Self Help AFRICA

University of BRISTOL

INNATE VALUES LTD.

UNITY AND FREEDOM

BEYOND FORECAST

Study on Climate Risk Assessment of WASH Services in Thyolo District, Malawi

Study Brief, November 2024

www.selfhelpafrica.org

Contents

Citation: Nijharwan, A., Tomoka, S., Kawala, C., Tillett, W., Hutton, G. (2024): *Beyond forecast: Study on Climate Risk Assessment of WASH Services in Thyolo District, Malawi Study Brief, November 2024.*

Executive Summary

Background and rationale for the study:

With over 90 percent of natural disasters being water-related weather events, water is the primary means through which we feel the effects of a changing climate. In Thyolo District, Southern Malawi, recurrent cyclones in recent years have battered communities, and the water, sanitation and hygiene (WASH) services they depend on. Intense rainfall, droughts and strong winds cause widespread damage, leading to secondary hazards, like landslides and waterborne disease outbreaks. In 2023 Malawi suffered the deadliest cholera outbreak in its history.

Self Help Africa (SHA), with funding from Co-op UK and The One Foundation, has been working in Thyolo District since 2013. Over the period climate change has been one of the key challenges impacting access to WASH, and causing SHA to regularly switch between long-term development, and humanitarian response programming. As part of SHA's long-term collaboration with Co-op UK, The One Foundation and Thyolo District Government, SHA embarked on a study in 2023 to better understand climate risks to WASH services, to use these insights to inform future actions as well as provide a strong case for planning and investments in Thyolo District marking a shift, from a reactive, to a proactive approach to safeguard WASH services from increasing climate-related hazards.

Overview of the study methodology:

The study was undertaken between October 2023 and August 2024, led by a SHA team, with significant technical input from Dr. Anisha Nijhawan of the University of Bristol (UK), a local consultant (Tchaka Pulumuka), and economic modelling inputs from Dr. Guy Hutton.

It sought to understand current and future climate risks, to WASH services in the district, and develop recommendations for investments to increase climate resilience. It also sought to collect information around the impacts of climate change that could be used for advocacy, and undertake economic modelling of the costs of not investing in more resilient services, versus the costs of doing so. Secondary objectives of this study involved building capacities and awareness of SHA, government and sector actors, on climate resilient WASH. The study involved desk review and secondary data analysis, 4 national and local stakeholder workshops, 29 key informant interviews, 9 focus group discussions, 488 field surveys in communities, schools and clinics, and spatial and economic modelling.

Key findings:

The study provided quantitative and qualitive insights which are elaborated in the synthesis report (the next section of this document) and detailed in full in the main study report. Findings confirmed SHA's understanding that climate change is *already* negatively impacting communities' quality of life, livelihoods, and WASH services, and has helped generate the evidence base on how and where the impacts are already felt, and to project these impacts into the future, using different climate scenarios. Key findings on the existing situation are:

- Droughts are causing water shortages and water point failures, causing communities (mostly women and children) and students to spend more time collecting water instead of engaging in other socioeconomic activities, and also drawing from unprotected water sources. 83% of schools face water shortages, and flush toilets in clinics become blocked during dry season.
- Floods and cyclones are damaging household toilets, leading to significant contamination risks, and leading to 10% of affected households reverting to open defecation. Flooding and intense rainfall are also causing water quality and erosion issues for drinking water infrastructure, and rendering water points inaccessible or non-functional, again leading to extra time burden for households to collect water, and/or collection from unsafe sources.
- The poorest suffer the most: lower-income households were more likely to have a non-durable toilets and more likely to experience damage of toilets from flooding and high winds.
- There is limited systemic resilience and disaster preparedness / response capacity at the household, community service provider and district level. WASH strategic plans do not adequately factor in resilience-building, and capacity is limited for hydrological and water quality monitoring. Relatively weak arrangements for maintenance and repairs mean when toilets and water points fail, they are down for sustained periods, increasing negative impacts felt by users.

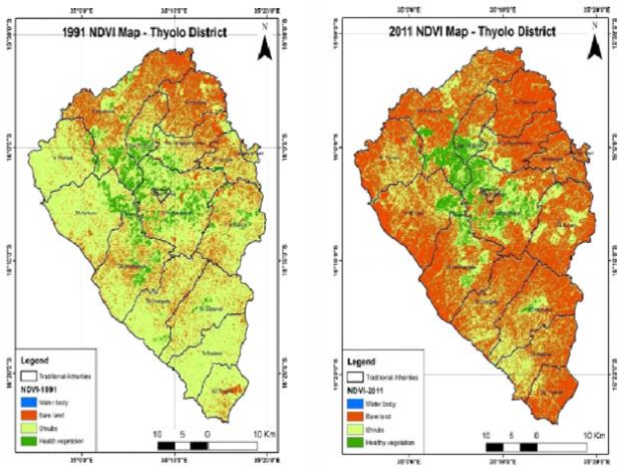


Figure : Maps showing decrease in vegetation cover

- Anecdotal reports from farmers, tea growers and sugarcane cooperatives highlight issues of lower and less reliable yields and crop quality, and its impact on trade and incomes.
- Poor land, soil and water management, poor agricultural practices, deforestation, and environmental degradation are likely to further exacerbate hazards and vulnerabilities.

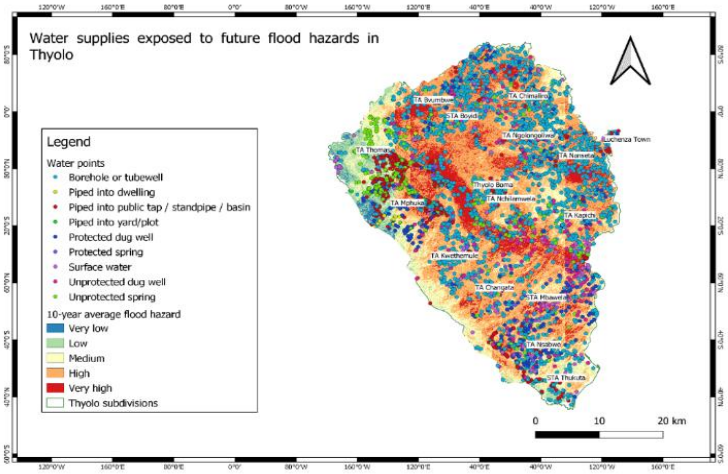


Figure A: Water supplies in Thyolo exposed to future flood hazards in 2034-2043 under SSP 5-8.5 climate scenario

In addition to these *existing* impacts, spatial analysis using climate and hydrological modelling, overlain with the district-wide water point inventory maps, helped give a sense of the *future* district-wide scale of flooding and drought risk. Scenarios broadly forecast increasing frequency and magnitude of climate hazards. It found that 182 (12%) of Thyolo's existing water points may be at medium to very high risk of flooding in coming decades.

The study findings particularly from droughts, cyclones and flooding, fed into an economic model, which sought to contrast the economic costs, such as the impacts on households and emergency response measures, compared to the costs of investing in WASH services to make them more resilient to climate-induced disasters. The net costs modelling over a 20-year time horizon by subtracting the total economic losses avoided (by investing in climate resilient water services) from the infrastructure costs of making water services more climate resilient. Results were modelled at the district-wide level drawing on risk assessment from two sources: (1) household surveys (to assess historical risk to water points) and (2) climate modelling (to assess potential future climate risks to water points). This economic analysis, although incomplete, demonstrated that measures to increase climate resilience can have positive returns over a 20-year period (see Figure B, where damages averted exceed costs of increasing climate resilience). As modeling of this type is relatively new in the WASH sector globally, this study also yielded valuable learning for others seeking to try this in the future.

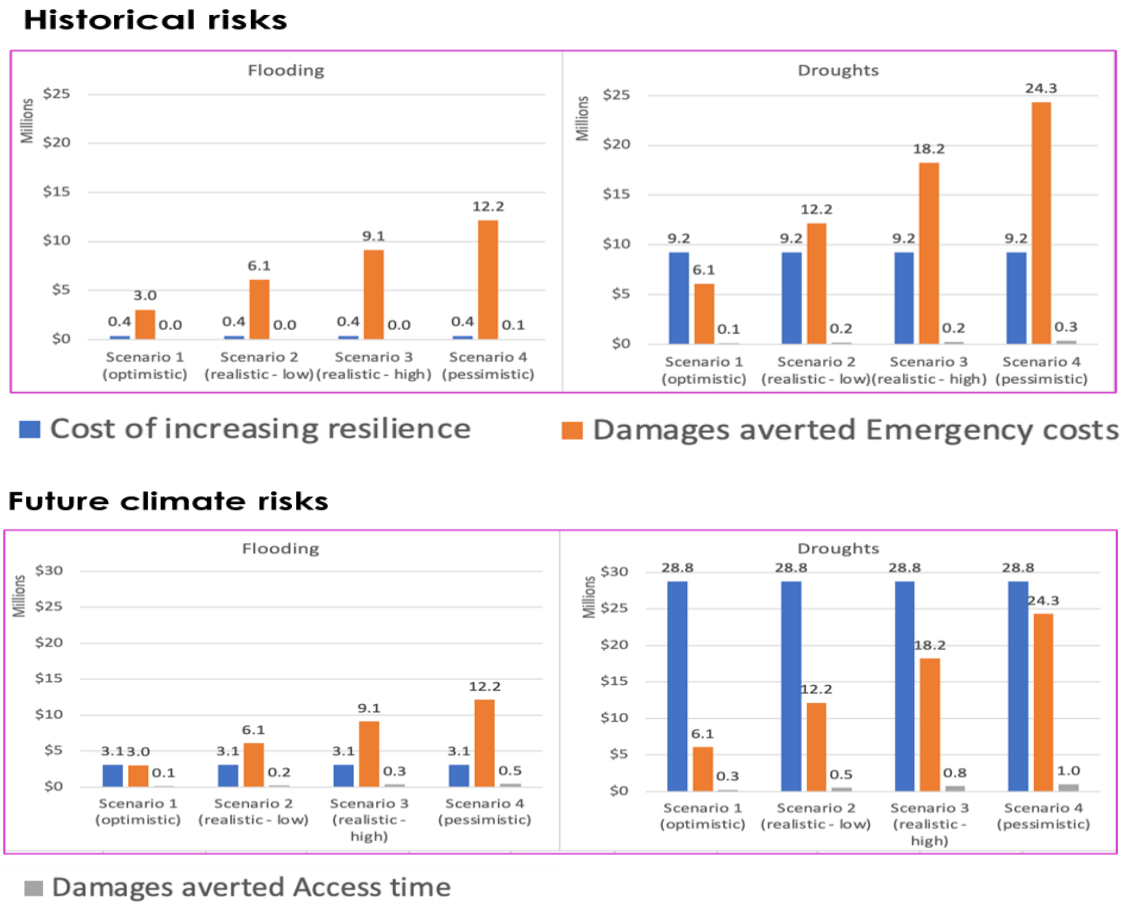


Figure B: Economic modelling scenarios of flood and droughts in Thyolo over a 20-year time horizon

Key implications and recommendations:

Findings and recommendations from the study were presented and discussed through district and national stakeholder workshops, and in the months following the study, SHA has further reflected on what the study implies for its WASH programming and government partnerships.

A key reflection is the need for our (SHA) WASH programming to 'go beyond business as usual':

- Our planning and infrastructure development needs to avoid a 'one size fits all' solution, with a stronger focus on localized risk analysis, to have solutions and infrastructural designs customized to the local context and climate risks. We have already started to integrate raised aprons and pump designs into our 'standard' rehabilitation works for flood-prone water points. Our sanitation work needs to support households and market actors like masons to identify disaster risks, select relevant technical options, and understand how low-income households can afford more durable structures.

Figure 5: Flood proof borehole (Thyolo)

- Our WASH work needs a stronger water resources management focus, working with communities and authorities, across WASH, agriculture, forestry and natural resource sectors, to reverse environmental degradation that can be accentuating climate risks, and to protect and recharge groundwater resources. Our work strengthening the maintenance and functionality monitoring of water points, needs to better integrate monitoring of water contamination risks, and where possible, monitoring of yields and aquifer levels.
- Whilst seeking to increase resilience to the extent that is possible (and cost-effective), we appreciate there will still be residual disaster risk, that needs to be better prepared for and responded to. This implies integrating DRR and emergency preparedness in our long-term development programming, for example by strengthening cross-sectoral coordination, increasing the usage of early warning systems, strengthening disease surveillance linked with water quality surveillance, and increasing availability of chlorine. It also implies flexibility for a rapid shift to disaster response in programs/budgets, when needed.
- We have realized that increasing the resilience of WASH services costs substantially more than 'standard' programming and service delivery, and whilst this study has shown that it makes economic sense to invest in these additional costs, we need to increase our understanding of climate finance, and our ability to help our government partners - who we have already helped develop a district WASH sector investment plan - to access such funds.

The study also highlighted recommendations for government and development partners:

- Government should increase the monitoring, availability and usage of hydrological and climate-related information to inform WASH planning, prioritization and investments. Support may be needed to operationalise the National Water Resources Agency functions and capacities at the district level, and for further studies to inform planning
- Government should support more effective cross-sector coordination, planning and learning on climate resilience, helping to bring agriculture, natural resources, WASH (etc) together
- WASH program funders should require, incentivize and support NGOs to engage meaningfully on climate resilience, accepting to do this will likely increase unit costs of WASH access, and may imply supporting programs that cut across sectors (e.g. WASH, agriculture, natural resources management), and may imply including humanitarian/DRR elements into longer-term development programs. Funders are encouraged, especially where they have long-term grantee partners and focus geographies, to support such partners to undertake similar studies, building capacities and technical partnerships in the process.

SHA would like to sincerely thank Coop and The One Foundation for the encouragement and support to undertake this study, and thank all those in SHA, Innate Values and University of Bristol and Thyolo District Council, for their collaboration, in this learning journey of a study.

Study Synthesis Report

1. Background, and scope of this study and report

Changing climate patterns pose a threat to the integrity of water and sanitation services in Malawi where extreme events already cause damage to infrastructure and loss of life. The district of Thyolo in southern Malawi is particularly exposed to climate-related extreme events: between 2018 and 2023, Thyolo was hit by 3 deadly cyclones – Idai in 2019, Gombe in 2022 and Freddy in 2023 – that damaged water and sanitation infrastructure worth millions of dollars. Building the resilience of infrastructure, service providers and authorities will be essential to ensure that the progress made towards improving access to drinking water and sanitation in communities and institutions is not undone.

The One Foundation (TOF) and Co-op, who have been long-term supporters of SHA's WASH work in Thyolo, having witnessed the Cyclone Freddy crisis, provided Self Help Africa (SHA) and the District Government an opportunity to look more into the climate vulnerability of WASH infrastructure and services in the district, and develop evidence-based actions that could improve resilience. A study was thus launched in partnership with SHA, government, climate resilient WASH experts at the University of Bristol (UK), and inputs of additional consultants - Guy Hutton and Tchaka Ndhlamini Pulumuka.

This study, conducted between October 2023 and August 2024, sought to:

- Undertake an analysis of current and future vulnerabilities, exposures and impacts of climate change on WASH services in the district
- Develop a series of costed recommendations on how to increase resilience and reduce such risks, that can inform updates to the DSIP and future investments of government, One Foundation/Coop, SHA and other actors in Thyolo
- Attempt to undertake an economic modelling of the 'costs of inaction' of not investing in more resilient services, versus the costs of doing so
- In the process of the study, to increase capacities, dialogue and learning on climate resilience in WASH, in Thyolo and Malawi's WASH sector more generally, and to provide evidence that can be used in local to global advocacy on this topic.

A series of written deliverables were produced from the study, already shared with TOF. These include: an overall study report; a report from the economic modelling workstream; an internal donor-facing report, that presents progress against project activities, and also shares learning and positive impact of the project; and an 'impact stories' report, that documents findings from key informant interviews and focus group

discussions in Thyolo and Chikwawa districts, looking at impacts of climate change on WASH and also on tea and sugarcane production.

This study synthesis report was requested by TOF to summarize the key findings of the project/study, which draws on key elements of all the deliverables mentioned above.

2. Study methodology

The study included: a desk review of global to local documents and existing secondary data; two in-country visits by Anisha Nijhawan from University of Bristol, and ongoing actions by in-country teams; spatial analysis of potential exposure coupled with flood and drought modelling; two stakeholder workshops each at the Malawi national and Thyolo district level; primary data collection involving 488 field surveys in communities, schools, clinics and water points; 6 interviews with sector, government and community-level stakeholders; qualitative interviews (23) and Focus Group Discussions (9) to understand impacts of climate change in Thyolo and Chikwawa; and economic analysis using primary and secondary data. Primary data collection focused on 7 perceived higher-risk Traditional Authorities (TAs) of the 27 TAs within the district, whilst spatial modelling, secondary data and district-level interviews sought to develop and quantify district-wide findings.

3. Key findings

Overview of the current situation in Thyolo:

Thyolo is a district in southern Malawi located within the Shire Highlands. Over half of the land area is hilly, especially in the south and southwest parts of the district. The hilly areas currently/historically receive between 1200 and 1600mm of annual rainfall while the plans receive between 800 and 1200mm. Temperatures range from 14°C to about 30°C, with the highest daily temperatures recorded in the river valleys. Thyolo is divided into 27 lowest administrative units called Traditional Authorities (TAs.) In 2023, it was projected to have a population of 829,668, with an annual growth rate of 2%. The economy is primarily agriculture-based, with 70% of the population involved in farming. Tea is the main cash crop (in the upland areas), along with maize, groundnuts and pulses. The average household earns 64,000 Malawian Kwacha (approximately US$36) per month.

The District Government is responsible for WASH services, through the District Water Office (DWO) and Ministry of Health and District Health Management Team. Water supply in Thyolo's two larger towns is the responsibility of the Southern Region Water Board (parastal), whilst the majority population in the rural areas rely on decentralised water points, with the prevailing management model being voluntary Water Point Committees (WPCs), (which should be) supported by Area Mechanics and the District Water Office.

Health Surveillance Officers are community-based extension workers supporting and monitoring on hygiene and sanitation.

According to the Thyolo District WASH survey conducted in 2021, there are 3,632 water points in the district. Of these 3,239 are boreholes and shallow wells equipped with Afridev handpumps; 393 are taps connected to 4 gravity-fed schemes and 678 are piped connections within the yard or dwelling connected to motorised boreholes, some connected to solar power. At the time of the survey, 55% of these water points were fully functional (Thyolo DSIP, 2023). Household sanitation coverage in 2021 was at 76%, with 136,081 toilets for 179,698 households. 27% of these toilets did not have drop hole covers and only 16% had hand washing facilities with soap. The most common type of facility was a pit latrine. There are 188 primary schools in the district, 41 primary health facilities in the district, and a district hospital (see the Study Report for WASH access data for these institutions).

Hazard and exposure analysis

The natural hazards that occur in Thyolo and the current level of risk in different traditional authorities (TAs) within the district were identified from a review of national reports and mapped based on historical data available in open-source global datasets. Hydrological analysis using weighted sum method in ArcMap was performed to map flood and drought exposure in Thyolo. Future risks of flooding and drought in Thyolo were mapped using CMIP6 climate projections for the period between 2024 and 2054, for two climate change scenarios – SSP 2-4.5 (middle of the road) and SSP 5-8.5 (fossil-fuelled development).

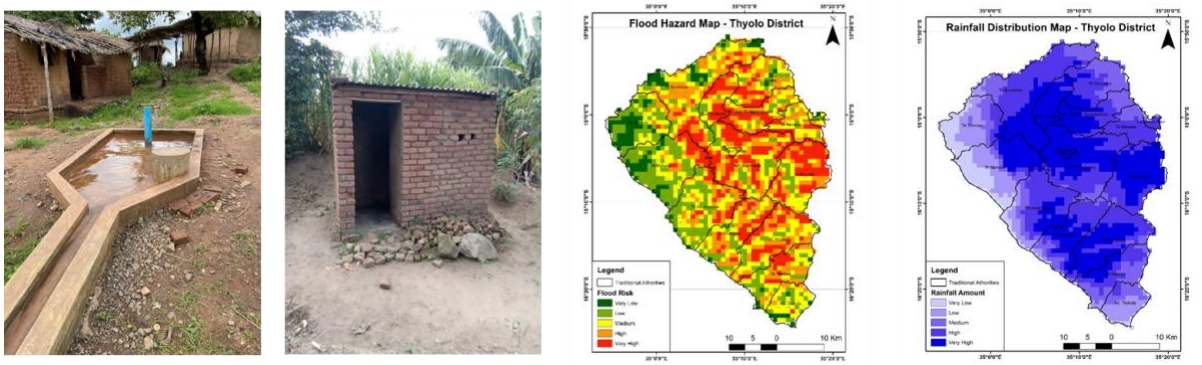


Figure 1 Photos from Thyolo of communal water collection point, and a household toilet; Historical flood hazard and rainfall anomalies in Thyolo

While several climate-related hazards can affect the performance of water and sanitation services, the following three were identified as being the biggest threats in Thyolo district – flooding, drought and landslides, based on a review of historical trends and consultation with the district government. Cyclones were also identified as a key challenge, and wind-related damage was also investigated, where possible. Whilst extreme heat, wildfires,

natural disaster-induced epidemics (e.g. cholera outbreaks after floods), and increased disease trends due to rising temperatures are all known in literature to be hazards associated with climate change, these were not looked into in detail due to the study scope and data availability.

***Key findings from the primary data collection on vulnerability of water and sanitation services* to climate risks and events**

The seven Traditional Authorities (TAs) in Thyolo that were included in the quantitative primary data collection had comparable levels of socio-economic vulnerability, primarily driven by high poverty and low education levels.

The household surveys, WASH infrastructure assessment and key informant interviews, provided insights into the current issues faced in households, schools and health care facilities. The study highlighted the following key issues (see the main study report for a wider findings):

Water supply:

1. Dry season (31%) and heavy rainfall (21%) were the most commonly reported hazards that make water sources insufficient or unavailable.
2. The most common negative outcomes faced by households are breakdown of water point for longer than 3 days (41%), water shortages in the dry season (31%) and seasonal changes in collection time (26%). The most common reason for changes in collection time was water shortage in the dry season. Stakeholders also reported that roads and bridges are often damaged or washed away in the rainy season, which affects access to water supplies.
3. Gravity-fed supplies were most likely to have low water yield in the dry season, which is likely because they typically access shallow groundwater which declines in the dry season.
4. Households respond to these issues primarily by collecting water from an alternative source. Of the 201 households with access to a secondary water source, 58% (n=117) use another borehole with handpump and 21% (n=44) use an unprotected dug well.
5. Drought and heavy rain were the top two climate-related events that Water Point Committee (WPC) members perceive as threats to water supplies. Trainings to WPCs generally do not include disaster response.
6. Of the 76 schools surveyed, 90% used borehole with handpump as their primary water source. In 68% of schools, learners are the only ones responsible for collecting water and spent, on average, 15 minutes per trip to collect water.
7. Negative outcomes reported by schools were similar to those for households. For 50% of the schools, collection time changes with season. The most common cause of this was water shortage followed by no water available in the dry season. Water shortage in the dry season (reported by 83% of schools) and heavy rainfall (reported by 42% of schools) make water insufficient or unavailable. A majority of the respondents cope with this by collecting water from an alternative source.

8. Out of 14 healthcare facilities (HCFs) surveyed, 57% use boreholes with handpump as their primary source, followed by tap on the premises (36%). Compared to schools, there were fewer negative performance outcomes reported in the HCF survey. 21% of HCFs reported seasonal change in collection time compared to 50% for schools, with the longest time reported in dry seasons.

Sanitation and hygiene:

9. The most common type of damage reported in the survey from climate-related hazards were damage or flooding of the toilet superstructure. 20% of households reported flooding during cyclones and damage from high winds or falling debris.
10. Toilets with durable superstructures i.e., corrugated iron roof and walls made of burnt bricks, were less likely to be damaged compared to toilets with thatched roof and walls made of mud or unburnt brick. Lower-income households were more likely to have a non-durable superstructure and more likely to report flooding from cyclone and damage from high winds and falling debris.
11. Half of the households who experienced damage or flooding of their toilet superstructure are unable to use it for an average of 13 days, but responses ranged from 1 day to 5 months. Approximately 10% of these households (representing 1% of the study sample) revert to open defecation.
12. In schools, The most commonly reported negative outcome was flooding of their toilets during cyclone, followed by damaged superstructure from high winds or falling debris. Of the 49 respondents who have faced damage or flooding to their superstructure or containment, 86% (n=42) said they are unable to use the toilet for an average of 7 days.
13. In Health Care Facilities (HCFs), The most commonly reported negative outcome on their sanitation facilities was blockage in the dry weather, reported for water-based toilets, followed by damage and flooding of superstructures from high winds or debris fall. Of the 7 respondents who reported such issues, 71% said they are unable to use the toilet for an average of 13 days, including 60 days for one facility. This disruption is similar to that reported from households but longer than for schools.
14. Across the district, the incidence of emptying of the toilet facilities is very limited. According to the District Water Development Office, there are no private emptying services in the district.

The 'impact stories' report provides findings from interviews and focus group discussions, on current felt impacts of climate change not only on WASH, but also on tea and sugarcane production and trade (tea being the main cash crop, widely produced in Thyolo highlands). In general, it is clear that climate change and climate-related events is already resulting in low yield, low quality of sugar and tea, and consequently negatively affecting farmers' annual income. All those interviewed expressed concern over the future in this regard.

Discussion on <u>current</u> felt impacts of climate change on WASH:

It is clear that WASH services are already being significantly negatively affected by climatic events, and that communities perceive that issues are getting worse, and are concerned for the future. It is also clear that there is spatial variation in the impacts from different climatic events across the district, with some types of infrastructure more vulnerable than others. Whilst floods, droughts and wind-related damage were the most commonly mentioned, other hazards exist, such as wildfires, erosion and siltation, extreme heat and landslides, and disease outbreaks related to climate-induced disasters. The primary impacts of the currently experienced issues for WASH felt by users (in communities, schools, and to a lesser extent health care facilities) are resorting to open defecation when toilets are damaged, walking further to source water sometimes use of unsafe sources (and the negative implications of this extra journey, from a productivity, educational and also safety perspective).

Lower income households seem to be harder hit by climate impacts on their WASH services, for example due to their less durable toilets, and presumably, more limited coping mechanisms. Existing relatively high rates of open defecation in certain Traditional Authorities, pose significant risks for public health, and with increased heavy rainfall and flooding events, this poses significant risks for disease outbreaks such as cholera (noting Malawi has recently endured it's deadliest cholera outbreak in its history). In terms of water supply, interviewees also remarked another key challenge in certain areas of Thyolo relate to at times poor conceptualisation, siting or development of water supply infrastructure, that can leave them vulnerable to flood or drought risk.

Climate hazards are occurring, and perceived to be increasing in magnitude and frequency, in a backdrop of already limited WASH access, and relatively weak institutional and financial arrangements for WASH services in the district. These mean that there are already challenges in existing arrangements and capacities for meeting the needs of WASH users, and particularly in sustaining WASH services. There is therefore more limited capacity or resilience within the wider WASH system in Thyolo, to cope with these climate-related stresses.

According to the Thyolo District Water Development Office (DWDO), there are no provisions to address the risks of flooding or drought in district investment plans yet. While the district contingency plan has allocated funds for disaster preparation, there is no dedicated budget to improve resilience of water and sanitation services. The DWDO recommends developing guidelines on improving resilience of services and to allocate additional funds for disaster response and preparation.

Challenges beyond the WASH sector:

Beyond the WASH sector specifically, land use and land cover can also be a driver of hydrological hazards. In section 3 of the main study report, existing and historical land use and land cover is mapped and discussed. Significant reductions of ground cover have occurred, and this, linked with unsustainable farming/soil management practices, can increase run-off, reducing infiltration and recharge, and increasing flooding, and also landslides (Ray & Ray 2011).

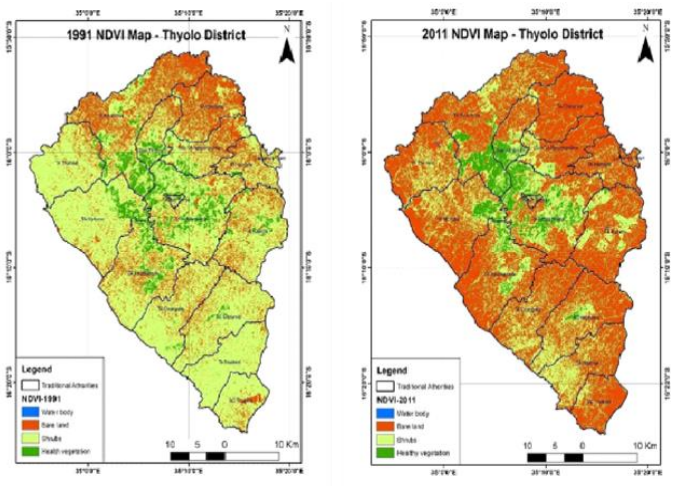


Figure 2: Land cover change in Thyolo from 1991-2011 (brown colour indicates extent of bare land)

It is clear that increasing population, changing land use and environmental degradation risks further exacerbating these issues, and the hazards they pose to WASH services. This shows how looking at climate resilience of WASH services, requires looking beyond the WASH sector - both in terms of hazards and accentuation of these, and in terms of possible mitigation measures.

Extrapolating findings district-wide, and projecting issues into the future

Whilst earlier sections of this report talk of historical trends and current felt impacts, this section focusses on projections of risks into the *future* and aiming to quantify these district-wide. It starts with a narrative on likely risks with climate change in Thyolo, followed by efforts in the study to model and quantify the potential risks, with a focus on floods and droughts.

<u>Narrative on likely future risks with climate change in Thyolo:</u>

Communities relying on gravity-fed water supplies and boreholes with handpumps may be more likely to face disruptions from a combination of silting and water shortages in the dry season if droughts become more intense.

The potential negative impacts of water scarcity on sanitation and hygiene could not be measured. However, intuitively and based on global literature, it seems highly likely that increasing water scarcity, and also times of poor water quality, will lead to impaired hygiene practices (such as limited water, leading to further reduced handwashing practice), and likely elevated risks of diarrheal disease. Blockage of water-based toilets in healthcare facilities during dry seasons, is already being reported.

The potentially significant risks for water safety during the rainy season are also concerning. With heavier rainfall and more rapid surface runoff (also likely exacerbated

by decreased land/vegetation cover), water quality is very likely to deteriorate in areas with poor sanitary protection and lack of cleanliness around water points. Rising groundwater tables during rainfall season can also cause sub-surface transport of faecal and other contaminants to groundwater. Without a detailed study on the design and condition of latrine containments in these communities, it is not possible to comment whether faeces are being safely contained. Therefore, the risk of faecal contamination of groundwater sources cannot be ruled out. The presence of poorly managed sanitation is linked to disease outbreaks after flooding worldwide, which could become more common given the projected increase in flood risk for several parts of the district.

Another concern with heavier rainfall is the physical accessibility of water points. Communities and schools already face problems in collecting water during the rainy season as a result of damage to roads or flooding around the water point. If this becomes more common or if flood levels increase, households might be cut off from accessing their primary water supply. Similar issues of access were reported for toilets as well, despite the majority of households using toilets located within the dwelling.

Finally, heaver rainfall and windstorms may also increase flooding and damage to toilet superstructures, which already affects nearly a quarter of the households in the study area, causing slippage to open defecation for some. This was especially pronounced for toilets made with non-durable materials, largely used by lower-income households.

Modelling and quantifying flood and drought risk into the future:

Projecting the climatic hazards into the future was somewhat of a challenge, given the initially defined scope of the study, the gaps in data that would have been required to enable such modelling, and uncertainties in the future climate models and scenarios. Nevertheless, modelling was undertaken, focussing on floods and droughts, yielding valuable insights.

Based on flood modelling using both SSP 2-4.5 and 5-8.5 climate change scenarios, there is high to very high risk of flooding projected for most central parts of the district in the coming decades. The projected risk of drought is more uniformly distributed across the district (due in part, by low-resolution data in models). Most

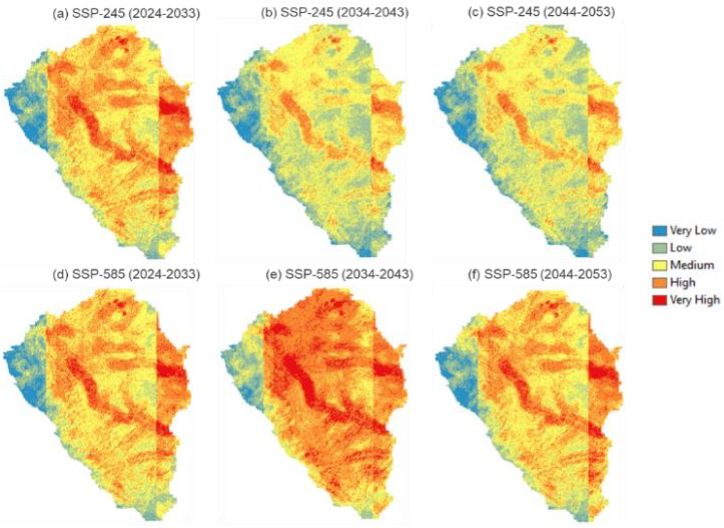


Figure 3: Flood hazard maps over 2024-2053 under CIMP6 SSP2-4.5 and SSP5-8.5 scenarios

parts of the district have severe or extreme risk of drought projected under both climate change scenarios.

The current water supply infrastructure that are included in Thyolo's district-wide water point inventory were overlayed with the future modelled flood and drought hazard maps to identify those that may be exposed to flooding and drought in the future.

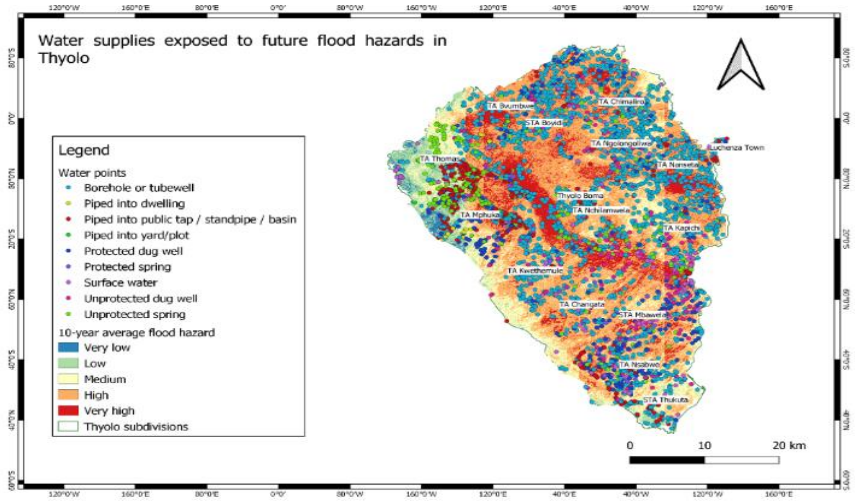


Figure 4: Water supplies in Thyolo exposed to future flood hazards in 2034-2043 under SSP 5-8.5 climate scenario

For the purpose of the economic modelling workstream (described below), efforts were made to quantify the different types of water points in Thyolo that the drought and flood modelling suggest fall into differing risk categories. The drought and flood maps, overlain with existing water points, together with certain assumptions informed by the household surveys, provided data for the quantification of water points across the whole of Thyolo district that are likely to be affected by climate events. Further, assumptions (due to a lack of more robust data) were made around frequency and magnitude of flood and drought events over a 20-year modelling period. This all fed into the economic modelling.

As discussed in the main study report, this process of aiming to extrapolate localised data to generate district-wide findings, and projecting and quantifying risks into the future, was challenging, and generated useful learning, should such a study be undertaken in future.

4. Actions identified that can help to strengthen resilience:

The study, desk review and stakeholder consultations at local, district and national level, generated a series of suggested actions that could be considered to help build resilience of WASH services in Thylolo district. These are summarized below and elaborated in the main report. Specifically what SHA proposes to take forward of the below, will be detailed in future proposals, and in work plans with the Thyolo District government.

- Strengthen water point siting and design, and access to updated hydrological data: Improving capacities and processes of WASH sector actors in Thyolo around

understanding climate risks to water resource availability, and following guidelines for siting water abstraction points and carrying out geophysical investigations to tap high-yield aquifers. Increasing access to hydrogeological information and increasing hydrological and groundwater monitoring will assist this, and further strengthen sector focus on managing the future risk of water scarcity.

- Consider more drought-resilient technologies: Planning for new infrastructure will need to consider more climate resilient technologies, such as boreholes in high-yield aquifers with pumps using renewable energy (such as solar), that can serve a range of communities who may not live proximal to drought-resilient sources. Other handpump types exist, such as LifePumps (piloted by SHA elsewhere), to consider in contexts where groundwater levels drop below the common Afridev lifting depth.
- Flood-proof at-risk water points: With existing and new infrastructure that may be at risk of flooding, infrastructural upgrades can be done to raise casings and collection points (see photo) and considering working with communities on raising access paths to these sources. In contexts of piped water schemes, tapstands should be sited away from or raised above flood risk zones.
- Evolve training to WPCs, and roll-out Climate Resilient WASH safety plan training and implementation: Trainings and support to communities and water scheme operators should include elements of climate resilient water safety planning, and where relevant, can include measures around demand management, and for piped schemes, leakage detection and management. It can also increase measures to prevent the likely increasing risk of water source contamination, and measures to improve source protection and reduce erosion and siltation risk.

Figure 5: Flood proof borehole construction by SHA and Baseflow in Thyolo

- Strengthen foundations for sustainability of water services generally, to increase systemic resilience: Having strong foundations for sustainability of WASH services generally, also improves the foundations for systemic resilience to climate risks. As such, work is needed on broader systems strengthening on issues affecting sustainability, such as increasing the coverage and effectiveness of Area Mechanic-led maintenance services and spare parts access, and financing mechanisms allowing for rapid repairs where needed. There could be further review of how to make such professionalized maintenance services more climate resilience, e.g. their ability to continue to provide such services in times of crisis. Increased water

point monitoring and reporting disruptions, by improving the capacities and recurrent financing of those who monitor, will help to build the datasets at district level as to water schemes most affected, and hence help to further prioritise future investments.

- Increase water quality monitoring, contamination prevention and response: In hand with increased monitoring of water resources and water levels, is increasing water quality monitoring and risk-reduction measures. With likely increasing risks of contamination, not only are prevention measures needed, but also monitoring processes and rapid response in the event of identified contamination, together with the potential increased use of household water treatment (such as Waterguard or pot-to-pot chlorination) during high-risk times and in high-risk locations. For piped water schemes, in-line chlorination may be considered.
- Consider climate-risk to ODF slippage, and support households to construct more durable toilets: Regarding sanitation, efforts should be intensified in eliminating open defecation, and post-ODF monitoring and enforcement needs to consider the risk of slippage due to toilet flooding, inaccessibility or collapse. Households should be guided as to how to site and construct domestic toilet facilities that are less exposed and more resilient to climate risks – aiming to construct with durable materials e.g., with bricks and corrugated iron sheets. Increasing the supply of quality and affordable sanitary products and masons will further assist this, and consideration may be needed in how households can be supported to construct more resilient services, such as loans or targeted subsidy. Guidelines should also be developed and endorsed by the district to minimise the risk of faecal pollution of groundwater from toilets.
- Promote climate-smart appropriate sanitation models: Sanitation technology choices will also be important. Care should be made in terms of widespread promotion of water-flush toilets (such as those in health care facilities), where they are already observed to be failing in dry periods. In flood-prone and shallow groundwater areas, alternative options such as shallow or above-ground options, and Ecological sanitation options (such as Arborloos) can be promoted, again with consideration on how households could meet the costs of these.
- Integrate climate resilience aspects into recurrent sector monitoring tools: Studies on climate resilience provide useful 'snapshot in time' information, but such information needs to be updated and monitored on a recurrent basis. This study has generated suggested adaptions to water point assessment and recurrent monitoring tools, which will be provided to the mWater national taskforce for potential adoption.
- Assess and strengthen capacities for WASH disaster risk reduction and response: Strengthening the overall WASH system and stakeholder capacities in Thyolo for

disaster preparedness, early warning systems, disaster management, and response. This would help to ensure that when the somewhat inevitable climate induced disaster strikes, the response can be effective, coordinated, and rapid, to minimize WASH service disruption and downtimes. This would also help to reduce risk of post-disaster epidemics, such as cholera. An assessment should be made of WASH disaster preparedness and response capacity in Thyolo, and seek to build this during non-emergency times.

- Build climate resilience into district strategic plans: Strategic investment plans (such as the existing Thyolo District WASH Sector Investment Plan) should be updated to more comprehensively cover the actions and investments needed to increase climate resilience and strengthen DRR capacities in the district.
- Go beyond WASH sector, to improve catchment soil and land management: Given that deforestation and poor soil and land management are key aggravators, and also potential resilience-building elements of climate change in WASH, efforts are required beyond the WASH sector, looking at improving catchment management, reversing deforestation, promoting water retention, infiltration and soil erosion management. Starting by mapping and assessing the current status and degradation of water catchments in Thyolo could be a good first step in this regard.

5. Economic analysis of the costs of inaction:

As mentioned in Section 3 above, a component of the study sought to undertake economic modelling of 'the costs of inaction' of investing in increasing climate resilience of WASH services in Thyolo. In simple terms, this means comparing the economic costs of enduring climate disasters, such as the impacts on households and undertaking emergency response, and contrasting this with the costs of investing in WASH services, to make them more resilient to such climate-induced disasters. Depending on the findings of such an analysis, it could generate the economic and investment case for investing in the additional costs of making WASH services more climate resilient.

For the economic modelling, Dr Guy Hutton was engaged, who worked with the wider study team of SHA and University of Bristol, who provided data and steering to the analysis. Here a brief summary is provided of the separate, detailed economic analysis report.

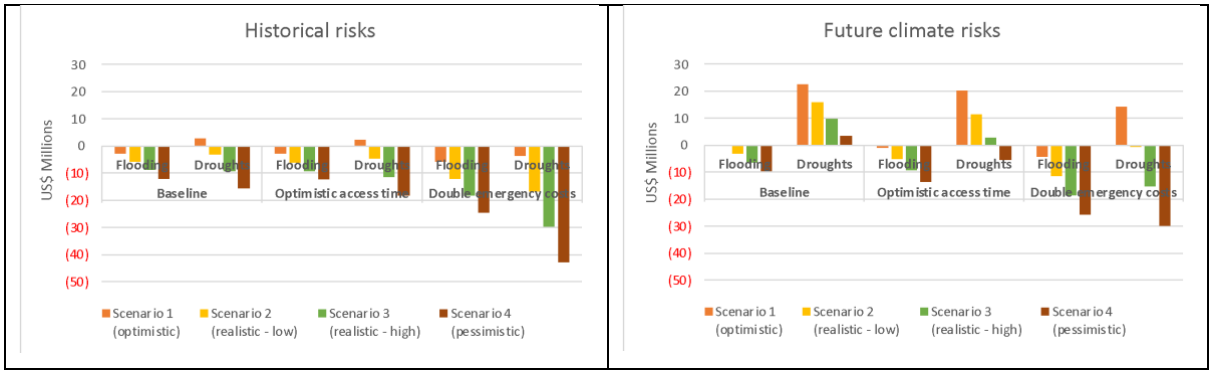
Using data from the aforementioned surveys and flood and drought modelling, the economic analysis assessed selected costs and benefits of certain resilience measures, with a focus on flooding and drought events, based on what are the major and measurable variables that can be captured within the timeframe and resources of the wider study. Net costs of the resilience building interventions were estimated by subtracting the benefits of resilience measures from the costs of resilience measures. As

boreholes are the primary water supply source for the majority of the population, the analysis focused on boreholes.

The costs of resilience measures included providing new boreholes and upgrading existing boreholes, based on the risk of water supply being impacted from flooding or drought events. The benefits included emergency response costs that would be averted if water points were more resilient to extreme weather events, as well as time saved of household members from not having to access water supply from more distant water sources (during or after an extreme weather event). Results are presented under two risk scenarios and four climate event scenarios. The risk scenarios are (1) historical risks identified from the impacts already being felt by households from the household survey, and (2) future climate risks using climate models mapped onto borehole location. The latter approach led to considerably higher boreholes being impacted by flooding and drought events, as might be expected under the most pessimistic climate scenario (SSP8.5). The four climate event scenarios estimated the number of flooding and drought events predicted over a 20-year period, from most 3 of each event under the optimistic scenario to 12 of each under the most pessimistic scenario.

Overall, the economic analysis, although incomplete, demonstrates that measures to increase climate resilience can have positive returns over a 20-year period. The results and conclusions vary considerably between whether historical risks or future climate risks are used and the number of predicted extreme weather events. Using historical risks, there are potential net benefits for resilience measures for both flooding and droughts. Using future climate risks, there are potential net benefits for flooding events, but net costs are more likely for drought events. However, both costs and benefits might be significantly different from those projected due to omitted variables and uncertainties in values used. Please see the full economic analysis report for further details

Figure 6 Net costs (above x-axis) and net benefits (below x-axis) under baseline assumptions and varying key parameters in sensitivity analysis – historical risk (left-side) and future climate risk (right-side)



6. Key achievements from this study:

Overall, the project/study achieved all of its intended objectives, as summarized below:

Aim / objective of the study	**Achievements**
Understand the current and future risks, and actions needed to increase resilience, and inform plans	The study has provided a comprehensive initial understanding of current and future issues, and highlighted possible actions, that have been discussed within SHA, Thyolo District Council, and the wider sector, and will feed into future plans and proposals.
Strengthen awareness, prioritization and capacities on climate resilience, of government, SHA and Malawi's WASH sector	The process of the study, the partnerships developed (e.g. with Bristol University and Dr. Hutton), and the learning-while doing, has been very valuable for SHA and the government of Malawi. For SHA, such learning and partnerships are already being replicated beyond Malawi.
Generate and disseminate evidence, learning and advocacy	The study has build sector interest and focus and dialogue on climate resilience within the WASH sector in Malawi, and generated valuable evidence, and assessment/monitoring tools, that can be replicated by others, and used in advocacy. The study generated valuable learning, which will be shared in two global WASH conferences in 2024 (WEDC and UNC), and summarises of the report will be disseminated nationally and globally.

Further details on the significant beneficial impact of this project, are covered in section 2 of the 'Beyond Forecasts' project report.

7. Envisaged next steps:

In the coming weeks, SHA will be discussing internally and with district government partners to what actions recommended in this report, to prioritize in 2024 and 2025 funding. SHA is also holding global organisation-wide webinars to share learning from this study, and discuss what cross-sectoral approach to improving climate resilience WASH could look like. This summary will be further refined, condensed, and formatted for uploading and dissemination to sector actors in Malawi and beyond. This study was presented at a global conference in August (WEDC), and will be presented within a wider Aguaconsult-led session in the University of North Carolina's Water & Health conference in October. On the run-up to this, the whole study team will be meeting to review lessons learning from this study, to document this and share internally and with other sector actors seeking to undertake such a study in future.

Finally, we wish to sincerely thank The One Foundation and Co-op for providing the opportunity to SHA and Thyolo District Council to undertake this study. It has been very positively impactful.

Photos taken during the study: Thyolo district dissemination workshop; enumerator during primary data collection; participants at the national workshop in Lilongwe. *(Informed consent was obtained from the project participants for the publication of this image in accordance with SHA's safeguarding policy)*

MALAWI OFFICE
PO Box B-495, Lilongwe
Tel. +265 175 0568