

Economic Appraisal and Cost Benefit Analysis for Malawi National Adaptation Plan (NAP)

Malawi Ministry of Natural Resources, Environmental Affairs Department

July 2026



Ministry of
Natural
Resources &
Climate Change



Table of Content

Acronyms	4
1 Introduction	6
2 Vulnerability and risk profile of Malawi	7
2.1.1 Vulnerabilities	7
2.1.2 Risks	8
2.1.3 Policy, legislative and regulatory framework	9
3 Prioritization of National Adaptation Plan (NAP) strategies.....	11
3.1 CBA Methodology	11
3.1.1 Step by step methodology for the CBA	13
3.1.2 Types of Benefits	14
3.1.3 Sectoral application of CBA	19
Agriculture sector.....	19
Fisheries sector.....	20
Forestry sector	20
Water sector.....	20
Infrastructure and disaster risk reduction	21
Social sector	22
3.1.4 Assumptions for the baseline scenario	22
3.2 Baseline scenario	24
3.2.1 Malawi without adaptation measures: economic impacts of RCP 4.5 and RCP 8.5 scenario.....	25
3.2.2 Costs of inaction in agriculture	28
3.2.3 Costs of inaction in the fishery sector	30
3.2.4 Costs of inaction in the forestry sector.....	31
3.2.5 Costs of inaction on the infrastructure of Malawi.....	32
3.2.6 Costs of inaction on the social sector	33
3.3 Process for the identification and prioritization of the adaptation measures	35
3.4 Adaptation scenario, with the project.....	35
3.4.1 Scope of the interventions	35
3.5 Data collection	36
3.5.1 Country-relevant information.....	36
3.5.2 Field-survey information and key findings	38
3.6 Costing the adaptation measures: survey data, and proxies information	39
3.6.1 Identification of the costs	39
3.6.2 Monetary evaluation of the adaptation options costs	40
3.7 Valuing the benefits of the adaptation measures in the priority sectors.....	45
Social impact of the adaptation measures compared to the BAU	51
Economic impact of the adaptation measures compared to the BAU.....	52
Environmental benefits of the adaptation measures compared to the BAU	53
3.8 Key model assumptions.....	53
3.8.1 Discount Rate	53
3.8.2 Investment period and inflation-adjusted cost projections.....	54

3.8.3 Calculation of the total costs and benefits of the adaptation options	55
3.8.4 Calculation of the investment rate of return and net present value	56
Differentiated CBA results by scenario (RCP 4.5 and RCP 8.5)	56
Ranking of the 22 adaptation measures at national level under RCP 4.5	59
Ranking of the 22 adaptation measures at national level under RCP 8.5	59
Discussion about the results	59
Comparative Analysis of BAU, RCP 4.5 and RCP 8.5 scenarios with adaptation measures in Malawi's priority sectors	60
3.8.5 Sensitivity Analysis	61
4 Conclusions and Recommendations	63
Conclusions	63
Recommendations	63
Recommendation 1. Accelerate agricultural productivity through adaptation measures	63
Recommendation 2. Scale up irrigation and rainwater harvesting systems	64
Recommendation 3. Prioritize high-return nature-based solutions	64
Recommendation 4. Monetize reforestation activities via carbon sequestration through Article 6.2 and Voluntary Carbon Markets	65
Recommendation 5. Boost fisheries resilience through sustainable aquaculture and habitat restoration	65
Recommendation 6. Enhance social protection systems as 'No-Regret' interventions ...	66
Recommendation 7. Integrate EWS and disaster preparedness nationally	66
Recommendation 8. Strengthen resilient infrastructure and flood management measures to avoid escalating climate costs	67
Recommendation 9. Mainstream adaptation into district and national development planning	68
Annexes	69
Annex 1. Questionnaire for the survey	69
General Information	69
Section 1: Adaptation Strategies and Current Measures	69
Section 2: Economic Appraisal of Adaptation Options	70
Section 3: Private and Public Sector Engagement	71
Section 4: Monitoring and Evaluation	72
Section 5: Policy and Institutional Context	73
Section 6: Cross-Sectoral Linkages	74
Section 7: Long-Term Sustainability and Scaling	75
Section 8: Open-Ended Questions	75
Annex 2. Results of the survey with mission reports	77
Annex 3: List of participants (Prioritization workshop)	79
Annex 4: CBA Modelling	82
List of tables	
Table 1. Legislative, policy and regulatory framework	10
Table 2. CBA criteria and indicators	12
Table 3. Sector-specific assumptions for the baseline scenario	23
Table 4. Climate change risks under RCP 4.5 and RCP 8.5 in Malawi	25

Table 5. Projected impacts of climate change in Malawi under the baseline scenario (WOP)	26
Table 6. Policy baseline and implementation gaps for adaptation under the BAU scenario ...	27
Table 7. Fisheries statistics for Malawi.....	30
Table 8. Estimated Economic Losses in Malawi WASH Sector due to climate variability	34
Table 9. Key documents.....	36
Table 10. Economic indicators.....	37
Table 11. Contribution of the key sectors to the GDP of Malawi.....	37
Table 12. Projected GDP reduction due to the impacts of climate change	37
Table 13. Summary of the consultation process	38
Table 14. Identification of the costs (derived from the adaptation options)	39
Table 15. Cost parameters for agriculture sector adaptation measures.....	40
Table 16. Cost parameters for fisheries sector adaptation measures.....	41
Table 17. Cost parameters for forestry sector adaptation measures.....	41
Table 18. Cost parameters for infrastructure and DRR sector adaptation measures.....	42
Table 19. Cost parameters for the social sector adaptation measures	42
Table 20. Summary of the CAPEX unit costs (USD) for adaptation options.....	43
Table 21. Identification of the benefits derived from the adaptation options	46
Table 22. Parameters to assess the benefits of the 22 adaptation measures, for the priority sectors	47
Table 23. Marketed economic benefits	52
Table 24. Increased benefits of adaptation measures under RCP 8.5 compared to RCP 4.5 in Malawi All values in USD million.....	54
Table 25. Most capital-intensive measures, by CAPEX	55
Table 26. National economic appraisal of the 22 adaptation measures in the 5 priority sector under RCP 4.5	58
Table 27. National economic appraisal of the 22 adaptation measures in the 5 priority sector under RCP 8.5	58
Table 28. Comparison of BAU versus the implementation of the 22 adaptation measures (under RCP 4.5, and RCP 8.5).....	60

List of figures

Figure 1. Possible long-run impact of a climate extreme event of GDP per capital	9
Figure 2. Climate change will impose large economic costs; development will strengthen resilience but will require doing different things.	27
Figure 3. Projected total annual crop values across policy and climate scenarios.....	29
Figure 4. Estimated number of people engaged in small-scale fisheries (SSF) livelihoods in Malawi.....	31
Figure 5. Projected exposure of major roads (left graph) and of urban land area (right graph) to river floods at least once per year for Malawi for different GHG emissions scenarios	33

Acronyms

ARR	Afforestation, Reforestation, and Revegetation
BAU	Business as Usual
BCR	Benefit-Cost Ratio
CBA	Cost-Benefit Analysis
CAPEX	Capital Expenditure
CCA	Climate Change Adaptation
CRCF	Carbon Removals and Carbon Farming
CRVA	Climate Risk and Vulnerability Assessment
CSA	Climate-Smart Agriculture
DCCMS	Department of Climate Change and Meteorological Services
DDP	District Development Plan
DESC	District Environmental Sub-Committee
DoDMA	Department of Disaster Management Affairs
DRM	Disaster Risk Management
EAD	Environmental Affairs Department
ENSO	El Niño-Southern Oscillation
EWS	Early Warning System
FAO	Food and Agriculture Organization
FSC	Forest Stewardship Council
GCF	Green Climate Fund
GDP	Gross Domestic Product
GHG	Greenhouse Gas
HAI	Healthcare-Associated Infections
IPCC	Intergovernmental Panel on Climate Change
IRR	Internal Rate of Return
LDC	Least Developed Country
MGDS	Malawi Growth and Development Strategy
MNRCC	Malawi Ministry of Natural Resources & Climate Change
NAP	National Adaptation Plan
NCCMP	National Climate Change Management Policy
NDC	Nationally Determined Contribution
NPV	Net Present Value
NSCCC	National Steering Committee on Climate Change
NTCCC	National Technical Committee on Climate Change
OECD	Organisation for Economic Co-operation and Development
OPEX	Operating Expenditure
PDNA	Post-Disaster Needs Assessment
RCP	Representative Concentration Pathway

Detailed economic appraisal, disaggregated by the priority sectors

REDD+	Reducing Emissions from Deforestation and Forest Degradation
SEP	Socio-Economic Profile
SFM	Sustainable Forest Management
UNCCD	United Nations Convention to Combat Desertification
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
WASH	Water, Sanitation, and Hygiene
WCS	Wildlife Conservation Society
WWF	World Wide Fund for Nature

1 Introduction

This report is part of the project entitled “Advancing the National Adaptation Plan (NAP) process: climate resilience for sustainable development in Malawi”, led by the Environmental Affairs Department (EAD) with support from the United Nations Environment Programme (UNEP), and includes costing and feasibility analysis.

As part of the NAP process, this report aims to evaluate and prioritize the climate change adaptation options at the national level, encompassing costing and feasibility analyses within five priority sectors (agriculture, fisheries, forestry, infrastructure and social sector), prioritizing them based on a comprehensive economic assessment considering aspects such as feasibility of the measures, social contributions, and strategic climate, vulnerability and overall priorities, complemented with a detailed financial assessment of the measures through cost-benefit profiles for adaptation measures.

In addition, the prioritization process results in the creation of a national implementation plan for the prioritized adaptation actions, which is aligned with the Climate Risk and Vulnerability Assessments (CRVA) and identified adaptation options recently developed for eight districts in Malawi: Phalombe, Balaka, Chikwawa, Dedza, Karonga, Kasungu, Rumphi, and Salima. These districts are highly vulnerable to climate change impacts, including floods, droughts, extreme weather events, and environmental degradation, which severely affect their socio-economic development and livelihoods. This economic appraisal aims to provide a robust evaluation of the financial viability, economic benefits, and sustainability of adaptation strategies across five priority sectors: agriculture, fisheries, forestry, infrastructure and social sector.

In this context, the present report provides an introduction to the climate change risk and vulnerability profile of Malawi and then a prioritisation process to identify the relevant measures for the NAP in the five priority sectors: agriculture, fisheries, forestry, infrastructure and social sector. The prioritisation exercise provides an overview of the methodology employed to conduct the Cost-Benefit Analysis (CBA). The report finalises summarising the next immediate project steps to move forward with project implementation.

Using this CBA, an Adaptation Financing Strategy will be prepared, incorporating the strategic investment plan for the prioritized adaptation measures. The present report supplies the economic evidence base (costing, IRR, NPV and ranking of the 22 measures) while the Adaptation Financing Strategy will convert that evidence into a sequenced and costed investment programme together with the financing mechanisms, sources and instruments required to deliver it.

It is hence intended to guide strategic decision-making by policymakers, development partners, and stakeholders involved in climate adaptation planning. By assessing the Net Present Value (NPV), Benefit-Cost Ratio (BCR), and Payback Period of each adaptation intervention, this appraisal seeks to identify cost-effective and high-impact strategies that can enhance community resilience, stimulate economic growth, and promote sustainable development in Malawi. The findings contribute to the NAP of Malawi, aligning with national climate policies and international frameworks, including the Green Climate Fund (GCF)'s investment priorities.

2 Vulnerability and risk profile of Malawi

The assignment “Economic Appraisal and financing strategy consultancy services for the National Adaptation Plan”, is framed within the current Malawi efforts –with support of parties such as the UNEP, to identify and address its vulnerabilities to climate change, fostering climate change adaptation in the country.

This report provides a detailed economic appraisal of adaptation measures at national level. Malawi faces significant climate risks, including floods, droughts, and extreme weather events, affecting their socio-economic development. The report evaluates the financial viability, economic benefits, and sustainability of adaptation strategies in five priority sectors: agriculture, fisheries, forestry, infrastructure and social sector.

The NAP process for Malawi was announced in 2014¹, with the support of the NAP Global Network, through consultations with national stakeholders and a framework exercise conceived as a long term and inter-sectorial process. A preliminary roadmap for NAP implementation was formulated and validated by representatives from the Ministry of Natural Resources & Climate Change (MNRCC), as well as stakeholders from the Working Group on Adaptation, National Technical Committee on Climate Change (NTCCC) and National Steering Committee on Climate Change (NSCCC). This serves as a permanent coordinating body regarding climate change issues. It is headed by the Director from the EAD² at the political level and supported by nominated technical focal points in each related institution.

Through consultations during the stocktaking and roadmap development, the Government of Malawi has defined the NAP process as key to identifying, prioritizing, and funding adaptation interventions as well as to increasing technical capacity for climate change adaptation (CCA), planning and mainstreaming of climate change into its policies and sectorial strategies.

As part of the preparation process, CRVAs were conducted in 2023 and 2024, whose results were presented in September 2024³. This CRVA is a key reference source for the current assignment, together with the list of CCA measures at national and local levels identified by previous consultancy assignments. The CRVA concludes that Southern Malawi faces heightened climate risks due to regional factors, leading to an increased likelihood of extreme events such as storms, floods, and droughts. Rising temperatures, with projections of up to 4.5°C warming by the end of the century, are expected to bring unpredictable rainfall patterns. These changes contribute to greater climate-related hazards, including more frequent flooding and alternating drought conditions, as highlighted in recent Post-Disaster Needs Assessment (PDNA) reports for Malawi. Additionally, the influence of ENSO (El Niño-Southern Oscillation) is anticipated to have stronger effects on weather patterns, exacerbating climate variability in the region.

In this regard, the following paragraphs offer the main findings of the CRVA at national and local levels:

2.1.1 Vulnerabilities

According to the 2023 State of Malawi Climate⁴, the country is subject to increasing risks over time, particularly under pessimistic scenarios. Currently, agriculture, forestry, fisheries and infrastructure and social (including education, human health, gender, etc.) are the most vulnerable sectors, which together with urban development, have been identified as the highest-

¹ NAP Global Network (2020). *Malawi's National Adaptation Plan Framework*. Available at: <https://napglobalnetwork.org/wp-content/uploads/2020/03/napgn-en-2020-malawis-national-adaptation-plan-framework.pdf>

² Environmental Affairs Department, Government of Malawi (n.d.). *Official Website*. Available at: <https://www.ead.gov.mw/>

³ Validation Workshops, Lilongwe, 10-11 September 2024, *Producing Climate Change Scenarios and Risk Assessments for Africa*, Government of Malawi

⁴ Malawi Department of Climate Change and Meteorological Services (2023). *The State of Malawi Climate in 2023 - Part 2*. Available at: https://www.metmalawi.gov.mw/documents/40/The_State_of_Malawi_Climate_in_2023_part2_Final_Final.pdf

risk sectors in the future. Energy and transport face also increasing risks both now and in the future.

Key factors amplifying climate risks across all sectors include Malawi's small size, population concentration in the Central and Southern Regions⁵, economic fragility, high public debt, dependency on specific sectors, inadequate environmental management, and insufficient climate data and monitoring⁶.

Risks are unevenly distributed, with vulnerable groups, such as the elderly, infants, people with health issues⁷, the poor, and women, facing heightened exposure. Rural areas and marginalized neighborhoods are particularly at risk⁸.

To enhance Malawi's climate adaptation capacity, comprehensive risk and vulnerability assessments are needed, focusing on resilient systems for flood management, soil erosion, water resources, and early warning systems across sectors like forestry, agriculture, fisheries, infrastructure (including water) and social (i.e. education and health). Effective adaptation planning depends on robust climate data and monitoring systems. However, key challenges persist, including insufficient historical data, limited capacity to monitor phenomena such as droughts and extreme weather events, and inadequate integration of climate change considerations into sectoral policies⁹.

2.1.2 Risks

Malawi faces significant risks and disaster threats, with varying exposure and severity across its territory. Key risks and natural hazards include floods, landslides, wildfires, droughts, tropical cyclones, and biological threats. Vulnerability is amplified by socio-economic factors such as population growth, urbanization, resource degradation, poverty, weak institutional capacity, inadequate disaster risk management, and low community engagement¹⁰. A brief overview of the main exposure, impacts and vulnerabilities per climate threat is provided below:

- **Floods:** Most impactful on infrastructure and agriculture, with extreme socioeconomic risk in the municipalities of Lilongwe, Blantyre, Mzuzu and Zomba¹¹.
- **Landslides:** Highest exposure to this threat is found in areas with steep slopes such as the Chiweta area¹² in Northern Malawi and Chiradzulu^{13,14}.
- **Wildfires:** Intensified by climate change, with complex management challenges due to factors like topography and climatic conditions (Malawi's population exposure to wildfires was estimated at 38.77% in 2020)¹⁵.

⁵ GeoRef (n.d.). Malawi: Geographical and Environmental Profile. Available at: <https://geo-ref.net/pdf/malawi.pdf>

⁶ Ibidem

⁷ International Federation of Red Cross and Red Crescent Societies (IFRC) and Red Cross Climate Centre (2022). Country Assessments: Malawi. Available at: https://www.climatecentre.org/wp-content/uploads/RCRC_IFRC-Country-assessments-Malawi_Final3.pdf

⁸ World Bank (2024). Malawi Climate Resilience and Disaster Risk Management Project - Environmental and Social Management Framework. Available at: <https://documents1.worldbank.org/curated/en/099945111012218840/pdf/P17722007c2a230eb08b5309696098f760e.pdf>

⁹ Kajumba, T. (2018). Climate Risk Assessment - Malawi. International Institute for Environment and Development (IIED). Available at: <https://www.iied.org/sites/default/files/pdfs/2023-11/22076g.pdf>

¹⁰ UNFCCC (n.d.). Case Study: Malawi Cyclones and Climate Change Factors. Available at: https://unfccc.int/sites/default/files/resource/casestudy_malawi_cyclones-climatechangefactors.pdf

¹¹ Water For People (2021). Climate Change, Water Resource Management, and WASH in Malawi: Country Case Study. Available at: <https://thewashroom.waterforpeople.org/wp-content/uploads/sites/2/2021/07/Climate-Change-WRM-and-WASH-in-Malawi-Country-Case-Aug-2021.pdf>

¹² Kamanga, M., et al. (2023). Landslides Mapping and Susceptibility Analysis Using RS and QGIS Techniques in Chiweta Area, Northern Malawi. Available at: <https://www.hilarispublisher.com/open-access/landslides-mapping-and-susceptibility-analysis-using-rs-and-qgistechiniques-in-chiweta-area-northern-malawi.pdf>

¹³ Mdpi (2023). Article on Climate or Environmental Science, Volume 5, Issue 3, Article 32. Available at: <https://www.mdpi.com/2624-795X/5/3/32>

¹⁴ ScienceDirect (2024). Article on Environmental Research and Climate Impact. Available at: <https://www.sciencedirect.com/science/article/pii/S1464343X24000207>

¹⁵ CEIC Data (n.d.). Percentage of Population Exposure to Wildfires in Malawi. Available at: <https://www.ceicdata.com/en/malawi/social-air-quality-and-health-non-oecd-member-annual/percentage-of-population-exposure-to-wildfires>

- **Biological Hazards:** Risks include pandemics (e.g., COVID-19), antibiotic resistance, and waterborne diseases, posing threats to health, livestock, and the economy^{16,17}.
- **Climate extreme events:** Tropical Storm Ana, cyclones Idai, Gombe and Freddy and - most recently - El Niño have all caused huge economic losses that will take a long time to recover from. Malawi's Department of Disaster Management Affairs (DoDMA) estimates catastrophes between 2015 and 2023 have cost the country USD 1.19 billion¹⁸. These economic shocks have lasting impacts on national development.

Figure 1. Possible long-run impact of a climate extreme event of GDP per capita¹⁹

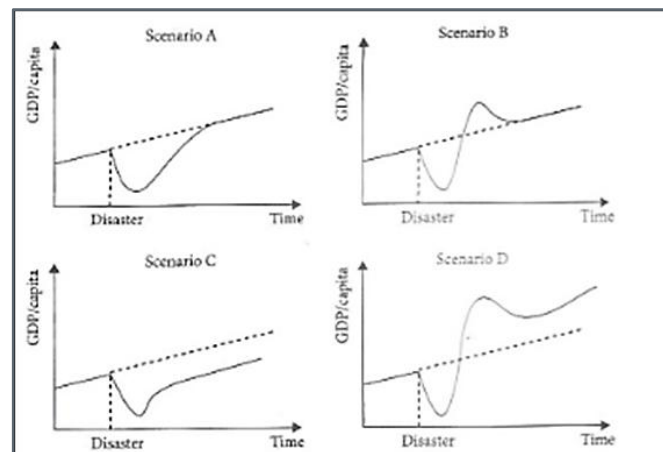


Figure 1 illustrates four possible long-run trajectories of Gross Domestic Product (GDP) per capita following a climate-related extreme event, such as a flood or drought: Scenario A depicts a situation where GDP per capita temporarily declines due to the disaster, but the economy gradually recovers and eventually returns to its original growth path. Scenario B shows a scenario where the disaster leads to a short-term dip, but reconstruction and adaptive responses result in a higher long-run growth trajectory, effectively improving resilience and capacity. Scenario C represents a more pessimistic path where the disaster causes long-term economic stagnation or decline, reflecting inadequate recovery and persistent vulnerabilities. Finally, scenario D portrays a severe initial drop followed by a strong recovery that surpasses the original trajectory, indicating a transformational adaptation or economic restructuring following the climate-related disaster. These scenarios highlight the importance of proactive climate risk management and adaptation planning. Effective risk management in Malawi requires addressing vulnerabilities, strengthening institutional capacity, improving forecasting and early warning systems, and involving local communities in disaster preparedness.

Based on this vulnerability analysis, a long list of CCA measures has been previously identified and reviewed by UNEP and national stakeholders. The current project is basing its analysis on this list of measures to obtain the final prioritization.

2.1.3 Policy, legislative and regulatory framework

¹⁶ OECD (n.d.). *Climate Risks and Disasters*. Available at: <https://www.oecd.org/en/topics/climate-risks-and-disasters.html> ; Ministry of Health Malawi (n.d.). *Biosafety and Biosecurity TWG in Lilongwe to Finalise National Guidelines*. Available at: <https://phim.health.gov.mw/biosafety-biosecurity-twg-in-lilongwe-to-finalise-national-guidelines/>

¹⁷ ReliefWeb (2021). *Malawi Climate and Health Vulnerability Assessment*. Available at: <https://reliefweb.int/report/malawi/malawi-climate-and-health-vulnerability-assessment#:~:text=Climate%20change%20related%20challenges%20that,aridity%2C%20droughts%2C%20and%20cyclones>

¹⁸ PreventionWeb (2023). *Extreme Weather Jeopardises Malawi's Development Goals*. Available at: <https://www.preventionweb.net/news/extreme-weather-jeopardises-malawis-development-goals#:~:text=For%20six%20years%20now%2C%20Malawi,long%20time%20to%20recover%20from.>

¹⁹ *The Economic Impacts of Natural Disasters* Edited by Debarati Guha-Sapir, Indhira Santos, and Managing Editor, Alexandre Borde, Oxford University Press, 2013. <https://global.oup.com/academic/product/the-economic-impacts-of-natural-disasters-9780199841936?cc=fr&lang=en&>

A structured overview of Malawi's legislative and policy framework on climate action is presented below, outlining the key laws, strategies, and plans that shape national efforts in mitigation, adaptation, and sustainable development. This section highlights the legal and institutional arrangements that guide Malawi's response to climate change and environmental challenges, while aligning with international commitments and reinforcing national governance to build resilience and support low-carbon development. The table provides an overview of the key legislation, policies, plans, and strategies related to climate action.

Table 1. Legislative, policy and regulatory framework

Legislation, Policies and Plans	Year	Summary
National Disaster Risk Management Policy	2015	Guides integration of disaster risk management into development planning, emphasizing preparedness, resilience, and risk reduction.
National Guidelines for Community-Based Early Warning Systems	2018	Sets standards for local early warning systems for hazards like floods, enhancing community preparedness and governance.
National Forest Policy	2016	Promotes sustainable forest management, afforestation, biodiversity conservation, and community participation.
National Climate Change Management Policy	2016	Provides an enabling framework for coordinated climate change adaptation, mitigation, and technology transfer.
National Environmental Policy	2004 (revised from 1996)	Framework for sustainable natural resource management, environmental protection, and biodiversity conservation. Governs sustainable environmental management, pollution control, and mandatory environmental impact assessments.
National Resilience Strategy (2018-2030)	2018	Comprehensive strategy integrating agriculture, risk reduction, social protection, and catchment management to address food insecurity.
National Fisheries and Aquaculture Policy	2001	Guides sustainable management of fisheries and aquaculture, focusing on conservation, food security, and community participation.
National Climate Change Policy	2012	Promotes climate change adaptation and mitigation for sustainable development and increased resilience.
National Agriculture Policy	2024	Framework to transform agriculture through productivity, commercialisation, sustainable land management, and climate-smart approaches.
Resettlement Policy Framework (MASAF 4)	2013	Outlines procedures for addressing resettlement impacts with emphasis on community-driven processes and fair compensation.
Malawi National Land Policy	2002	Provides framework for equitable land access, tenure security, and sustainable land use to support development and poverty reduction.
Land Acquisition Act	1979	Regulates procedures for compulsory land acquisition for public purposes, ensuring fair compensation principles.
Water Resources Act	2013	Provides for integrated water resources management, equitable access, and protection of catchment areas.
National Forest Landscape Restoration Strategy	2017	Outlines Malawi's forest restoration targets, enhancing degraded areas, improving carbon sequestration, and supporting livelihoods.

In conclusion, the legislative and policy instruments presented reflect Malawi's comprehensive approach to climate governance, spanning biodiversity protection, renewable energy, sustainable agriculture, and gender equality. Together, they demonstrate the country's commitment to integrating climate action across sectors in alignment with the Paris Agreement and global sustainability goals.

3 Prioritization of National Adaptation Plan (NAP) strategies

This section outlines the methodology applied to prioritize adaptation actions. The process relies on a CBA to rank and prioritize key actions across all sectors based on various economic and financial criteria. Specifically, the CBA has been applied to review the 22 adaptation strategies identified in the priority sectors (8 adaptation strategies in agriculture, 3 in fisheries, 4 in forestry, 3 in infrastructure and 4 in social sector).

Additionally, given their capacity to contribute to reinforce the governance, policy, capacity and institutional frameworks necessary for implementing the NAP, cross-sectoral measures have been also reviewed.

Also, in conducting the CBA, it is important to ensure that the prioritized sectors are the most relevant, economically speaking.

The 22 measures analyzed through the CBA were assessed against their economic viability and long-term benefits. This approach ensures a systematic, rationale and evidence-based prioritization of actions and the further development of the measures for the implementation process, aligned with strategic objectives and available resources.

3.1 CBA Methodology

The CBA is based on a methodology that involves identifying the key activities necessary for implementing a measure and assessing the social costs and benefits it may entail, expressed in monetary terms. This process includes defining a time horizon during which the measures will be implemented and their benefits realized. Lastly, these values are adjusted to the present period using a social discount rate²⁰, enabling a clear understanding of the social costs and benefits associated with a specific project. The methodology applied is based on well-respected bibliography for this type of analysis such as the UNFCCC “Assessing the costs and benefits of adaptation options an overview of approaches” publication²¹, the European Commission’s “Guide to Cost Benefit Analysis of Investment Projects”²², the IMF-World Bank’s “The IMF-World Bank Climate Policy Assessment Tool (CPAT): A Model to Help Countries Mitigate Climate Change”²³ and the following books: “Handbook on the economics of climate change”²⁴, “Economic Analysis of Environmental Impacts”²⁵ and the book “The Economic Impacts of Natural Disasters”²⁶.

As a first step to conduct the CBA, a set of criteria and indicators was proposed and discussed and agreed with UNEP and national NAP experts, to analyse the measures against those. The suggested set of indicators is based on prioritization criteria from the Green Climate Fund

²⁰ The social discount rate contributes to determining the present value of net benefits in economic analyses and investment projects. Guidelines on appropriate social discount rates are grounded in welfare economics. According to standard welfare analysis, the net benefits of a project should be valued based on their marginal impact on welfare at the time they occur. The core assumption is that the marginal value of an additional dollar of net benefits decreases as recipients become wealthier. In a growing economy, future beneficiaries of a project will be wealthier than present ones, leading to a lower valuation of future benefits compared to those received today. Applying this discounting approach requires an assessment of how much wealthier future beneficiaries will be relative to current ones. World Bank (2023). Strengthening the Economic Case for Climate Adaptation: A Technical Report. Available at:

<https://documents1.worldbank.org/curated/en/099610503022315638/pdf/IDU02e978a2a023f704c140bb1b082595e67e593.pdf>

²¹ UNFCCC (2011). Assessing the Costs and Benefits of Adaptation Options: An Overview of Approaches. Available

at: https://www.unclearn.org/wp-content/uploads/library/pub_nwp_costs_benefits_adaptation.pdf

²² European Commission (2014). Guide to Cost-Benefit Analysis of Investment Projects. Available at: https://ec.europa.eu/regional_policy/sources/studies/cba_guide.pdf

²³ IMF (2023). Climate-Sensitive Fiscal Policies in Low-Income Countries. Available at: <https://www.imf.org/-/media/Files/Publications/WP/2023/English/wpia2023128-print-pdf.ashx>

²⁴ Haites, E. (ed.) (2015). Handbook on the Economics of Climate Change. Available at: <https://www.e-elgar.com/shop/gbp/handbook-on-the-economics-of-climate-change-9780857939050.html?srsltid=AfmBOorqyGAKvYPAjBm2Jym9yFS1qfLgHCOKq-jw1gHo8GyJMh4ICIZ>

²⁵ Dixon, J.A., Scura, L.F., Carpenter, R.A. and Sherman, P.B. (1994). Economic Analysis of Environmental Impacts. Available at: <https://documents1.worldbank.org/curated/en/272091487845936282/pdf/110201-PUB-Box396328B-PUBLIC-Economic-Analysis-Of-Environmental-Impacts-1994.pdf>

²⁶ Cavallo, E. and Noy, I. (2011). The Economic Impacts of Natural Disasters. Available at: <https://global.oup.com/academic/product/the-economic-impacts-of-natural-disasters-9780199841936?cc=fr&lang=en&>

Detailed economic appraisal, disaggregated by the priority sectors

(GCF)²⁷ and the UNFCCC Technical guidelines for the national adaptation plan process²⁸, as well as the Consultants' expertise and knowledge derived from similar projects²⁹.

These criteria and indicators are presented below for ease of reference.

Table 2. CBA criteria and indicators

Criterion	Indicator
Effectiveness	Anticipated reduction in climate risk; number of direct beneficiaries
Cost-efficiency	BCR; NPV; cost per beneficiary
Social co-benefits	Impact on vulnerable groups, especially women and youth; contribution to poverty reduction
Environmental co-benefits	Enhancement of ecosystem services; contribution to biodiversity conservation; mitigation co-benefits
Institutional alignment	Consistency with national policies and district development plans; availability of implementing agencies
Scalability and replicability	Potential for replication or upscaling in other sectors
Sustainability	Likelihood of continued operation post-implementation; local ownership and capacity

The criteria selection process was thoroughly discussed and agreed upon with the client and national experts, incorporating their feedback and inputs to ensure that the indicators and weights were appropriately tailored to the national context. This process included the inception phase, online meetings attended by representatives from EAD, relevant line ministries and UNEP.

The primary objective of the CBA is to estimate the cost, by priority sector, of implementing each adaptation option in relation to its projected benefits (measured as avoided economic losses under different climate change scenarios (RCP 4.5 and RCP 8.5) and time horizons (2040 and 2080). The analysis considers the potential of each option in each sector, to support transformational change and contribute to broader national priorities, such as the Malawi Growth and Development Strategy (MGDS) and the adaptation and mitigation commitments outlined in the country's NDC. Furthermore, the social and gender equality impacts of each measure were also evaluated.

As part of the prioritization exercise, and of the financial assessment, the CBA was carried out in close collaboration with UNEP and national stakeholders involved in the NAP process.

Regarding climate scenarios applied and underlying assumptions, the scenario framework of the CBA is run under two Representative Concentration Pathways (RCP): RCP 4.5, an intermediate stabilization pathway assuming moderate global mitigation, and RCP 8.5, a high-emission pathway assuming a continuation of current emission trends. No best-case or low-emission pathway (such as RCP 2.6) has been appraised, on the grounds that it does not provide a plausible planning envelope for adaptation investment decisions in Malawi over the appraisal period. RCP 4.5 should therefore be read as the moderate case and RCP 8.5 as the severe case, and the two together bracket the range within which the economic case for each measure is expected to fall.

Both scenarios are appraised against a single common counterfactual, the business-as-usual (BAU) baseline described in section 3.1.4, in which no adaptation measure is implemented beyond current trends, practices and institutional capacities. Costs and implementation timelines are held identical across the two scenarios; only the benefits differ, since avoided losses are estimated separately for each pathway to reflect the different levels of projected

²⁷ Green Climate Fund (n.d.). Appraisal Guidance Annex 6, Version 4. Available at: <https://www.greenclimate.fund/sites/default/files/document/gcf-appraisal-guidance-annex-6-v4.pdf> (note: GCF Appraisal Guidance and its annexes were removed from circulation in 2022 and replacement guidance is still pending. We are using these guides in the meantime)

²⁸ UNFCCC (n.d.). Technical Guidelines for the National Adaptation Plan Process. Available at: https://unfccc.int/files/adaptation/cancun_adaptation_framework/application/pdf/naptechguidelines_eng_high_res.pdf

²⁹ The Consultant has employed in numerous assignments CBAs to prioritise CCA measures with similar criteria and methodologies to the ones proposed in the current assignment. Some of these examples include the projects: "Adaptation Finance: Enabling Direct Access to the GCF in Bangladesh (Phase III: Economic and Financial Analysis (EFA) of GCF adaptation project)" (2024-2025, GCA) or the project "Provision of consultancy to perform evaluation of Climate Change Adaptation (CCA) options under the Albania National Adaptation Plan (NAP)" (2024-2025, UNDP).

climate impact. Because avoided losses are larger under RCP 8.5, the IRR and NPV of most measures are higher under RCP 8.5 than under RCP 4.5. The results reported under RCP 4.5 are consequently the more conservative estimate of the economic case for adaptation, and those under RCP 8.5 the upper bound. Neither pathway is designated as the single reference case: the two are reported side by side so that decision-makers can test the robustness of each investment under both futures.

The remaining assumptions underpinning the appraisal are as follows: two time horizons, 2040 (short to medium term) and 2080 (long term); an appraisal period of 20 years for the cash-flow analysis; a social discount rate of 8%, aligned with Green Climate Fund (GCF) practice for least-developed countries (LDC) and tested between 5% and 10% in the sensitivity analysis; and an average USD inflation rate of 5% applied to the cost projections. The robustness of the results is further tested in section 3.5 through cost overruns of +10% to +30% and benefit reductions of -10% to -30%. These assumptions are documented in full in section 3.4 (key model assumptions).

3.1.1 Step by step methodology for the CBA

The CBA methodology adopted in this report integrates both primary and secondary data sources, including sector-level socio-economic data, stakeholder interviews, field surveys, and sector-specific reports. The analysis was conducted using a standardized framework that evaluates the financial feasibility, economic benefits, and socio-environmental impacts of adaptation strategies across the five priority sectors.

The specific steps and methodology to implement the CBA in this particular project are the following:

1. Identification of the scope of the intervention including its time horizon and sectoral coverage: In this case, the sectors and the long list of measures were already identified in previous assignments. Hence, the appraisal analyses the adaptation measures resulting from the CRVA, relevant to each priority sector (agriculture, fisheries, forestry, infrastructure and social sector) ensuring alignment with sector-level climate risks and socio-economic priorities. In other words, the economic assessment was conducted to assess the priority sectors and related 22 adaptation measures. This approach enables direct comparison of the relative benefits of adaptation options within each sector and between sectors, across the entire country. It becomes possible to prioritize measures and clusters of high-impact interventions in specific sectors at national level, before considering geographic areas, thereby improving cost-efficiency, implementation feasibility, and coherence of investment. This prevents the formulation of a scattered portfolio of adaptation options spread thinly across the country, which would be difficult to coordinate, monitor, and sustain from a project management perspective.

The time horizon for implementation (against the inaction scenario or BAU) was discussed and agreed with EAD and UNEP to be as follows:

- *short-term to mid-term: 2040*
 - *long-term: 2080*
2. Compilation of available country-relevant cost and benefit information: Accurate project costing analysis ensures that all expenses are accounted for and budgeted for appropriately. These steps include:
 - All direct and indirect costs without (WOP) and with the project (WP), including labour, materials, equipment, and any other significant expenses.
 - Estimates of the costs and benefits of inaction (WOP).

- Estimates of the costs and benefits of each measure (WP), including avoided damages. This may involve obtaining quotes from suppliers, researching market prices, or consulting industry benchmarks.
- For ecosystem services (particularly in the forestry sector) such as reforestation, community forest management, and sustainable forest management, environmental benefits were monetized based on their contribution to ecosystem functions such as carbon sequestration, erosion control, and watershed protection. These were quantified using benchmark values from national studies, and cross-checked with unit values from comparable GCF and UNFCCC adaptation projects.
- Total cost for each measure by multiplying the quantity required by the unit cost.
- All direct and indirect costs to determine the total cost of the project. This includes one-time expenses (e.g., equipment purchases), this is the Capital Expenditure or CAPEX, and recurring expenses (e.g., monthly salaries or maintenance work) or Operation Expenditure (OPEX).
- Contingencies and allowances for unexpected costs or changes in the scope of the project.

Part of the costing information was provided by national stakeholders through the field survey.

As for the benefits of the priority measures, understanding the different types of benefits and how to quantify them is essential to making informed decisions and maximizing return on investment. The estimation of benefits was conducted by the Consultant using the survey results and other sources of information or proxy data.

3.1.2 Types of Benefits

When performing a cost-benefit analysis, the following different types of benefits should be considered:

- Tangible benefits: Tangible benefits are quantifiable and directly measurable in monetary terms. These benefits can be easily expressed in financial metrics, such as increased revenue, cost savings, or increased profits. Tangible benefits are typically easier to evaluate and justify, as they have a clear and immediate impact on the organization's balance sheet.
- Intangible benefits: Intangible benefits are not monetary and are difficult to quantify, but they still provide value for a given investment. Although intangible benefits cannot be easily measured in financial terms, they are important considerations in the decision-making process and can have a significant impact on long-term success.
- Immediate benefits: Immediate benefits are achieved shortly after a project or decision is implemented.
- Long-term benefits: Long-term benefits accrue over an extended period and may take time to fully materialize. These benefits often result from strategic investments or initiatives on the environment protection.
- Avoided losses versus new income benefits: It is essential to distinguish between avoided losses, economic damages or productivity losses prevented by adaptation measures, and new income benefits, which represent additional economic gains such as increased production, revenue, or resource value. Both contribute to the economic rationale for adaptation but must be clearly separated to ensure transparent benefit-cost assessment. Avoided losses represent the economic damages, productivity declines, or service disruptions prevented by adaptation measures (e.g., reduced flood damage to roads or lower crop failure rates). New income benefits reflect additional economic gains generated through increased production, improved resource use, or market access (e.g., higher agricultural yields, aquaculture expansion, or diversified livelihoods).

- Non-market environmental benefits: In addition to direct, market-based economic benefits, the analysis underscores the substantial non-market environmental gains generated by adaptation measures, particularly in forestry, watershed management, and ecosystem restoration.
- Private versus public benefits: Private benefits represent gains incurred by those directly involved in the implementation and use of the actions/sub-actions. Public benefits encompass the broader societal impacts, both positive and negative, resulting from implementation.

Measuring and quantifying benefits is just as important as understanding what those benefits are when compared to the total costs associated with a proposed project or investment. Several methods can be used to assess the value of benefits and determine their impact generally on the environment's overall performance.

Quantifying the identified benefits and translating them into measurable terms depends on their nature of the benefit. Various methods were used such as market valuation (e.g., increased agricultural yields, reduced water treatment costs), avoided cost estimation (e.g., flood damage prevention), benefit-transfer methods (e.g., ecosystem service valuation based on existing studies) and proxy indicators (e.g., time saved, hectares of land restored).

A cost and benefit matrix was developed based on national statistics, stakeholders' feedbacks from the field surveys, and proxies, to assess costs and benefits for the 22 measures. The matrix identifies the relevant costs items associated with the implementation of each intervention, including capital expenditure (CAPEX) related costs such as labour/manpower, materials, and equipment, and operational expenditure or OPEX related costs, that are repeated in time for maintenance and operation of each intervention, such as operating staff costs, maintenance of the infrastructure or vegetation, etc. The matrix is included in Annex 2 to facilitate reference and transparency regarding the underlying data and assumptions. 2

It includes a list of possible activities or sub-steps that are necessary for the implementation of each measure, which are aimed at facilitating the cost estimation. This level of specificity about the necessary activities for each measure is informed by a similar exercise conducted in 2024 in selected districts, as part of the development of the CRVAs and the identification of adaptation options.

3. Estimation and calculation of remaining cost and benefit items not available in the country: For the assessment of the benefits, the Consultant considered both direct financial benefits, such as reduced financing costs or direct remuneration such as payment for ecosystem services, and indirect (non-financial) benefits, such as enhanced resilience, avoided damages, and social co-benefits. All costs and benefits were assessed based on technical descriptions of each adaptation measure, technical proxy data, and available sector-level data. Where possible, these identified costs and benefits were then converted into monetary terms using market prices, benefit-transfer methods, and estimates from previous adaptation projects or national benchmarks. For financial costs and benefits, this is relatively straightforward. For economic (non-financial) benefits, appropriate assessment techniques were adopted, such as the evaluation of avoided damages and/or production losses. Further detail into the proposed methods for benefit estimation is provided below:

Methodology note for quantification of benefits in climate change adaptation cost-benefit analysis

The analysis starts with a basic question: what are the factors to evaluate to calculate the environmental impact?

The environmental impact of human beings is measured in terms of greenhouse gases (GHG) emitted, the quantity of natural resources used, the pollution that human activities cause for:

- Soil;
- Air;
- Water.

To assess the various factors and have a detailed picture, specific information is needed on the human or industrial activities that are intended to be evaluated such as:

- Water consumed;
- Quantity of waste produced;
- Gas emissions;
- Energy used;
- Natural resources exploited.

By cross-referencing these data with specific environmental data, it is possible, through mathematical models, to estimate the human impact on a specific ecosystem or globally.

Examples of approaches to determining the greatest direct and indirect benefits

The identification of the types of benefits for each intervention shall consider the positive and negative externalities of each measure:

Externalities

- Positive externality (external economy): Benefit that an economic agent determines in favor of a third party without receiving compensation
- Negative externality (external diseconomy): Damage that an economic agent causes to a third party without paying compensation

The benefit estimation methods to be employed can be selected measure by measure depending on the characteristics of each intervention (such as whether they are soft, green or grey interventions), however the suggested methods to employ are:

Hedonic Value method

The impact (improving or worsening) of a project on "environmental quality" can be assessed by referring to the variations (real or expected) in the values of the properties influenced by the implementation of the project

Examples of application of the hedonic value: by estimating the presumed variation in the prices of the properties around the intervention area, it is possible to monetarily evaluate - the negative impact (negative externality) of the construction of an incinerator - the positive impact of the creation of an urban park - the positive impact of the creation of a protected area.

To adopt this methodology, as a "minimum" two estimative phases of the determination of the hedonic value must be applied:

A) Estimate of the impact of environmental quality on the value of the property

B) Estimation of willingness to pay for an improvement in environmental quality – (social value of environmental improvement)

Willingness To Pay

This approach is one of the most employed ones in cost-benefit analysis in projects with important environmental components such as CCA. Briefly, this method is defined as follows:

“The maximum amount that an individual is willing to pay to receive an improvement or to avoid a loss in his level of well-being.”

Willingness to pay is limited above by the maximum amount of resources available to the individual.

However, there is another typology for evaluating the preferences of individuals and, through these, the value of goods that do not have a market price: the so-called Willingness to Accept,

understood as: “The minimum amount that an individual asks to bear a cost, a loss or to voluntarily give up a good that he owns.”

Willingness to Pay and Willingness to Accept are usually represented by market prices. The market price is determined by the value of the last unit of goods, which according to the law of decreasing marginal utility is valid for consumers.

For instance, in an example that can concern a vulnerability risk mitigation measure to climate change impacts against sudden floods in a certain territory belonging to one or two municipalities such as a project for a water collection area or flood retention reservoir. In this case, the direct beneficiaries involved are different including the two municipalities. Based on the means available to study the Willingness To Pay, a survey can be developed by interviewing the population of the project area or estimating the possible damages due to both the private and public sectors in road restoration interventions, utilities, etc.

The interview system is more precise but also more expensive in terms of time and cost.

Willingness To Pay is widely used in ecosystems protection where tourism is developed in terms of camping and hotels and entrance fees to parks, in irrigation systems and land reclamation where climate change impacts are more evident.

It is worth noting that in recent years the population's sensitivity towards CC has increased with attitudes of safeguard and prevention towards the reduction of agricultural harvests, damage to protected areas of tourist interest, transport infrastructures, soil erosion, etc. That is, a series of damages or costs to be converted into indirect benefits in terms of prevention.

Furthermore, if the climate risk mitigation measures are well designed, further development of the territory can be achieved with direct benefits in terms of: an increase in agricultural production, increase in environmental capital, increase in tourist flow, health, social stability etc.

Important: In projects or climate change adaptation measures, the calculation of benefits is very effective by applying economic analysis to avoid the network of market prices that are not adequate for assessing environmental variables and impacts. In this case, "shadow prices" are used through a methodology well explained in the manuals of international organizations such as the guidance “The IMF-World Bank Climate Policy Assessment Tool (CPAT): a Model to Help Countries Mitigate Climate Change”³⁰.

In any case, it should be emphasized that each adaptation measure represents a project with its own specificities where the project analyst judges from time to time the opportunity to use one calculation method compared to another. The major variables that come into play in general are: air, soil, water pollution; risks for extreme events in terms of flooding and drought, soil erosion, seasonal changes for traditional crops; sudden and uncontrollable emigration phenomena.

It is important to underline the role of young people and women in climate change mitigation and adaptation projects. Another social variable that is not taken into account in these particular projects is the trend towards an aging population in Europe.

³⁰ Parry, I.W.H., Black, S., Roaf, J., Vernon, M., and Zhunussova, K. (2023). *The IMF-World Bank Climate Policy Assessment Tool (CPAT): A Model to Help Countries Mitigate Climate Change*. Available at: <https://www.imf.org/en/Publications/WP/Issues/2023/06/22/The-IMF-World-Bank-Climate-Policy-Assessment-Tool-CPAT-A-Model-to-Help-Countries-Mitigate-535096>

Suggested recent guidelines considered:

- Black, S., Parry, I., Mylonas, V., Vernon, N., & Zhunussova, K. (2023), “The IMF-World Bank Climate Policy Assessment Tool (CPAT): A Model to Help Countries Mitigate Climate Change”. IMF Working Papers
- Chichilnisky, G., Rezai, A. (2020) “Handbook on the economics of climate change”. Edward Elgar Publishing
- Dixon, J., Scura, L., Carpenter, R., Sherman, P. (2013) “Economic Analysis of Environmental Impacts”. Routledge
- Morris, P., Therivel, R. (2001) “Methods of Environmental Impact Assessment”. Taylor & Francis
- Edited by Debarati Guha-Sapir, Indhira Santos, and Managing Editor, Alexandre Borde (2013) “The Economic Impacts of Natural Disasters”, Oxford University Press³¹

4. Calculation of the Net Present Value (NPV), payback period and cost-benefit ratio: Based on the cost information and the estimation of the benefits to be performed in the previous step, the Consultant calculated the NPV, payback period and the BCR to perform the financial analysis of the measures.

A time horizon for carrying out the CBA and calculating the NPV was set according to the longevity of the intervention, considering the definition of time horizons agreed with UNEP that defines the following implementation periods: short term to mid-term (2040), and long term for measures to be implemented until 2080.

To calculate the NPV of the costs and benefits a discount rate was applied. This is necessary to consider the changing value of money over time. To do so, future costs and benefits are adjusted to their present values with a discount rate to reflect their worth in today's terms. This is necessary to calculate the net present value subtracting costs from the total discounted benefits, and in that way define if the measure benefits exceed the costs. There are different approaches to define the specific discount rate to be applied. Here, it is proposed to employ the discount rate that it is being considered for other costing exercises within the NAP, as shared by national stakeholders.

The NPV itself was calculated as the difference between the present value of benefits and the present value of costs over the period, i.e. by taking the annual social costs and benefits of the measure and updating them financially by using discount rates.

The formula is

$$NPV = \sum_{t=1}^T \frac{B_t - C_t}{(1+r)^t}$$

Where:

t is the time period,

B_t are the benefits for the given period in currency

C_t are the costs for the given period in currency

r is the discount rate, and

T is the last period in the series

The benefit-cost ratio was calculated by dividing the total benefits by the total costs to assess the economic viability.

$$\text{Benefit-Cost ratio} = (\text{Total benefits}) / (\text{Total costs})$$

This ratio illustrates the relationship between the net present benefits and the net present costs. A value greater than 1 indicates that the net present benefits exceed the net present

³¹ Cavallo, E. and Noy, I. (2011). *The Economic Impacts of Natural Disasters*. Available at: <https://global.oup.com/academic/product/the-economic-impacts-of-natural-disasters-9780199841936?cc=fr&lang=en&>

costs, suggesting that the project may be economically viable. Conversely, a value below 1 signifies that the costs outweigh the benefits, indicating that the measure may not be prioritised³².

5. Sensitivity analysis: The process was complemented with a sensitivity analysis to assess the degree of financial reliability of the measures for changes in the components of the analysis. This analysis enables to evaluate the robustness of results under varying discount rates, cost increases, and benefit reductions.
6. Identification of “No-Regret” measures: Based on the calculation from the previous step, the Consultant assessed the performance of the measures in the CBA aiming to give more urgency for implementation to the measures that show higher impact and low regret, i.e. that are “justified under all plausible future scenarios, including the absence of climate change impacts such as floods or droughts”³³.

The methodology ensures a comprehensive and rigorous economic evaluation of climate adaptation strategies, providing reliable data for policy formulation and investment decisions. It integrates both primary and secondary data obtained from sectoral planning documents, stakeholder interviews, and field surveys. In order to ensure that the CBA was tailored the specific national context, key information needs were being discussed with UNEP and national stakeholders to obtain as much information as possible from the country during the field survey, which took place the first and second weeks of February 2025.

The information that was not readily available within the country was inferred through desk review of similar cost and benefit items, whether in Malawi, in the region, or in other regions if needed, complemented with the Consultant’s experience in similar assignments.

Once the available country information was shared with the Consultant, and gaps filled in by the Consultant, the CBA methodology, as specified above, was applied, completed and cross-checked with the reviewed findings.

3.1.3 Sectoral application of CBA

The CBA offers an evidence-based, transparent approach at national level and by sector to guide resource allocation and strengthen the economic rationale for adaptation investments.

The key sectoral applications and benefits of CBA in the Malawian context are outlined below³⁴:

Of the sectors described below, five carry the prioritized measures appraised in this report: agriculture, fisheries, forestry, infrastructure and disaster risk reduction, and social. The water sector is described for completeness of the sectoral picture; it carries no measure among the 22 appraised, and no cost, IRR or NPV is attributed to it.

Agriculture sector

Objective: Enhance climate resilience, food security, and livelihoods through improved agricultural practices, climate-smart technologies, and sustainable land management.

Costs:

³² World Bank (1994). *Economic Analysis of Environmental Impacts*. Available at: <https://documents1.worldbank.org/curated/en/272091487845936282/pdf/110201-PUB-Box396328B-PUBLIC-Economic-Analysis-Of-Environmental-Impacts-1994.pdf>

³³ UNFCCC (n.d.). *Costs and Benefits of Adaptation*. Available at: https://unfccc.int/resource/docs/publications/pub_nwp_costs_benefits_adaptation.pdf

³⁴ Following consultation with the Environmental Affairs Department (EAD), health is not constituted as a sixth standalone sector in this economic appraisal. It is addressed transversally across the two sectors that already carry it: the infrastructure and disaster risk reduction sector, which covers climate-resilient health infrastructure and the assets on which health service delivery depends; and the social sector, which covers access to health care and services, surveillance and community health and emergency response, health workforce capacity building, and sustainable healthcare operations. The scope of the 22 prioritized adaptation measures, the costing, and all IRR and NPV results presented in this report hence include health issues. Education is embedded in the social sector of this appraisal, through the “access to services (health, education)” and “awareness and education” measures. The education sector will be reflected in the final NAP on the basis of the existing sector-specific assessment developed with the support of Save the Children (source/ EAD, July 2026). No education-specific measure has been added to the 22 measures appraised here.

Detailed economic appraisal, disaggregated by the priority sectors

- CAPEX: Investment in irrigation infrastructure, drought-tolerant seed varieties, soil fertility restoration measures, and agroforestry systems.
- OPEX: Operational costs for extension services, maintenance of irrigation schemes, seed production systems, and training programs.

Benefits:

- Increased agricultural productivity and reduced crop losses.
- Avoided food insecurity and economic losses linked to climate hazards (droughts, floods).
- Improved soil health and ecosystem services (e.g., water retention, erosion control).
- Job creation in agriculture-related value chains.

Fisheries sector

Objective: Build climate resilience in fisheries and aquatic systems through sustainable management and infrastructure improvements.

Costs:

- CAPEX: Investments in fish breeding centers, cold storage, aquaculture systems, and community monitoring structures.
- OPEX: Operational costs for fisheries governance, community programs, and infrastructure maintenance.

Benefits:

- Sustained fish stocks and aquatic biodiversity.
- Livelihood security for fishing communities.
- Reduced post-harvest losses and increased incomes.
- Nutrition co-benefits linked to improved fish availability.

Forestry sector

Objective: Restore degraded landscapes, enhance forest cover, and improve watershed functions to reduce vulnerability.

Costs:

- CAPEX: Tree planting, assisted natural regeneration, fire prevention, and woodlot development.
- OPEX: Maintenance of reforested areas, community stewardship programs, and monitoring systems.

Benefits:

- Carbon sequestration and reduced GHG emissions.
- Reduced flood risk, soil erosion, and sedimentation.
- Biodiversity conservation and ecosystem service enhancement.
- Improved livelihoods from sustainable forest products.

Water sector

Objective: Strengthen water security and climate resilience through infrastructure and ecosystem-based solutions.

Costs:

- CAPEX: Water harvesting systems, boreholes, small-scale dams, catchment restoration interventions.
- OPEX: Operation, maintenance, and community management costs.

Benefits:

- Improved access to clean water for domestic, agricultural, and productive uses.
- Reduced water scarcity and vulnerability to droughts.
- Health co-benefits linked to improved water quality.
- Enhanced ecosystem services from catchment restoration.

Infrastructure and disaster risk reduction

Objective: Reduce climate-related damage to infrastructure, including energy, schools and health infrastructure and enhance community resilience through structural and non-structural measures. Health infrastructure is understood here as health facilities and the water, sanitation, drainage, power and access assets on which the continuity of health care depends. Reduce also the exposure and vulnerability of the transportation and energy system (generation, transmission and distribution) to climate hazards, and secure continuity of supply under increasing flood, storm, drought and heat stress. Reduced exposure of communication networks to climate hazards and secure continuity of connectivity under flood, storm and heat stress to ensure a better availability of connectivity at the moment of a hazard event.

Costs:

- CAPEX: Flood protection and site hardening of power plants and substations; climate-proofing of hydropower intakes and sediment management; elevation or relocation of assets on exposed sites; reinforcement of transmission towers and lines to higher wind loading; re-routing or undergrounding of exposed distribution feeders; vegetation-corridor clearance; decentralised generation and storage to reduce single-point dependency. Climate-resilient pavement design and surfacing; culverts and cross-drainage resized to revised flood return periods; bridge scour protection and deck raising; embankment stabilisation and slope protection on landslide-prone sections; raising of road levels above design flood; bioengineering and erosion control of road corridors; realignment of segments on chronically flooded routes. Site hardening and flood protection of base stations, exchanges and data facilities; elevation or relocation of equipment on exposed sites; tower reinforcement to higher wind loading; burial or rerouting of exposed backhaul and fibre; redundant and diverse routing to remove single points of failure; back-up power and storage at critical sites; hydromet and sensor telemetry links; cell broadcast and mass-alerting capability.
- OPEX: Maintenance, early warning system operation, and capacity building. Asset inspection and condition monitoring; vegetation management; spare-parts stockpiling for rapid restoration; emergency response and restoration capacity; operator training. Pre-rainy-season silt clearance of drains and culverts; routine and periodic maintenance; pavement condition monitoring; post-event inspection and emergency repair capacity; spot-improvement programmes; asset management and climate-risk screening of the network. Battery replacement for back-up power. Telecommunication network resilience testing and drills; operator training; maintenance of alerting platforms.

Benefits:

- Avoided losses from floods, storms, and climate-related disasters.
- Improved connectivity and economic activity.
- Enhanced safety and reduced human displacement.

Detailed economic appraisal, disaggregated by the priority sectors

- Health and social co-benefits from improved infrastructure, including continuity of health care and of access to health facilities during and after climate shocks.
- Avoided damage to generation, transmission and distribution assets from floods, storms and landslides; reduced outage frequency and duration; avoided economic losses from supply interruption; sustained hydropower output under altered hydrology and higher sedimentation; reduced thermal derating of plant and lines under rising temperatures; improved supply reliability to productive sectors.
- Avoided reconstruction and repair after floods, storms and landslides; reduced network downtime and days of lost access; maintained access to markets, schools and health facilities through the rainy season; lower vehicle operating costs; avoided spoilage of perishable produce from route closure; faster relief access after disasters.
- Sustained connectivity during and after hazard events; reduced outage frequency and duration; continuity of early warning dissemination when it matters most; avoided economic losses from service interruption; maintained mobile money and market price information for rural households; faster emergency coordination and post-disaster response.

Social sector

Objective: Enhance community resilience and human capital by reducing climate-related health risks, strengthening education systems, and expanding social protection mechanisms as well as climate-resilient health care and essential service delivery. Surveillance and early warning for climate-sensitive diseases, community health and emergency response, health workforce capacity building, and sustainable healthcare operations.

Costs:

- CAPEX:
 - Construction or rehabilitation of climate-resilient health centers, schools, and social service infrastructure.
 - Investment in climate-proofed sanitation, hygiene facilities, and nutrition programs.
 - Expansion of social protection schemes, including cash transfers for vulnerable households affected by climate shocks.
- OPEX:
 - Operation and maintenance of facilities.
 - Training for health workers, educators, and social welfare officers on climate risks.
 - Administrative costs for scaling social safety nets.

Benefits:

- Reduced disease burden from climate-exacerbated illnesses (malaria, cholera, malnutrition), and improved continuity and quality of care during climate shocks.
- Improved learning outcomes and education continuity during climate shocks.
- Enhanced food security and income stability through targeted social protection.
- Strengthened social cohesion and reduced vulnerability, especially for women, children, and marginalized groups.

3.1.4 Assumptions for the baseline scenario

The baseline scenario used in the CBA corresponds to RCP 4.5 and RCP 8.5 trajectories, in which no adaptation measures are implemented beyond current trends and practices. It assumes that no additional large-scale adaptation measures are implemented beyond current trends, practices, and existing institutional capacities. The scenario is defined by the continuation of sectoral development patterns, prevailing infrastructure quality, and the current level of climate risk management, without the introduction of transformative policies, scaled-up investments, or additional institutional capacity.

The purpose of this baseline is to quantify the economic costs of inaction under evolving climate conditions and provide a counterfactual for evaluating the benefits of the planned adaptation strategies (With Project or WP).

Key assumptions underpin the baseline scenario across the five priority sectors. These assumptions are informed by a combination of national data sources, sectoral-level information historical trends, and international projections from IPCC and other recognized institutions.

1. **Policy and institutional context:** The scenario reflects full implementation of existing legislations, policies, and plans as currently resourced and enforced, without significant policy reforms, increased financing, or scaled-up implementation. While Malawi has adopted several relevant policies (e.g., the National Agriculture Policy 2024, National Climate Change Policies, and the National Resilience Strategy 2018-2030), under the baseline, institutional bottlenecks, limited resources, and weak enforcement restrict their large-scale impact on resilience outcomes.
2. **Socio-economic context:** The scenario assumes that socio-economic development follows historical trends, with modest improvements in productivity, livelihoods, and infrastructure quality, but without significant progress in building systemic resilience or addressing structural vulnerabilities.
3. **Climate risk management:** Disaster risk management, early warning systems, and climate services remain at current operational capacity, with no expansion of community-based early warning systems or integrated catchment management beyond existing initiatives.
4. **No adaptation measures and no scale-up of adaptation finance:** There are no major external investments, donor programs, or domestic budget increases targeting climate resilience, reflecting existing fiscal constraints and absorptive capacity to implement the priority adaptation measures.

Table 3. Sector-specific assumptions for the baseline scenario

Sector	Assumptions under the baseline scenario	Data sources
Agriculture	No expansion of climate-smart agriculture; no new irrigation schemes; yield declines directly translate to GDP loss	National Agriculture Policy (2024), SEPs, MoA, FAO, CRVAs, IPCC (RCP 4.5 & 8.5), historical yield data
Fisheries	Fisheries and aquaculture remain underdeveloped. No investment in sustainable aquaculture, co-management, or stock restoration; fish stock declines affect economic contribution	National Fisheries and Aquaculture Policy (2001), SEPs, FAO, fisheries reports, national statistics
Forestry	Forest Landscape Restoration targets under the NFLR Strategy (2017) are unmet due to resource gaps. No enhanced reforestation or protection measures; forest cover decline continues based on past deforestation trends	National Forest Policy (2016), National Forest Landscape Restoration Strategy (2017), SEPs, national forestry data, FAO, IPCC projections
Infrastructure	No significant upgrades to infrastructure resilience (roads, water systems, or public buildings); vulnerability to floods, storms, and droughts remains unchanged	National Resilience Strategy (2018-2030), World Bank infrastructure assessments, SEPs, disaster records
Water resources	Water security interventions remain minimal. Irrigation and water harvesting are limited to current schemes, exacerbating exposure to droughts and water scarcity.	National Water Resources Act (2013), National Irrigation Policy, SEPs
Social Sector	Health, education, and gender-related resilience interventions remain fragmented. Social vulnerability	National Social Protection policies, Resettlement Policy Framework (2013), SEPs, National Resilience Strategy (2018-2030). SEPs,

	to climate shocks persists, especially among women and youth.	World Bank, health and education sector reports, gender analysis reports
--	---	--

Under this scenario, several additional structural and institutional limitations are expected to persist, reinforcing Malawi's vulnerability to climate risks and environmental degradation:

- **Soil conservation, land tenure and sustainable land management:** No significant acceleration is anticipated in the implementation of land tenure reforms articulated in the National Land Policy (2002) and the Land Acquisition Act (1979). As a result, insecure land rights continue to undermine investments in sustainable land management, particularly among smallholder farmers, women, and vulnerable groups. Incentives to adopt long-term soil conservation, reforestation, or agroforestry practices remain limited.
- **Environmental governance and natural resource degradation:** Weak enforcement of the Revised National Environmental Policy (2004), coupled with insufficient financial and technical capacity at both national, and in some cases, sectoral levels, contributes to the ongoing degradation of forests, watersheds, and critical ecosystems. Community engagement in environmental stewardship remains fragmented, further eroding natural capital.
- **Resettlement and social safeguards:** Despite the existence of the Resettlement Policy Framework (2013), operational and resource constraints impede its effective application. Consequently, communities affected by disasters, land acquisition, or infrastructure development face heightened resettlement risks, with limited access to safeguards, compensation, or livelihood restoration measures.
- **Forest and catchment degradation:** Deforestation, land degradation, and the deterioration of watersheds continue largely unchecked, with minimal progress towards the restoration targets outlined in the National Forest Landscape Restoration Strategy (2017). This exacerbates Malawi's exposure to climate-induced hazards, including floods, droughts, and biodiversity loss, while diminishing ecosystem services essential for agricultural productivity, water security, and rural livelihoods.

In conclusion, it is baseline assumed that no major policy or regulatory reforms are introduced and no large-scale financing or external donor-supported programs are implemented. Economic losses are expected to scale proportionally with physical impacts, such as yield or production declines and damage to infrastructure or ecosystems. Furthermore, market demand, technology uptake, and pricing conditions are assumed to remain relatively stable over time.

This baseline is designed to reflect a conservative trajectory that enables the identification of adaptation benefits by comparison with investments in the planned [22 adaptation strategies](#). It hence serves as the counterfactual against which all adaptation options are evaluated within the framework.

3.2 Baseline scenario

This section presents the Business-As-Usual (BAU) scenario, which represents the situation in which Malawi does not take any adaptation measures. The CBA evaluates the advantages and disadvantages of investing in an adaptation project compared to what would have happened without intervention (i.e., the counterfactual or baseline scenario). This process involves analyzing two cases: "with project" (WP) and "without project" (WOP), as detailed in Step 2 of the methodology. Since spontaneous adaptation may naturally occur within the project area, defining the baseline scenario is important.

Forecasting outcomes due to adaptation measures involves intricate interdependencies among variables. To enhance impact assessment, various models – such as crop, livestock, or farm

models – are employed to simulate project effects versus the BAU. It accounts for the heterogeneity of agricultural sector, considering geographic and agro-climatic conditions in Malawi, productivity, capital and labor availability, technology levels, and market access. This is done under two Representative Concentration Pathways (RCPs), RCP 4.5 and 8.5, to assess the additional costs and benefits of adaptation measures. Benefits may be reflected in avoided climate change damage costs against the baseline scenario, while costs include the necessary investments to implement adaptation interventions.

3.2.1 Malawi without adaptation measures: economic impacts of RCP 4.5 and RCP 8.5 scenario

This section presents the baseline scenario, i.e. the situation in which Malawi does not take any adaptation measures in response to climate change. It serves as the counterfactual situation (WOP) against which costs, and benefits of adaptation measures are assessed. Without intervention, climate change is expected to drive significant economic, environmental and social consequences, including increased extreme weather events, reduced agricultural productivity, water scarcity, and heightened vulnerability of infrastructure and communities³⁵. The impacts of climate change will vary depending on the emissions pathway, with RCP 8.5 leading to more severe and frequent disruptions than RCP 4.5³⁶.

Table 4. Climate change risks under RCP 4.5 and RCP 8.5 in Malawi³⁷

Aspect	RCP 4.5 (Intermediate stabilization)	RCP 8.5 (High emissions, BAU)
Description	A scenario where global GHG emissions peak around 2040 and then decline due to moderate mitigation efforts.	A scenario where emissions continue to rise due to high fossil fuel dependency and limited climate action.
CO ₂ Concentration (2100)	~650 ppm	>1,000 ppm
Projected Temperature Rise (by 2100)	1.7–3.2°C above pre-industrial levels	3.7–5.4°C above pre-industrial levels
Timeframe-Specific Impacts	<u>2040</u> : Moderate increases in extreme weather, minor disruptions to agriculture, early adaptation measures can limit economic damages. <u>2080</u> : Stabilization of climate impacts, though residual risks remain for key sectors (e.g., agriculture, water, and infrastructure).	<u>2040</u> : Increased extreme weather, severe droughts and floods, disruptions in agricultural productivity, and heightened infrastructure vulnerability. <u>2080</u> : Uncontrolled climate change leading to irreversible economic damages, migration pressures, biodiversity loss, and major disruptions in food and water security.
Economic Implications	Moderate adaptation costs (in the range of USD 280–700 million over the planning horizon). Climate-related damages remain manageable with planned interventions. Suitable for incremental adaptation investments in agriculture, water management, and infrastructure resilience.	High adaptation costs due to escalating climate risks exceeding USD 700 million, typically arising in scenarios where escalating climate risks lead to substantial projected losses). Substantial economic losses across agriculture, health, and infrastructure. Justifies transformational adaptation strategies to build resilience against worst-case climate impacts.

The projected impacts of climate change in Malawi will be different under RCP 4.5 and RCP 8.5. Under RCP 4.5, some climate risks can be mitigated with moderate adaptation efforts,

³⁵ Malawi Department of Climate Change and Meteorological Services (2023). *The State of Malawi Climate in 2023 - Part 2*. Available at: https://www.metmalawi.gov.mw/documents/40/The_State_of_Malawi_Climate_in_2023_part2_Final_Final.pdf; CRVAs; World Bank Climate Knowledge Portal (n.d.). *Malawi Historical Climate Data*. Available at: <https://climateknowledgeportal.worldbank.org/country/malawi/climate-data-historical/#?text=Malawi%20has%20two%20main%20seasons,30%C2%B0%2D%2035%C2%B0C>; <https://www.ipcc.ch/report/ar6/wg2/chapter/chapter-9/>; <https://openknowledge.worldbank.org/entities/publication/ea68d466-764a-5c06-90c9-14105f558955>

³⁶ IPCC (2022). Chapter 9: Africa, in *Climate Change 2022: Impacts, Adaptation, and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*. Available at: https://www.ipcc.ch/report/ar6/syr/downloads/report/IPCC_AR6_SYR_FullVolume.pdf

³⁷ https://www.metmalawi.gov.mw/documents/40/The_State_of_Malawi_Climate_in_2023_part2_Final_Final.pdf; CRVAs; World Bank (n.d.). *Publication on Climate Change Adaptation and Impacts*. Available at: <https://climateknowledgeportal.worldbank.org/country/malawi/climate-data-historical/#?text=Malawi%20has%20two%20main%20seasons,30%C2%B0%2D%2035%C2%B0C>; IPCC (2023). *AR6 Synthesis Report - Full Volume*. Available at: <https://www.ipcc.ch/report/ar6/wg2/chapter/chapter-9/>; <https://openknowledge.worldbank.org/entities/publication/ea68d466-764a-5c06-90c9-14105f558955>

though residual impacts will persist. In contrast, under RCP 8.5, climate-related damages will be more severe, requiring transformational adaptation approaches. These consequences will impact key sectors, including agriculture, forestry, fisheries, water security, infrastructure, health, and overall economic stability, exacerbating socio-economic vulnerabilities. The table below summarizes these projected impacts across different impact areas.

Table 5. Projected impacts of climate change in Malawi under the baseline scenario (WOP)³⁸

Impact Area	Consequences under RCP 4.5	Consequences under RCP 8.5
Extreme Weather Events	Increased frequency and intensity of storms, floods, and droughts, particularly affecting southern Malawi	More severe and frequent storms, floods, and droughts, leading to widespread displacement and economic losses
Agricultural Decline	Prolonged dry spells and unpredictable rainfall patterns leading to reduced crop yields and food insecurity	Large-scale crop failures, severe food shortages, and loss of agricultural livelihoods
Water Scarcity	Periodic drought conditions affecting water supply for households, agriculture, and hydropower	Chronic water shortages and declining hydropower generation, impacting economic productivity
Infrastructure Damage	Increased destruction of roads, bridges, schools, and health facilities due to flooding and extreme weather	Widespread infrastructure collapse, requiring costly reconstruction efforts
Forestry	Increased deforestation due to rising demand for fuelwood and timber, coupled with higher tree mortality from extreme weather	Widespread loss of forests, desertification, and loss of biodiversity due to prolonged droughts and land degradation
Fisheries	Declining fish stocks due to changing water temperatures and seasonal variability, affecting local livelihoods	Drastic reductions in fish populations due to water scarcity and rising temperatures, severely impacting food security
Social Sector (Health, Education, Gender, etc.)	Rising temperatures and water shortages increase vector-borne diseases like malaria, as well as heat-related illnesses; Increased burden on healthcare systems, reduced school attendance due to climate-related disruptions, and higher vulnerability of marginalized groups	High mortality and morbidity due to worsening health conditions, compounded by failing health systems; Widespread health crises, collapse of education systems in affected regions, and deepened gender inequalities due to climate-induced migration and resource scarcity
Economic Losses	Moderate decline in GDP, manageable increases in poverty levels	Severe economic downturn, drastic poverty increase, and failure to meet national development goals

Overall, Malawi's economic growth is already increasingly affected by climate-related shocks, including droughts, floods, and cyclones, which have caused severe damage to infrastructure and livelihoods. In recent years, extreme weather events such as Cyclones Idai (2019), Ana, Gombe (2022) and Freddy (2023, with 1,209 fatalities)³⁹ have led to economic losses equivalent to 1.5 to 2.7% of GDP, severely impacting hydropower generation and reducing electricity supply.

According to the 2022 *World Bank Country Climate Development Report*⁴⁰, climate change is projected to reduce Malawi's GDP by up to 9% by 2030 and 8 to 16% by 2050 (with the risk of having an additional 2 million people into poverty by 2030 and 4 million by 2050). The primary economic damage channels include reduced crop and labor productivity, destruction of roads and bridges, and damage to hydropower infrastructure.

³⁸ National Adaptation Plan Readiness Project in Malawi - Climate change modelling and climate change risk assessment consultancy, *Adaptation Options Report (v4)*, April 2024, Government of Malawi and UNEP

³⁹ <https://files.emdat.be/2024/04/CredCrunch74.pdf>

⁴⁰ World Bank (2022) *Country climate and development report of Malawi* <https://documents1.worldbank.org/curated/en/099545010272237260/pdf/P1772201ced75ce9182e7142761bde013662bca4fe42.pdf>

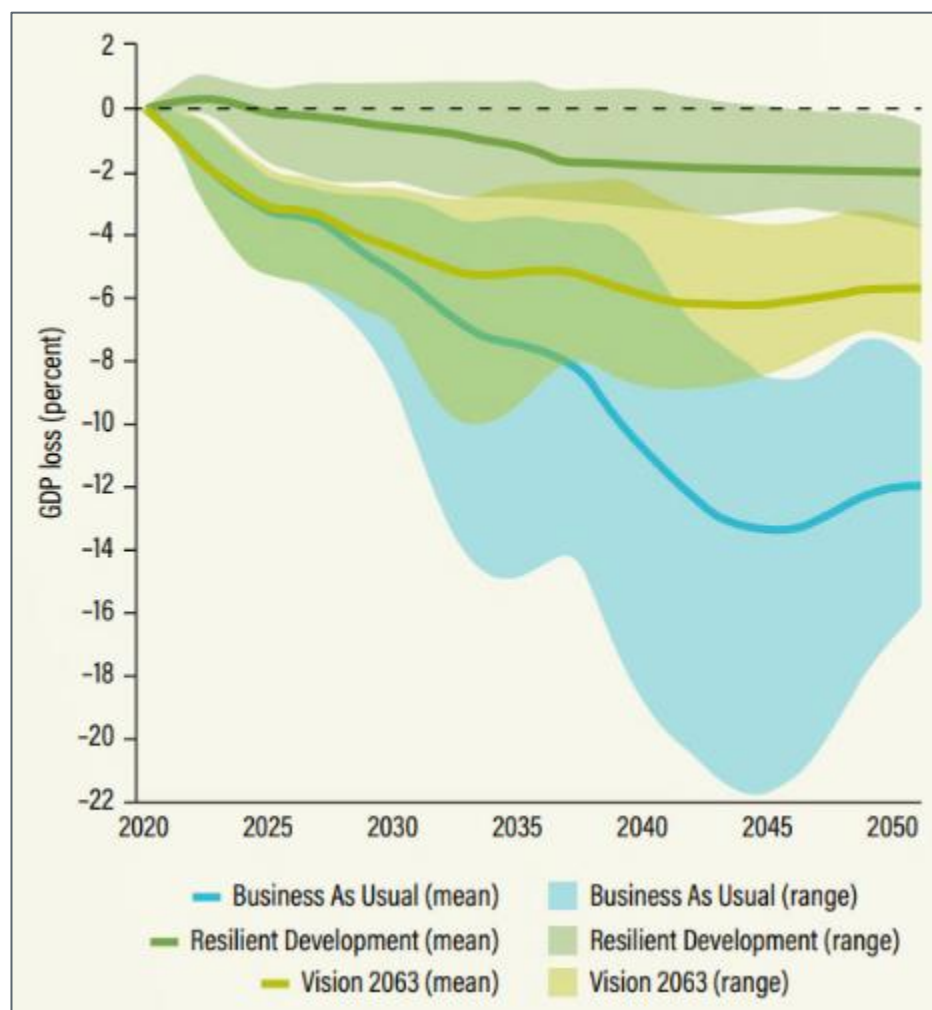


Figure 2. Climate change will impose large economic costs; development will strengthen resilience but will require doing different things.⁴¹

The graph illustrates that GDP losses under the baseline scenario (defined here as the BAU pathway with no significant additional adaptation or resilience investment) could reach 12% by 2050, whereas investing in resilient development and high-growth pathways under Vision 2063 could significantly reduce these losses.

Table 6. Policy baseline and implementation gaps for adaptation under the BAU scenario

Legislation, Policies and Plans	Year	Summary	BAU Implementation Gaps
National Disaster Risk Management Policy	2015	Integration of disaster risk management into development planning, emphasizing preparedness and resilience	Limited integration of risk reduction in district development plans; EWS coverage remains incomplete
National Guidelines for Community-Based Early Warning Systems	2018	Standards for local early warning systems for hazards like floods	EWS not scaled nationally; many flood-prone communities lack operational systems
National Forest Policy	2016	Sustainable forest management, afforestation, biodiversity conservation, community participation	Forest loss persists; enforcement of community management and afforestation weak
National Climate Change Management Policy	2016	Framework for coordinated climate change adaptation, mitigation, and technology transfer	Limited mainstreaming of adaptation across sectors; coordination remains fragmented

⁴¹ The analysis includes major sector and considers main pathways of climate change impact. World Bank (2022). Country climate and development report of Malawi. Available at: <https://documents1.worldbank.org/curated/en/099945012012289449/pdf/P17952904c6c4603d0b0660c8a8483efa59.pdf>

Detailed economic appraisal, disaggregated by the priority sectors

National Environmental Policy	2004	Sustainable natural resource management, environmental protection, biodiversity conservation	Weak enforcement of environmental safeguards; land degradation continues
National Resilience Strategy (2018–2030)	2018	Integrated agriculture, risk reduction, social protection, catchment management for food security	Partial implementation; resilience measures underfunded; catchment degradation ongoing
National Fisheries and Aquaculture Policy	2001	Sustainable fisheries and aquaculture management for conservation and food security	Fisheries overexploited; aquaculture growth below policy targets
National Climate Change Policy	2012	Climate change adaptation and mitigation for sustainable development and resilience	Adaptation planning inconsistently applied; limited climate-proofing of infrastructure
National Agriculture Policy	2024	Transform agriculture via productivity, commercialisation, sustainable land management, climate-smart approaches	Chemical input reliance persists; climate-smart agriculture underutilized
Resettlement Policy Framework (MASAF 4)	2013	Procedures for resettlement, community-driven processes, fair compensation	Resettlement often reactive; safeguards weakly applied during climate-related displacement
Malawi National Land Policy	2002	Equitable land access, tenure security, sustainable land use for development and poverty reduction	Land tenure insecurity persists; enforcement of sustainable land use limited
Land Acquisition Act	1979	Regulates compulsory land acquisition, ensures fair compensation principles	Outdated provisions complicate climate-resilient infrastructure and relocation processes
Water Resources Act	2013	Integrated water resources management, equitable access, catchment protection	Catchment degradation ongoing; water governance challenges persist
National Forest Landscape Restoration Strategy	2017	Forest restoration targets, enhancing degraded areas, carbon sequestration, livelihood support	Forest restoration targets off-track; degraded landscapes remain widespread

Despite Malawi’s policy framework for climate adaptation, several gaps in implementation persist under the BAU, leaving the country still highly exposed to climate risks. As shown in the table above, many national policies, ranging from the National Resilience Strategy (2018–2030) to sectoral strategies in forestry, agriculture, fisheries, and water management, outline ambitious adaptation objectives. However, enforcement shortfalls, fragmented coordination, underfunding, and weak mainstreaming of adaptation across sectors continue to undermine progress.

Examples include the limited expansion of irrigation despite clear targets in the Irrigation Master Plan, ongoing forest loss despite the NFLRS, and slow uptake of climate-smart agriculture under the National Agriculture Policy from 2024. For irrigation, 407,862 ha were identified for development, yet only 25% is utilized, limiting agricultural resilience to drought. Forest restoration targets are off-track, with reforestation rates below the 4.5 million ha ambition. Similarly, gaps in EWS coverage, incomplete disaster risk integration into district plans, and the reactive nature of resettlement processes further compound vulnerability. The same applies with the National Fisheries and Aquaculture Policy (2001) outlining aquaculture growth, yet scale-up has been modest, contributing to protein deficits.

These policy and governance shortcomings directly contribute to the rising costs of inaction, as climate hazards intensify, infrastructure deteriorates, natural resources degrade, and vulnerable populations face deepening poverty and food insecurity. Quantifying these economic, environmental, and social costs per sectors enables to close policy gaps and scale adaptation investment.

3.2.2 Costs of inaction in agriculture

The economic implications of climate change for the agriculture sector, especially smallholder farmers in Malawi are significant, as agricultural productivity is expected to lower. A study by Cacho et al. (2020)⁴² provides valuable insights into the costs of inaction. Without planned adaptation, smallholder farmers in Malawi will face substantial economic losses due to climate change, under both RCP 4.5 and 8.5. It is estimated that, from 2020 to 2050, the present value of these losses amounts to approximately USD 1.6 billion, equating to an average annual loss of USD 103 million. This translates to a 7.7% reduction in annual income per farm, even after accounting for autonomous adaptation measures. The World Bank's 2022 Country Climate and Development Report⁴³ provides complementary data pointing in the same direction, projecting

⁴² Mechler, R., Bouwer, L.M., Schinko, T., Surminski, S. and Linnerooth-Bayer, J. (2020). *Loss and Damage from Climate Change: Concepts, Methods and Policy Options*. Available at: <https://link.springer.com/content/pdf/10.1007/s10584-020-02817-z.pdf>

⁴³ World Bank's 2022 Country Climate and Development Report <https://openknowledge.worldbank.org/handle/10986/38217>

that, without adaptation, Malawi could face a GDP reduction of up to 9% by 2030 and a decline of 8% to 16% by 2050, primarily driven by reduced agricultural productivity, infrastructure damage, and lower labor productivity, with an additional 2 million people falling into poverty by 2030 and 4 million by 2050.

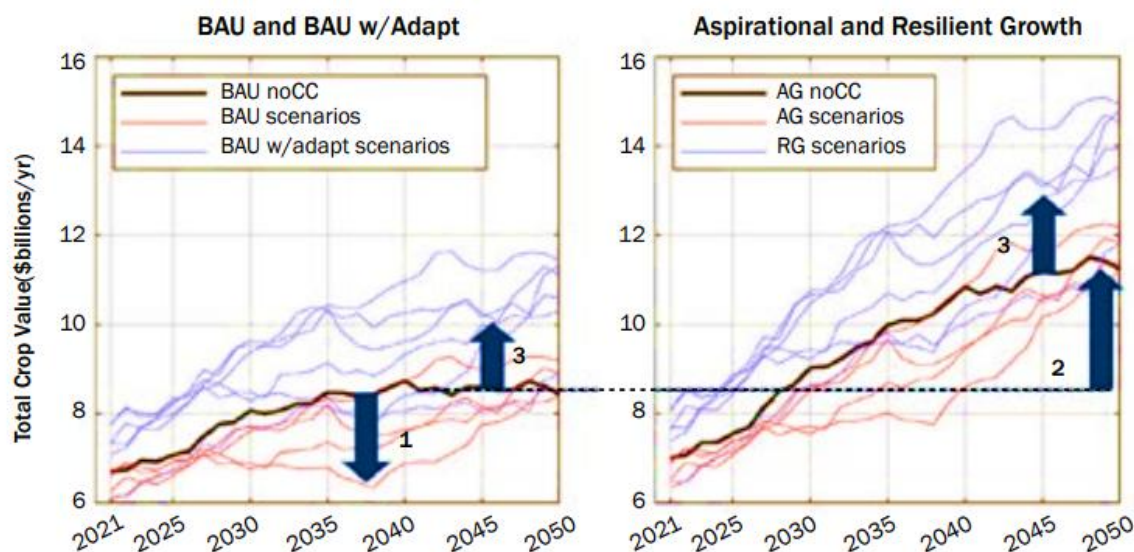


Figure 3. Projected total annual crop values across policy and climate scenarios⁴⁴

b

In the agriculture sector, land degradation caused by extreme weather conditions, particularly drought, poses significant economic challenges to Malawi. Research on the economics of land degradation indicates that, in Malawi, the average annual cost of land degradation between 2000 and 2009 was about USD 244 million. Over a 30-year period, if no remedial actions are taken, Malawi could incur losses totaling approximately USD 15.6 billion⁴⁵. This is due to the fact that land degradation adversely affects crop yields, particularly for staple crops like maize. Under the BAU scenario, maize yields decline by approximately 34% over recent decades due to soil erosion and nutrient depletion, irrigated rice yields by 33% and wheat yields by 6%⁴⁶. Climate change is projected to negatively impact yields of key crops in Malawi, with anticipated declines for maize (–4 %), millet and sorghum (–12 %), and groundnuts (–4 %).

The improvements shown in the adaptation and resilient growth scenario are based on the implementation of adaptation options for the agriculture sector, including soil and water conservation (e.g., contour farming, mulching, agroforestry), climate-smart agriculture practices (e.g., drought-resistant seed varieties, conservation agriculture), irrigation expansion and efficiency improvements, and improved extension services and early warning systems. The

These measures intend to stabilize and improve crop yields, protect soil health, and increase overall agricultural resilience under both moderate and high climate risk scenarios (RCP 4.5 and 8.5).

In conclusion, the total cost of land degradation on cropland in Malawi is estimated at 7.4% of GDP. These estimates are conservative, as they do not account for additional factors such as

⁴⁴ World Bank (2023). *Malawi: Climate Adaptation and Resilience Project*. Available at: <https://documents1.worldbank.org/curated/en/099545010272237260/pdf/P1772201ced75ce9182e7142761bde013662bca4fe42.pdf>

⁴⁵ Sietz, D., & Baumüller, H. (2017). *Climate Change Adaptation and Livelihoods*. In: *Disaster Risk Reduction and Climate Change Adaptation in Africa*. Springer. Available at: https://link.springer.com/chapter/10.1007/978-3-319-19168-3_20

⁴⁶ Ibidem

soil erosion, salinity, and offsite costs of pesticide use, meaning the actual cost of land degradation may be even greater.

3.2.3 Costs of inaction in the fishery sector

Malawi's fisheries sector, particularly the inland fisheries of Lake Malawi, is an important component of the country's economy and food security. The sector provides employment, income, and a primary source of animal protein for a significant portion of the population. However, climate change poses substantial threats to this sector, and failing to implement adaptation measures – inaction under the BAU – would result in severe socio-economic consequences.

Erratic rainfall and rising temperatures have disrupted the ecosystemic balance of the lakes of Malawi, starting with Lake Malawi, but also Lakes Chilwa, Malombe, Chiuta, etc., altering fish breeding cycles and reducing fish populations⁴⁷. Warmer temperatures affect oxygen levels and nutrient distribution, leading to declining fish stocks and reduced biodiversity.

These environmental changes directly threaten the sustainability of fisheries, which are a major source of income and protein for Malawians. Additionally, the increased frequency and intensity of extreme weather events, such as floods and droughts, further disrupt fishing activities, often resulting in the destruction of boats, gear, and essential infrastructure like landing sites and processing facilities. Droughts lead to reduced water levels, which, in turn, impact fish breeding grounds and limit fishing access, further exacerbating the sector's vulnerability. Moreover, shifts in wind patterns, particularly the intensification of the Mwera winds, have made fishing more hazardous and unpredictable. Stronger and more erratic winds not only increase risks to fishermen's safety but also contribute to changing water currents, which can alter fish migration patterns and make traditional fishing methods less effective. Without adaptation strategies to address these climate-induced challenges, Malawi's fisheries sector is expected to face declining productivity and hence economic losses^{48,49}.

The fisheries sector in Malawi is predominantly characterized by artisanal and small-scale operations, with some large-scale commercial fishing activities, especially in the southern regions of Lake Malawi. In 2017, the annual fish capture production was approximately 153,000 tonnes, with the majority comprising small pelagic species such as Usipa, which alone accounted for about 55% of the total catch, and Utaka, contributing approximately 18%.

Table 7. Fisheries statistics for Malawi⁵⁰

Year	1995	2000	2005	2010	2015	2016	2017	2018
Employment (thousands)	40.98	43.66	146.47	157.05	161.76	163.34	163.34	168.08
Aquaculture (thousands tonnes)	0	0	0	6.00	9.00	10.07	10.07	15.00
Capture (thousands tonnes)	40.98	43.66	146.47	151.05	152.76	153.27	153.27	153.08
Fleet (thousands boats)	15.32	15.32	15.32	15.60	17.12	16.54	18.00	21.36

The fishery sector contributes to approximately 4 to 7.2% to the GDP⁵¹. It provides direct employment to nearly 168,000 fishers and over 8,000 fish farmers. Indirectly, it supports over 600,000 individuals engaged in activities such as fish processing, marketing, boat building, and engine repair. According to the Food and Agriculture Organization (FAO)⁵², fish accounts for

⁴⁷ FAO (n.d.). Fisheries and Aquaculture Country Profile: Malawi. Available at: <https://www.fao.org/fishery/en/facp/mwi?lang=en>

⁴⁸ MDPI (2018). Article on Climate or Fisheries, Volume 6, Issue 2, Article 34. Available at: <https://www.mdpi.com/2225-1154/6/2/34>

⁴⁹ FAO (n.d.). Fisheries and Aquaculture Country Profile: Malawi. Available at: <https://www.fao.org/fishery/en/facp/mwi?lang=en>

⁵⁰ FAO (n.d.). Fishery and Aquaculture Statistics. Available at: - <https://www.fao.org/fishery/fr/fishstat>

⁵¹ This percentage varies depending of the sources. FAO (n.d.). Fisheries Country Profile: Malawi. Available at: https://www.fao.org/fishery/docs/DOCUMENT/fcp/en/FL_CP_MW.pdf; Copenhagen Consensus Center (n.d.). Fisheries Technical Report. Available at: https://copenhagenconsensus.com/sites/default/files/mp_fisheries_technical_report.pdf

⁵² FAO (n.d.). Fisheries and Aquaculture Country Profile: Malawi. Available at: <https://www.fao.org/fishery/en/facp/mwi?lang=en>

around 40% of Malawi's total animal protein intake and is a vital source of micronutrients such as iron, calcium, and vitamin A, particularly for low-income rural communities. As such, the sector plays a notable role not only in economic development but also in household food security and nutritional wellbeing across the country.

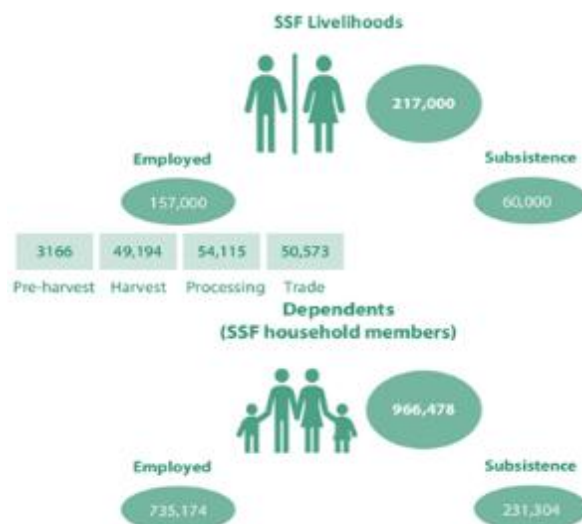


Figure 4. Estimated number of people engaged in small-scale fisheries (SSF) livelihoods in Malawi⁵³

In addition to the impacts of climate change, the sector faces significant challenges, including overfishing (and the use of illegal fishing practices)⁵⁴ and weak governance structures, leading to the decline of crucial fish stocks and biodiversity. Notably, three out of the four species of Chambo, Malawi's most economically valuable fish, are now classified as critically endangered. The cost of inaction in the fisheries sector will result in annual economic losses comprised between USD 156 and 280 million⁵⁵.

3.2.4 Costs of inaction in the forestry sector

As of 2020, Malawi had approximately 2.13 million hectares of natural forest, covering about 18% of its land area⁵⁶. But Malawi's forests are disappearing, with an estimated area comprised between 30,000 to 40,000 hectares lost every year. Rising temperatures and shifting precipitation patterns contribute to increased droughts and dry spells, making forests more susceptible to pests, diseases, and wildfires. These disturbances can cause widespread tree mortality, altering forest composition and reducing biodiversity⁵⁷. From 2001 to 2023, Malawi lost 247,000 ha of tree cover, equivalent to a 16% decrease in tree cover since 2000, and 105 Mt of CO₂e emissions, with, during the same period a loss of 654

⁵³ Subsistent fishers are defined as those who engage in small-scale fisheries livelihoods for fish as food only, compared to those fishing for sale. Dependents are the total number of small-scale fisheries household members ; <https://digitalarchive.worldfishcenter.org/server/api/core/bitstreams/eb1d700d-a903-4110-8603-f1797b18203f/content>

⁵⁴ 90% of nets used are illegal, with mesh sizes that are too small, capturing juvenile and spawning fish, thereby reducing the reproductive capacity of fish species. This has led to a change in the composition of species being caught in Lake Malawi, with large pelagic fish being replaced by smaller pelagic fish such as Usipa. Source: https://copenhagenconsensus.com/sites/default/files/mp_fisheries_technical_report.pdf

⁵⁵ This amount is estimated considering that the sector contributes, depending of the sources, between 4% (FAO, 2005) and 7.2% (Copenhagen Consensus Center, 2021) of the national GDP, which equates between USD 520 and 936 million (based on a \$12.71 billion GDP in 2023 estimate provided by the World Bank statistics; <https://data.worldbank.org/indicator/NY.GDP.MKTP.CD?locations=MW>).

⁵⁶ Global Forest Watch (n.d.). Malawi Country Dashboard. Available at: <https://www.globalforestwatch.org/dashboards/country/MWI/>

⁵⁷ World Bank Climate Knowledge Portal (n.d.). Malawi Climate Data. Available at: <https://climateknowledgeportal.worldbank.org/country/malawi>

Detailed economic appraisal, disaggregated by the priority sectors

ha of tree cover from fires (the year with the most tree cover loss due to fires during this period was 2017 with 90 ha lost to fires - 0.59% of all tree cover loss for that year)⁵⁸.

The Southern Miombo woodlands, covering parts of Malawi (e.g. Kasungu), are particularly vulnerable to climate change. In the RCP 8.5 scenario, where global temperatures rise by 4.5°C, projections indicate that around 90% of amphibian species, 86% of bird species, and 80% of mammal species in the Miombo region could disappear⁵⁹.

Under the BAU, because of the threats to Malawi's forests through increased susceptibility to pests, diseases, and wildfires, leading to biodiversity loss and reduced carbon sequestration, economic losses are due to i) higher energy supply (considering that 96% of households relying on wood or charcoal for cooking, with deforestation leading to fuelwood shortages, increasing the time and effort required to collect wood and driving up energy costs), ii) biodiversity losses (Malawi's forests are home to unique flora and fauna), and iii) decrease commercial forestry and logging activities⁶⁰. Indeed, the forestry sector contributes significantly to Malawi's economy but data are missing. According to the FAO, the forest sector's contribution to Malawi's economy was approximately USD 475.7 million in 2014, and an extra USD 95 million through indirect and induced effects⁶¹.

3.2.5 Costs of inaction on the infrastructure of Malawi

Climate change is expected to have high economic impacts on Malawi's infrastructure under RCP 4.5 and 8.5 scenarios. Under RCP 4.5, GDP losses from climate-induced infrastructure damage could range between 3 and 9% by 2040, largely due to increased flooding, extreme temperatures, and prolonged droughts affecting transport, energy, and water infrastructure. Under RCP 8.5, the damages will be more severe, with economic losses projected to surpass 10% of GDP by 2040 due to more frequent extreme weather events. By 2080, if no significant adaptation measures are taken, climate change will intensify infrastructure vulnerabilities, leading to long-term economic stagnation, with cumulative losses exceeding 15% of GDP under RCP 8.5, compared to lower but still significant losses under RCP 4.5⁶².

The transportation sector is one of the most affected, with increasing floods and extreme weather events deteriorating road networks and bridges, leading to higher maintenance costs and disruptions in trade and mobility⁶³. Given that only about 30% of Malawi's roads are paved, climate-induced damage will further isolate rural communities and hinder economic activities⁶⁴.

⁵⁸ Global Forest Watch (n.d.). Malawi Fire Dashboard. Available at: Liao, C., Sillmann, J., et al. (2018). Impact of climate change on wildfire activity and carbonaceous aerosol emissions in California. *Climatic Change*. Available at: <https://www.globalforestwatch.org/dashboards/country/MWII/?category=fires&lang=en&location=WYJb3VudHJ5liwiTVdJlI0%3D>

⁵⁹ Liao, C., Sillmann, J., et al. (2018). Impact of climate change on wildfire activity and carbonaceous aerosol emissions in California. *Climatic Change*. Available at: <https://link.springer.com/article/10.1007/s10584-018-2158-6>; ScienceDaily (2018). Study Shows Climate Change is Increasing Wildfires. Available at: <https://www.sciencedaily.com/releases/2018/03/180313225505.htm>

⁶⁰ Kadzuwa, H. (2023). Potential of Commercial Forestry in Malawi. Scotland Malawi Partnership. Available at: https://www.scotland-malawipartnership.org/assets/resources/Potential_of_Commercial_Forestry_in-Malawi_Final_Version_Henry_Kadzuwa_Edited_23_04_2023.pdf

⁶¹ FAO (2021). The State of the World's Forests 2020. Available at: <https://openknowledge.fao.org/server/api/core/bitstreams/8e1ed78d-cd05-42a5-aca8-597d149a621b/content>

⁶² World Bank (2023). Malawi: Climate Adaptation and Resilience Project. Available at: <https://documents1.worldbank.org/curated/en/099545010272237260/pdf/P1772201ced75ce9182e7142761bde013662bca4fe42.pdf>

⁶³ African Climate Foundation (2023). Malawi Country Note. Available at: <https://africanclimatefoundation.org/wp-content/uploads/2023/11/800833-ACF-Malawi-country-note-05A.pdf>

⁶⁴ Pinard, M. (2011). LVR Design Standards Review, Malawi. Research4CAP. Available at: <https://www.research4cap.org/wp-content/uploads/ral/Pinard-Malawi-2011-LVR%2BDesign%2BStandards%2BReview-AFCAPmal016-v111015.pdf>

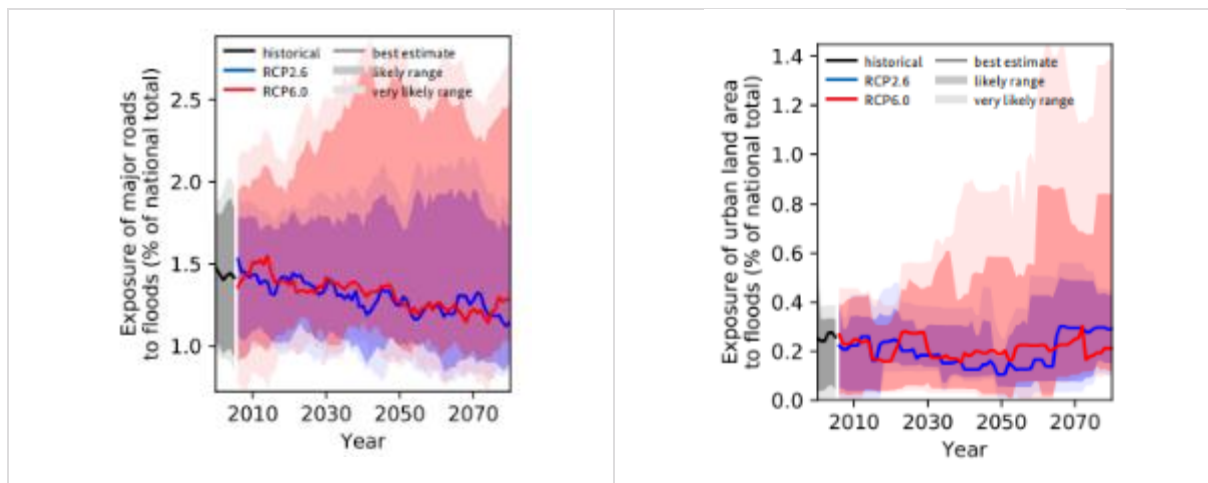


Figure 5. Projected exposure of major roads (left graph) and of urban land area (right graph) to river floods at least once per year for Malawi for different GHG emissions scenarios⁶⁵

In the energy sector, hydropower, which provides over 90% of Malawi's electricity, is highly vulnerable to changing rainfall patterns. Droughts and erratic precipitation under both RCP 4.5 and 8.5 will reduce water availability in major hydroelectric plants, leading to severe electricity shortages and increasing reliance on costly and unsustainable alternatives like biomass and diesel generators⁶⁶. The anticipated decrease water availability in Malawian rivers and reservoirs will lead to reduced hydropower generation. Specifically, annual hydropower production in Malawi is projected to decline: by 2040, the country's hydropower production is expected to decline by 2.5% under RCP 4.5 and 1% under RCP 8.5, while by 2080, the situation is expected to worsen, with a 5% decline under RCP 4.5 and up to a 24% reduction under RCP 8.5, severely impacting energy security and economic stability⁶⁷.

3.2.6 Costs of inaction on the social sector

The social sector covers health, education, gender and employment aspects. Starting with water, sanitation and hygiene (WASH), assessing the economic losses due to climate variability under RCP 4.5 and 8.5 by 2040 and 2080 involves complex modeling and is highly region-specific. The water and sanitation sector faces significant threats, as climate variability disrupts water supply systems, leading to shortages, contamination, and a rise in climate-related diseases such as cholera and malaria, which will increase public health expenditures and reduce labor productivity. While precise global figures are challenging to ascertain, existing studies provide insights into potential impacts, such as the increasing vulnerability of Malawi's WASH sector due to climate-induced crises, financial constraints, and inadequate infrastructure investments⁶⁸.

Malawi's WASH sector is already experiencing significant disruptions due to climate-related shocks, including droughts and floods, which contribute to non-functionality of water systems and increased prevalence of waterborne diseases. 45% of traditional water systems in the country are non-functional, and climate-induced disasters are a major cause of service failures⁶⁹.

⁶⁵ AGRICA (2022). *Climate Risk Profile: Malawi*. Available at: https://agricade/wp-content/uploads/2022/02/SLICE_Climate-Risk-Profile_Malawi_EN.pdf

⁶⁶ International Energy Agency (IEA) (n.d.). *Climate Risks to African Hydropower*. Available at: <https://www.iea.org/reports/climate-impacts-on-african-hydropower/climate-risks-to-african-hydropower>

⁶⁷ Ibidem and MDPI (2024). *Article on Hydropower Projections under Climate Scenarios*. Available at: <https://www.mdpi.com/2073-4441/16/24/3548>. Both sources support the projections of reduced hydropower production in Malawi under both RCP 4.5 and RCP 8.5 scenarios by 2040 and 2080.

⁶⁸ UNICEF Malawi (2023). *WASH Budget Brief 2023-24*. Available at: <https://www.unicef.org/malawi/media/10126/file/WASH%20Budget%20Brief%202023-24.pdf>; UNICEF Malawi (2022). *WASH Budget Brief 2022-23*. Available at: <https://www.unicef.org/esa/media/11836/file/UNICEF-Malawi-WASH-Budget-Brief-2022-23.pdf>;

⁶⁹ UNICEF Malawi (2021). *WASH Budget Brief 2021-22*. Available at: <https://www.unicef.org/esa/media/9766/file/UNICEF-Malawi-2021-2022-WASH-Budget-Brief.pdf>

By 2040 and 2080, under the RCP 4.5 and RCP 8.5 scenarios, these challenges are projected to continue, leading to increased health costs, infrastructure damage, and productivity losses.

Climate variability can lead to increased incidence of waterborne diseases such as cholera and malaria, which in turn elevate public health expenditures and reduce labor productivity. While specific economic loss figures under RCP 4.5 and 8.5 by 2040 and 2080 are scarce, the general trend indicates a substantial economic burden due to healthcare costs and diminished workforce efficiency.

Table 8. Estimated Economic Losses in Malawi WASH Sector due to climate variability⁷⁰

Year	Scenario	Estimated Economic Loss (billion USD)	Key Drivers
2040	RCP 4.5	0.659	Infrastructure repair costs, healthcare expenditures, labor productivity loss
2080	RCP 4.5	2.160	Water scarcity, sanitation failures, increased disease burden
2040	RCP 8.5	0.912	Higher infrastructure damage, severe health impacts
2080	RCP 8.5	4.040	Extreme climate disruptions, flooding risks, intensified disease outbreaks

Regarding public health, the country is already facing waterborne diseases such as cholera, diarrhea, and malaria, which account for 13% of under-five child mortality. As climate change intensifies under RCP 4.5 and RCP 8.5, the economic burden on healthcare services and labor productivity is expected to increase. More frequent outbreaks of waterborne diseases will require higher government expenditures on health, while reduced workforce productivity due to illness will negatively impact economic growth. While the cause-effect relationship is very difficult to establish, some data can give a first overview of the situation: in 2022, Malawi reported approximately 250,000 Healthcare-Associated Infections (HAIs) cases, resulting in an economic burden of USD 246 million, equivalent to 2.92% of the GDP. The financial costs of treating these infections amounted to USD 79 million, representing 11% of the total health expenditure⁷¹. According to the World Bank report from 2012⁷², Malawi incurs annual losses of approximately USD 57 million, equating to 1.1% of the national GDP, due to inadequate sanitation. These losses encompass healthcare costs, productivity losses, and premature deaths⁷³. Similarly, heatwave exposure in Malawi is projected to rise alongside increasing temperatures, impacting both the population and the economy. By 2080, under RCP 6.0, up to 5% of the national GDP and 5.1% of the population could be affected, while heat-related mortality may more than triple, reaching 14 deaths per 100,000 inhabitants⁷⁴.

⁷⁰ Estimated from UNICEF data. Climate-related shocks, such as floods, have already significantly affected the WASH sector. For instance, the Post-Disaster Needs Assessment report revealed an estimated total damage of around USD 42.64 million to the WASH sector resulting from Tropical Cyclone Freddy, affecting over 1.3 million people. https://malawi.un.org/sites/default/files/2023-06/Tropical%20Cyclone%20Freddy%20Post%20Disaster%20Needs%20Assessment%20Government%20of%20Malawi%20%20April%202023-12_05_2023.pdf

⁷¹ WaterAid (2024). Costs of healthcare acquired infections due to inadequate water, sanitation and hygiene (WASH) in healthcare facilities in Malawi. Available at: <https://washmatters.wateraid.org/sites/g/files/jkxoof256/files/2024-04/Costs-healthcare-acquired-infections-Malawi.pdf>

⁷² The report titled "Economic Impacts of Poor Sanitation in Africa: Malawi" was published in March 2012 by the World Bank's Water and Sanitation Program (WSP). World Bank (2010). Malawi: Environmental and Social Impact Assessment. Available at: <https://documents1.worldbank.org/curated/fr/810581468044979852/pdf/724470WSP00PUB0x371917B0ESI0Malawi.pdf>

⁷³ IPCC (2022). Chapter 9: Africa. In *Climate Change 2022: Impacts, Adaptation, and Vulnerability*. Available at: <https://www.ipcc.ch/report/ar6/wg2/chapter/chapter-9/>; World Health Organization (WHO) (2021). *Climate change and health*. Available at: <https://www.who.int/news-room/fact-sheets/detail/climate-change-and-health>

⁷⁴ AGRICA (2022). *Climate Risk Profile: Malawi*. Available at: https://agricade/wp-content/uploads/2022/02/SLICE_Climate-Risk-Profile_Malawi_EN.pdf

Climate change is also expected to disrupt educational services: extreme weather events, such as floods and droughts, can lead to school closures and reduced educational attainment⁷⁵. This disruption can result in long-term economic losses due to a less educated workforce. For instance, climate change has severely disrupted education at Mitole Primary School in Chikwawa, leading to prolonged school closures, infrastructure damage, and declining academic performance. Frequent floods, cyclones, and droughts have resulted in the school being used as an evacuation center, affecting over 1,757 students, 53% of whom are girls. Dropout rates, particularly among girls, have increased due to displacement, poverty, and trauma, highlighting the urgent need for resilient educational infrastructure and psychosocial support for students⁷⁶. This shows that there are also gender impacts, because women and girls are often more vulnerable, facing increased health risks and caregiving burdens during climate-induced health crises, synonym of gender inequalities.

3.3 Process for the identification and prioritization of the adaptation measures

The process to define and prioritize Malawi's adaptation actions has been a multi-step, consultative approach, building on national frameworks and district-level assessments. Malawi has identified 22 priority adaptation actions, covering key sectors including agriculture, water, fisheries, infrastructure, forestry, health, and disaster risk reduction. These national priorities were informed by the NAP process, technical studies, and extensive stakeholder engagement, including consultations and inputs from development partners such as UNEP.

3.4 Adaptation scenario, with the project

This section outlines the scenario with a project (WP), i.e. with adaptation measures aimed at ensuring resilience at national level. The adaptation scenario builds upon the previous baseline assessment of climate risks and related economic impacts. A key component of this strategy is the application of the CBA to evaluate adaptation options, to ensure that they are not only effective but also economically viable, socially equitable, and environmentally sustainable.

As the adaptation measures are already identified at both district and national levels, the purpose is to assess if they are aligned with socio-economic projections and climate risks. Hence under this scenario, the economic assessment focuses on quantifying the costs, benefits, and net present values of adaptation under RCP 4.5 and RCP 8.5 for 2040 and 2080, ensuring that the most cost-effective strategies are prioritized. This leads to a comparative analysis to evaluate priority sectors and sector-level adaptation investments versus the baseline or *do nothing* scenario, eventually highlighting the economic risks of inaction and the financial benefits of proactive climate resilience measures.

3.4.1 Scope of the interventions

To mitigate the economic losses, Malawi intends to invest in adaptation and climate-resilient activities that can withstand extreme weather events. Enhancing early warning systems and improving climate forecasting technologies or developing and flood-resistant water sanitation

⁷⁵ World Bank (2021). *Malawi: Economic Update*. Available at: <https://openknowledge.worldbank.org/server/api/core/bitstreams/8dacb40a-cc6f-4fd8-97fe-96ab7e5793ae/content>

⁷⁶ Limbani, F. (2023). *The impacts of climate crises on education disruptions and disadvantages at Mitole Primary School in Malawi*. Available at: https://www.researchgate.net/publication/376307987_The_impacts_of_climate_crises_on_education_disruptions_and_disadvantages_at_Mitole_Primary_School_in_Malawi

or energy systems will minimize losses and damages and response costs. Additionally, sustainable land management practices, such as reforestation and soil erosion control, may also help reduce the severity of climate-induced disasters that directly impact infrastructure. These measures may require significant financial investment, stronger institutional governance, and international support to ensure Malawi's priority sectors can withstand future climate threats.

Most adaptation strategies are widely applied across all districts. Agriculture adaptation measures are well-distributed across Malawi's districts, with key interventions such as drought-tolerant crops, afforestation, conservation agriculture, and irrigation schemes, with the aim to enhancing agricultural resilience against climate-induced challenges like erratic rainfall and prolonged droughts.

Fisheries adaptation needs targeted measures, particularly in districts with lakes, where fishing is a primary livelihood. While sustainable fishing practices and habitat restoration strategies are widely implemented, aquaculture development remains underutilized in some areas. This is especially relevant for lake districts. Expanding aquaculture in these districts is expected to provide an alternative food source and economic stability for fishing communities.

Most of the forestry adaptation measures, such as sustainable forest management and reforestation or community-led forestry initiatives are considered. In Karonga and Phalombe, where wild fires threats are particularly pronounced, enhancing fire management programs was identified to mitigating damage and ensuring long-term forest resilience.

The CRVA highlighted that infrastructure resilience strategies, such as climate-proofing infrastructure, flood management, and early warning systems, are widely needed. Early warning systems, in particular, are expected to be implemented and integrated across all districts, for disaster preparedness and response capacity. Strengthening these systems in areas where they are lacking will minimizing climate-related risks, particularly in flood-prone and cyclone-exposed districts. Ensuring that all districts have robust and accessible early warning mechanisms will benefit to community readiness, reduce economic losses, and enhance long-term infrastructure resilience.

Social sector adaptation strategies have also been identified, with measures such as climate education, livelihood diversification, access to services, and social safety nets broadly integrated. This will be beneficial in terms of ensuring equitable access, particularly for vulnerable communities that face barriers to education, healthcare, and financial safety nets. These targeted investments in climate-responsive education systems and expanded social protection programs are necessary to bridge gaps and support at-risk populations.

3.5 Data collection

3.5.1 Country-relevant information

This section compiles Malawi-specific economic, social, and environmental data relevant to climate adaptation measures. It includes national climate policies, economic growth indicators, sectoral contributions to GDP, and district-level information such as the socio-economic profiles (SEPs), to refine the CBA.

Table 9. Key documents

Title of key documents	Description	Source
National Climate Change Management Policy (NCCMP)	Provides strategic direction for Malawi's climate change interventions, covering adaptation, mitigation, capacity building, and financing.	https://faolex.fao.org/docs/pdf/mlw201716.pdf
National Adaptation Plan (NAP) Framework	Guides medium- to long-term adaptation planning to benefit vulnerable communities and sectors.	https://napglobalnetwork.org/wp-content/uploads/2020/03/napgn-en-2020-malawis-national-adaptation-plan-framework.pdf

Detailed economic appraisal, disaggregated by the priority sectors

Updated Nationally Determined Contribution (NDC) 2021	Outlines Malawi's commitment to reducing GHG emissions and enhancing resilience to climate change.	https://unfccc.int/sites/default/files/ND C/2022-06/Malawi%20Updated%20NDC%20 July%202021%20submitted.pdf
Malawi's Strategy on climate change learning	Objective of the Strategy is to strengthen human resources and skills development for the advancement of green, low emission and climate resilient development.	https://www.unccllearn.org/wp-content/uploads/2021/02/Updated-Malawis-Strategy-on-Climate-Change-Learning-2021.pdf
Climate Risks Assessment (CRA)	Evaluation of the exposure, sensitivity, and adaptive capacity of the districts to climate change impacts.	Report published in September 2024

Table 10. Economic indicators

Economic Indicators	Description	Source
GDP Growth Forecast	The government projects economic growth at 3.2% for 2025, down from an earlier forecast of 4.0%.	http://www.nsomalawi.mw/ https://data.worldbank.org/country/malawi
Inflation Rate	As of January 2025, the year-on-year inflation rate stands at 28.5%, driven by foreign exchange shortages affecting imports of essential goods.	https://www.nsomalawi.mw/consumer-price-index https://www.rbm.mw/
Public Debt	Public debt is approximately 86% of GDP as of September 2024, with ongoing debt-restructuring negotiations.	https://www.rbm.mw/ https://data.worldbank.org/country/malawi
Discount rate	Social discount rate varies between 8 and 10% depending of the institutions	https://copenhagenconsensus.com/sites/default/files/mp_nrm_technical_report.pdf https://openknowledge.fao.org/server/api/core/bitstreams/8861602d-7c62-4ee7-9302-c6c24be2305c/content

Table 11. Contribution of the key sectors to the GDP of Malawi

Sectors	Contribution to GDP	Description	Source
Agriculture, Forestry, and Fisheries	22.7%	These sectors are climate-sensitive and employ 62% of Malawi's workforce.	https://africanclimatefoundation.org/wp-content/uploads/2023/11/800833-ACF-Malawi-country-note-05A.pdf
Tobacco	~50% of export earnings	Tobacco is Malawi's most significant cash crop, heavily influencing export revenues.	https://africanclimatefoundation.org/wp-content/uploads/2023/11/800833-ACF-Malawi-country-note-05A.pdf
Hydropower	~98% of electricity generation	Malawi's electricity is predominantly generated from hydropower, making it vulnerable to climate variability.	https://africanclimatefoundation.org/wp-content/uploads/2023/11/800833-ACF-Malawi-country-note-05A.pdf

Table 12. Projected GDP reduction due to the impacts of climate change

Climate Change Impacts on GDP : Scenario	Projected GDP Reduction	Description	Source
Business as Usual (BAU)	3–9% by 2030; 6–20% by 2040; 8–16% by 2050	Without intervention, climate change could significantly reduce Malawi's GDP.	https://documents1.worldbank.org/curated/en/099545010272237260/pdf/P1772201ced75ce9182e7142761bde013662bca4fe42.pdf
Vision 2063 Development Path	3–7% by 2030; 3–9% by 2040; 4–7% by 2050	Accelerated development could mitigate some climate change impacts on GDP.	https://documents1.worldbank.org/curated/en/099545010272237260/pdf/P1772201ced75ce9182e7142761bde013662bca4fe42.pdf

Resilient Development with Adaptation Measures	-1 to 3% by 2030 and 2040; 1 to 4% by 2050	Implementing adaptation strategies could stabilize or even improve GDP despite climate challenges.	https://documents1.worldbank.org/curated/en/099545010272237260/pdf/P1772201ced75ce9182e7142761bde013662bca4fe42.pdf
--	--	--	---

3.5.2 Field-survey information and key findings

Findings from the field survey conducted in February 2025 provide ground-level insights into climate adaptation needs. Interviews with national and district planners, local farmers, fishery operators, and infrastructure experts confirmed key vulnerabilities and validated cost estimates. The survey was designed to validate cost estimates, assess sector-specific vulnerabilities, and identify feasible adaptation measures.

The field survey was based on a structured questionnaire administered to key stakeholders, including national and district planners, local farmers, fishery operators, infrastructure experts, and members of District Environmental Sub-Committees (DESCs). It is presented in Annex. The data collection process followed a structured consultation plan covering all priority sectors and related national-level institutions.

The survey followed a participatory approach, engaging multiple stakeholders to collect both quantitative and qualitative data on:

- Barriers to adaptation (financial, technical, governance-related).
- Local and indigenous adaptation practices that can be scaled up.
- Economic, social, and environmental benefits of adaptation measures.
- Sectoral financing needs and the role of public-private partnerships.
- Cross-sectoral linkages in climate adaptation planning.

Several District Environmental Sub-Committee (DESC) members participated. Additionally, interviews were conducted at the national level with representatives from the Ministry of Agriculture (Lilongwe), the Meteorological Department (Blantyre), CISONICC (Lilongwe), and the Wildlife Society of Malawi (Blantyre).

Table 13. Summary of the consultation process

Sectoral thematics	Key findings from the survey
Agriculture and food security	Farmers in Dedza, Balaka, and Kasungu reported a <u>30% reduction in maize and groundnut yields</u> due to <u>shifting rainfall patterns</u> . Unpredictable rainfall and increased drought frequency were cited as major constraints, with limited access to drought-resistant seed varieties. Adoption of climate-smart agriculture remains low due to lack of financial incentives and limited extension services.
Fisheries and aquatic resources	Fisheries in Salima and Karonga have experienced up to a <u>15% decline in fish stocks</u> , attributed to <u>rising lake temperatures and changing water levels</u> . Fishery operators noted a <u>reduction in breeding grounds</u> , leading to <u>lower fish catches and income losses for local communities</u> . Some traditional fishery management practices were identified as potential adaptation strategies, but more enforcement and scientific monitoring are needed.
Infrastructure and Disaster Risk Management (DRM)	<u>Infrastructure damage in Chikwawa and Phalombe due to floods has increased maintenance costs by 50% since 2020</u> . Communities reported <u>frequent road washouts, damaged bridges, and destroyed irrigation canals</u> , affecting agricultural supply chains. <u>Investment in flood-resilient infrastructure</u> , such as elevated roads and reinforced bridges, was <u>identified as a priority need</u> .
Water resources and irrigation	<u>Water shortages in Rumphi and Kasungu have reduced irrigation farming</u> , threatening food security. Smallholder farmers face <u>limited access to irrigation technology</u> due to high costs and lack of financing mechanisms. Community-led water management practices were identified as a potential solution but require institutional support and capacity building.
Energy and forestry	<u>Unsustainable charcoal production in Dedza and Phalombe was linked to deforestation and increased vulnerability to soil erosion</u> . Limited access to

	alternative energy sources was reported, with solar and improved cookstoves identified as potential mitigation options. Reforestation efforts are ongoing, but lack of financial incentives hinders widespread adoption.
Health and social vulnerabilities	<u>Climate-induced displacement in Chikwawa has increased cases of malaria and cholera</u> outbreaks due to poor water and sanitation conditions. The survey highlighted <u>gender disparities in climate adaptation</u> , with women and youth having less access to adaptation resources despite their key roles in agriculture and water management. There is a <u>need for integrating climate adaptation into local health planning, particularly in flood-prone areas</u> .
Financial and institutional barriers	<u>Limited funding</u> : many adaptation strategies remain underfunded, and local governments rely heavily on international donors and NGOs. <u>Technical capacity gaps</u> : a shortage of trained personnel limits the implementation of advanced climate-smart solutions. <u>Lack of private sector involvement</u> : Few private-sector investments exist in adaptation, and incentives for businesses to invest in resilient infrastructure remain weak. <u>Poor coordination between sectors</u> : Adaptation efforts in agriculture, water, and energy sectors often operate in silos, reducing overall effectiveness.

The data collected through the field survey enabled also to gather quantitative information to derive cost estimates for the various adaptation measures, from key stakeholders such as national and local government officials, farmers, fishery operators, women groups and infrastructure experts.

3.6 Costing the adaptation measures: survey data, and proxies information

3.6.1 Identification of the costs

To fill data gaps, proxy information from regional studies and international reports was used. The identification of the costs and benefits of the project sets the boundaries of the analysis. Costs and benefits have been classified according to the 5 sectors (agriculture, fishery, forestry, infrastructure and social sector). On the cost side, two types of costs have been identified: the initial investment costs related to adaptation measures, as well as the operating costs resulting from the running, maintenance and management of the measures. The costs considered in the analysis are listed hereafter. Hence, adaptation cost estimates incorporate:

1. Capital Expenditures: Infrastructure investments (irrigation, flood management).
2. Operational Expenditures: Maintenance, community engagement, policy enforcement.

Table 14. Identification of the costs (derived from the adaptation options)⁷⁷

Type of costs	Costs
---------------	-------

⁷⁷ The adaptation options are presented in the "climate change modelling and climate change risk assessment", April 2024

Initial investment cost	Climate Smart Agriculture: Climate-resilient and drought resistant crop varieties, conservation agriculture, no-till and reduced-tillage cultivation, establishment of community grain banks, early warning systems. index-based crop insurance initiative, livestock farming promotion, reservoirs, filters and roof/rainwater harvesting system (pipes and taps), storage reservoirs/tanks, artificial lakes, run-off irrigation, micro-irrigation Fishery: Deeper fish ponds to prevent drying before fish matures and harvesting. Wells and boreholes to supplement water in the ponds. Pond liners to prevent seepage of water especially when ground water reduces due to drought. Species that can with stand increased water temperatures and lower water levels such as catfish. Treatment of aquaculture wastewater Forestry: Reforestation (per hectare), agroforestry promotion, introduction of alternative energy sources, law enforcement to curb illegal logging, Infrastructure: Retrofit and climate-proof facilities, upgrading of road designs in flood-prone areas, adequate drainage systems, evacuation shelters, enforcement of building codes and standards, investment in renewable energy systems, climate-proof pumps at wastewater treatment plants to increase allowable water level during flooding, flood barriers to withstand the flood water Social sector: Establishment of community climate adaptation committees, skills development programs for women and youth, social safety net initiatives
Operating costs	Maintenance of the water harvesting system and reservoirs Maintenance of the irrigation systems Maintenance of climate-proof infrastructure Maintenance of the aquaculture and ponds Project monitoring and capacity building

Indeed, in order to identify the benefits, the expected consequences of the investment and operating costs are first inventoried. These potential benefits were confirmed or not through stakeholder interviews and field visits. At the same time, unfavourable outcomes of the project are also identified. No significant negative consequence (for the beneficiaries and non-beneficiaries) has been identified. No unexpected and significant negative outcomes (either internal or external) generated by the investment and operating costs are foreseen but an environment impact assessment will be needed.

3.6.2 Monetary evaluation of the adaptation options costs

The costs of the adaptation options have been identified by analyzing the data from the field survey and by using proxies from the literature review for similar projects and academic papers. Estimating operating costs required interviewing of stakeholders and beneficiaries. In each case, available evidence has in addition been examined in the light of official reports or similar case studies. The field visit has enabled to ensure the options corresponded to the needs of installations.

The estimates of the investments and operating costs are presented below, by sector. Confidence intervals are proposed (low – L, central – C and high – H estimates) by considering +/- 20% margin as the value has been transferred from similar projects reports or academic papers.

Table 15. Cost parameters for agriculture sector adaptation measures

Adaptation Measure	CAPEX Estimate (USD)	OPEX Estimate (USD per year)	Assumptions / Source
Drought-tolerant crops	50 to 150 USD per hectare (seeds and distribution)	20 to 40 USD per hectare (extension and support)	Based on seed procurement and distribution projects in Malawi
Afforestation/Reforestation	750 to 2,500 USD per hectare (site preparation, seedlings, planting)	50 to 150 USD per hectare (maintenance and monitoring)	Costs from Malawi's National Forest Landscape Restoration Strategy (2017), UNDP proxies
Climate-smart agriculture	100 to 400 USD per hectare (tools, inputs, training)	25 to 75 USD per hectare (ongoing support)	Based on CSA trials in Malawi and neighbouring countries (FAO)
Conservation agriculture	100 to 200 USD per hectare (inputs, training)	5 to 10 USD per hectare (support, monitoring)	Malawi conservation agriculture promotion programmes and regional trials (World Bank, FAO)
Improve soil fertility	50 to 200 USD per hectare (organic inputs, amendments)	5 to 10 USD per hectare (extension services)	Empirical data from similar countries for soil fertility management programmes (World Bank, FAO, CGIAR, CIRAD, IFAD)

Detailed economic appraisal, disaggregated by the priority sectors

Rainwater harvesting	1,000 to 5,000 USD per system (tanks, catchment infrastructure)	100 to 200 USD per system (maintenance)	Based on GCF- and GEF funded smallholder rainwater harvesting project
Irrigation schemes	2,000 to 7,000 USD per hectare (infrastructure and equipment)	100 to 300 USD per hectare (operation, maintenance)	Derived from Malawi Greenbelt Initiative data, smallholder schemes (Ministry of Agriculture)
Crop diversification	150 to 400 USD per hectare (seed inputs, technical support)	25 to 50 USD per hectare (extension, market access support)	Based on diversification programs in Malawi agriculture (FAO, World Bank)
General notes on the costs structure			
• Drought-tolerant crops: ○ CAPEX includes procurement and distribution of certified seed varieties (e.g., maize, cassava) ○ OPEX covers extension services, seed multiplication, and technical support to farmers • Afforestation/reforestation: ○ CAPEX covers nursery establishment, site preparation, planting indigenous or mixed species ○ OPEX includes weeding, fire control, and survival rate monitoring, typically over 3 to 5 years • Climate-Smart Agriculture (CSA): ○ CAPEX includes tools, improved inputs, soil conservation materials, and farmer field school establishment ○ OPEX reflects technical assistance, extension support, and monitoring for CSA package implementation • Conservation agriculture: ○ CAPEX includes basic conservation agriculture tools, soil cover materials, and initial farmer training ○ OPEX covers follow-up extension services, soil health monitoring, and knowledge exchange at community level • Improve soil fertility: ○ CAPEX covers organic inputs (compost, manure), lime application, and agroforestry integration materials ○ OPEX includes soil testing, fertility monitoring, and ongoing farmer advisory services • Rainwater harvesting: ○ CAPEX includes construction of water harvesting systems (rooftop tanks, ponds, surface runoff infrastructure) ○ OPEX covers maintenance, repairs, and community management of water storage systems • Irrigation schemes: ○ CAPEX includes infrastructure development (canals, pumps, pipes, solar systems) tailored to smallholder needs ○ OPEX covers operational costs, water management, maintenance, and irrigation governance structures • Crop diversification: ○ CAPEX covers seeds, inputs for alternative crops (legumes, horticulture, oilseeds), and training on diversification practices ○ OPEX reflects technical support, market access facilitation, and ongoing farmer advisory services			

Table 16. Cost parameters for fisheries sector adaptation measures

Adaptation Measure	CAPEX Estimate (USD)	OPEX Estimate (USD per year)	Assumptions / Source
Sustainable fishing	50 to 200 USD per fisher (gear upgrades, training, co-management setup)	20 to 50 USD per fisher (monitoring, enforcement, ongoing training)	Based on co-management schemes in Lake Malawi and Southern Africa (Department of Fisheries)
Protect/restore habitats	1,200 to 4,500 USD per hectare (habitat restoration, wetland protection, buffer zones)	100 to 200 USD per hectare (maintenance, monitoring)	Costs from wetland restoration and riparian buffer zone projects in Malawi (UCN, UNDP)
Aquaculture development	5,000 to 20,000 USD per aquaculture unit (pond or cage installation, seed stock, equipment)	500 to 1,500 USD per unit (feed, maintenance, labor)	Based on smallholder aquaculture programs and WorldFish Malawi studies (WorldFish, FAO)
General notes on the costs structure			
• Sustainable fishing: ○ CAPEX includes fishing gear improvements, co-management structures, and training materials ○ OPEX reflects community-level enforcement, monitoring, and technical support • Protect/restore habitats: ○ CAPEX covers costs for replanting aquatic vegetation, stabilizing shorelines, and catchment rehabilitation ○ OPEX accounts for patrols, habitat monitoring, and community-based protection measures • Aquaculture development: ○ CAPEX depends on system type (pond, cage, or tank) and location; higher for cages in Lake Malawi ○ OPEX covers feed costs, fingerlings restocking, operational labor, and maintenance			

Table 17. Cost parameters for forestry sector adaptation measures

Adaptation Measure	CAPEX Estimate (USD)	OPEX Estimate (USD per year)	Assumptions / Source
Sustainable forest management	50 to 300 USD per hectare (training, boundary demarcation, governance structures)	20 to 50 USD per hectare (monitoring, enforcement, community engagement)	Based on co-management and participatory forest management costs from Malawi Forestry Programs
Reforestation (indigenous or mixed species)	750 to 2,500 USD per hectare (site preparation, seedlings, planting)	50 to 150 USD per hectare (maintenance, fire prevention, monitoring)	Malawi Forest Landscape Restoration Strategy (2017) and international reforestation benchmarks
Community forest management	100 to 500 USD per hectare (capacity building, resource mapping, governance support)	20 to 50 USD per hectare (forest patrols, monitoring)	Based on IUCN and Malawi Department of Forestry pilot CFM schemes
Fire management	20 to 500 USD per hectare annually (firebreak construction, equipment, community fire response systems)	Included in CAPEX, as fire management is largely recurring annual expenditure	Data from integrated fire management initiatives in Malawi and Mozambique forests
General Notes on Cost Structure			
• Sustainable Forest Management (SFM): ○ CAPEX includes institutional strengthening, resource planning, and initial training			

Detailed economic appraisal, disaggregated by the priority sectors

○ OPEX reflects ongoing enforcement, patrols, and community liaison activities
● Reforestation: ○ Higher CAPEX for degraded lands requiring intensive planting, lower for assisted natural regeneration ○ Maintenance costs include weeding, fire protection, and monitoring survival rates
● Community Forest Management (CFM): ○ CAPEX focuses on governance structures, bylaws, and capacity building ○ OPEX covers forest patrols, conflict resolution, and benefit-sharing mechanisms
● Fire management: ○ Primarily annual operational costs (firebreak maintenance, early detection systems, rapid response) ○ Carbon co-benefits valued at USD 15/ton CO₂e for avoided emissions

Table 18. Cost parameters for infrastructure and DRR sector adaptation measures

Adaptation Measure	CAPEX Estimate (USD)	OPEX Estimate (USD per year)	Assumptions / Source
Resilient infrastructure	10% to 30% additional cost over standard infrastructure (roads, bridges, public facilities)	2% to 5% of asset value annually (maintenance, monitoring)	Based on climate-proofed design cost increases from World Bank and AfDB Malawi studies
Flood management	500,000 to 2 million USD per km of levees, dikes, riverbank stabilization OR 1,500 to 3,500 USD per hectare of protected floodplain	50 to 200 USD per hectare or protected area annually (maintenance, inspections)	Costs from flood mitigation projects in Malawi's Lower Shire Basin and World Bank disaster resilience reports
Early warning systems (EWS)	50,000 to 150,000 USD per system (hydromet stations, communication infrastructure)	5,000 to 15,000 USD per system annually (operations, maintenance, training)	Based on Malawi EWS investments under GCF, UNICEF, and WMO programs
General notes on the costs structure			
● Resilient infrastructure: ○ CAPEX calculated as a percentage increase over conventional infrastructure costs for roads, drainage, bridges ○ Higher-end estimates apply to flood-prone or high-risk zones ● Flood management: ○ High CAPEX for structural measures (levees, embankments) ○ Nature-based solutions (wetland restoration) generally at the lower end of cost range ● Early Warning Systems: ○ CAPEX includes procurement of equipment, installation, and initial training ○ OPEX reflects system maintenance, updates, and ongoing capacity building <u>Example Interpretation:</u> ○ A 5 km stretch of climate-resilient road may cost 20% more than conventional design (standard road ≈ 500,000 USD/km → resilient upgrade ≈ 600,000 USD/km) ○ A flood protection intervention for 500 hectares may require 750,000 to 1.75 million USD in CAPEX			

Table 19. Cost parameters for the social sector adaptation measures

Adaptation Measure	CAPEX Estimate (USD)	OPEX Estimate (USD per year)	Assumptions / Source
Awareness and education	10 to 50 USD per trained person (materials, workshops)	2 to 5 USD per person for follow-up engagement	Based on Malawi DRM public education campaigns and WMO guidance on climate literacy
Livelihood diversification	200 to 1,000 USD per household (skills training, start-up support)	50 to 150 USD per household (ongoing technical assistance)	FAO, IFAD rural livelihoods projects in Malawi (enterprise development, climate-resilient agriculture)
Access to services (health, education)	20,000 to 50,000 USD per health facility or school upgrade for resilience	5% to 10% of facility cost annually (maintenance, training)	Reflects costs for climate-proofed upgrades to rural health centres and schools (UNICEF, WHO Malawi)
Social safety nets (cash transfers, in-kind)	10 to 20 USD per beneficiary per month (cash transfer value)	Admin costs 5% to 15% of total transfer amount (programme management) or 24 per beneficiary per year	Based on Malawi Social Cash Transfer Programme, GIZ shock-responsive safety net evaluations
General notes on the costs structure			
● Awareness and education: ○ CAPEX reflects materials, community sessions, and information campaigns ○ OPEX includes follow-up sessions and local facilitator support ● Livelihood diversification: ○ Start-up costs vary by intervention type (e.g., small enterprises, livestock, crop diversification) ○ Ongoing costs cover extension, monitoring, and market linkages ● Access to services: ○ Infrastructure upgrades focus on building resilience to floods, droughts, or storms ○ OPEX accounts for essential supplies, staffing, and basic maintenance ● Social Safety Nets: ○ Transfer values aligned with Malawi SCTP (Social Cash Transfer Programme) and emergency response pilots ○ Administration cost estimates drawn from comparable programmes in Southern Africa			

Table 20. Summary of the CAPEX unit costs (USD) for adaptation options

Sector	Adaptation options	Description	CAPEX - Unit Cost (USD)	Source	Explanations
Agriculture	Drought tolerant crops	Introduction of drought-resistant crop varieties	50-150/ha	FAO report on drought risk management ⁷⁸	This unit cost price is based on a minimum number of units per activity (for economies of scale): typically, this unit cost is for a targeted area of e.g., 500–1,000 ha with a minimum number of farmers/households involved in the intervention.
	Climate Smart Agriculture	Integrated approach to managing agricultural systems to enhance productivity, resilience, and sustainability	Approximately 100 to 400/ha	World Bank and FAO reports on Climate-Smart Agriculture implementation costs	The unit cost reflects the average investment required to implement CSA practices per hectare. This includes expenses related to training, acquisition of improved seeds and inputs, development of water management systems, and adoption of sustainable land management techniques. Costs can vary based on specific practices adopted, local context, and scale of implementation. Economies of scale may reduce per-hectare costs.
	Soil conservation/rehabilitation/improved soil fertility	Soil restoration practices like low tillage	50-200/ha	UNCCD soil restoration studies ⁷⁹	This unit cost price is based on a minimum number of units per activity (for economies of scale): typically, this unit cost is for a targeted area of e.g., 500–1,000 ha with a minimum number of farmers/households involved in the intervention.
	Afforestation/Reforestation	Planting trees to restore degraded land	From 750 to 2,500/ha	WCS and WWF reforestation reports ⁸⁰	This unit cost price is based on a minimum number of units per activity (for economies of scale): typically, this unit cost is for a targeted area of e.g., 500–1,000 ha with a minimum number of farmers/households involved in the intervention.
	Crop diversification	Intercropping or crop rotation integrating high-value crops, legumes, fruits, and vegetables, to also improve soil health and reduce pest and disease incidence	From 150 to 400/ha	Cost estimates are derived from studies from e.g. CGIAR centers, CIRAD, agronomic research centers, etc.	The unit cost encompasses expenses related to seeds for multiple crops, additional labor for varied planting and harvesting schedules, and potential investments in new tools or equipment.
	Irrigation /rainwater harvesting	Development of irrigation networks for climate resilience	1,750-7,000/ha	World Bank irrigation cost estimate ⁸¹	This unit cost price is based on a minimum number of units per activity (for economies of scale): typically, this unit cost is for a targeted area of e.g., 500–1,000 ha with a minimum number of farmers/households involved in the intervention.
Fisheries	Sustainable fishing	Adoption of sustainable fishing practices	50/per fisher or 200/per household	FAO sustainable fishing report ⁸²	It reflects the training and provision of sustainable fishing gear or practices per person involved in fishing, as per the FAO sustainable fishing guidelines.
	Protect/restore habitats	Conservation and rehabilitation of critical ecosystems such as wetlands, riverbanks, lake shores, and breeding grounds essential for sustaining fish populations	Between 1,200 and 4,500/ha	Adapted from habitat restoration benchmarks from FAO Inland Fisheries Guidelines, Trillion Trees initiative reports, and regional ecosystem rehabilitation case studies (e.g., Lake Chilwa Wetland Management Plan, Malawi).	This cost estimate includes ecological assessments, labor and materials for habitat restoration, community engagement, and monitoring. Investments vary depending on habitat type, degree of degradation, and accessibility. Restoration activities in fisheries typically focus on breeding/nursery habitats and water quality improvements, which are key to rebuilding fish stocks. Community co-management and local bylaws often reduce long-term maintenance costs and improve enforcement. The option includes many different activities (and hence costs) such as removing invasive species, replanting native vegetation, reducing

⁷⁸ FAO (2022). *Climate Risk Profile: Malawi*. Available at: <https://openknowledge.fao.org/server/api/core/bitstreams/6d75fe02-b4eb-402f-80df-966d044d236e/content>

⁷⁹ Copenhagen Consensus Center (2019). *Natural Resource Management Technical Report*. Available at: https://copenhagenconsensus.com/sites/default/files/mp_nrm_technical_report.pdf

⁸⁰ Trillion Trees (2022). *Defining the Real Cost of Restoring Forests*. Available at: https://trilliontrees.org/wp-content/uploads/2022/08/Trillion-Trees_Defining-the-real-cost-of-restoring-forests.pdf

⁸¹ World Bank (2019). *Disclosable Restructuring Paper: Irrigation Development and Support Project (P102459)*. Available

at: <https://documents1.worldbank.org/curated/en/525971544634365617/pdf/Disclosable-Restructuring-Paper-Irrigation-Development-and-Support-Project-P102459.pdf>

⁸² FAO (2003). *Aquaculture Development. 2. Use of wild fish as feed in aquaculture*. Available at: <https://www.fao.org/4/ai002e/ai002e00.pdf>

Detailed economic appraisal, disaggregated by the priority sectors

Sector	Adaptation options	Description	CAPEX - Unit Cost (USD)	Source	Explanations
					pollution inflows, restoring natural water flows, and enforcing no-fishing zones in degraded areas.
	Aquaculture development	Investment in sustainable aquaculture systems	15,000/per aquaculture unit or 20,000/pond/farm	Research on aquaculture investment ⁸³	It includes infrastructure (pond construction, water management), fingerlings, feed, training, etc.
Forestry	Sustainable forest management	Implementing forest management best practices	50-300/ha annually	FSC and REDD+ forest management data ⁸⁴	It includes: technical planning, fire control, forest zoning, patrolling, basic silviculture, and sometimes certification costs. Typically applied across forest blocks or community-managed forest zones.
	Reforestation	Planting trees to restore degraded land	From 750 to 2,500/ha	WCS and WWF reforestation reports ⁸⁵ , CIFOR reports ⁸⁶	This unit cost price is based on a minimum number of units per activity (for economies of scale): typically, this unit cost is for a targeted area of e.g., 500–1,000 ha with a minimum number of farmers/households involved in the intervention.
	Fire management	Prescribed burning, mechanical thinning, creation of firebreaks, and community education programs	Approximately 20 to 500/ha	Cost estimates are based on various studies and reports on fire management practices, including data from the Global Fire Management Platform (UNEP and FAO) and other regional fire management programs.	The unit cost reflects the average investment required for implementing fire management practices per hectare. This includes expenses related to planning, labor, equipment, and monitoring. Costs can vary significantly based on the specific methods employed, terrain, vegetation type, and local labor rates. For instance, prescribed burning may be less expensive in flat, accessible areas, while mechanical thinning in rugged terrain can be more costly. Certain expenses can be annual while others are every 5 to 7 years.
	Community forest management	Community-led initiatives for sustainable forestry	1,000/per community group or forest user group or 100 – 500/ha	Community forestry economic studies ⁸⁷	It includes mobilization, training, legal setup, governance support, transaction costs (permits, monitoring, benefit sharing mechanisms). It is calculated per community forest initiative, not by area.
Infrastructure	Resilient infrastructure	Infrastructure designed to withstand climate impacts	1,000,000/per infrastructure unit or project (e.g., bridge, school, health center, road segment) or 10–30% cost increase over standard infrastructure	World Bank and OECD resilience studies ⁸⁸	It includes climate-proof design, elevated foundations, flood barriers, reinforced materials, and sometimes drainage/green infrastructure. However, it is highly variable depending on infrastructure type (road vs. school), but USD 1M is a benchmark for a single small-to-medium facility.
	Flood management	Constructing and rehabilitating infrastructure to mitigate flood risks in urban and rural areas (e.g. stormwater drainage systems, flood protection bunds, culverts, and retention basins)	Approximately 1,500–3,500/ha or 500,000 - 2 million per km	Cost estimates are based on data from the Malawi Floods Emergency Recovery Project ⁸⁹ and other related infrastructure rehabilitation initiatives.	Expenses relate to the design, construction, and maintenance of flood management structures. Costs can vary depending on the specific interventions, terrain, and materials used. For instance, constructing flood protection bunds and rehabilitating drainage channels in flood-prone areas like the Shire River basin have been integral to reducing flood risks.
	Early warning systems	Systems for forecasting and disaster preparedness	50,000–150,000/per system installed or per district	UN early warning system reports ⁹⁰	This covers installation of meteorological stations, software/hardware for communication, training, community drills. This is often scaled per district or sub-national area, and USD 50,000

⁸³ USDA Natural Resources Conservation Service (2003). *Cost Scenarios for Aquaculture Pond*. Available at: https://efotg.sc.egov.usda.gov/references/public/CT/CostScenarios_397-AquaculturePond.pdf

⁸⁴ Forest Stewardship Council (FSC) (2020). *FSC Public Reports and Publications*. Available at: <https://open.fsc.org/entities/publication/5f2ee6dd-58a6-49ae-bbff-8bd8a54a5556>

⁸⁵ Forest Stewardship Council (FSC) (2020). *FSC Public Reports and Publications*. Available at: https://trilliontrees.org/wp-content/uploads/2022/08/Trillion-Trees_Defining-the-real-cost-of-restoring-forests.pdf

⁸⁶ CIFOR-ICRAF (2024). *Knowledge Hub*. Available at: <https://www.cifor-icraf.org/knowledge/>

⁸⁷ Mwangi, E. and Wardell, A. (2012). *Transaction costs of community-based forest management: Empirical evidence from Tanzania*. Available at: https://www.researchgate.net/publication/227636565_Transaction_costs_of_community-based_forest_management_Empirical_evidence_from_Tanzania

⁸⁸ World Bank (2021). *Malawi Poverty and Social Impact Analysis*. Available at: <https://openknowledge.worldbank.org/entities/publication/c3a753a6-2310-501b-a37e-5dcab3e96a0b>

⁸⁹ World Bank (2019). *Malawi Floods Emergency Recovery Project*. Available at: <https://documents1.worldbank.org/curated/en/116211627912178702/pdf/Malawi-Floods-Emergency-Recovery-Project.pdf>

⁹⁰ United Nations (n.d.). *Early warnings for all*. Available at: <https://www.un.org/en/climatechange/early-warnings-for-all>

Sector	Adaptation options	Description	CAPEX - Unit Cost (USD)	Source	Explanations
					is a baseline estimate (actual costs can range from USD 30k– USD 150k depending on complexity and coverage).
Social Sector	Awareness and education	Educational campaigns on climate adaptation	20,000/per district-level campaign or program or 10 – 50/participant	UNESCO climate adaptation education study ⁹¹	This cost assumes a full education/awareness campaign rolled out at the district level or to a defined target population. The expenses involve development and dissemination of educational materials, workshops, radio/TV campaigns, community theater, school-based outreach.
	Livelihood diversification	Income-generating activities beyond traditional subsistence farming for rural households	Between 200 - 1,000 per household	Various programs and studies, including the Climate Adaptation for Rural Livelihoods and Agriculture project ⁹² and the Malawi Social Support for Resilient Livelihoods Project ⁹³ .	The unit cost encompasses expenses related to training, provision of starter kits (e.g., livestock, seeds, tools), and initial capital for small enterprises. Costs can vary based on the specific livelihood activity, scale of implementation, and local market conditions. For instance, establishing a small livestock enterprise may require higher initial investment compared to initiating a handicraft business.
	Health	Access to healthcare services and investment	20,000/healthcare package/intervention or per facility upgrade or 50 - 200 per person	Scientific research on health investment ⁹⁴	It reflects basic investment, not full hospital builds. May cover a small clinic, or a specific climate-related disease response package. Investments are for basic climate-resilient health infrastructure improvements, disease monitoring capacity, vaccine cold chain enhancement, training for health workers.
	Social safety nets	Programs providing financial and social support to vulnerable populations	10/per beneficiary per month	World Bank social protection cost analysis ⁹⁵	This is a monthly transfer value per person, typically used for poverty targeting in low-income settings. It includes direct cash transfers, food assistance, school stipends, or emergency relief.

3.7 Valuing the benefits of the adaptation measures in the priority sectors

Estimating the monetary value of the benefits of the NAP options at national level for the priority sectors constitutes one of the most important tasks of the CBA. On the one hand, assessing monetary values requires the adoption of hypotheses in order to transfer prices, wage levels and rate of return from similar (yet different) situations. On the other hand, capturing the incremental benefit due to the adaptation measures also requires making a hypothesis on the situation without the project.

Obviously, the availability and quality of information on the adaptation measures and its benefits constitute a key issue for the accuracy of the benefits estimates. Interviewing the beneficiaries and collecting local data allow to determine the willingness to pay of the beneficiaries for the benefits. In the case of the adaptation measures in the priority sectors, the availability of data is relatively good. However, the quality and veracity of this information remains at stake since it suffers from gaps and inaccuracies (e.g. concerning the costs of soil restoration or aquaculture). Accordingly, confidence intervals for each benefit estimates are set. These margins of errors result from the use of different valuation methodologies, transfer sources or hypothesis.

Agricultural adaptation measures: Drought-tolerant crops, climate-smart agriculture, conservation agriculture, irrigation schemes, crop diversification, soil fertility improvement, rainwater harvesting. For instance, the adaptation options lead to an increase in the production of crops. This increase is due to the lower impact of soil erosion thanks to the low-tillage practices for instance, that increases the soil fertility. Without the project, the situation is

⁹¹ UNESCO (n.d.). *Education and Climate Adaptation*. Available at: <https://unesdoc.unesco.org/education-climate-adaptation>

⁹² https://www.afdb.org/fileadmin/uploads/afdb/Documents/Project-and-Operations/Malawi_-_AR_-_Climate_Adaptation_for_Rural_Livelihood_and_Agriculture_CARLA_-_LOTB_-_Approved_.pdf

⁹³ World Bank (n.d.). *Malawi Agriculture Climate Adaptation Project (P169198)*. Available at: <https://projects.worldbank.org/en/projects-operations/project-detail/P169198>

⁹⁴ Faye, M., et al. (2020). "Socioeconomic and environmental impacts of climate change in Sub-Saharan Africa." *Sustainable Cities and Society*, 62, 102383. Available at: <https://www.sciencedirect.com/science/article/pii/S2405844020323355>

⁹⁵ World Bank (2021). *Malawi Flood Emergency Recovery Project - Environmental and Social Management Framework*. Available at: <https://openknowledge.worldbank.org/server/api/core/bitstreams/04b68ea1-c06e-5a9a-b8ff-239a37323569/content>

characterized by declining soil fertility and land degradation, with inappropriate farming techniques, especially on steep slopes with increased soil erosion, focusing only on the direct contribution on agricultural productivity. The loss of production due to erosion appears gradually over time while the impact of the use of soil conservation practices appears in the short term: using data on yields, prices and production cost as well as the information collected from the beneficiaries, the total value added of climate smart agriculture is estimated.

Ecosystem and natural resource management measures: Reforestation, afforestation, sustainable forest management, fire management, community forest management, sustainable fishing, habitat restoration & aquaculture development (by improving the ecological health of freshwater and nearshore systems, support fish reproduction, and increase the long-term productivity and resilience of fisheries under climate stress).

Infrastructure and social resilience measures: Resilient infrastructure, flood management, early warning systems, awareness and education, livelihood diversification, access to services, social safety nets.

Table 21. Identification of the benefits derived from the adaptation options⁹⁶

Categories	Benefits
Agriculture	Additional value added compared to the situation without the project due to : Lower loss due to soil erosion control Higher yield due to resilient / high-value export crops Additional income from irrigation
Fishery	Additional value added compared to the situation without the project due to aquaculture
Forestry	Lower pressure on the forest ecosystem. Reduction of GHG emissions through ARR (without the project, GHG emission resulting from the illegal logging would have happened anyway. Furthermore, GHG emissions from forest fires would have happened) Environmental benefits in terms of protection ecosystems
Resilient infrastructure	Time saving due to the lower distance to fetch for water Lower risks of flooding of road, pumps, etc. Climate-proof and more secured infrastructure reduces their exposure to natural disaster. Compared to the situation before the project, this lead to a lower amount of degradation and economic loss. The availability of more secured, better quality and larger houses compared to the situation without the project generates a gain of welfare (better quality of life) for the beneficiaries.
Social sector	Health and economic benefits (lower health cost, gain of working and education days) due to the lower prevalence of waterborne related diseases Social benefits can be measured with healthier farmers or a higher rate of school attendance by the children living in the region increase the economic rate of return of education (higher productivity of labour) The people belong to a community sharing some risks and opportunities. The community has a great importance to the beneficiaries. They declare they feel more secure, better integrated in society and more confident for the future.

The identification of benefits derived from the implementation of adaptation options forms the foundation for evaluating their economic, social, and environmental relevance within the context of Malawi's climate resilience strategy. As summarised in the table above, the primary benefits associated with each sector include both direct economic gains (such as increased agricultural value added, improved productivity, and reduced damage to infrastructure) and wider social and environmental co-benefits, including enhanced food security, ecosystem protection, and improved health outcomes. These broad benefit categories reflect the systemic nature of adaptation, where interventions contribute not only to reducing vulnerability but also to strengthening development outcomes.

To operationalise these benefits within the CBA framework, a detailed set of quantitative parameters has been established for each priority adaptation measure. The next table presents

⁹⁶ Ibidem

Detailed economic appraisal, disaggregated by the priority sectors

these parameters, specifying the technical indicators, benefit magnitudes, measurement units, and data sources used to assess the economic value of the 22 adaptation measures prioritised across the agriculture, fisheries, forestry, infrastructure, and social sectors. This ensures that benefit estimation is transparent, consistent, and aligned with both national data and international best practices, providing a robust basis for comparing adaptation options and informing investment decisions.

Table 22. Parameters to assess the benefits of the 22 adaptation measures, for the priority sectors⁹⁷

Sector	Adaptation measures	Benefits (parameters used for the CBA)
Agriculture	Drought tolerant crops	<u>Increased crop yields</u> : +15% to +40% yield improvement over traditional varieties Unit: per hectare Source: FAO, CGIAR publications (proxy)
		<u>Reduced crop failure risk</u> : 20% to 50% lower probability of complete crop loss Unit: per hectare Source: Modelled reduction in yield variability under drought scenarios (proxy)
		<u>Enhanced food security</u> : Additional 250 to 500 kg of staple food produced annually Unit: per hectare Source: Assuming maize or cassava for household consumption, Malawi food security data, FAO
		<u>Income stability for smallholders</u> : USD 100 to USD 250 annual income increase Unit: per household Source: Based on farm-gate price improvements and reduced production volatility, FAO (proxies and CSA reports)
	Afforestation/Reforestation	<u>Carbon sequestration (mitigation co-benefit)</u> : 5 to 12 tons CO ₂ e sequestered annually Units: per hectare Price assumption: USD 15 per ton of CO ₂ sequestered (Verra standard, if community forests related to agriculture) Source: Xpansiv for carbon market data, FAO data
		<u>Restoration of degraded land</u> : 70% to 90% increase in vegetation cover after 5 years Unit: per hectare Source: Satellite-based assessments from Southern Africa restoration projects (e.g. IUCN, TNC, etc.)
		<u>Reduction in soil erosion and flood risk</u> : 20% to 50% decrease in runoff and soil loss Unit: per hectare Source: World Bank / GEF reports for watershed modelling in comparable areas such as Zambia
		<u>Improved biodiversity and ecosystem services</u> : 15% to 30% increase in species diversity or habitat quality Unit: per hectare Source: Based on forest restoration sites monitored by Department of Forestry (and proxies)
		<u>Enhanced water retention in catchments</u> : 10% to 25% increase in soil moisture retention Unit: per hectare Source: Data from afforestation impacts on hydrology in riparian zones in various FAO Africa studies
		<u>Improved yields through resilient practices</u> : +20% to +50% increase in crop yields Unit: per hectare Source: Proxy data from Kenya (e.g. More People, Less Erosion, Mary Tiffen, Michael Mortimore, Francis Gichuki, 1994, ODI. No data for Malawi but recommendations is to do field trials for CSA practices in Malawi (conservation tillage, crop rotation)
	Climate smart agriculture	<u>Efficient use of inputs (fertilizer, water)</u> : 15% to 30% reduction in input use per unit of output Unit: per hectare Sources: Proxies (studies of improved soil management and water-use efficiency, FAO, CGIAR, CIRAD, etc.)
		<u>Reduced GHGH from farming</u> : 0.5 to 2 tons CO ₂ e avoided annually Unit: per hectare Price Assumption of carbon farming: USD 35/ton of CO ₂ Sources: World Bank Carbon Pricing Dashboard, mitigation potential from reduced tillage, improved soil carbon, and lower fertilizer use
		<u>Income diversification for rural communities</u> : USD 150 to USD 400 annual income increase Unit: per hectare Assumption: Additional revenue from diversified crops, improved productivity, and market access
		<u>Strengthened resilience to climate shocks</u> : 20% to 40% reduction in yield variability (stability gains) Unit: per hectare Source: Measured reduction in production volatility under CSA systems (proxies, various research papers)
		<u>Enhanced soil structure and fertility</u> : 15% to 35% increase in soil organic matter over 5–10 years Unit: per hectare Source: Proxies (ideally, use soil health monitoring in conservation agriculture pilot sites)
	Conservation agriculture	<u>Increased yields, particularly over long term</u> : +15% to +40% yield increase after 3–5 years of adoption Unit: per hectare Sources: FAO-supported trials in Southern Africa, including Malawi

⁹⁷ Government of Malawi (2024) Policy Brief (February 2024), and CRVA documents, including the validation presentation from Sept 2024.

Detailed economic appraisal, disaggregated by the priority sectors

		<u>Reduced erosion and land degradation</u>: 25% to 60% reduction in soil erosion and runoff Unit: per hectare Sources: Studies from sloped and degraded areas under conservation agriculture (proxies) <u>Lower input costs</u> (e.g., reduced tillage): 10% to 25% reduction in production costs (labour, fuel) Unit: per hectare Sources: Farm budget analyses from other countries conservation agriculture promotion programmes (proxies) <u>Improved moisture retention</u>: 10% to 30% higher soil moisture availability Unit: per hectare Data from field demonstrations under semi-arid conditions in other African countries
		<u>Increased agricultural productivity</u>: +20% to +50% increase in yields (maize, legumes) Unit: per hectare Empirical studies from Southern African countries on soil fertility management <u>Enhanced food security and nutrition</u>: Additional 300 to 800 kg of staple food produced annually Unit: per hectare Price of staple foods: FAO Food Price Index Sources: Based on typical maize productivity responses with improved soil fertility inputs, FAO World Food Situation <u>Long-term soil health and carbon storage</u>: 0.5 to 2 tons CO₂e sequestered per hectare annually Unit: per hectare Price of carbon soil: USD 15 (for Carbon Removals and Carbon Farming) Source: S&P Commodities, linked to soil organic matter improvements from organic inputs and reduced degradation <u>Reduced land degradation</u>: 20% to 50% decrease in soil erosion and nutrient depletion Unit: per hectare Studies from degraded land restoration programmes in research papers (proxies) <u>Economic stability for farming households</u>: USD 120 to USD 300 annual income increase Unit: household Assumption: It reflects both higher yields and reduced fertilizer dependency in sustainable soil management systems
		<u>Increased water availability for agriculture</u>: 5,000 to 15,000 litres of water harvested annually per system Unit: per rainwater system Smallholder rooftop and surface runoff harvesting systems common in Malawi <u>Reduced dependence on unreliable rainfall</u>: 15% to 40% reduction in crop losses due to rainfall variability Unit: per hectare Empirical data from rainwater harvesting pilot sites/projects in the literature <u>Improved resilience to drought</u>: 1 to 2 additional planting cycles per year (partial irrigation support) Unit: per hectare Based on small-scale water storage and use during dry spells (project information from GEP and GCF websites) <u>Enhanced productivity, especially for high-value crops</u>: +30% to +70% increase in yields for vegetables, fruits, or cash crops Unit: per hectare Based on supplemental irrigation enabling diversified crop production <u>Strengthened water security for communities</u>: +25% to +60% increase in access to reliable water for domestic and agricultural use Unit: per household or community Community-level benefits from shared rainwater harvesting infrastructure
	Irrigation schemes	<u>Year-round agricultural production</u>: Enables 2 to 3 planting cycles per year Unit: per hectare Sources: Data from smallholder irrigation schemes in Malawi's Greenbelt Initiative (2012) <u>Increased crop yields and diversification</u>: +50% to +150% increase in annual crop yields Unit: per hectare Based on irrigated maize, rice, horticulture systems <u>Improved resilience to erratic rainfall</u>: 60% to 90% reduction in crop failure risk due to dry spells Unit: per hectare Ideally, empirical data from Malawi smallholder irrigation pilots <u>Enhanced food security and incomes</u>: USD 300 to USD 900 increase in annual household income Unit: per household Based on yield improvements and market access for irrigated crops <u>Potential for high-value, market-oriented crops</u>: Up to 70% increase in production of vegetables, fruits, or cash crops Unit: per hectare Observed outcomes in irrigation-supported agricultural zones (literature review)
		<u>Reduced risk of total crop failure</u>: 20% to 50% reduction in household-level food insecurity Unit: per household or per hectare Based on livelihood resilience studies in mixed farming systems <u>Improved dietary diversity and nutrition</u>: +15% to +40% increase in household dietary diversity scores Unit: per household Based on introduction of legumes, fruits, and vegetables in smallholder systems (eg UNICEF nutrition surveys) <u>Market opportunities for alternative crops</u>: Access to new markets for 2 to 5 alternative crops per farming household Unit: per household Assumption: Diversified value chains (legumes, horticulture, oilseeds) <u>Enhanced household income streams</u>: USD 200 to USD 500 increase in annual income Unit: per household Reflecting higher value crops and price stability from diversified production
	Crop diversification	<u>Reduced risk of total crop failure</u>: 20% to 50% reduction in household-level food insecurity Unit: per household or per hectare Based on livelihood resilience studies in mixed farming systems <u>Improved dietary diversity and nutrition</u>: +15% to +40% increase in household dietary diversity scores Unit: per household Based on introduction of legumes, fruits, and vegetables in smallholder systems (eg UNICEF nutrition surveys) <u>Market opportunities for alternative crops</u>: Access to new markets for 2 to 5 alternative crops per farming household Unit: per household Assumption: Diversified value chains (legumes, horticulture, oilseeds) <u>Enhanced household income streams</u>: USD 200 to USD 500 increase in annual income Unit: per household Reflecting higher value crops and price stability from diversified production

Detailed economic appraisal, disaggregated by the priority sectors

		<u>Greater resilience to pests, diseases, and climate variability</u>: 30% to 60% reduction in yield losses from pests or climatic shocks <u>Unit</u>: per hectare Based on empirical evidence from crop rotation and species diversification
Fisheries	Sustainable fishing	<u>Reduced overfishing and stock depletion</u>: 20% to 50% increase in fish stock biomass over 5 years <u>Unit</u>: per managed fishery area (hectare or zone) Based on fisheries co-management outcomes in Lake Malawi (Department of Fisheries, Ministry of Natural Resources and Climate Change)
		<u>Stabilized income for fishing households</u>: USD 150 to USD 400 annual income stability improvement <u>Unit</u>: per fisher Linked to sustainable catch limits and improved governance
		<u>Food security through reliable fish supply</u>: 15% to 35% increase in fish availability for local markets <u>Unit</u>: per household or per community Reduction in seasonal fish scarcity documented in Malawi riparian communities
		<u>Enhanced breeding grounds and fish diversity</u>: 25% to 60% increase in fish recruitment rates in protected areas <u>Unit</u>: per hectare of restored habitat Evidence from Lake Malawi and surrounding wetlands restoration projects
	Protect/restore habitats	<u>Reduced sedimentation and water quality improvement</u>: 20% to 50% decrease in turbidity and pollutants <u>Unit</u>: per hectare Benefits related to catchment restoration and buffer zone management
		<u>Resilience of fish populations to climate stressors</u>: 15% to 30% reduced fish mortality during drought or temperature extremes <u>Unit</u>: per fishery zone Outcomes from aquatic habitat conservation in sub-Saharan Africa (IUCN)
	Aquaculture development	<u>Increased fish production and food security</u>: 2 to 5 tons of fish produced annually <u>Unit</u>: per aquaculture unit (pond or cage) Based on Malawi aquaculture productivity benchmarks
		<u>Income generation and diversification</u>: USD 500 to USD 1,500 net income increase per year <u>Unit</u>: per aquaculture operator Profitability estimates for smallholder aquaculture systems eg WorldFish
		<u>Reduced pressure on wild fish stocks</u>: 10% to 25% decrease in fishing pressure in adjacent areas <u>Unit</u>: per community Based on substitution effects where aquaculture supplements local fish demand
Forestry	Sustainable forest mgt.	<u>Enhanced forest cover and biodiversity</u>: 15% to 40% increase in forest health index over 5–10 years <u>Unit</u>: per hectare Assumption: based on SFM practices in Malawi forest reserves
		<u>Reduced illegal logging and deforestation</u>: 20% to 50% decrease in deforestation rates in managed areas <u>Unit</u>: per hectare Community-led forest governance results from Malawi forest co-management project
		<u>Improved livelihoods from forest products</u>: USD 150 to USD 400 income increase from NTFPs annually <u>Unit</u>: per household participating Income from sustainable harvesting of firewood, honey, and medicinal plants (see Forest Livelihoods Program, World Bank)
	Reforestation	<u>Carbon sequestration (climate mitigation)</u>: 5 to 12 tons CO₂e stored annually per hectare <u>Unit</u>: per hectare Carbon price: USD 8,5 (Verra standard) Reforestation with indigenous or mixed species in degraded areas
		<u>Soil erosion control and watershed protection</u>: 20% to 50% reduction in soil loss <u>Unit</u>: per hectare Assumption: slope stabilization and catchment restoration
		<u>Improved ecosystem services (pollination, shade)</u>: 10% to 25% increase in ecosystem productivity <u>Unit</u>: per hectare Ecosystem service assessments from Malawi agroforestry and reforestation sites
	Community forest mgt.	<u>Increased community ownership and forest protection</u>: 30% to 70% decrease in unauthorized harvesting <u>Unit</u>: per managed forest area Sources: IUCN, community forest management groups usually show significant reduction in illegal resource use
		<u>Sustainable fuelwood and forest product availability</u>: 20% to 50% improvement in household access to forest products <u>Unit</u>: per household Income and energy security benefits observed in CFM pilot area
		<u>Strengthened governance and local capacity</u>: Measurable improvements in compliance and participation <u>Unit</u>: per community Enhanced local governance structures documented in Malawi CFM schemes
	Fire management	<u>Reduced forest fire frequency and severity</u>: 40% to 80% reduction in burned area annually <u>Unit</u>: per hectare managed Based on firebreaks, early detection, and community fire management
		<u>Preserved forest carbon and biodiversity</u>: 5 to 15 tons CO₂e emissions avoided per hectare annually <u>Unit</u>: per hectare Price of carbon: USD 15 Reduced emissions from avoided fire damage in forest landscapes, Verra
		<u>Protection of infrastructure and livelihoods</u>: 20% to 50% reduction in fire-related damages to farms and homes <u>Unit</u>: per community

Detailed economic appraisal, disaggregated by the priority sectors

Infrastructure	Resilient infrastructure	Documented impacts from integrated fire management in forest-adjacent areas <u>Reduced infrastructure damage from floods/droughts</u> : 20% to 50% reduction in repair and reconstruction costs <u>Unit</u> : per km of road, bridge, or facility <u>Sources</u> : World Bank Transport Resilience Studies (climate-proofed design standards in Malawi's road and public infrastructure)
		<u>Improved service continuity during climate shocks</u> : 25% to 60% reduction in transport or service disruptions <u>Unit</u> : per community or facility Observed benefits from resilient infrastructure investments in flood-prone districts
		<u>Long-term cost savings from reduced maintenance</u> : 10% to 25% reduction in lifecycle maintenance costs <u>Unit</u> : per infrastructure unit <u>Sources</u> : AfDB Infrastructure Report, etc. (durability of resilient construction materials and drainage systems)
	Flood management	<u>Reduced flood exposure for communities</u> : 30% to 70% reduction in population at risk <u>Unit</u> : per intervention zone Benefits from levees, drainage improvements, riverbank stabilization
		<u>Decreased economic losses from flooding</u> : USD 500 to USD 2,000 avoided losses annually per household <u>Unit</u> : per affected household Based on flood damage assessments in Malawi's Shire and Lower Basin regions
		<u>Enhanced land productivity and settlement safety</u> : 20% to 50% increase in land available for productive use <u>Unit</u> : per protected area <u>Sources</u> : see Malawi Water Board, observed in flood mitigation areas following dike construction and wetland restoration
	Early warning systems	<u>Reduced disaster-related fatalities and injuries</u> : 30% to 80% reduction in casualties during extreme events <u>Unit</u> : per community with EWS EWS deployment and community preparedness drills
		<u>Increased lead time for preparedness actions</u> : Additional 12 to 72 hours of warning provided <u>Unit</u> : per event Typical performance of upgraded hydromet and early warning systems in Southern Africa (WMO)
		<u>Avoided economic damages through timely evacuation</u> : USD 1,000 to USD 3,000 avoided losses per household per major event <u>Unit</u> : per household covered by EWS Empirical studies from cyclone Idai and Malawi flood-affected districts
Social Sector	Awareness and education	<u>Improved knowledge on climate risks</u> : 50% to 80% increase in awareness among targeted populations <u>Unit</u> : per trained person
		<u>Behavioural change adoption (e.g., early action)</u> : 20% to 40% increase in proactive risk reduction behaviours <u>Unit</u> : per household Documented impacts from community education and sensitization campaign (Malawi DRM Reports)
		<u>Reduced disaster vulnerability through informed decision-making</u> : 15% to 30% reduction in disaster-related losses or impacts <u>Unit</u> : per community <u>Sources</u> : WMO, FAO, based on international experience with climate risk literacy programs
	Livelihood diversification	<u>Increased household income stability</u> : USD 200 to USD 600 increase in diversified income annually <u>Unit</u> : per household <u>Sources</u> : FAO, IFAD (alternative income sources (e.g., small enterprises, climate-resilient crops))
		<u>Reduced dependence on climate-sensitive sectors</u> : 15% to 40% reduction in income volatility <u>Unit</u> : per household Benefits from livelihood diversification schemes in Malawi's rural areas
		<u>Improved health service coverage</u> : 15% to 30% increase in access to essential health care <u>Unit</u> : per community <u>Assumption</u> : rural health system strengthening
		<u>Reduced morbidity and mortality from climate-sensitive diseases</u> : 20% to 50% reduction in climate-linked illnesses <u>Unit</u> : per household <u>Assumption</u> : benefits from malaria, malnutrition, and waterborne disease prevention (WHO)
	Access to services	<u>Strengthened resilience to climate shocks</u> : 25% to 50% reduction in negative coping strategies post-disaster <u>Unit</u> : per household <u>Sources</u> : UNICEF (see Social Protection Programs)
		<u>Enhanced educational continuity post-disaster</u> : 10% to 25% decrease in school dropouts during emergencies <u>Unit</u> : per school <u>Assumption</u> : improved access to resilient schools and education services <u>Sources</u> : UNICEF and UNESCO
		<u>Reduced poverty and vulnerability</u> : USD 120 to USD 300 in avoided income shortfalls during shocks <u>Unit</u> : per beneficiary <u>Sources</u> : Based on Malawi Social Cash Transfer Programme and shock-responsive safety nets documented in GIZ reports
		<u>Increased consumption and food security</u> : 10% to 25% increase in household food consumption scores <u>Unit</u> : per household <u>Assumption</u> : benefits from safety net programs in drought-prone regions
	Social safety nets	<u>Improved community resilience to disasters</u> : 20% to 40% reduction in negative coping mechanisms <u>Unit</u> : per community

Social impact of the adaptation measures compared to the BAU

The implementation of the proposed adaptation measures across agriculture, fisheries, forestry, infrastructure, and social protection sectors is expected to generate substantial positive social outcomes, particularly for vulnerable populations in Malawi. This section summarizes the key social benefits, with quantified indicators derived from the CBA and complementary socio-economic modelling.

Poverty reduction and income stability: Several measures directly target household income stabilization, diversification of livelihoods, and poverty alleviation:

- Drought-tolerant crops: Expected to increase household income by USD 100 to USD 250 per year through yield improvement and reduced crop failure risk. It is assumed in the model that the intervention will target circa 500,000 smallholder households.
- CSA: Income diversification for rural communities is estimated at USD 150 to USD 400 per hectare annually, with potential to benefit 1 million hectares under CSA.
- Livelihood diversification programs: Targeting approximately 400,000 households, these measures are assumed, to increase annual household income by USD 200 to USD 600, with an average of USD 350 per household based on market access to alternative crops and resilience gains.

Food security and nutrition improvements: Interventions significantly enhance food production and dietary diversity:

- Irrigation schemes: Compared to the BAU, it is proposed to irrigate approx. 290,000 hectares (“Out of the estimated potential of 407,8621 hectares, only about 104,6342 hectares have been developed for irrigation purposes representing 25% of the potential area”⁹⁸), leading to a 100% average yield increase, with household income improvements of USD 600 per year.
- Crop diversification: The aim is to promote dietary diversity (+15% to +40% increase in diversity scores) and reduces household food insecurity by 20% to 50%, aligning with national nutrition objectives.
- Rainwater harvesting and soil fertility management: This will contribute to enhanced water security and staple food production, estimated at 300 to 800 kg of additional food per hectare annually.

Health, education, and basic service access: Social sector interventions strengthen human capital and resilience to climate-linked health risks:

- Access to services: Against the BAU, health system improvements are expected to reduce morbidity and mortality from climate-sensitive diseases by 20% to 50%, with a 15% to 30% increase in access to essential healthcare.
- Awareness and education campaigns: In addition to a BAU scenario, climate-oriented nationwide risk literacy programs aim to improve climate risk awareness by 50% to 80%, fostering behavioural change (20% to 40% increase in proactive risk reduction).
- Educational continuity: Under an adaptation plan, versus the BAU, it is anticipated to see a 10% to 25% decrease in school dropouts during climate emergencies, supported by resilient school infrastructure and community preparedness.

Community resilience and social protection: Safety nets and early recovery programs play a role in protecting vulnerable groups:

- Social safety nets: It is expected to reduce income shortfalls during shocks as compared to the BAU by USD 120 to USD 300 per beneficiary annually. Approximately 30% of

⁹⁸ 2016 National Irrigation Policy (<https://faolex.fao.org/docs/pdf/mlw175713.pdf>)

the population living below the food poverty line are targeted, with significant improvements in food consumption scores (10% to 25% increase).

- EWS: The deployment of 180 EWS, covering 2,500 households each, is projected to significantly reduce fatalities and injuries during disasters, while providing up to 72 hours of early warning, enhancing preparedness and reducing economic losses.

Gender and inclusion considerations: While the interventions have broad community benefits, specific attention is required to ensure:

- Equitable access to adaptation benefits for women-headed households, particularly in agriculture and social protection programs.
- Enhanced participation of marginalized groups in governance mechanisms, notably in community forest management and disaster risk reduction committees.
- Integration of nutrition-sensitive agriculture and health services with targeted outreach to women and children, addressing underlying vulnerability drivers.

Economic impact of the adaptation measures compared to the BAU

Compared to the BAU scenario, the alternative adaptation scenario enables to quantify both direct and indirect economic benefits resulting from the 22 adaptation measures in the 5 priority sectors. The analysis was grounded in productivity modelling, comparing agricultural and fisheries outputs under current climate risks versus improved outcomes with adaptation investments. Specifically, the CBA incorporated yield gains from drought-tolerant crops (averaging 20% to 30% increase), productivity enhancements through climate-smart agriculture, and fish stock protection linked to sustainable fisheries management.

Where monetizable, the valuation of ecosystem services was included to capture avoided costs associated with land degradation, deforestation, and flood damage. This encompassed the role of reforestation, improved soil fertility, conservation agriculture, and flood management in safeguarding natural capital and mitigating disaster risks. The benefits of resilient infrastructure were similarly assessed in terms of avoided economic losses due to climate shocks.

National-level estimates highlighted the broader economic contribution of adaptation investments to agriculture and fisheries GDP, alongside income stability for smallholder households, job creation in aquaculture, forestry, and conservation sectors, and enhanced market access for rural producers.

Also, the national-level CBA distinguishes clearly between marketed economic benefits, which directly contribute to household incomes, agricultural productivity, and national economic output, and non-marketed benefits, which reflect environmental services and resilience gains not typically captured by traditional market transactions. Based on the results, marketed benefits from the proposed adaptation measures amount to approximately USD 682.57 million per year, highlighting the substantial contribution of yield improvements, income stability, and increased fish and crop production to Malawi's BAU scenario in terms of economic development.

Table 23. Marketed economic benefits⁹⁹

Category	Total Annual Benefits (USD) under RCP 4.5
Increased crop yields	USD 512.61 million
Income stability for farmers and fishers	USD 169.96 million
Productivity improvements (irrigation, fisheries, diversified agriculture)	Not separately identifiable in the current dataset

It is important to note that the CBA results reflect assumptions on productivity gains, market prices, and ecosystem service valuation based on available data and proxies. Local variations and data gaps necessitate periodic validation and refinement of these estimates to support evidence-based decision-making.

⁹⁹ The CBA dataset quantifies increased yields and income stability. Benefits linked to broader productivity improvements (e.g., diversified agriculture, irrigation efficiencies) are either aggregated under these categories or not distinctly specified in the available benefits descriptions.

Environmental benefits of the adaptation measures compared to the BAU

The results of the national CBA present a quantification of the environmental benefits of the 22 priority adaptation measures. The assessment focused on four key categories of environmental impact:

- **Biodiversity conservation:** Investments in reforestation, habitat restoration, and community forestry contribute to reducing ecosystem degradation, restoring vegetation cover, and improving habitat quality.
- **Carbon sequestration:** Afforestation and reforestation efforts enhance carbon storage, delivering measurable climate mitigation benefits.
- **Soil and water conservation:** Sustainable land management practices, including conservation agriculture and improved soil fertility, reduce erosion, restore soil health, and increase water retention at landscape level.
- **Climate risk reduction:** Flood management, fire control, and early warning systems reduce the exposure of communities and ecosystems to extreme weather events. For example, early warning systems are expected to reduce flood damages by up to 30% in targeted areas.

The CBA estimates that environmental benefits from carbon sequestration alone amount to approximately USD 83.4 million per year, reflecting the monetized value of avoided GHG emissions based on conservative carbon price assumptions (USD 15 per ton CO₂e for ARR, USD 8.5 for conservation, USD 15 for Carbon Removals and Carbon Farming or CRCF).

While the economic valuation of biodiversity gains, improved soil and water resources, and disaster risk reduction was not fully captured in monetary terms, these non-marketed benefits remain substantial. For instance, interventions are projected to reduce deforestation rates by 10% to 20%, enhance vegetation cover, and significantly improve water availability, all of which underpin long-term resilience, agricultural productivity, and ecosystem stability.

Further work is recommended to integrate non-market valuation approaches, ensuring a more comprehensive quantification of the environmental co-benefits associated with adaptation investments.

3.8 Key model assumptions

3.8.1 Discount Rate

Assumption: The discount rate for this CBA is set at 8%, reflecting Malawi's historical economic conditions and national policies. This rate is chosen to balance the need for economic growth with the long-term sustainability of adaptation investments. It sits below the 13% average observed in Malawi over 1963-2016 and is tested between 5% and 10% in the sensitivity analysis, ensuring that adaptation measures are financially sustainable and effective.

Rationale related to the historical context: Malawi's discount rate has varied significantly over the years, with an average of 13% from 1963 to 2016.

Rationale related to inflation considerations: Malawi's inflation rate has been volatile, increasing to 28.50% in January 2025 from 28.10% in December 2024¹⁰⁰. The average inflation rate is forecast to decrease by 24.1% points between 2024 and 2029, with an estimated rate of 6.48% in 2029.

Sensitivity analysis: To ensure the robustness of the CBA, a sensitivity analysis was conducted using discount rates ranging from 5% to 10%. This range accounts for varying economic scenarios and risk perceptions.

¹⁰⁰ RBM (Reserve Bank of Malawi) (n.d.). Available at: <https://www.rbm.mw/>

3.8.2 Investment period and inflation-adjusted cost projections

Assumption: The investment period for the adaptation measures spans twenty years from 2025, with results reported at the 2040 and 2080 horizons. Cost projections reflect the phasing of capital expenditure over the investment phase and the escalation of recurrent costs and benefits.

Rationale for the long-term planning: This period aligns with the long-term nature of climate change impacts and the need for sustained adaptation efforts.

Climate scenarios: The analysis considers climate risks based on RCP 4.5 and RCP 8.5 scenarios, focusing on the horizons of 2040 and 2080.

Table 24. Increased benefits of adaptation measures under RCP 8.5 compared to RCP 4.5 in Malawi¹⁰¹
All values in USD million

Adaptation Measure	Benefits RCP 4.5	Benefits RCP 8.5	Increased benefits (%)	Rationale
Drought tolerant crops	3,341.3	4,677.9	40	Crop failures rise sharply under RCP 8.5; resilient varieties prevent larger losses.
Afforestation/Reforestation	1,106.6	1,770.6	60	Tree cover restores degraded land and buffers heat and erosion, both of which intensify under RCP 8.5.
Climate smart agriculture	1,617.6	2,183.8	35	Integrated practices sustain yields as rainfall becomes more variable and growing seasons shift.
Conservation agriculture	299.7	404.6	35	Reduced tillage and soil cover limit moisture loss and erosion under heavier rains and longer dry spells.
Improve soil fertility	1,005.9	1,307.7	30	Nutrient loss accelerates with heavier rains and drought cycles; restored fertility protects yields.
Rainwater harvesting	556.4	778.9	40	Water scarcity intensifies with warming; storage buffers household and farm needs through longer dry spells.
Irrigation schemes	9,436.9	12,267.9	30	Rainfall variability and drought under RCP 8.5 make supplementary irrigation increasingly decisive for output.
Crop diversification	2,920.2	3,796.3	30	A wider crop portfolio spreads exposure as single-crop failure becomes more frequent.
Sustainable fishing	73.2	117.1	60	Fish stocks decline more severely with rising water temperatures; managed effort prevents collapse.
Protect/restore habitats	352.6	458.3	30	Breeding grounds degrade faster under warming; restoration sustains stock recruitment.
Aquaculture development	96.1	120.1	25	Controlled production partially offsets falling capture fisheries as lake conditions deteriorate.
Sustainable forest mgt.	682.9	853.6	25	Managed forests resist fire and pest pressure, both of which rise with temperature.
Reforestation	1,292.9	1,939.3	50	Restored forest cover regulates runoff and stores carbon as extremes intensify.
Community forest mgt.	1,265.5	1,898.3	50	Local stewardship reduces deforestation pressure, which grows as livelihoods come under climate stress.
Fire management	164.0	262.4	60	Fire frequency and intensity rise steeply with heat and drought; prevention avoids larger losses.
Resilient infrastructure	411.3	740.3	80	Infrastructure faces greater damage risks; resilient designs avoid escalating repair costs.
Flood management	2,822.8	3,951.9	40	More intense floods under RCP 8.5 make protective works essential to avoid high economic damage.
Early warning systems	123.0	166.0	35	Faster, more intense hazards increase the value of timely alerts.
Awareness and education	205.0	328.0	60	Higher exposure to climate risk requires stronger public awareness to enable adaptive behaviour.
Livelihood diversification	623.1	841.2	35	Income sources outside rain-fed farming gain value as climate shocks become more frequent.
Access to services	495.3	792.5	60	Heat, vector-borne disease and health shocks rise sharply with high emissions, raising the value of service access.
Social safety nets	798.3	1,237.4	55	Increased climate shocks push vulnerable groups into poverty; safety nets prevent deeper crises.

Rationale due to historical inflation trends: Malawi's inflation rate has shown significant variability, with recent rates as high as 28.50% in January 2025. Adjusting for inflation ensures that the cost estimates remain relevant and accurate over the long term. The rate reached an all-time high of 50.23% in 2000 and a record low of 4.50% in 1967¹⁰². The average inflation rate is forecast to decrease by 24.1 percentage points between 2024 and 2029, with an estimated rate of 6.48% in 2029¹⁰³. The average inflation rate is based on USD and is defined at 5%.

¹⁰¹ Source: CBA model, tabs "22 adaptation options RCP4.5 IRR NPV" and "22 adaptation options RCP8.5 IRR NPV". Benefit figures are the total additional income per measure over the appraisal period. The rationale column summarises the underlying mechanism and is the authors' own.

¹⁰² CEIC Data (n.d.). Malawi Discount Rate (End of Period). Available at: <https://www.ceicdata.com/en/malawi/money-market-and-policy-rates-annual/mw-discount-rate-end-of-period>

¹⁰³ Statista (n.d.). Inflation rate in Malawi. Available at: <https://www.statista.com/statistics/520536/inflation-rate-in-malawi/>

3.8.3 Calculation of the total costs and benefits of the adaptation options

Based on the unit cost for adaptation options and the 22 priority sector adaptation options, a calculation of the total investment costs for each adaptation measure was conducted. The cost estimates cover initial capital expenditures and, where applicable, maintenance costs, aggregated over a 20-year implementation horizon.

The cost calculation draws from district-level data compiled through stakeholder consultations and sectoral investment plans, applied consistently across all 22 adaptation measures. These measures span five sectors: agriculture, forestry, fisheries, infrastructure, and social development. Assumptions for unit costs and implementation scale were tailored per activity (e.g., hectares reforested, households served, kilometers of infrastructure rehabilitated), reflecting both national guidelines and localized needs.

The cumulative investment needed for implementing all 22 adaptation options across the priority sectors at national level is estimated at USD 4.5 billion. This figure is the total capital expenditure (CAPEX) of the 22 measures, deployed over the five-year investment phase (Y1–Y5); it does not include operating expenditure. OPEX is modelled separately, at USD 437 million in the first year of operation and escalating at 5% per year, which brings the full cost of the programme over the appraisal period to approximately USD 14 billion undiscounted, or USD 7.2 billion in present value at the 8% discount rate. The USD 4.5 billion should therefore be read as the capital requirement, not as the lifecycle cost of adaptation. The analysis highlights several highly capital-intensive measures that dominate overall investment needs.

Table 25. Most capital-intensive measures, by CAPEX

Priority Sectors	Adaptation measures	Total CAPEX (USD, Y1–Y5)
Agriculture Sector	Irrigation schemes	1.76 billion
Agriculture Sector	Drought-tolerant crops	400 million
Infrastructure	Flood management	354.55 million
Forestry Sector	Reforestation	307.28 million
Agriculture Sector	Crop diversification	260.01 million
Agriculture Sector	Afforestation/Reforestation	260 million
Agriculture Sector	Climate-smart agriculture	200 million
Agriculture Sector	Improve soil fertility	175 million
Forestry Sector	Community forest management	165.46 million
Agriculture Sector	Rainwater harvesting	112.5 million

Among these, irrigation expansion represents the most significant investment need, accounting for nearly 40% of total adaptation financing requirements, reflecting the scale of Malawi's underutilized irrigation potential and the critical role of water security in enhancing agricultural productivity and climate resilience.

Drought-tolerant crops and climate-smart agriculture similarly require large upfront investments to achieve widespread adoption, improve food security, and stabilize rural incomes. Other measures, while less capital-intensive individually, contribute essential ecosystem, social, and disaster risk reduction benefits, underscoring the integrated nature of adaptation investments.

The investment plan prioritizes scalable, high-impact interventions, with significant co-benefits in terms of economic growth, environmental protection, and social resilience.

In terms of adaptation measures costing by sector, the table presents it below. All amounts are total CAPEX in USD million over the Y1–Y5 investment phase, at the national scale of deployment assumed in the costing¹⁰⁴.

Table 26. Total investment requirement by adaptation option and by priority sector

Priority sector	Adaptation option	Total CAPEX (USD million, Y1–Y5)
Agriculture – sector total		3,237.51
Forestry – sector total		580.05
Fisheries – sector total		92.68
Infrastructure and DRR – sector total		422.56
Social – sector total		249.41

¹⁰⁴ All sector totals are taken directly from the costs tab of the CBA model.

The profile of the investment requirement is concentrated. Agriculture accounts for the large majority of the CAPEX, and irrigation schemes alone for nearly 40% of the total adaptation financing requirement, which reflects both the scale of Malawi's under-utilised irrigation potential and the unit costs of the measure. Forestry and infrastructure and DRR follow, driven respectively by reforestation and by flood management. The fisheries and social sectors carry the smallest capital requirements, yet several of their measures rank among the highest performers on IRR (see Tables 26 and 27), which is the central message for prioritisation.

Conversely, interventions such as rainwater harvesting, aquaculture development, sustainable fishing, and awareness and education campaigns present lower overall investment requirements, typically under USD 10 million each. For example, the total investment needed for rainwater harvesting infrastructure across target communities amounts to less than USD 7 million, while small-scale aquaculture development and sustainable fishing programs each require under USD 5 million. Social sector initiatives, including community awareness, education, and early warning systems, similarly demand modest capital investments relative to large infrastructure projects. Despite their lower financial footprint, these measures can generate high returns in terms of household-level resilience, improved food security, and strengthened adaptive capacities, particularly among vulnerable groups.

In parallel with the cost calculations, the total benefits of each adaptation option presented above were estimated incorporating both market and non-market benefits over a 20-year time horizon. These benefits include avoided damages against the BAU (e.g. from floods or crop failure), enhanced productivity (e.g. through improved agriculture or fisheries), ecosystem services (e.g. carbon sequestration, biodiversity), and social co-benefits (e.g. improved health, education, and household income stability).

Across all 22 measures, the total NPV of adaptation benefits exceeds USD 5.76 billion for the entire country, indicating a strong case for investment. This figure is the sum of the net present values of the 22 measures under RCP 4.5 and is already net of their discounted costs; it is therefore not to be set against the USD 4.5 billion investment requirement a second time. For instance, under RCP 4.5, climate-smart agriculture and afforestation/reforestation deliver NPVs of respectively USD 221 and 171 million, due to high returns in yield gains, ecosystem restoration, and long-term resilience. Crop diversification, drought-tolerant crops, and livelihood diversification also stand out with NPVs above USD 100 million, offering strong financial justification for local deployment. Despite lower cost profiles, interventions like social safety nets and early warning systems yield substantial benefits in terms of avoided social and economic disruption.

3.8.4 Calculation of the investment rate of return and net present value

The CBA for the adaptation strategies rely on standard financial methodologies to evaluate investment viability, i.e. the social Internal Rate of Return (IRR) and the NPV to determine the economic feasibility of adaptation measures across Malawi's priority sectors. This enables us to indicate if an adaptation investment is economically viable, meaning the projected benefits exceed the costs over the assessed time horizon, integrating non-marketed costs and benefits (the so-called externalities).

This is applied to the priority adaptation options, across five key sectors: agriculture, fisheries, infrastructure, forestry and social. The financial evaluation considers long-term adaptation benefits over a 20-year period, incorporating private and public cash flows within each sector.

Differentiated CBA results by scenario (RCP 4.5 and RCP 8.5)

This section presents the differentiated CBA results for the prioritized adaptation measures under the climate scenarios RCP 4.5 (intermediate stabilization pathway with moderate global mitigation) and RCP 8.5 (high emissions, business-as-usual trajectory). By disaggregating the NPV and IRR, the analysis provides deeper insights into how climate risks influence the economic justification for adaptation investments.

Detailed economic appraisal, disaggregated by the priority sectors

All 22 priority adaptation measures were evaluated under consistent assumptions for costs and implementation timelines. Benefits, particularly avoided losses, were estimated separately for each emissions scenario, reflecting different levels of projected climate impacts (agriculture yield losses, infrastructure damage, etc., with different time horizons: 2040 (short to medium-term) and 2080 (long-term)).

Table 27. National economic appraisal of the 22 adaptation measures in the 5 priority sector under RCP 4.5

Priority Sectors	Adaptation Options	IRR (%)	NPV (USD)
Agriculture Sector	Crop diversification	89,19%	800,241,509
Social	Access to services	56,20%	154,666,755
Social	Livelihood diversification	55,95%	125,760,154
Social	Social safety nets	49,98%	172,231,194
Infra	Flood management	48,25%	721,388,324
Fisheries Sector	Sustainable fishing	46,56%	6,901,750
Infra	Resilient infrastructure	44,86%	69,056,593
Forestry Sector	Community forest mgt.	43,86%	289,759,881
Forestry Sector	Sustainable forest mgt.	43,13%	97,883,779
Agriculture Sector	Climate smart agriculture	40,97%	221,462,676
Forestry Sector	Fire management	35,97%	36,877,456
Infra	Early warning systems	35,66%	24,811,507
Agriculture Sector	Drought tolerant crops	32,54%	153,523,844
Agriculture Sector	Improve soil fertility	30,96%	243,491,899
Social	Awareness and education	30,49%	16,209,818
Fisheries Sector	Aquaculture development	28,44%	13,534,337
Agriculture Sector	Irrigation schemes	27,70%	2,079,087,918
Fisheries Sector	Protect/restore habitats	24,62%	67,824,350
Agriculture Sector	Rainwater harvesting	22,32%	90,027,270
Agriculture Sector	Afforestation/Reforestation	19,12%	171,369,266
Agriculture Sector	Conservation agriculture	18,53%	48,657,914
Forestry Sector	Reforestation	17,09%	155,794,949

Table 28. National economic appraisal of the 22 adaptation measures in the 5 priority sector under RCP 8.5

Priority Sectors	Adaptation Options	IRR (%)	NPV (USD)
Fisheries Sector	Aquaculture development	159,08 %	219,082,128
Forestry Sector	Community forest mgt.	154,75%	1,199,692,905
Forestry Sector	Sustainable forest mgt.	148,27%	26,916,367
Agriculture Sector	Conservation agriculture	133,36%	290,169,079
Forestry Sector	Reforestation	121,13%	372,426,423
Agriculture Sector	Afforestation/Reforestation	105,17%	225,195,520
Agriculture Sector	Rainwater harvesting	102,16%	72,301,204
Agriculture Sector	Improve soil fertility	94,26%	578,275,916
Agriculture Sector	Crop diversification	91,56%	762,932,502
Agriculture Sector	Irrigation schemes	89,56%	1,236,218,103
Social	Awareness and education	82,61%	81,738,119
Social	Livelihood diversification	81,82%	479,616,902
Infra	Early warning systems	72,30%	175,727,746
Fisheries Sector	Protect/restore habitats	61,91%	44,433,680
Infra	Flood management	45,95%	381,092,394
Forestry Sector	Fire management	45,40%	24,484,211
Infra	Resilient infrastructure	41,17%	3,369,946,643
Social	Access to services	39,43%	474,111,377
Fisheries Sector	Sustainable fishing	39,05%	191,501,941
Agriculture Sector	Climate smart agriculture	37,04%	116,052,850
Agriculture Sector	Drought tolerant crops	33,96%	450,548,032
Social	Social safety nets	28,73%	96,486,962

Ranking of the 22 adaptation measures at national level under RCP 4.5

Under RCP 4.5, among the 22 adaptation options assessed, crop diversification, access to services, livelihood diversification and social safety nets stand out with the highest IRRs (between 49 and 89%), suggesting these options deliver highly efficient returns relative to their cost. This justifies them as no-regret options, with high forestry needs, where soil degradation and erratic rainfall are significant challenges.

While comparing IRR and NPV of the 22 adaptation options offer useful guidance for prioritizing investments, the results have to be interpreted with caution. During field consultations, local stakeholders expressed highly diverse preferences and operational realities for each category of adaptation option.

This variability implies that the same adaptation label may encompass different implementation modalities, cost structures, and benefit streams depending on the national context. As such, aggregate IRR and NPV values should not be used in isolation to determine investment priorities. Instead, these figures must be interpreted alongside sector-specific conditions, vulnerability profiles, and stakeholder inputs to ensure that the selected measures are both context-appropriate and locally supported.

Ranking of the 22 adaptation measures at national level under RCP 8.5

It is not surprising to find exceptionally high returns (IRR > 120%) under RCP 8.5. The fisheries, forestry and agriculture sectors dominate the ranking with IRR exceeding 120%, reflecting highly attractive investment cases. Across the top six ranked measures, three are forestry-sector measures (community forest management, SFM and reforestation), with afforestation/reforestation appraised under agriculture, underlining that forest ecosystems provide buffers against climate shocks, carbon sequestration, and livelihoods support, especially as deforestation accelerates under severe scenarios like RCP 8.5. Measures like conservation agriculture, rainwater harvesting, soil fertility improvement, crop diversification, and irrigation schemes all demonstrate IRRs between 90% and 130%. This reflects the worsening climate impacts on crop yields and water availability under RCP 8.5, increasing the economic benefits of investments that stabilize food production and water resources.

Awareness & education, livelihood diversification, and EWS fall in the 70% to 85% IRR range. Though not as financially lucrative as forestry or agriculture, these options build human and institutional resilience, which are increasingly valuable as disasters, health crises, and vulnerability escalate under RCP 8.5.

Discussion about the results

The IRR ranking is broadly consistent with global and regional evidence on the economic performance of similar adaptation investments in other countries. Numerous studies demonstrate that low-cost, community-based, and social interventions, such as awareness raising, education, crop and livelihood diversification, and social protection, tend to deliver some of the highest IRRs due to their rapid deployment, low capital requirements, and immediate resilience benefits. This is supported by findings from different sources (GCA, 2019¹⁰⁵ ; FAO, 2022¹⁰⁶, World Bank, 2016¹⁰⁷), which highlights benefit-cost ratios exceeding 10:1 for early warning systems, crop diversification and CSA, education, and social protection, and the high returns observed for crop diversification and aquaculture development, showing

¹⁰⁵ Global Commission on Adaptation (2019). *Adapt Now: A Global Call for Leadership on Climate Resilience*.

. https://gca.org/wp-content/uploads/2019/09/GlobalCommission_Report_FINAL.pdf

¹⁰⁶ FAO (2022). *The State of Food and Agriculture: Leveraging Adaptation for Food Security*. <https://openknowledge.fao.org/server/api/core/bitstreams/6fa56152-c232-4bc6-8eee-7d413261ad64/content>

¹⁰⁷ World Bank (2015). *The triple dividend of resilience : realizing development goals through the multiple benefits of disaster risk management*. Overseas Development Institute (ODI), International Bank for Reconstruction and Development / International Development Association or The World Bank. . <https://documents1.worldbank.org/curated/en/993161515193991394/pdf/P151463-01-05-2018-1515193988640.pdf>

substantial productivity and income gains from agroecological interventions. Conversely, more capital-intensive measures such as irrigation schemes, afforestation, and reforestation exhibit lower IRRs in line with literature, reflecting longer time horizons for ecosystem service delivery and higher upfront costs (UNEP, 2021¹⁰⁸; WRI, 2018¹⁰⁹). Overall, the CBA's IRR structure corresponds with the empirical evidence base, reinforcing the economic viability of integrated, nature-based, and social adaptation measures in the Malawian context.

Ultimately, this reinforces the importance of localized adaptation planning and sectoral-level customization of investment packages, rather than relying solely on national-level economic rankings.

Regarding the difference in the findings between climatic scenarios, it indicates that under RCP 8.5, the economic viability (NPV, IRR) of most adaptation measures improves, due to higher avoided losses associated with more severe climate impacts.

However, higher costs and longer payback periods may also arise for infrastructure-heavy interventions under extreme climate scenarios.

Differentiating results by scenario provides decision-makers with a risk-informed investment perspective, ensuring adaptation strategies remain robust under varying future conditions.

Comparative Analysis of BAU, RCP 4.5 and RCP 8.5 scenarios with adaptation measures in Malawi's priority sectors

This section presents a comparative assessment of the BAU scenario and the two alternative climate scenarios for Malawi: adaptation measures across the five key sectors taking into account RCP 4.5 and RCP 8.5.

Table 29. Comparison of BAU versus the implementation of the 22 adaptation measures (under RCP 4.5, and RCP 8.5)

Sector	BAU Scenario (No/Minimal Adaptation)	Adaptation measures (under RCP 4.5)	Adaptation measures (under RCP 8.5)	Key Findings
Overall Scenario Definition	Limited adaptation, exposure to escalating climate risks, continued environmental degradation. BAU policies focus on fragmented, underfunded interventions; limited enforcement of environmental safeguards; dominance of short-term food security programs.	Stabilized emissions, moderate climate impacts, integration of sectoral adaptation priorities.	High emissions, severe impacts, requiring transformative, large-scale adaptation aligned with national policy reforms.	Comprehensive adaptation yields stronger economic returns under severe climate scenarios.
Agriculture	Yield declines (maize, groundnuts, staples), soil degradation, food insecurity. BAU reflects Malawi's over-dependence on maize (NAP 2024), limited mechanization, weak uptake of climate-resilient technologies, and persistent underfunding of diversified value chains.	Productivity gains via drought-tolerant crops, irrigation, conservation agriculture, supported by targeted programs (NAP 2024, Resilience Strategy).	Climate-smart agriculture, afforestation, crop diversification, transformative adaptation boosts yields (10-25%), incomes, and resilience.	IRRs up to 133% (conservation agriculture) and 91% (drought-tolerant crops) justify scaling investment.
Fisheries	Fisheries collapse, overexploitation, protein deficits. BAU policies include weak enforcement of participatory fisheries management (2001 Policy), limited investment in aquaculture despite stated objectives, and declining fish stocks.	Sustainable fisheries management slows resource decline; small-scale aquaculture expands.	Large-scale aquaculture, habitat restoration, fisheries co-management sustain food security and income.	Aquaculture IRR of 159% shows potential to offset fisheries collapse under severe scenarios.
Forestry	Accelerated deforestation, biodiversity loss, degraded watersheds. BAU reflects partial implementation of the National Forest Landscape Restoration Strategy (2017) and weak community engagement.	Community forestry, sustainable management, reforestation slow degradation trends.	Landscape-scale restoration, carbon finance, community incentives deliver carbon, biodiversity, and income gains.	IRRs of 154% (community management) and 148% (sustainable forestry) demonstrate high returns under RCP 8.5.
Infrastructure	High damage to roads, water infrastructure, settlements from floods and storms. BAU shows weak disaster preparedness, gaps in infrastructure design standards, limited enforcement of the Resilience Strategy 2018-2030.	Early warning systems and localized flood management reduce disaster losses.	Large-scale resilient infrastructure, flood protection, disaster preparedness avoid major economic damages.	Resilient infrastructure IRR of 159% and flood management IRR of 89% make adaptation economically sound.

¹⁰⁸ UNEP (2021). *State of Finance for Nature: Transforming Global Financial Flows for Nature-Positive Outcomes*. <https://www.unep.org/resources/state-finance-nature-2021>

¹⁰⁹ World Resources Institute (2018). *Roots of Prosperity: The Economics and Finance of Restoring Land*. <https://www.wri.org/research/roots-prosperity-economics-and-finance-restoring-land>

Social Protection & Livelihoods	Rising poverty, malnutrition, high vulnerability to shocks. BAU continues fragmented safety net programs (e.g., MASAF 4), weak integration with climate resilience, limited coverage of most vulnerable groups.	Livelihood diversification, improved services, safety nets reduce vulnerability to shocks.	Expanded social protection, education, health services, livelihood programs build long-term resilience.	Social protection IRR of 121%, livelihood diversification IRR of 105% highlight strong economic and social benefits.
---------------------------------	---	--	---	--

Comparative analysis demonstrates that targeted adaptation across agriculture, fisheries, forestry, infrastructure, and social sectors significantly mitigates climate risks under both RCP 4.5 and 8.5 scenarios. Economic profitability, measured through IRR and NPV, consistently favors robust adaptation, with especially high returns under the more severe RCP 8.5 scenario due to the higher avoided losses and increased productivity.

Integration of Malawi's national policies, including the National Climate Change Policy, National Forest Landscape Restoration Strategy, and sectoral policies, provides a framework for scaling adaptation. The evidence supports urgent investment in transformative adaptation pathways, particularly under high-emission futures, to safeguard food security, livelihoods, and natural resources, aligned with Vision 2063 and Malawi's international commitments.

3.8.5 Sensitivity Analysis

The sensitivity analysis provides insights under the RCP 4.5 scenario. The aim is to evaluate how variations in key parameters impact the cost-benefit results of adaptation measures. Given the inherent uncertainties in climate projections, economic growth rates, and implementation efficiency, this analysis ensures robustness in decision-making. In terms of uncertainties, adaptation benefits are subject to i) climate variability, ii) policy effectiveness (e.g. implementation delays or governance challenges, and iii) economic fluctuations (such as exchange rate risks affecting project financing).

Key variables considered: The sensitivity analysis focuses on the following factors:

1. Cost overruns (+10% to +30%)
 - Unexpected capital and operational cost increases due to inflation, procurement delays, or labor shortages.
2. Benefit reductions (-10% to -30%)
 - Climate variability or weak policy enforcement could reduce the effectiveness of adaptation interventions.
 - Example: Lower-than-expected crop yields despite conservation agriculture adoption.

Base case (USD)		33%	5 760 563 141,95
Costs +	10%	27%	4 982 845 706,85
Costs +	20%	23%	4 205 128 271,76
Costs +	30%	20%	3 427 410 836,67
Revenue +	10%	39%	7 114 336 891,24
Revenue +	20%	46%	8 468 110 640,52
Revenue +	30%	53%	9 821 884 389,81
Revenue -	10%	27%	4 406 789 392,66
Revenue -	20%	21%	3 053 015 643,37
Revenue -	30%	16%	1 699 241 894,08

The sensitivity analysis confirms that Malawi's climate adaptation strategies are robust under different economic and climatic conditions. While uncertainties exist, targeted financial planning and policy adjustments can ensure long-term resilience and economic stability.

- Agriculture and water interventions remain economically viable under all scenarios, confirming their resilience to cost fluctuations.

Detailed economic appraisal, disaggregated by the priority sectors

- Infrastructure projects are more sensitive to cost overruns and discount rate variations. Phased investments and co-financing mechanisms can mitigate risks.
- Social sector interventions (health, education, and gender-focused adaptation) show high long-term returns, but their impact depends on effective policy implementation.
- Early Warning Systems (EWS) and disaster preparedness programs have the highest Benefit-Cost Ratios (BCR >3.0), making them ‘no-regret’ investments under all scenarios.

4 Conclusions and Recommendations

Conclusions

The CBA conducted across the 5 priority sectors in Malawi has revealed significant economic losses associated with climate inaction under both RCP 4.5 and RCP 8.5 scenarios. Across all five priority sectors (agriculture, fisheries, forestry, infrastructure, and social), climate-related shocks are projected to impose cumulative losses equivalent to 6–20% of GDP by 2040, increasing to over 30% by 2080 under high-emission pathways. This is the results of the modelling under the BAU scenario.

It demonstrates that under the BAU scenario, Malawi faces escalating economic losses equivalent to 4–7% of district-level GDP by 2040, rising further under RCP 8.5 without adaptation. Also, targeted adaptation measures under both RCP 4.5 and RCP 8.5 are expected to deliver important avoided losses hence generating high economic returns, with IRRs exceeding 90%: under the alternative scenario, the total investment required to implement 22 priority adaptation measures at national scale is estimated at USD 4.5 billion, with particularly high capital needs in agriculture (irrigation schemes, drought-tolerant crops) and flood management infrastructure, the returns as significant.

Despite these significant upfront investments, the CBA reveals strong positive returns across all sectors. Measures such as drought-tolerant crops, climate-smart agriculture, and irrigation expansion generate quantifiable economic benefits including yield increases of 20% to 40%, improved food security, and enhanced household incomes. In agriculture alone, rainwater harvesting and sustainable soil management are projected to increase water availability and reduce crop losses, while diversified agriculture boosts resilience and household income streams by up to USD 500 per year per household.

In the fisheries sector, sustainable fishing practices, habitat restoration, and small-scale aquaculture contribute to stabilizing fish stocks, supporting food security, and generating new income opportunities, yielding an estimated annual benefit of over USD 18 million, including both market and ecosystem service gains. Reforestation, afforestation, and community forest management in the forestry sector provide additional co-benefits, including carbon sequestration valued at USD 36 to 42 million per year, reduced erosion, and improved biodiversity.

The infrastructure sector demonstrates high cost-effectiveness, particularly through flood management measures projected to reduce flood exposure by 30% to 70%, safeguarding communities and avoiding economic losses. Social sector investments, including awareness programs, social safety nets, and access to essential services, offer some of the highest IRR, exceeding 50% in several cases under RCP 4.5 and 100% under RCP 8.5, highlighting the rapid, high-yield impact of socially focused adaptation.

Overall, the updated CBA confirms that adaptation investments significantly enhance Malawi's resilience, with market-based benefits exceeding USD 682 and 787 million annually respectively under RCP 4.5 and RCP 8.5, complemented by non-market ecosystem services. While the agriculture sector remains among the most vulnerable to climate risks, the analysis underscores that well-targeted adaptation strategies deliver robust economic, environmental, and social dividends, justifying scaled investment across sectors to address Malawi's climate vulnerabilities.

Recommendations

Recommendation 1. Accelerate agricultural productivity through adaptation measures

Malawi's agriculture sector faces growing productivity challenges due to climate change, soil degradation, and unsustainable input use. To meet food security and economic targets, Malawi must shift from over-reliance on chemical fertilizers and pesticides toward climate-resilient

adaptation measures that offer higher productivity, long-term soil health, and stronger resilience to shocks.

Scaling up the use of drought-tolerant crops, conservation agriculture, and soil fertility restoration through organic approaches can deliver substantial benefits, as indicated by the national CBA. These measures reduce dependence on costly synthetic inputs, improve soil structure, and increase yields even under erratic rainfall and temperature extremes. Under the RCP 8.5 scenario, investments in such adaptation-driven agriculture yield marketed benefits exceeding USD 561.5 million annually, with IRRs surpassing 90%, making them economically superior to short-term chemical-based productivity approaches.

Beyond enhancing food security, these measures contribute to long-term soil regeneration, reduce environmental degradation, and lower production costs for smallholders. Integrated with rainwater harvesting and agroforestry, they represent a sustainable pathway to boost productivity, stabilize rural incomes, and build systemic resilience across Malawi's agricultural landscapes.

Recommendation 2. Scale up irrigation and rainwater harvesting systems

Malawi should expand irrigation and rainwater harvesting, to safeguard food production and livelihoods under worsening climate variability, particularly in the high-risk RCP 8.5 scenario.

Currently, only around 130,000 hectares are irrigated nationwide, representing less than one-third of the identified 407,862 hectares of irrigable land (Malawi Irrigation Master Plan, 2015–2035). Even under existing growth trends, only 184,400 hectares are projected to be irrigated by 2029, leaving over 223,450 hectares of viable land unutilized for irrigation development.

In parallel, rainwater harvesting presents a scalable, cost-effective adaptation for smallholders. Up to 375,000 hectares of Malawi's agricultural land can benefit from rainwater harvesting infrastructure, including household storage tanks, micro-dams, and community water retention systems.

Despite high capital costs, these investments yield IRRs approaching 90%, particularly under RCP 8.5 where rainfall variability and drought risks intensify.

Priority Areas for Intervention: Based on the National Irrigation Master Plan (2015), the National Resilience Strategy (2018–2030), and the National Agriculture Policy (2024), the districts most in need of expanded irrigation and water management include:

- Dedza: High drought exposure, rainfall deficits affecting staple crops.
- Balaka: Semi-arid zone with recurrent food insecurity.
- Chikwawa: Lower Shire Valley, prone to droughts and floods, urgent need for water control.
- Salima: Central lakeshore, irrigation potential for rice, horticulture, and resilience building.
- Phalombe: Southern Region, severe water scarcity, dependency on rain-fed agriculture.
- Mangochi: Lakeshore district, unreliable rainfall, irrigation crucial for diversification.
- Karonga: Northern lakeshore, climate variability threatens livelihoods, irrigation expansion needed.

Recommendation 3. Prioritize high-return nature-based solutions

Under the BAU scenario, the country faces accelerating deforestation, biodiversity loss, and land degradation, driven by unsustainable fuelwood harvesting, agricultural expansion, and weak enforcement of forest protection policies¹¹⁰. This trajectory undermines soil stability, increases vulnerability to floods and droughts, and erodes rural livelihoods, with no significant economic returns beyond short-term resource extraction.

In contrast, scaling up high-return nature-based solutions, such as reforestation, community forest management, agroforestry, and sustainable forest practices, provides a proven pathway

¹¹⁰ Malawi National Forest Policy, 2016, pp. 3-5, Malawi NFLR Strategy, 2017, Sections 2.1 and 3.2, Malawi National Environmental Policy, 2018, pp. 7-9, FAO, State of the World's Forests, 2022 - Malawi Country Profile

to reverse degradation while delivering substantial economic, social, and climate benefits. These measures consistently achieve IRRs exceeding 120%, driven by increased timber production, improved ecosystem services, and monetizable carbon sequestration.

In addition to direct, market-based economic benefits, the analysis underscores the substantial non-market environmental gains generated by adaptation measures, particularly in forestry, watershed management, and ecosystem restoration. For example, biodiversity conservation and watershed protection services linked to forest landscape restoration are estimated at USD 200–500 per hectare annually¹¹¹, based on international studies in comparable African contexts. Applying these proxies to Malawi’s forest restoration targets of 4.5 million hectares translates into potential non-market benefits exceeding USD 900 million to 2.25 billion per year, through improved water regulation, soil stabilization, flood mitigation, and biodiversity preservation. Recognizing these co-benefits strengthens the economic case for nature-based adaptation, even beyond the already high IRRs observed for direct revenue-generating intervention.

Recommendation 4. Monetize reforestation activities via carbon sequestration through Article 6.2 and Voluntary Carbon Markets

Malawi’s afforestation, reforestation, and community forestry efforts present a major opportunity to generate additional revenue streams through carbon markets, while advancing climate resilience, biodiversity, and rural livelihoods. Forest adaptation investments already show high returns (up to 154% IRR for community management), and monetizing carbon sequestration can further improve project bankability, finance broader adaptation priorities, and scale restoration efforts.

Malawi should actively pursue Article 6.2 bilateral agreements under the Paris Agreement, enabling the sale of high-integrity carbon credits (ITMOs) to countries seeking international mitigation outcomes, such as Norway, Switzerland, and others leading in forest carbon finance. In parallel, Malawi can leverage the fast-growing Voluntary Carbon Market (VCM) by certifying community forestry projects under standards like Verra, Gold Standard, or Plan Vivo, ensuring alignment with national safeguards and benefit-sharing.

Tapping into both Article 6.2 and VCM channels can unlock substantial climate finance to directly support Malawi’s NFLRS¹¹², while providing flexible funding to implement other priority adaptation measures across agriculture, infrastructure, and social protection, enabling to meet Vision 2063 and NDC targets.

Recommendation 5. Boost fisheries resilience through sustainable aquaculture and habitat restoration

Malawi’s fisheries sector, vital for food security, nutrition, and rural livelihoods, faces mounting climate stress, overfishing, and habitat degradation—threatening fish stocks and the 70% of animal protein that fish provides, especially to the rural poor. Under the BAU trajectory, capture fisheries in Lake Malawi, Lake Malombe, and Lake Chilwa continue to decline due to overexploitation, weak enforcement of fisheries regulations, and limited investment in habitat restoration¹¹³.

Scaling up aquaculture development and restoration of critical fish habitats offers a high-return solution to stabilize fish production, enhance food security, and reduce pressure on wild stocks. Malawi’s CBA results show that aquaculture development achieves IRRs exceeding 100%,

¹¹¹ *The Economics of Ecosystems and Biodiversity Reports (TEEB, 2010). The document provides global estimates for ecosystem services from forest landscapes, with watershed protection and biodiversity services valued between USD 100–500 per hectare annually, depending on context. (TEEB for Policy Makers, 2010; https://www.teebweb.org/media/2010/09/TEEB_D2_Local_Policy-Makers_Report-Eng.pdf); See also the Ecosystem Service Valuation Database (ESVD), <https://www.esvd.net/>, the Wealth Accounting and the Valuation of Ecosystem Services (WAVES) from the World Bank.*

¹¹² <https://library.cepa.org.mw/government-publications/national-forest-landscape-restoration-strategy/>

¹¹³ *National Fisheries and Aquaculture Policy, 2001; National Resilience Strategy, 2018–2030*

driven by strong market demand, year-round production potential, and reduced vulnerability to climate-induced lake productivity fluctuations.

This strategy is particularly urgent in districts highly reliant on fisheries, including Mangochi, Salima, Karonga, Nkhata Bay, and Nkhatakota, where climate variability, warming waters, and habitat loss directly threaten livelihoods. Expanding community-based aquaculture, restoring wetlands and breeding grounds, and strengthening participatory fisheries management will build resilience across these vulnerable regions.

In parallel, tapping into carbon markets, such as through mangrove restoration or blue carbon initiatives where applicable, can generate co-benefits for fisheries while unlocking new revenue streams for ecosystem protection.

Recommendation 6. Enhance social protection systems as 'No-Regret' interventions

In the absence of scaled-up adaptation, the BAU scenario leaves Malawi's most vulnerable populations increasingly exposed to poverty, malnutrition, and climate-induced shocks. Social safety nets and livelihood diversification programs under BAU remain fragmented, reaching only an estimated 15% of ultra-poor households, with limited alignment to climate resilience objectives¹¹⁴.

In contrast, expanding climate-responsive social protection systems delivers rapid, measurable poverty reduction, gender-sensitive resilience, and strong economic returns. Cost-benefit analysis results for Malawi show that investments in social safety nets and livelihood diversification generate IRRs exceeding 105%, with additional market-based benefits of over USD 290 million annually under RCP 8.5. These measures provide income stability, reduce negative coping strategies, and enhance food security, particularly for women, youth, and marginalized groups.

Evidence from the Social Cash Transfer Program and community livelihood initiatives shows that, with targeted adaptation investments, Malawi could increase coverage of social safety nets to at least 40% of at-risk households, tripling the reach compared to BAU.

Recommendation 7. Integrate EWS and disaster preparedness nationally

Under the BAU scenario, Malawi remains highly exposed to floods, droughts, cyclones, and other climate-related disasters, with limited national coverage of operational EWS. Despite the existence of policies such as the Malawi National Disaster Risk Management Policy (2015)¹¹⁵ and the Community-Based Early Warning Systems Guidelines (2018)¹¹⁶, institutional capacity gaps and weak integration across sectors constrain effectiveness, leading to preventable loss of lives, infrastructure damage, and economic setbacks.

Scaling up EWS and disaster preparedness offers a highly cost-effective solution. National CBA results show these measures deliver IRRs exceeding 70%, with significant savings in avoided disaster losses, reduced humanitarian response costs, and improved resilience at household and community levels.

To achieve this, Malawi should prioritize collaboration with key national institutions, including:

- The Department of Disaster Management Affairs (DoDMA)¹¹⁷, for EWS coordination and disaster risk reduction.
- The Department of Climate Change and Meteorological Services (DCCMS)¹¹⁸, as the technical backbone for weather forecasting and climate information dissemination.

¹¹⁴ MASAF 4 Resettlement Policy Framework, 2013; National Resilience Strategy, 2018-2030

¹¹⁵ <https://www.preventionweb.net/publication/malawi-national-disaster-risk-management-policy-2015>

¹¹⁶ https://drimms.sadc.int/sites/default/files/document/2020-03/2018_Malawi%20National%20Guidelines%20for%20CBEWS%20Final.pdf

¹¹⁷ <https://www.dodma.gov.mw>

¹¹⁸ <https://www.metmalawi.gov.mw/>

- The Ministry of Water and Sanitation, to better integrate flood forecasting and early warnings for water-related hazards.
- The District Councils and Civil Protection Committees (CPCs)¹¹⁹, for localized EWS deployment and community preparedness activities.
- Malawi Red Cross Society¹²⁰ and Civil Society Organizations, to enable grassroots implementation and awareness campaigns.
- Academic and research institutions, such as the Department of Geography, Earth Sciences and Environment at the University of Malawi¹²¹, the Lilongwe University of Agriculture and Natural Resources¹²² and the Malawi University of Science and Technology¹²³ for enhancing modeling, forecasting accuracy, and risk mapping.

Expanding EWS coverage, integrating real-time alerts, strengthening last-mile communication, and investing in community awareness programs are priority actions to reduce disaster losses, safeguard development gains, and build systemic resilience, particularly under worsening climate scenarios like RCP 8.5. This requires a coordination mechanisms, including integration of EWS priorities into the National Meteorological Services Strategic Plan and formal alignment with district-level DRM organizations or structures, ensuring localized implementation and local communication systems.

Recommendation 8. Strengthen resilient infrastructure and flood management measures to avoid escalating climate costs

Malawi's infrastructure is highly vulnerable to floods, storms, and climate variability, with the BAU scenario projecting severe and rising economic losses. According to Malawi's National Resilience Strategy (2018–2030) and CBA results, floods alone currently cause an estimated USD 70 to 100 million in annual damage to roads, bridges, water infrastructure, and settlements. Without scaled-up adaptation, these losses could double by 2040, particularly under the high-risk RCP 8.5 scenario.

Upgrading transport, energy, and water infrastructure to climate-resilient standards, combined with expanded flood management systems, provides substantial avoided costs and high economic returns. Malawi's CBA data shows that investments in resilient infrastructure yield IRRs exceeding 159%, while flood management measures deliver IRRs above 89%, driven by reduced infrastructure damage, uninterrupted economic activity, and lower disaster response costs.

Priority measures include:

- Reinforcing roads and bridges with climate-resilient materials, particularly in flood-prone districts such as Chikwawa, Phalombe, and Salima.
- Expanding drainage, embankments, and river management systems in urban centers and vulnerable rural communities.
- Integrating resilience criteria into public investment planning, guided by the Malawi National Disaster Risk Management Policy (2015).

While upfront capital requirements for resilient infrastructure are higher than conventional designs, the long-term avoided damage, enhanced connectivity, and protection of livelihoods far outweigh initial costs—making this an economically sound, no-regret investment for Malawi under both moderate (RCP 4.5) and severe (RCP 8.5) climate scenarios.

¹¹⁹ See the *Guidelines for the Management of Disaster Risk Management Functions Devolved to Local Authorities* January, 2017. https://drmins.sadc.int/sites/default/files/document/2020-03/Management%20%20Guidelines_DoDMA.pdf

¹²⁰ <https://www.redcross.mw/>

¹²¹ <https://www.unima.ac.mw/departments/geography-earth-sciences-and-environment>

¹²² <https://luanar.ac.mw/luanar/>

¹²³ <https://www.must.ac.mw/>

Recommendation 9. Mainstream adaptation into district and national development planning

The BAU leaves gaps in the integration of climate adaptation into development processes, particularly at the district level where resource allocation often overlooks resilience-building measures. This results in fragmented project implementation, underfunding of high-return adaptation options, and escalating climate vulnerability, especially in the 8 districts with high-risk districts.

Systematically integrating adaptation into national budgets, district development plans, and Vision 2063 Strategy¹²⁴ will enable coordinated, cost-effective climate action that safeguards livelihoods and accelerates economic growth. The results of the national CBA show that prioritized adaptation measures across agriculture, forestry, fisheries, infrastructure, and social protection consistently deliver high returns, with IRRs exceeding 90–150% under the RCP 8.5 scenario.

Target priority districts for immediate action are:

- Karonga: highly exposed to floods, droughts, and infrastructure vulnerability, yet rich in fisheries and agriculture potential requiring integrated adaptation in local planning.
- Dedza: Prone to water scarcity, soil degradation, and food insecurity; mainstreaming adaptation is essential to stabilize agriculture and reduce social vulnerability. Also, in Dedza, scaling up irrigation to 20,000 ha would for instance significantly reduce drought-induced crop failures.
- Phalombe: Located in a high-flood-risk zone with recurrent disasters; integrating flood management, resilient infrastructure, and social protection are priorities, with for instance a requirement of 5,000 ha of targeted flood management infrastructure to meet risk reduction needs.

To operationalize this, Malawi could mandate the inclusion of high-return adaptation measures within District Development Plans (DDPs)¹²⁵, starting with Karonga, Dedza, and Phalombe, align district planning cycles with national frameworks like the National Resilience Strategy, NDC Implementation Plan, and Vision 2063 Pillar 1 (Agricultural Productivity and Commercialization) and mobilize public budgets, climate finance, and private sector investment to fund locally identified adaptation priorities, ensuring coherence across sectors.

¹²⁴ <https://malawi.un.org/sites/default/files/2021-01/MW2063-%20Malawi%20Vision%202063%20Document.pdf>

¹²⁵ <https://www.unicef.org/childfriendlycities/media/2286/file/Malawi%20-%20District%20Development%20Plan%20Process.pdf>

Annexes

Annex 1. Questionnaire for the survey

Questionnaire designed for conducting the survey as part of the economic appraisal of adaptation strategies at both district and national levels in Malawi. The questions are designed to capture data that will inform a CBA and prioritize adaptation interventions based on economic criteria. This will be administered based on the main priority sectors mentioned in our document. During the fieldwork in the selected districts, the Focal Points we will target a member of each sector to get right and precise information from his/her sector).

General Information

1. Name of the Respondent:

2. District/Institution:

3. Position/Title:

4. Sector (e.g., Agriculture, Water, Infrastructure, Health):

5. Contact Information:

Section 1: Adaptation Strategies and Current Measures

1. What are the barriers to implementing current adaptation strategies in your district/sector (e.g., financial, technical, governance-related)?
2. Are there any community-driven or indigenous adaptation practices that you think could be scaled up in your district/sector?
 - a. Yes
 - b. No

If yes, please describe the practices.

3. How do you involve vulnerable groups (e.g., women, youths, disabled individuals) in decision-making and implementation of adaptation strategies in your district/sector?

- a. Yes
 - b. No
-

4. Do the benefits of adaptation strategies extend beyond direct economic returns (e.g., social cohesion, ecosystem services, long-term health benefits)?

- a. Yes
- b. No

If yes, please explain the non-economic benefits.

5. Are there any financial incentives or subsidies that could make adaptation options more affordable for communities (e.g., tax breaks, government support programs)?

- a. Yes
- b. No

If yes, please describe.

6. Do you think adaptation strategies could create new economic opportunities or jobs in your district (e.g., in green technologies, sustainable agriculture)?

- a. Yes
- b. No

If yes, please explain.

Section 2: Economic Appraisal of Adaptation Options

1. Do the benefits of adaptation strategies extend beyond direct economic returns (e.g., social cohesion, ecosystem services, long-term health benefits)?

- Yes
- No

If yes, please explain the non-economic benefits.

2. Are there any financial incentives or subsidies that could make adaptation options more affordable for communities (e.g., tax breaks, government support programs)?

- Yes

- No

If yes, please describe.

3. Do you think adaptation strategies could create new economic opportunities or jobs in your district (e.g., in green technologies, sustainable agriculture)?

- Yes
- No

If yes, please explain.

4. In your opinion, which adaptation strategies are the most cost-effective in your district/sector?

(Please provide details if possible.)

5. What is the estimated cost of implementing the most critical adaptation strategies in your district/sector? (If available, provide specific numbers or ranges.). Is it possible to name the strategy and then estimated cost?

6. What are the expected benefits (e.g., improved livelihoods, better infrastructure resilience) of these adaptation strategies?

7. Do you believe the costs of adaptation in your district/sector outweigh the benefits, or vice versa?

- Benefits outweigh costs
- Costs outweigh benefits
- Equal balance

8. . How do you think adaptation efforts could be financed in your district/sector (e.g., government funding, private sector investment, international funds)? If possible, name the efforts and which part they can support.

Section 3: Private and Public Sector Engagement

1. How can the private sector benefit from investing in climate adaptation in your district/sector (e.g., through corporate social responsibility, new market opportunities)?

2. What specific government policies or incentives (e.g., grants, tax incentives, low-interest loans) could encourage the private sector to increase investment in adaptation measures?

3. Are there any private sector investments currently involved in adaptation efforts in your district/sector?

- Yes
- No
- If yes, please provide examples.

4. What barriers do you think are preventing more private sector involvement in adaptation strategies?

What opportunities can you identify as attracting more private sector involvement in adaptation strategies?

5. . What role do you think the public sector should play in financing adaptation strategies?

6. How can the government encourage more private-public partnerships in climate adaptation?

Section 4: Monitoring and Evaluation

1. Do you use cost-benefit analysis or other financial metrics to assess the economic returns of adaptation strategies?

- Yes
- No

If yes, please explain the methods used.

Detailed economic appraisal, disaggregated by the priority sectors

2. Are there any unintended negative consequences of adaptation strategies (e.g., maladaptation, displacement, or environmental degradation)?

- Yes
- No

If yes, please provide examples.

3. Are there any mechanisms in place to monitor and evaluate the effectiveness of adaptation strategies in your district/sector?

- Yes
 - No
 - If yes, please describe the mechanisms.
-

4. What indicators or data sources do you currently use to measure the success of adaptation strategies (e.g., reduction in climate risks, economic returns)?
-

5. . Do you think there is a need for additional data or monitoring systems to effectively evaluate adaptation strategies?

- Yes
 - No
 - If yes, please provide details.
-

Section 5: Policy and Institutional Context

1. Do you think the current institutional capacity (e.g., expertise, human resources, infrastructure) in your district/sector is sufficient to implement adaptation strategies effectively?

- Yes

If yes, please explain.

- No

If no, please describe the gaps.

2. How well do you think local governance structures (e.g., district councils, traditional authorities) are aligned with national policies on climate adaptation?

3. How would you rate the level of technical expertise available within your district/sector to support the development and implementation of climate adaptation strategies (e.g., high, medium, low)?
-

4. Do you think climate adaptation efforts in your district/sector are adequately funded by the national budget or international donors?

a. Yes

If yes, please explain.

b. No

If no, please explain the funding gaps.

5. Do you feel that the current policies and regulations support effective climate adaptation in your district/sector? (Open question for discussion)

- Yes : If yes, argue and comment how.

- No : If no, please explain the gaps

... Please include any additional observations.

6. Are there any policy reforms or legal frameworks that you think are necessary to enhance climate adaptation efforts?
-

7. How well do different sectors and institutions collaborate on climate adaptation planning and implementation?
-

Section 6: Cross-Sectoral Linkages

1. How do climate adaptation strategies in your sector link with other sectors (e.g., water and agriculture, energy and infrastructure)?
-

2. Are there any cross-sectoral programs or projects that coordinate climate adaptation efforts?

Yes

Detailed economic appraisal, disaggregated by the priority sectors

No

If yes, please describe the programs.

3. What are the key challenges or opportunities for cross-sector collaboration on climate adaptation strategies?
-

Section 7: Long-Term Sustainability and Scaling

1. What steps can be taken to ensure the long-term sustainability of adaptation strategies in your district/sector?
-

2. Do you see potential for scaling up successful adaptation strategies to other regions of the country?

a. Yes

b. No

If yes, please describe the strategies and their scalability.

Section 8: Open-Ended Questions

1. What do you think are the greatest challenges to implementing effective adaptation strategies in your district/sector?
-
-

2. What additional resources (financial, technical, etc.) would be needed to enhance climate adaptation in your district/sector?
-
-

3. Do you have any suggestions on how to improve the economic appraisal of adaptation strategies in Malawi?
-
-

Detailed economic appraisal, disaggregated by the priority sectors

4. How do you believe climate change will change the needs and priorities for adaptation strategies in your sector over the next few decades? Please provide examples where possible.

This questionnaire aims to gather insights from district-level stakeholders and national entities to inform a robust economic analysis of adaptation strategies. It covers multiple sectors, focusing on capturing detailed information on climate risks, current adaptation measures, costs, benefits, and financing options.

Annex 2. Results of the survey with mission reports

Sector	Key Findings
Agriculture	Farmers in Dedza, Balaka, and Kasungu reported a 30% reduction in maize and groundnut yields due to shifting rainfall patterns. Unpredictable rainfall and increased drought frequency were cited as major constraints, with limited access to drought-resistant seed varieties. Adoption of climate-smart agriculture remains low due to lack of financial incentives and limited extension services.
Fisheries	Fisheries in Salima and Karonga have experienced up to a 15% decline in fish stocks, attributed to rising lake temperatures and changing water levels. Fishery operators noted a reduction in breeding grounds, leading to lower fish catches and income losses for local communities. Some traditional fishery management practices were identified as potential adaptation strategies, but more enforcement and scientific monitoring are needed.
Infrastructure and Disaster Risk Management	Infrastructure damage in Chikwawa and Phalombe due to floods has increased maintenance costs by 50% since 2020. Communities reported frequent road washouts, damaged bridges, and destroyed irrigation canals, affecting agricultural supply chains. Investment in flood-resilient infrastructure, such as elevated roads and reinforced bridges, was identified as a priority need.
Water Resources and Irrigation	Water shortages in Rumphi and Kasungu have reduced irrigation farming, threatening food security. Smallholder farmers face limited access to irrigation technology due to high costs and lack of financing mechanisms. Community-led water management practices were identified as a potential solution but require institutional support and capacity building.
Forestry	Unsustainable charcoal production in Dedza and Phalombe was linked to deforestation and increased vulnerability to soil erosion. Limited access to alternative energy sources was reported, with solar and improved cookstoves identified as potential mitigation options. Reforestation

	efforts are ongoing, but lack of financial incentives hinders widespread adoption.
Social	Climate-induced displacement in Chikwawa has increased cases of malaria and cholera outbreaks due to poor water and sanitation conditions. The survey highlighted gender disparities in climate adaptation, with women and youth having less access to adaptation resources despite their key roles in agriculture and water management. There is a need for integrating climate adaptation into local health planning, particularly in flood-prone areas.
Financial and Institutional Barriers	Limited Funding – Many adaptation strategies remain underfunded, and local governments rely heavily on international donors and NGOs. Technical Capacity Gaps – A shortage of trained personnel limits the implementation of advanced climate-smart solutions. Lack of Private Sector Involvement – Few private-sector investments exist in adaptation, and incentives for businesses to invest in resilient infrastructure remain weak. Poor Coordination Between Sectors – Adaptation efforts in agriculture, water, and energy sectors often operate in silos, reducing overall effectiveness.

Annex 3: List of participants (Prioritization workshop)

ATTENDANCE REGISTER						
NATIONAL CONSULTATION WORKSHOP FOR THE ECONOMIC APPRAISAL OF THE ADAPTATION OPTIONS UNDER THE NATIONAL ADAPTATION PLAN (NAP) READINESS PROJECT –						
Venue: SUNBIRD CAPITAL HOTEL- LILONGWE. 31 JANUARY, 2025						
	NAME	DESIGNATION	INSTITUTION	CELL NO.	EMAIL ADDRESS	SIGNATURE
1	TCHAKA KAMONDA	PC-NAP	EA/UXED	099567169	Tchaka.Kamondo@ea.org	
2	HOPE CHIPANDILA	ECONOMIST	EP&A	09944953092	hope.chipandila@yahoo.com	
3	Jessy Baloyi	Consultant	Oiko	0995064090	jessybaloyi11@gmail.com	
4	Chawez Tembo	II	OIKO	0985339432	Chaweztembo@gmail.com	
5	Patrick Mkwampira	EA/EO	EAD	0995317449	Patrick.Mkwampira@murec.gov.mw	
6	Chifundo Chopi	NAP-Admin	NAP-EAD	0997270721	chifundochopi@gmail.com	
7	PATRICK LIKONGWE	DD-EE	LEAD	0888879113	plikongwe@leadsea-mw	

Detailed economic appraisal, disaggregated by the priority sectors

	NAME	DESIGNATION	INSTITUTION	CELL NO.	EMAIL ADDRESS	SIGNATURE
8	Clement Tikuwa	CEO (EAD)	EAD	0993715971	clement.tikuwa@gmail.com	
9	Ruth Meki	DO	NPC	0884457570	rmekei@npc.mu	
10	Pacharo Mangomba	DMO	MOFEA-DAD	0995457296	pacharo9@gmail.com	
11	Innocent Bunga	WRDO	DWR	0884368901	innobunga@gmail.com	
12	Sifho Biliat	DPM	NPC	0991382843	sbiliat@npc.mu	
13	Madahe Ngambwa	PS-Admin	MOFPR	0888764501	madahe.ngambwa@gmail.com	
14	Hlazo Phiri	EO	EAD	0994636869	phirihlazo22@gmail.com	
15	Amidu Banda	EO	EAD	0997900251	latikuamidu22@gmail.com	
16	CHINSISI PHIRI	EO	EAD	0991146373	phirichinsi@gmail.com	
17	Golvati Gomanu	EI	EAD	0997383651	golvati.gomanu@nrec.gov.mu	

Detailed economic appraisal, disaggregated by the priority sectors

	NAME	DESIGNATION	INSTITUTION	CELL NO.	EMAIL ADDRESS	SIGNATURE
18	Carolyn Muntshu	PFO	Fisheries	088877005	Carolynmuntshu@hahigmail.com	
19	Julius Ngoma	Coordinator	CISONECC	088899595A	Julius@CISONECC.org	
20	Kefas Kamoyo	PLRCO	MOA LRCD	0999951981	kemreje@gmail.com	
21	Mariana C. Ngwira	PIEconomet	MOTPW	0888739901	jumbemarian193@gmail.com	
22	Joshua Mughagha	Economist	EPdD	0888653511	jmoshughagha@gmail.com	
23	J-A Koroja	Research *AD	*AD	09995453510		
24	S. Mwasimile	Account	*AD	099991520		
25	B. Mlowale	NL-U	DILCO	0888788333	mlowaleblessing@gmail.com	

Annex 4: CBA Modelling

Spreadsheet 1. National data

Spreadsheet 2. Costs

Spreadsheet 3. Benefits

Spreadsheet 4. 22 adaptation options RCP4.5 IRR NPV

Spreadsheet 5. 22 adaptation options RCP8.5 IRR NPV

Spreadsheet 6. Sensitivity



sustainable development
on our finite planet



Carrer Can Verí, 1 · 07001 · Palma de Mallorca · Spain



+34 971 72 56 66



administration@oikologica.com



www.oikologica.com