

PROJECT EXEMPLAR

Adapting Malawi's Road Networks Through Climate-Resilient Design and Asset Management



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KEY PROJECT INFORMATION



Country / Region

Malawi, East Africa



Sector

Transport (Roads)



Investment Value

\$65 million



Implementation Period

2025-2030



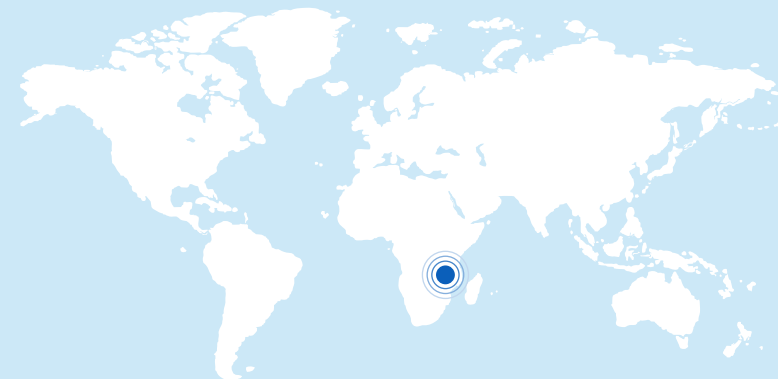
Key Partners

World Bank Group (WBG),
Malawi Roads Authority



Beneficiaries

500,000 people



THE ADAPTATION STORY

Context and adaptation challenge

Malawi is among the poorest countries in Africa and is highly vulnerable to the impacts of climate change. Malawi's population is set to double in the coming decade, raising a pressing need to invest in resilient infrastructure. With 80% of the population living in rural areas, and the country depending on neighboring countries for seaport access, connectivity networks are essential to unlocking economic opportunity and socioeconomic wellbeing.

Malawi's road network is increasingly disrupted by climate shocks, with floods, landslides, storms and drought intensifying over recent decades. Since 1980 the country has experienced more than 50 recorded disasters, and severe rainfall-related events (floods, landslides and storms) have increased in frequency over the last decade, while recent consecutive droughts have significantly affected agricultural production in the Lower Shire Valley, a region of national and regional economic importance. These compounding climate stresses highlight the need for reliable and climate-resilient transport and connectivity systems to sustain livelihoods, market access and regional trade.

Inaction would lock Malawi into escalating repair costs, loss of service continuity, and reduced economic resilience in a country where connectivity is essential for rural livelihoods and trade access to regional seaports. However, barriers are not only physical: planning and standards remain largely based on historic climate assumptions, road asset management is not fully climate-informed, and low capacity and fragmented standards limit the consistent application of resilient design and preventive maintenance.



Roads included in this assignment:

Road S136 between Chikwawa and Mwanza

Road S151 northbound from Bangula

What was GCA's role?

The RESTORE project (Resilient Transport Operational Enhancement), implemented by the World Bank Group (WBG), focuses on the Lower Shire Valley, a low-lying hotspot highly exposed to climate extremes that disrupt transport services and constrain access to essential services. Through the Africa Adaptation Acceleration Program (AAP), GCA provided technical assistance to the WBG and local implementation agencies, including the Malawi Roads Authority, to mainstream climate adaptation into the RESTORE project. The goal of the WBG investment project is to provide safe, climate-resilient transport connectivity in Malawi's Lower Shire Region and strengthen institutional capacity for climate-resilient road asset management. **GCA's support focused on mainstreaming resilience in the transport asset lifecycle and improving long-term operational sustainability.**

As part of this effort, GCA mapped climate risks across Malawi's road network under multiple future scenarios, identifying flooding, geomorphological change, and rising temperatures as key threats to connectivity. Based on this analysis, **GCA conducted an adaptation options appraisal, prioritizing green and grey resilience interventions and providing an evidence-based framework to compare risks, costs, and long-term performance to guide investment decisions.**

GCA's technical assistance emphasized institutional transformation and long-term sustainability alongside infrastructure upgrades. Beyond climate risk assessments, GCA strengthened systems and institutional capacity within the Malawi Roads Authority's asset management ecosystem by reviewing the Road Asset Management System (RAMS), technical standards, materials testing capacity, and institutional gaps, resulting in procurement-ready recommendations. GCA's multi-level climate risk and vulnerability assessment (national, regional, and asset) supported mainstreaming resilience across the full transport asset lifecycle, from planning and design to maintenance and investment decisions, translating technical analysis into implementable institutional pathways and sustained outcomes. Structured capacity building complemented this support, including the AAP masterclass on climate-resilient infrastructure PPPs, strengthening institutional knowledge on integrating climate risk, resilience standards, and sustainable financing into transport planning and delivery.

Results and impact

Asset-level assessments of targeted corridors highlighted critical river crossings and drainage bottlenecks where repeated failures sever access to essential services. In parallel, system-wide vulnerabilities were identified, linked to outdated design standards, limited integration of climate risk into asset management, and institutional capacity gaps.

Diagnostic reviews of the RAMS, technical standards, and materials testing laboratories produced concrete, procurement-ready recommendations to address these challenges. These included modernizing RAMS with integrated data systems and climate risk analysis, updating pavement, drainage, and bridge design standards to reflect future climate conditions, and upgrading national materials laboratories through equipment renewal, facility rehabilitation, and staff training.

Building on the corridor risk assessments, adaptation measures were prioritized combining climate-responsive road upgrades, catchment-level nature-based solutions, and institutional reforms. **Through multi-criteria and cost-benefit analysis, GCA supported the selection of economically viable intervention packages that restore connectivity while reducing erosion, sedimentation, and long-term maintenance burdens.**

INDICATOR	RESULT / TARGET
Direct and indirect losses	Without adaptation, direct flood damage is estimated at approximately USD 1.48 million per year under current conditions, increasing to around USD 2.46 million under SSP5-8.5, with total direct damage costs potentially rising by up to 86% by mid-century. Indirect losses include travel disruption, increased vehicle operating costs, reduced access to markets and services, and community isolation. Major river crossing failures currently cut off at least 5,000 people during flood events.
Benefit-cost ratios (BCR) of adaptation investments	The cost-benefit analysis shows that the most viable measures achieve BCRs above 1 (up to 1.6) under current conditions, with benefits increasing further under future climate scenarios.

Climate hazards, impacts, and prioritised adaptation measures:

KEY CLIMATE HAZARDS	IMPACTS ON INFRASTRUCTURE, SERVICES AND USERS	PRIORITIZED ADAPTATION MEASURES
 Fluvial flooding	Infrastructure: Bridge failures, embankment overtopping, culvert blockage, and road washouts. Services: Corridors frequently severed, disrupting regional connectivity. Communities: Prolonged isolation of communities during river floods, cutting thousands off from markets, health services, and emergency access.	Open-span bridges at major crossings; raised embankments; resilient river crossings; increased culvert capacity; climate-informed drainage design.
 Pluvial flooding	Infrastructure: Localized inundation, shoulder collapse, pavement deterioration. Services: Reduced road reliability and higher maintenance needs. Communities: Short-term access disruptions and increased travel delays, particularly affecting daily commuting and local service access during intense rainfall events.	Improved drainage systems; roadside swales; upgraded pavements and shoulders; targeted rehabilitation of vulnerable sections.
 Erosion and sedimentation	Infrastructure: Raised streambeds, clogged drainage structures, accelerated pavement damage. Services: Repeated failures at hotspots shorten asset life and increase lifecycle costs. Communities: Higher flood exposure, loss of agricultural productivity, weakened livelihoods.	Riparian reforestation; gully stabilisation; small retention basins; wetland restoration; catchment management to reduce runoff and sediment loads.
 Extreme heat	Infrastructure: Accelerated pavement degradation and structural stress. Services: Increased maintenance demand and declining performance under future climates. Communities: Indirect impacts through reduced service reliability and higher transport costs.	Heat-resistant pavement materials; climate-resilient road design standards; improved materials testing and quality control.

KEY LESSONS

LESSON

1

Asset management is a powerful entry point for climate resilience of road networks when embedded across the transport asset lifecycle through strengthened institutions, standards, and capacity.



Photo credit: GCA

WHAT WE HAVE LEARNT

Long-term climate resilience cannot be achieved through engineering upgrades alone. While asset-level interventions are essential, GCA found that limited integration of climate risk into planning, design standards, and asset management systems was a binding constraint on long-term resilience. Diagnostic reviews revealed outdated design standards, fragmented data systems, and capacity gaps that undermine sustainable investment. As a result, GCA provided targeted recommendations to strengthen climate resilience of the Road Asset Management System (RAMS), update technical standards, improve materials testing capacity, and build institutional capacity alongside physical upgrades. RAMS are key tools to plan and prioritize road section rehabilitations at various scales - including a climate risk perspective and socio-economic criticality is a major step toward resilience. Importantly, introducing advanced tools without first strengthening institutional foundations risks poor uptake and limited impact. Embedding climate risk across the full asset lifecycle, from planning and design to maintenance and renewal, emerged as the most durable pathway to system-wide resilience.

REPLICABILITY

This approach is highly transferable to other road agencies facing similar institutional constraints. Rather than focusing only on new systems or technologies, or asset only, MDB-supported projects can apply a multi-level framework, combining climate risk assessment with Road Asset Management Systems, standards updates, and capacity building, to strengthen resilience across entire networks. The model is adaptable to different country contexts and supports scalable, long-term improvements beyond individual corridor assets.

LESSON

2

In the Lower Shire Valley, changing river behaviour and erosion emerged as key drivers of road vulnerability, highlighting the need to address geomorphological risks to avoid maladaptation

WHAT WE HAVE LEARNT

In the Lower Shire Valley, GCA identified geomorphological processes, erosion, sedimentation, and scour, as dominant drivers of road failure, alongside flooding. Asset-level assessments of the targeted corridors showed that repeated washouts and bridge failures stem from higher flows, changing river dynamics and catchment degradation. The analysis highlighted that conventional drainage or pavement upgrades alone are insufficient and may even lead to maladaptation if geomorphology is ignored. Instead, resilience requires combining resilient crossings and road upgrades with upstream catchment management and nature-based solutions to reduce sediment loads and flood peaks, while restoring reliable connectivity for vulnerable communities.

REPLICABILITY

Many transport corridors across Sub-Saharan Africa face similar geomorphological pressures, particularly along river valleys and floodplains where shifting rivers, erosion, and sediment build-up threaten roads and crossings. Malawi's case demonstrates the value of integrating river dynamics and catchment processes into infrastructure planning, supported by targeted nature-based solutions. This lesson is replicable wherever erosion and sedimentation drive asset failure, provided projects incorporate geomorphological analysis early and coordinate road investments with upstream land and water management.



Photo credit: GCA

Actionable insights for MDBs

THEME	INSIGHTS
Asset management as adaptation	Treat asset management reform as climate adaptation by strengthening RAMS, updating design standards, improving materials testing, and building institutional capacity alongside physical investments. Embed climate risk across the full asset lifecycle rather than retrofitting resilience after construction, and reducing long-term OPEX through more preventive maintenance.
Sequencing investments for long-term resilience	Pair corridor upgrades with system-wide reforms to avoid repeated rehabilitation cycles, lower lifecycle costs, and protect public investment while stabilising future OPEX.
Managing geomorphological risk	Address erosion, sedimentation, and river channel change early in project design to avoid maladaptation, combining resilient crossings with upstream catchment management and nature-based solutions to reduce recurrent damage and emergency repair costs.



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