

PROJECT EXEMPLAR

Embedding Climate Resilience in Kenya's Nairobi–Mombasa Expressway PPP



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KEY PROJECT INFORMATION



Country / Region

Kenya, East Africa



Sector

Transport (Road)



Investment Value

\$3.6 billion



Implementation Period

2024-2030



Key Partners

Kenya National Highways Authority (KeNHA),
Everstrong



Beneficiaries

>5 million people, through improved
connectivity between largest 2 cities in Kenya



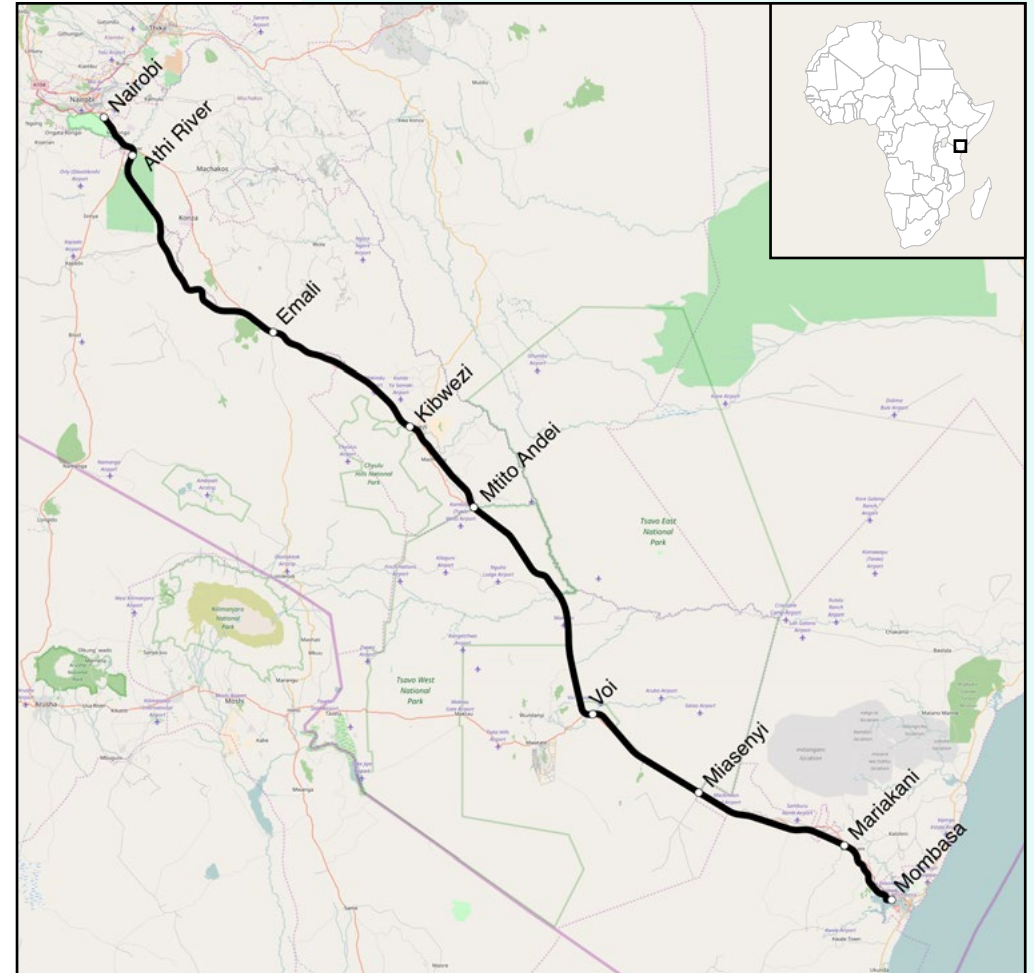
THE ADAPTATION STORY

Context and adaptation challenge

Kenya is highly exposed to climate variability and extremes, with flooding, drought, landslides, and heatwaves already causing significant social and economic disruption. It is estimated that over 70% of past disasters in the country are attributable to extreme climatic events. Typically, major droughts occur approximately every ten years, and moderate droughts or floods every three to four years. **Climate projections indicate rising temperatures and increasingly intense rainfall, which are expected to amplify risks of flash flooding, erosion, and damage to critical transport corridors, particularly across arid and semi-arid regions.**

These impacts disrupt mobility, safety, and economic activity while placing mounting pressure on public infrastructure systems. The planned Nairobi-Mombasa Expressway (NME), a major regional corridor linking Nairobi to Mombasa, Kenya's primary port and a gateway for trade serving both domestic markets and neighbouring landlocked countries, is expected to play a strategic role in strengthening connectivity between the country's two largest economic hubs and supporting regional commerce. As a flagship public-private partnership (PPP) currently under development, the NME presents a critical opportunity to embed climate resilience from the outset of project planning and design. Recent experience from comparable infrastructure highlights the urgency of this approach. The Nairobi Expressway, opened to traffic in 2022, has already demonstrated vulnerability to flooding during extreme rainfall events, resulting in transport disruptions and safety concerns. These impacts highlight the risks posed by climate variability to transport infrastructure and the importance of integrating resilience considerations early, particularly in PPP structures where performance and availability are central to financial viability.

The adaptation challenge is systemic: it requires strengthening the integration of climate risk information into planning and decision-making processes so as to support resilient infrastructure, maintain connectivity, and reduce future disruptions under increasingly variable climate conditions.



What was GCA's role?

Under the Africa Adaptation Acceleration Program (AAAP), the Global Center on Adaptation (GCA) partnered with the Kenya National Highways Authority (KeNHA) to support the integration of climate resilience into the Nairobi-Mombasa Expressway, a flagship public-private partnership designed to strengthen national and regional connectivity. **GCA provided technical assistance, including a high-resolution climate risk assessment to identify priority risk areas along the corridor and a targeted package of green and grey adaptation options supported by financing rationale.** In parallel, GCA developed technical guidelines to inform climate risk allocation and resilience performance standards within the PPP framework. This support is helping embed climate considerations across project planning, design, and operations, while strengthening institutional capacity and informing future climate-responsive transport PPPs in Kenya. In addition, GCA supported capacity strengthening for project partners, enabling developers to progressively update and refine climate risk assessments as project designs evolve and advance through the feasibility stage.

Results and impact

The climate hazard assessment and stakeholder consultations identified extreme temperature, extreme precipitation, and flooding as the most critical climate hazards affecting the Nairobi-Mombasa Expressway. The results of the assessment were embedded in the feasibility studies during the early stages of project development to inform subsequent design decisions and future phases of implementation.

Climate projections indicate climate hazards will increase in both intensity and frequency, driving the largest impacts on road assets over time. The climate stress test and vulnerability assessment revealed significant and escalating risks to infrastructure and surrounding communities, particularly from fluvial and pluvial flooding.

Climate risk hotspots were identified, particularly in areas with high flood exposure, high asset density, and proximity to urban centres, accounting for nearly 80% of total annual risk due to these combined factors. Projections indicate that indirect damages are expected to increase over time, resulting in more delays, detours, aborted trips, and cargo deterioration. This highlights the significant potential impact on both PPP costs and revenue streams, emphasizing the need to address and manage these risks upfront within the PPP framework itself.

In response, GCA supported the **identification, appraisal, and prioritization of green and grey adaptation measures, organized into three investment packages: maintenance, flood protection, and design improvements. These interventions target high-risk locations, including major river crossings and flood-prone peri-urban sections along the corridor, and integrate nature-based solutions to strengthen asset resilience while delivering co-benefits such as improved ecosystem services, livelihood opportunities, and potential revenue streams.** These results provide a strong evidence base to guide adaptation investments, reduce future disruptions, enhance user safety, and improve the long-term financial and operational sustainability of the corridor.

INDICATOR	RESULT / TARGET
Direct and indirect losses	Total annual climate risk is projected to be around five times higher by 2070 under high-emissions scenarios (SSP5-8.5) compared to baseline conditions. Indirect losses (from delays, detours, aborted trips, and cargo deterioration) are expected to rise most sharply, increasing by around six times compared to baseline, highlighting growing impacts on service reliability and economic activity.
Benefit-cost ratios (BCR) of adaptation investments	Economic appraisal shows BCR > 1 for all three adaptation packages (maintenance, flood protection, and design improvements). The design improvement package achieves the highest benefit-cost performance when applied to high-risk sections of road.

Climate hazards, impacts, and prioritised adaptation measures:

KEY CLIMATE HAZARDS	IMPACTS ON INFRASTRUCTURE, SERVICES AND USERS	PRIORITIZED ADAPTATION MEASURES
 Fluvial flooding	Infrastructure: Direct asset risk to bridges and low-lying sections, with risks of scour, structural damage, and washouts. Services: Prolonged closures, detours, and cargo delays. Communities: Extended isolation and reduced access to markets and essential services.	Bridge and culvert upgrades; protection of foundations and abutments; flood-resilient structural design; localized flood protection works; targeted maintenance in high-risk sections
 Pluvial flooding	Infrastructure: Carriageway overtopping, embankment erosion, and drainage failure during intense rainfall events. Services: Localized disruptions, reduced speeds, and safety risks. Communities: Temporary loss of access and increased accident risk.	Drainage capacity upgrades; improved roadside channels and culverts; slope stabilization; design improvements to manage surface water; enhanced operations and maintenance of drainage assets.
 Extreme heat	Infrastructure: Accelerated pavement degradation and long-term structural stress, with heat-related risks projected to increase over time. Services: Increased maintenance needs and reduced ride quality. Communities: Higher heat exposure for road users and workers.	Climate-resilient pavement and material specifications; design improvements for heat tolerance; preventative maintenance under the maintenance investment package.
 Drought	Infrastructure: Limited direct damage to road assets but increased stress on surrounding landscapes and materials. Services: Indirect impacts through reduced ecosystem stability and increased dust. Communities: Significant livelihood impacts in arid and semi-arid regions.	Routine maintenance measures and corridor management integrated within the maintenance package
 Wildfires	Infrastructure: Generally low direct asset damage, but risk to roadside assets and signage. Services: Visibility loss, safety hazards, and temporary closures during fire events. Communities: Health risks from smoke and disruption to local activities.	Operational preparedness and maintenance-based measures embedded within standard O&M and emergency response planning

KEY LESSONS

LESSON

1

Indirect climate impacts can exceed direct asset damage and must be considered in PPP structuring

WHAT WE HAVE LEARNT

The climate stress test shows that a large share of monetized climate risk is driven by indirect impacts on transport operations, rather than by direct physical damage to road assets. Flooding and extreme rainfall events can disrupt traffic flow, causing delays, detours, cancelled trips, and deterioration of transported goods, which generate economic losses even when infrastructure damage is limited. These disruption-related impacts are expected to increase over time as climate hazards intensify. In a PPP context, such indirect impacts are particularly important because they directly affect project revenues and operational performance. Reduced traffic flows, longer travel times, and service interruptions can translate into lower toll revenues and increased operating costs. Higher indirect risk therefore highlights the importance of integrating climate risk assessment early in project preparation and managing and fairly allocating climate risks upfront in PPP structuring to safeguard financial sustainability and corridor reliability.

REPLICABILITY

This lesson is relevant for transport PPPs globally, particularly for toll-based projects where climate-related traffic disruptions directly affect revenue streams. Climate risk assessments should therefore capture both direct asset damages and indirect operational impacts, such as traffic delays, route diversions, and service interruptions. Incorporating these risks into feasibility studies and financial modelling allows project developers and contracting authorities to better understand the full economic implications of climate hazards. In practice, this means integrating climate resilience into PPP structuring through climate-resilient design standards, performance requirements, and contractual provisions that ensure climate risks are appropriately allocated and managed between public and private partners over the project lifecycle.



LESSON

2

Embedding climate resilience requires early engagement and an iterative process, supported by capacity building, so project partners can reassess risks and refine adaptation measures as the project evolves

WHAT WE HAVE LEARNT

Significant design changes occurred after the initial climate risk assessment, altering exposure and vulnerability along the corridor. Rather than repeatedly redoing analyses externally, the process evolved toward building project partner capacity, enabling developers to update climate risk assessments themselves as designs progressed. This highlighted the importance of moving beyond one-off studies toward an iterative approach, where climate risks are revisited throughout project development. Technical assistance therefore focused both on delivering assessments and adaptation options, and on strengthening partner ownership of climate risk management. This supported the continued integration of climate considerations as feasibility studies were refined and project decisions advanced.

REPLICABILITY

Large infrastructure projects could undergo design changes over time. Early engagement combined with practical capacity building allows implementing agencies and developers to adapt climate assessments as projects mature. This approach supports long-term ownership of resilience outcomes and can be applied across sectors to help keep climate risk management active from planning through implementation.



Photo credit: GCA

Actionable insights for MDBs

THEME	INSIGHTS
Economic appraisal and prioritization	Require climate risk screening to include service-disruption and economic impact metrics (e.g., delays, detours, freight losses), not only physical asset damage, to strengthen investment appraisal and prioritization of resilience measures.
Adaptive project preparation	Structure technical assistance and financing to allow climate risk assessments and adaptation options to be updated as designs evolve, avoiding one-off studies and enabling iterative integration throughout feasibility and procurement.
Institutional capacity and market readiness	Pair analytical support with practical capacity building (guidelines, standards, and stakeholder engagement) so implementing agencies and private partners can apply climate resilience independently, supporting scalable uptake across future projects.



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