straining public health infrastructure). • **Heat-Related Health Strains:** Rising temperatures increase the number of cases of heat-related illnesses, particularly among vulnerable groups such as the elderly and agricultural workers. This raises demand for healthcare services in already resource-limited facilities. • **Impact on Supply Chains:** Heat stress disrupts workforce efficiency and supply chains, leading to potential shortages of essential medical supplies, including vaccines reliant on cold storage systems.	• **Flooding and Access Issues:** Increased rainfall elevates flooding risks, damages healthcare infrastructure, disrupts services, and increases waterborne disease outbreaks such as cholera. • **Infrastructure Damage:** High humidity and excessive rainfall lead to increased risk of structural degradation in health facilities, including mould growth and equipment damage. • **Sanitation System Strain:** Increased precipitation and humidity strain sanitation systems, increasing water contamination and the risk of disease outbreaks.	• **Flood Damage and Waterborne Disease Outbreaks:** Increased flooding overwhelms sanitation systems, leading to widespread outbreaks of waterborne diseases such as cholera and typhoid. • **Structural Damage to Health Facilities:** Increased humidity and water exposure degrades healthcare infrastructure, increasing maintenance costs and reducing service capacity. • **Supply Chain Challenges:** Disruptions in infrastructure due to flooding limit access to essential medicines and vaccines, weakening public health responses.

Livelihoods 	• **Casual Labour (Ganyu):** Reduced agricultural productivity lowers the demand for ganyu labour, worsening economic conditions for poorer households (FEWS NET, USAID, 2024). • **Market and Economic Impacts:** Declining agricultural yields and livestock productivity reduces household incomes and increases economic disparities, necessitating targeted adaptation strategies (FEWS NET, USAID, 2024).	• **Casual Labour (Ganyu):** Higher agricultural productivity creates more labour opportunities, but excessive moisture risks undermining better yields and reducing long-term benefits.	• **Casual Labour (Ganyu):** Higher agricultural output provides short-term labour opportunities, but variability in crop productivity and increased disease risks could undermine long-term stability.
Agriculture 	• **Maize and Sorghum:** Reduced precipitation and higher temperatures intensify moisture stress, reducing maize yields and increasing crop failures in rain-fed agriculture. Poorer households relying on these staples face heightened food insecurity. • **Livestock Productivity:** Decreased water availability degrade pasture conditions, reducing milk and meat production. Poorer households relying on livestock for economic stability face increased hardship.	• **Maize and Sorghum:** Increased rainfall temporarily improve yields due to enhanced soil moisture. However, excessive rainfall heightens risks of waterlogging, soil erosion and fungal diseases, so improved drainage systems are needed • **Horticultural Crops:** Higher rainfall enhances horticultural crop yields but also increases pest and disease pressure, necessitating integrated pest management.	• **Maize and Horticultural Crops:** Increased precipitation and humidity initially improves yields but also heightens risks of fungal diseases and pest infestations, necessitating disease-resistant crop varieties and improved management practices. • **Livestock Productivity:** Enhanced pasture conditions improve livestock productivity, but higher humidity may increase the prevalence of vector-borne livestock diseases, requiring sustained disease prevention strategies.

14. ICICLES - SYNTHESIS OF THE ENVIRONMENTAL AND SOCIO-ECONOMIC IMPACTS OF THE CLIMATE STORYLINES

The ICICLE storylines emerge from the combination of the district-level climate storylines with district information on environmental and socio-economic vulnerabilities (e.g., land degradation, poverty), NTDs and trends (e.g., population growth). To derive possible impacts, ***the methodological choice is to assume that current vulnerabilities will persist in the future and that no additional adaptation measures will be implemented.*** For each NTD, the possible impact (e.g., recrudescence of transmission), the underlying vulnerabilities (e.g., poor nutrition from reduced crop yields) and hazards (e.g., floods) are specified where possible, to lay out clearly the cause-effects chain.

Across all ten districts analysed in the **ICICLE storylines**, a set of **recurring climate-driven challenges** emerges, particularly in **disease transmission, agricultural productivity, public health infrastructure, and socio-economic resilience**.

14.1 Climate Change and Disease Transmission

A dominant pattern across all districts is rising temperatures, which exacerbate vector-borne and waterborne disease transmission dynamics. Under hotter and drier conditions, schistosomiasis transmission initially declines due to shrinking water bodies and reduced snail habitats, but this is countered by greater reliance on contaminated water sources, increasing exposure risks. Similarly, trachoma becomes more prevalent in drier, dustier environments due to heightened eye irritation and inadequate water for hygiene. Soil-transmitted helminths (STH) decline in viability in drier soils but persist where sanitation is poor.

In contrast, hotter and wetter conditions significantly increase the risk of vector-borne diseases such as lymphatic filariasis (LF) and onchocerciasis, with expanding water bodies providing ideal mosquito and blackfly breeding grounds. High humidity and increased rainfall also amplify schistosomiasis risks, as more snail habitats emerge and fluctuating water levels drive disease transmission surges. Many districts—especially Mangochi, Nsanje, Karonga, and Blantyre—report increased malaria, cholera, and diarrheal diseases linked to flooding, stagnant water, and compromised sanitation infrastructure. Fungal infections and pests also rise in humid environments, impacting both human and livestock health.

14.2 Agricultural and Livelihood Vulnerabilities

Climate change is disrupting staple crop production across all districts, with maize, cassava, rice, and cash crops (tobacco, groundnuts, and bananas) particularly affected. In hotter and drier districts like Chitipa, Mchinji, and Dedza, moisture stress is leading to declining maize yields, reduced cassava root size, and stunted growth of cash crops. Conversely, in hotter and wetter districts like Karonga, Mangochi, and Nsanje, excessive rainfall is improving short-term yields but also increasing fungal diseases, pest infestations, and crop storage challenges. Fluctuating rainfall patterns are disrupting planting cycles and leading to waterlogging, soil erosion, and post-harvest losses—problems observed in Lilongwe, Zomba, and Blantyre.

Livestock health is deteriorating in all climate scenarios. In drier districts, water scarcity and degraded grazing land are reducing milk and meat yields, while in wetter districts, muddy conditions and higher humidity are fueling livestock diseases. Fishing communities, particularly around Lake Malawi and Lake Chilwa, are also experiencing fluctuating fish stocks due to changing water levels and breeding conditions, impacting food security and household incomes.

14.3 Public Health Infrastructure and Socio-Economic Disparities

A major shared vulnerability across all districts is the strain on public health infrastructure due to climate-driven disease outbreaks, water scarcity, and flood damage. In drier scenarios, health facilities face challenges in maintaining sanitation and hygiene standards due to reduced water availability, increasing the risk of nosocomial infections and hygiene-related NTDs. In wetter conditions, flooding isolates communities, damages healthcare facilities, and disrupts access to essential services, worsening the burden on already limited health systems.

Throughout all storylines, socio-economic disparities are widening as wealthier households—able to adopt drought-resistant crops, invest in improved storage, and access alternative livelihoods—fare significantly better than poorer households dependent on rain-fed agriculture and seasonal casual labour (ganyu). This disparity is particularly pronounced in districts with high population densities (Lilongwe, Blantyre, and Zomba), where resource access is more competitive and health and economic inequalities are intensifying.

14.4. Cross-Cutting Adaptation Needs

Regardless of climate scenario, stronger adaptation strategies are needed across all districts, including:

- Strengthened disease surveillance and vector control for NTDs, malaria, and waterborne diseases.
- Improved sanitation and access to clean water to reduce hygiene-related disease risks.
- Climate-smart agriculture practices such as drought-resistant crop varieties, improved irrigation, and pest management.
- Resilient public health infrastructure to withstand flooding, humidity damage, and increased disease burdens.
- Livelihood diversification opportunities to reduce reliance on rain-fed agriculture and seasonal labour.

The ICICLE storylines reveal a consistent pattern of climate-driven health, agricultural, and socio-economic vulnerabilities across all ten districts. While specific impacts vary, the interplay of rising temperatures, shifting humidity, and changing precipitation patterns creates new health risks, disrupts food production, and exacerbates inequalities. Without urgent, localized adaptation measures, climate change will continue to intensify health crises, economic instability, and environmental degradation, placing Malawi's most vulnerable populations at greatest risk.

Details and references for the above statements are found in Chapter 6 of the CHAIRR- Malawi Technical Report.

15. RECOMMENDATIONS AND ACTIONS FOR ADVANCING CLIMATE-NTD ADAPTATION IN MALAWI

CHAIRR has made significant progress in developing:

- **Improved critical knowledge of NTD emergence** as well as current and future risks based on the new understanding of future climate;
- **Integrated Climate-Livelihood-Environment Storylines (ICICLEs)** to communicate climate change through defensible and engaging scientific narratives that explore long-term (chronic) and short term (acute) complicators of the target NTDs;
- **An integrated database** to provide health researchers and practitioners with a rich and integrated data resource that will span climate, environment, disease, and livelihoods; and
- **Change frameworks** for developing the time-line of adaptation actions needed to address long-term impacts of climate change and ensure discussions with stakeholders consider long-term decision making, when stakeholders face ongoing pressure from short-term issues.

To build on these developments and further strengthen climate resilience and NTD adaptation efforts in Malawi, the following key recommendations and actions are proposed based on the results of this analysis:

Enhancing Climate-NTD Impact Modelling

A more A more comprehensive quantitative assessment of climate change impacts on NTD transmission, agriculture, hydrology, and socio-economic factors is essential for a more coordinated and effective national response. Expanding the current analysis to additional districts will provide a broader understanding of climate risks and health concerns across the country, ensuring that adaptation strategies are both inclusive and targeted. To achieve this, it is crucial to overcome challenges in accessing district-level data by conducting a thorough review and rigorous assessment of new and emerging datasets.

While this initial Climate Risk and Vulnerability Assessment (CRVA) offers primarily qualitative insights, future research should incorporate epidemiological models, crop models, hydrological models, and socio-economic analyses to provide a more data-driven understanding of climate impacts. These modelling approaches will enable more precise adaptation planning, optimized resource allocation, and stronger evidence-based policy recommendations. Given the complex interactions between climate variability and NTD transmission, integrating these models into future CRVA rounds will be critical in refining intervention strategies and improving decision-making, ensuring that responses remain dynamic and responsive to changing conditions.

Strengthening Adaptation Planning and Stakeholder Engagement

In the first half of 2025, Sightsavers and the Walker Institute, University of Reading, will convene a national workshop on adaptation planning to bring together government representatives from the 10 focus districts, NTD Coordinators, Preventative Chemotherapy leads, agricultural and veterinary experts, water management specialists, and international adaptation stakeholders. The workshop will focus on co-developing practical, locally driven solutions with an emphasis on "My" Climate Risk, ensuring adaptation strategies are tailored to the specific vulnerabilities of each district.

Using established frameworks such as Dynamic Adaptive Policy Pathways (DAPP) and the ICECCAP Framework, participants will discuss and prioritize adaptation measures to address climate-sensitive NTDs. The two-day hybrid workshop will not only capture key insights to integrate into national and district-level adaptation policies but also establish a Dynamic Adaptive Policy Planning process to continuously monitor climate change impacts on NTDs. By improving the tracking of climate variables, particularly rainfall patterns, stakeholders will gain a clearer understanding of which climate scenarios are unfolding. This approach will enable real-time adjustments and refinements to adaptation plans, ensuring they remain responsive and effective in the face of changing conditions. Through this process, Malawi will strengthen its long-term capacity to anticipate and manage climate-driven health risks, fostering greater collaboration across sectors.

Communicating Adaptation Strategies and Strengthening Decision-Making

Clear and accessible communication strategies are needed to ensure that adaptation options are well understood and effectively implemented. Innovative methods, such as infographics, policy briefs, and data visualizations, will be developed to explain NTD adaptation strategies to local, national, and international stakeholders. Additionally, a Climate-NTD Community of Practice will be established in Malawi to provide a platform for ongoing engagement, capacity-building, and information-sharing among key stakeholders. Regular e-meetings will facilitate continuous dialogue, while "My Climate Risk" assessments and impact chains will be applied to refine adaptation planning. These discussions will help align adaptation efforts with government priorities and donor funding strategies, ensuring that proposed interventions receive necessary policy and financial support.

Advancing Research and Policy through Collaboration

A joint research paper will be developed to document how scientific evidence can support climate adaptation and NTD elimination strategies in Malawi. This research will highlight the need for integrating health, climate, and socio-economic considerations into adaptation planning. In parallel, stakeholder and donor forums will be organized to communicate co-designed solutions and mobilize funding for implementation. These forums will serve as a platform to connect policymakers, researchers, donors, and practitioners, helping to translate scientific insights into action. A collaborative training programme and knowledge-sharing network will also be established to strengthen capacity in climate-health adaptation across the African region, ensuring long-term sustainability and regional coordination.

Securing Long-Term Investment for Climate-NTD Adaptation

To sustain momentum, a multi-year CHAIRR regional project proposal will be developed for implementation starting in 2025. This initiative will focus on specific case studies across multiple African countries, examining how climate risk research can inform NTD adaptation strategies, health system resilience, and sustainable agriculture. A concept note for a collaborative interdisciplinary training programme will also be prepared to foster knowledge exchange and technical capacity-building. Additionally, strategic stakeholder and donor engagement meetings will be convened to explore funding opportunities and secure long-term investment in climate resilience and NTD management efforts across Africa.

These actions provide a roadmap to strengthen Malawi’s capacity to address climate-NTD challenges through science-driven adaptation, multi-stakeholder collaboration, and evidence-based policymaking. The success of these efforts depends on sustained engagement, knowledge-sharing, and financial support to implement solutions at local, national, and regional levels They underscore the critical need for integrated climate-health approaches to support NTD elimination goals and broader health system strengthening in Malawi and beyond.

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