IIGCC

PCRAM case study

East Africa Marine Transport (EAMT)

Environmental Change Institute eci University of Oxford
LSE
Grantham Research Institute on Climate Change and the Environment
PIDG Private Infrastructure Development Group
EAMT
UK International Development
Partnership | Progress | Prosperity

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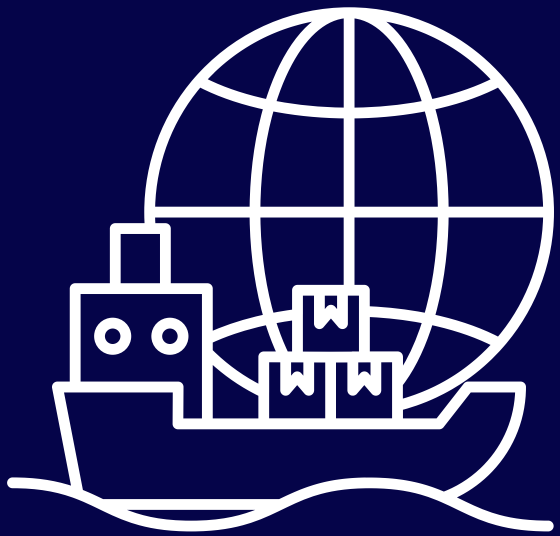
Status: This analysis was undertaken as a pilot to test and explore the methodology. The outputs are illustrative only and derived from simplified financial modelling based on a number of high-level assumptions; they have not been audited, assured, or independently verified, and do not constitute a full risk assessment. The purpose of this work is to support methodological development and to prompt discussion, rather than to provide definitive financial or risk analysis.

Investment overview



Private Infrastructure Development Group (PIDG) made an equity investment into East Africa Marine Transport (EAMT) for the design, construction and operation of MV Mpungu - a logistics and freight vessel operating on Lake Victoria.

Asset objectives:

- ✓ Provide a scheduled 18hr port to port ferry service
- ✓ Move 190k t of freight per year across 300 trips.
- ✓ Stable investor returns
- ✓ Proof of concept - a fixed day scheduled freight liner service on Lake Victoria

Project impacts:

- ✓ Trade efficiency and increased economic productivity
- ✓ Economic growth and poverty alleviation in the EAC region
- ✓ +38 long term jobs

Sector:

- ■ Power generation (renewable)
- ■ Power generation (other)
- ■ Power transmission
- ■ Other energy infrastructure
- ✓ **Maritime transport**
- ■ Rail
- ■ Water resources/network
- ■ Airport
- ■ Highway
- ■ Telecommunications
- ■ Data centres

Asset lifecycle:

- ■ Development
- ■ Construction
- ✓ **Operational**
- ■ Decommission

Investment stage:

- ■ Pre investment
- ✓ **Holding**
- ■ Exited

Hazards analysed:

- ■ Changing lake levels:
- ✓ **Precipitation**
- ✓ **Evaporation**
- ✓ **Lake inflows and outflows**

Finance type:

- ■ Blended finance facility
- ✓ **Private sector funding**
- ✓ **DFI funding**
- ■ Government funding

PCRAM 2.0 improvements:

- ✓ **Infrastructure systems analysis**
- ✓ **Adaptive pathways**

Figure 1: The PCRAM Process

	1	2	3	4
Steps	**Scoping and data gathering**	**Materiality assessment**	**Resilience building**	**Value enhancement**
Objective	Determine data sufficiency	Assessing asset vulnerability	Identifying adaptation options	Optimised resilience with residual risk transfer
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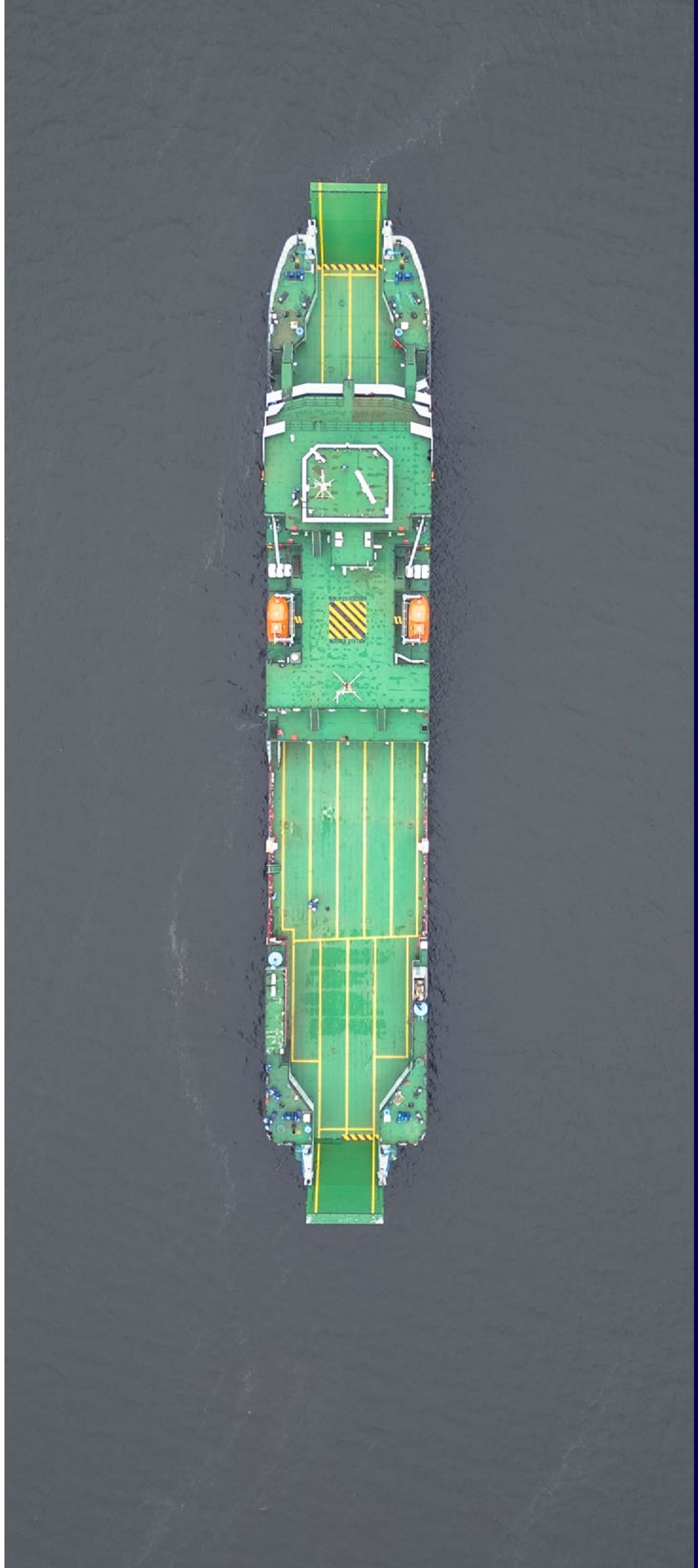

Step 1: Presentation of asset, scoping and data gathering

Exploring the assets operating conditions, climate and system dependencies.

Asset overview

East Africa Marine Transport (EAMT) is a pioneering scheduled roll-on/roll-off freight transport service across Lake Victoria, transporting up to twenty-one fully laden trucks between Port Bell (Kampala, Uganda) and the Port at Mwanza South (Tanzania).

The ferry was commissioned as a purpose-built vessel, M.V. Mpungu, which now operates the Lake's first fixed-day scheduled freight service. The development of the service also included remedial works at Port Bell to improve the port infrastructure, which is currently operated under a long-term lease agreement by Uganda Rail Corporation (URC).

EAMT was delivered by the Private Infrastructure Development Group (PIDG) through its project development solution, InfraCo, and in partnership with Grindrod Limited (Grindrod), logistics experts.

Before this asset became operational, ferry services across Lake Victoria were infrequent and unreliable. Consequently, only a small proportion of freight was shipped across the lake, and instead businesses were reliant on moving goods by road. Whilst some government and private sector owners operated across the lake, vessels were small, and their services tended to be carried 'on demand' once a sufficient quantity of cargo had been accumulated.

It is anticipated that the first vessel, which became operational in January 2025, will demonstrate market appetite for a scheduled service, attracting further investment to expand freight capacity and to provide additional cross-border routes in the future. As of Oct 2025, the vessel is now docking in Kisumu, Kenya, as part of the planned expansion of the service. This case study focuses on the route from Port Bell, Uganda, to Mwanza South, Tanzania.

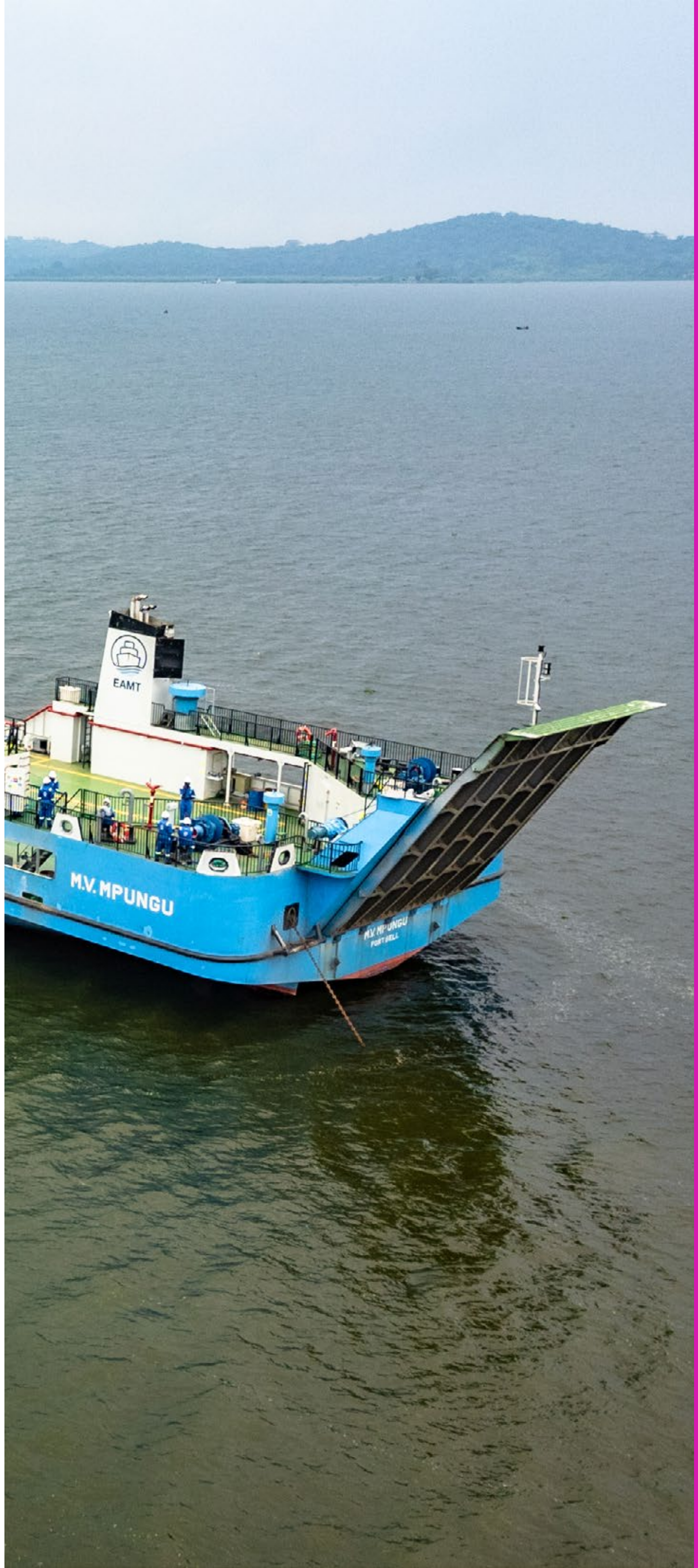

Figure 1: Asset location and ferry route

Imagery ©2025 NASA, Map data ©Google. Additional annotation overlaid on Google Maps image.

Figure 2: MV Mpungu docking in Entebbe

Climate dependencies

The effective operation of the vessel on Lake Victoria is highly dependent on lake water levels. At high extremes, elevated water levels may inundate the quay and associated infrastructure, causing damage and limiting access from the road network. At the other end, significantly low water levels increase the risk of vessel grounding, potentially preventing docking altogether.

The safe use of the vessel's loading ramp is also governed by lake water levels. The ramp's slope must not exceed a gradient of 1:10 under normal operating conditions and 1:8 under exceptional circumstances. These tolerances define the operational envelope within which trucks can be safely driven onto and from the vessel.

System dependencies

An initial asset and hazard screening, combined with high-level system mapping, highlights the Nalubaale and Kiira hydropower facilities near Jinja, Uganda, on the main outflow from the lake. Together, these plants provide a combined 380 MW of power to the Ugandan electricity grid and influence lake water levels.

Time horizon

For the purpose of this study, the analysis covers the period 2024 to 2044, covering the investment period, and any potential exits or future valuations.

Decision Gate A

What are the scope boundaries and data sufficiency according to the investment strategy?

Preliminary analysis identifies that a changing lake level, driven by precipitation and evaporation in and around the lake is a material risk for the effective operation of the vessel and its interaction with port infrastructure, the surrounding population and other connected infrastructure systems. This analysis also highlighted the key system dependencies, such as the hydro facilities, that operate in Jinja (Uganda) and have an impact on lake water levels.

Gate A summary:

- The asset provides freight and logistics service between Mwanza (Tanzania) and Port Bell (Kampala, Uganda)
- Effective vessel operation is dependent on a relatively stable lake level
- Changing lake levels identified as a material climate-related risk
- Lake level drivers and impact of hydro facilities to be explored further

	1	2	3	4
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Step 2: Materiality assessment

Assessing the impact of lake levels on vessel operation, factoring in future climate projections and hydro power management approaches.

Historic lake levels and water balance

From the 1950s to the present day, Lake Victoria's water levels have fluctuated by approximately ±3.3 meters, driven by a combination of natural climatic variability and human activities such as dam operations and land use changes. Historic lake level summary:

- Four main drivers of lake water levels - lake evaporation, precipitation on the lake, inflow from surrounding rivers and outflow at hydropower dams.
- Hydro facilities have an agreed management curve – varying levels of adherence historically.
- A changing climate will impact precipitation, rate of evaporation and inflows from surrounding rivers.
- Historical lake levels would result in minor annual disruption levels - 1.3% for the 1 in 10 threshold and 0.3% for the 1 in 8 maximum limit.

Future lake levels

The climate of the Lake Victoria region is comprised of a seasonal cycle of two rainfall seasons: a short rainy season between September and November, and a long rainy season between March and May with high inter-annual precipitation variability (Vanderkelen et al. 2018a). There is disagreement amongst studies on how climate change will impact mean precipitation rates, with some predicting increases and others predicting decreases. However, it is expected that extreme precipitation events will become more likely. Evaporation on the lake is projected to increase - driven by rising temperatures, and seasonal streamflow is projected to decrease in the Lake Victoria basin during the long rainy season but increase during the short rainy season.

A water balance model for Lake Victoria, developed by Vanderkelen et al (2018a) is used to model future water levels at Lake Victoria (Vanderkelen et al. 2018b). As inputs, the model takes lake precipitation, inflow, and evaporation from CORDEX Africa simulations (Nikulin et al, 2012), while outflow is simulated according to a hypothetical lake management scenario. Three emission scenarios (RCP 2.6, 4.5 and 8.5) and the agreed curve hydro management scenario are used to simulate the range of potential future lake levels. Each emission scenario includes a range of climate models. These projections are plotted in Figure 4 (below) along with the 90% confidence interval.

Figure 3: Historic lake levels with plotted disruption thresholds

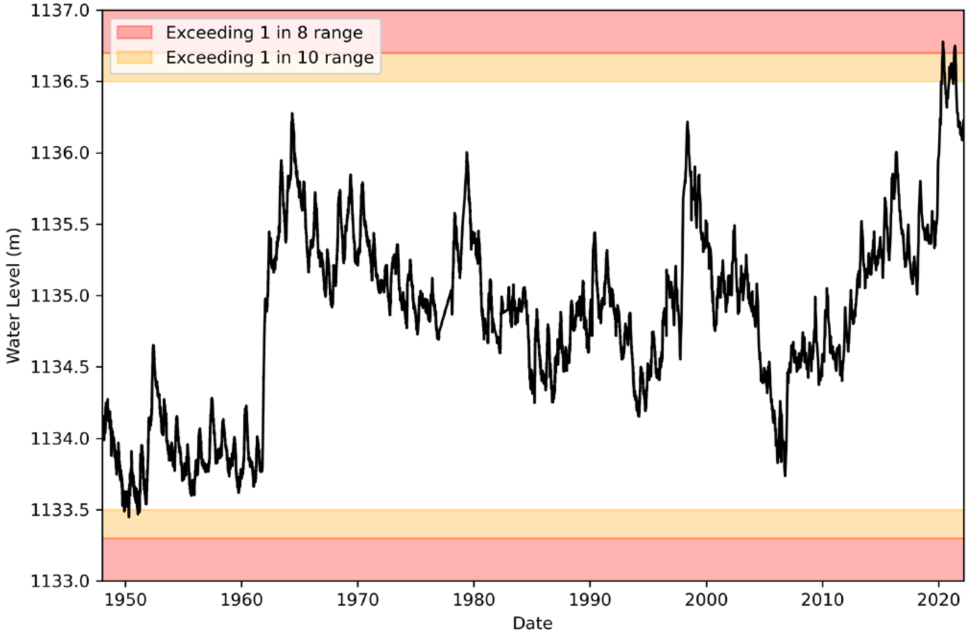
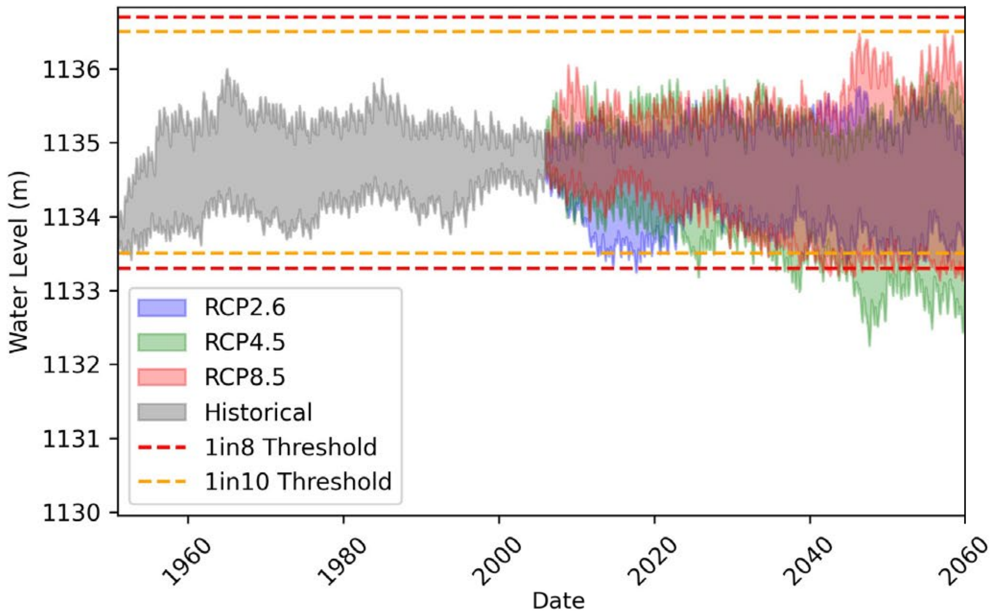


Figure 4: Modelled historical and future lake levels for RCP 2.6, 4.5 and 8.5 (90% confidence interval) as well as 1 in 8 and 1 in 10 ramp threshold.



Existing asset resilience

As part of the development of the vessel and supporting infrastructure at Port Bell, measures were introduced to improve resilience to fluctuating lake levels, such as a ramp to adjust quay levels in response to changing lake levels. Considering these measures, the impact of changing lake levels on vessel operations is assessed by calculating the annual downtime for each climate model and year. Results are summarised as decadal average annual downtime (AAD), including the median model AAD, the 90th percentile AAD, and the probability of annual downtime exceeding 25%.

Table 1: Decadal average annual downtime statistics for 1 in 10 operational port thresholds

RCP	Decade	P50	P90	P(>25%)
2.8	2030s	0%	0%	1%
	2050s	0%	3%	8%
4.5	2030s	0%	26%	11%
	2050s	0%	34%	12%
8.5	2030s	0%	3%	6%
	2050s	0%	15%	10%

This analysis uses the lower disruption threshold (1 in 10) and still shows no median disruption for the 2030s or 2050s. The 90th percentile results, however, indicate increasing disruption from the 2030s to the 2050s. For RCP 4.5, the models include a few outliers with more extreme disruption than those in RCP 8.5, explaining the higher projected average disruption under RCP 4.5 compared to RCP 8.5. This underscores the uncertainty inherent in these model projections.

Decision Gate B

Are physical climate risks (PCRs) material for the asset(s)? Reviewing asset KPIs, what factors influence the materiality?

Gate B summary:

- Future lake levels are highly uncertain, primarily due to differences in climate models rather than emission scenarios.
- Most projections indicate minimal to no disruption with the P50 disruption indicator 0% across all emission scenarios and time horizons considered.
- The following resilience building analysis will explore options to manage tail risks and approaches to address the levels of uncertainty present in the lake level analysis.

	1	2	3	4
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Step 3: Resilience building

Exploring resilience building options and dealing with uncertainty to protect investor returns and wider economic benefits.

Dealing with uncertainty – an adaptive pathway approach

While most projections of future water levels on Lake Victoria suggest minimal disruption, climate models for East Africa diverge considerably on key variables, such as mean precipitation, resulting in contrasting extremes for upper and lower forecasts of lake levels. There is also uncertainty around the long-term implementation of the current hydropower management regime, with a risk that operations may deviate from the agreed curve.

To manage the uncertainty of these factors and ensure the effective operation of the vessel, an adaptive pathways approach is proposed as a strategy for building long-term asset resilience and sustaining investor returns. This approach is further supported by modelled lake level projections, which indicate chronic, multi-year changes. Such trends enable proactive decision-making and timely actions, allowing future conditions to be anticipated and addressed based on lake level observations.

To explore this approach for EAMT, two trigger thresholds were defined to simulate the points at which investment would be required in two distinct resilience options:

- Option 1 – invest in a purpose-built link bridge and dredging / trigger 1 - threshold is exceeded for more than 25% of the year
- Option 2 – relocation of port facilities / trigger 2 - threshold is exceeded for 100% of the year

Adaptive pathway analysis

These triggers are combined with a range of climate projections to model potential future scenarios for the asset, accounting for disruption levels, revenue losses, and the costs of resilience-building measures.

Considering all climate models - General Circulation Models (GCMs) - and emissions scenarios, 49 distinct futures are assessed, with all GCMs treated as equally plausible for simplicity purposes.

The adaptive pathway model compares three different cases for each scenario:

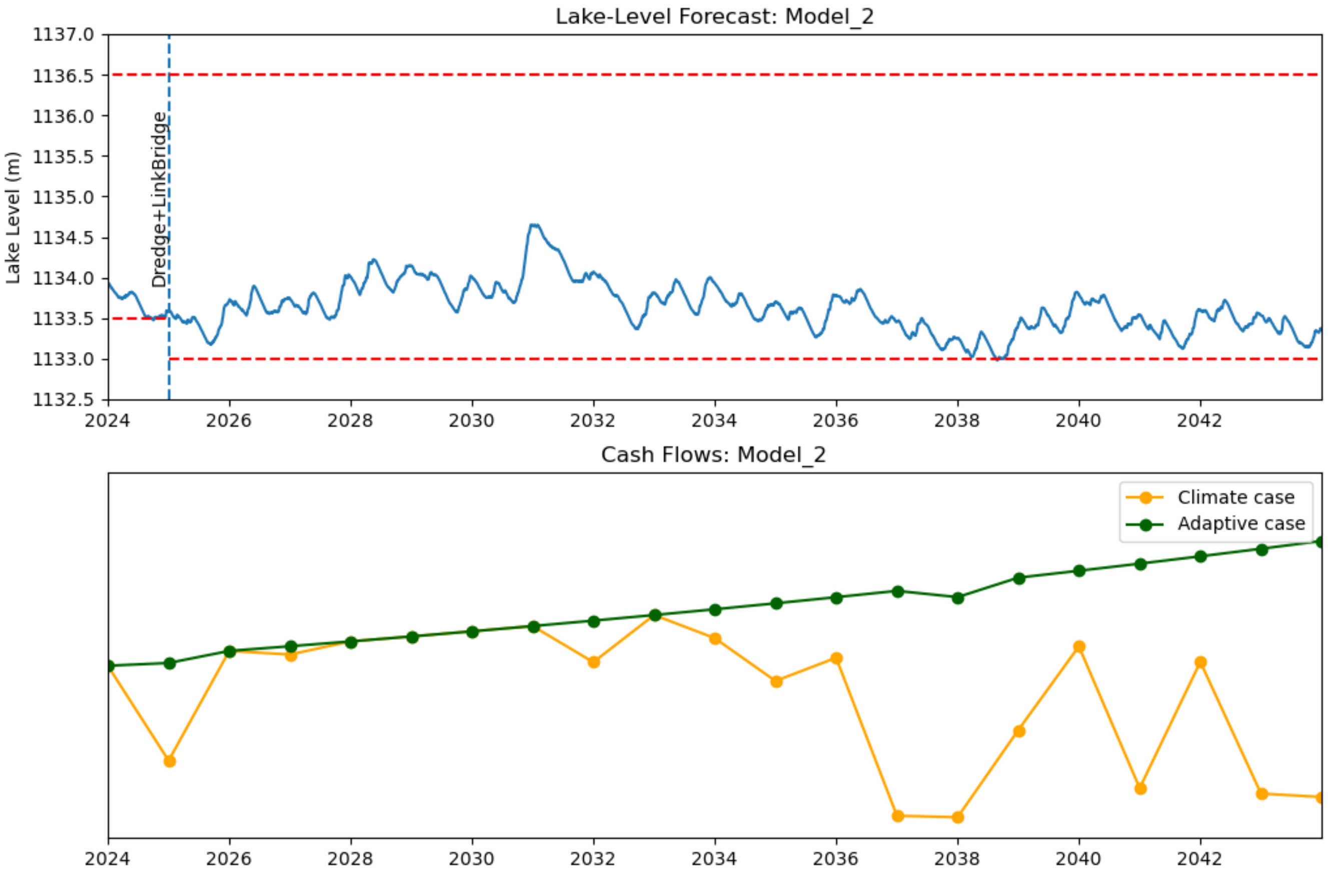
- the **base case** - current financial model assumptions
- the **climate case** - future scenario with no investment in resilience
- the **adaptive case** – the future scenario with investment in resilience where required.

Across the three cases, key asset KPIs and financial metrics are compared.

Of the 49 scenarios, five require investment in the link bridge (Option 1), while none require relocation over the 20-year assessment period. In two of these scenarios, no return on investment is achieved without adaptation, due to the high levels of disruption. In the remaining three, the absence of adaptation results in up to a 3% reduction in the projected internal rate of return (IRR).

For the adaptive case, any required investment in the link bridge - combined with reduced disruption - has only a minimal impact on the projected IRR (-0.1% to -0.2%). This demonstrates the asset's resilience in more extreme future scenarios, showing that the cost of adaptation does not materially affect investor returns.

Figure 5: Example of an adaptive pathway model for one scenario, with an example of the cash flow forecast for each case



Decision Gate C

What are the most effective resilience options for this asset, the optimal timing for their implementation, and the responsible parties for funding and execution?

The adaptive pathways model provides a flexible framework for assessing asset resilience across future scenarios, considering timing and financial impacts. While adaptation costs are modelled for EAMT alone, a cost–benefit sharing arrangement with other port users and the operator would likely reduce EAMT's actual costs and financial impact.

Gate C summary:

- 5 out of 49 modelled scenarios required the implementation of link bridge (resilience option 1)
- Account for the CAPEX investment, the investment in adaptation for the five scenarios results in minimal impact on IRR (-0.1 to -0.2%)
- Actual costs are expected to be lower, due to cost–benefit sharing considerations.

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Step 4: Value enhancement assessment

Building the investment story through benefit mapping, resilience metrics and valuation proposition

Benefit mapping

A key component of the initial business case for developing MV Mpungu and the EAMT business is the time, reliability, and efficiency gains offered by a fixed-service ferry compared to alternative transport routes around the lake. The ferry saves 1–2 days of travel time relative to road transport, which is often slowed by border delays and congestion. Operating between Mwanza, Tanzania, and Port Bell, Kampala, Uganda, the service intersects one of East Africa's main logistics corridors - Dar es Salaam to Kampala - allowing these time savings to help stimulate economic growth in the region.

The initial assessment of climate risk and resilience (steps 1–3) focuses on potential disruptions to the service that could result in revenue loss for the operator; investment in adaptation or resilience-building measures is weighed against the avoided losses from the asset continuing to operate in scenarios where, without intervention, operation would not have been possible. The ability of the asset to continue operating and generating revenue is seen as direct benefit for the asset owner - for the analysis conducted as part of this study, it is also assumed that the ferry operator will pay for the resilience measure(s).

In practice, this investment would benefit others – including other users of the port and the port operator. Beyond these beneficiaries, the service will provide additional indirect and wider economic benefits.

Direct benefits

To summarise, the direct benefits of a resilient freight service include revenue generation, stable investor returns, enhanced credit quality – which may enable future leveraging of the asset to expand the service and business – higher asset valuation, and maintained or improved future insurability. In this PCRAM assessment, annual average downtime (AAD) is used as a resilience metric to inform the need for future investment in resilience measures using an adaptive pathway approach.

The case study analysis indicates minimal levels of disruption across most GCMs, suggesting that the associated benefits of a climate resilient service are currently being - and are likely to continue being - realised. The adaptive pathways approach provides insight into how resilient the asset remains under more extreme climate scenarios, which vary significantly: some models project rising lake levels, while others show declines. This approach helps address uncertainties in lake level projections, reflecting differing scientific views on how climate change will affect East Africa, as well as the uncertain influence of hydropower operating regimes - a sensitive variable.

Where models show material disruption, the investment case for resilience-building options is clear. The CAPEX of adaptation measures is relatively low compared to annual revenue generation, and as a follow-up to this analysis, it would be valuable to explore how these measures could be incorporated into maintenance regimes, as well as who benefits from and bears the cost of such investments, given the wide range of beneficiaries. In 5 out of 49 scenarios where adaptation investment is required, the analysis shows that without adaptation, IRR losses are significant, whereas with adaptation, the impact is minimal - limited to approximately −0.1% to −0.2%.

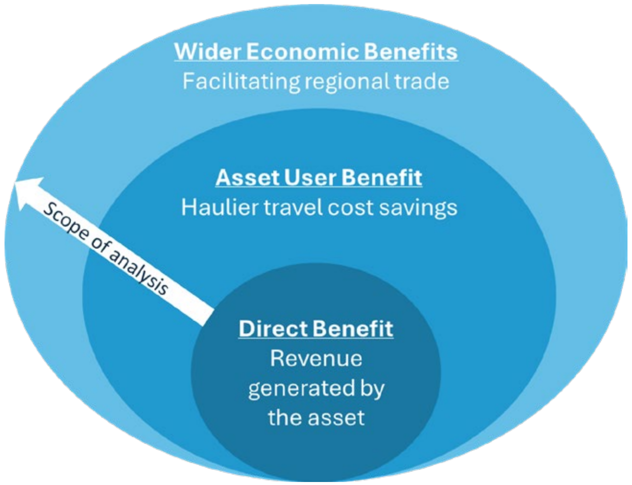
Indirect benefits

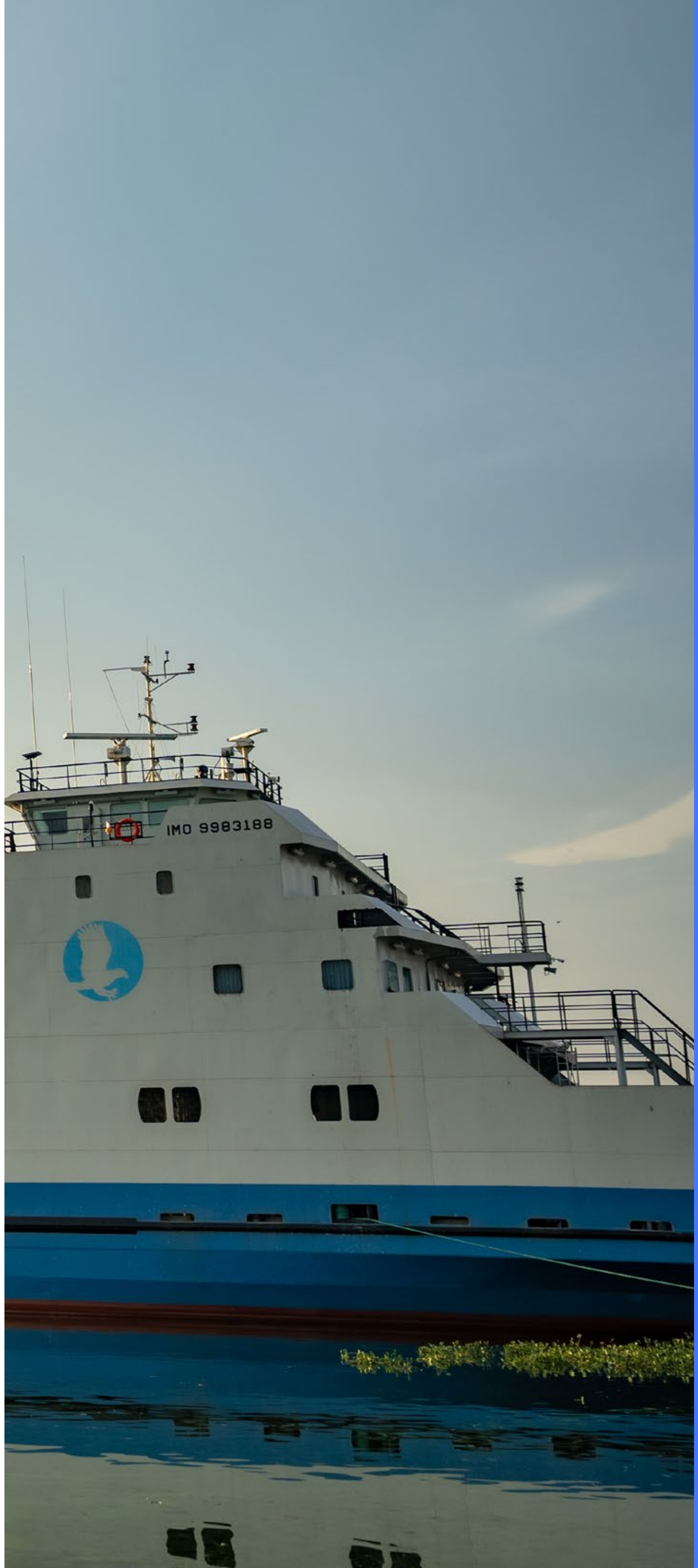
Beyond revenue generation, the ferry delivers wider economic benefits through the time, reliability, and efficiency savings offered by the new service. These benefits can be grouped into two types of indirect cost savings: a primary set borne by hauliers and businesses transporting goods across the lake, and a secondary set impacting the wider economy through delays or cancellations of imports and exports via Port Bell.

Primary indirect cost savings are likely to arise from reduced crossing fees, fuel savings, lower time and wage costs, improved asset utilisation, and reduced maintenance per trip. From the customer's perspective, further savings may result from lower inventory holding costs - such as freed-up working capital, reduced buffer stock, lower warehousing and insurance expenses, and reduced spoilage for perishable goods.

Just as investment in resilience can be offset against avoided direct cost losses, resilience measures also protect the indirect cost benefits generated by the asset - safeguarding value for both users and the wider economy.

Figure 6: Direct and indirect benefit mapping





Decision Gate D

How can resilience investment be optimised and incentivised, while ensuring equitable risk-reward distribution across the value chain actors?

Understanding the interplay and the benefits experienced across the value chain and wider economy from investing in interventions that enhance the resilience and adaptive capacity of an infrastructure asset, and its wider system, is crucial to building the case for resilience and to developing cost-sharing mechanisms. The work undertaken as part of this study highlights the complexity and interdependence of different systems, as well as the wide range of beneficiaries that such investments can generate.

Gate D summary:

- Where investment in adaption is required the investment case is clear.
- Mapping the beneficiaries of such investments can help identify risk–reward dynamics and initiate discussions on cost- and benefit-sharing mechanisms, including the interplay between public and private stakeholders.

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Lessons learned

This study shows that the freight route across the lake remains resilient to climate change under a range of plausible future scenarios. In some climate models, investment in port facilities is required to strengthen adaptive capacity. Even with these additional investments, the return on investment remains favourable, with minimal adverse impacts over the study period.

In applying the PCRAM methodology to this case study, the following lessons have been learned:

Dealing with uncertainty - Uncertainty arises across multiple dimensions, including hydropower operating regimes, climate change impacts over the Lake Victoria Basin, and the global trajectory of greenhouse gas emissions. This study developed an adaptive pathways approach to overcome these uncertainty challenges - a flexible, iterative framework for decision-making under uncertainty. Rather than committing to a single 'optimal' strategy, it explores multiple possible routes, each with predefined 'trigger points' that signal when a change in course is needed.

System interdependencies – The analysis has primarily focused on asset-level disruption across a range of future scenarios. However, it also underscores the interdependence between infrastructure systems. In particular, the continued viability of the lake as a logistics route depends on maintaining adequate water levels through the careful operation of the hydropower facilities at Jinga. In some scenarios, a trade-off may be required between using water for electricity generation and preserving lake levels for navigation and ecosystem stability.

A collaborative approach to adaptation – Building on the insights around interdependencies between infrastructure assets, resilience is often best addressed at the system or network scale, with investments targeted at strengthening the overall system's ability to withstand physical climate risks. The analysis revealed potential risks of maladaptation and Do No Significant Harm (DNSH) breaches, as well as opportunities for co-benefits - for example, balancing dredging requirements against potential environmental harm, and managing trade-offs with high-intensity electricity generation from downstream hydropower plants. These considerations reinforce the importance of effective public–private collaboration in identifying, funding, and managing resilience measures.

The role of nature for building resilience – Recent events, particularly in 2020 and 2021, have highlighted the increasing risks associated with elevated lake levels, which have led to flooding, infrastructure damage, and disruptions to operations. The lake water balance analysis supporting this study identifies hydropower infrastructure as a key mechanism for managing lake levels - both for ensuring navigability and for regulating high water events. However, the responsiveness of these facilities can be constrained.

In addition, human activities are reducing the capacity of lakeside ecosystems to absorb and moderate water during extreme precipitation events. The replacement of porous natural habitats with impermeable surfaces has diminished the shoreline's and surrounding catchments' ability to absorb runoff. Land use changes, including deforestation and the loss of wetlands, are further increasing flood risks throughout the basin.

As part of managing this risk, a study is being commissioned to explore nature-based solutions (NBS) to help manage this risk, whilst delivering additional co-benefits.

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The Private Infrastructure Development Group (PIDG)

PIDG is an innovative infrastructure project developer and investor which mobilises private investment in sustainable and inclusive infrastructure in sub-Saharan Africa and south and southeast Asia.

www.pidg.org

The Environmental Change Institute

The Environmental Change Institute (ECI) conducts world-class, interdisciplinary research across eight core programmes: Climate, Energy, Ecosystems, Infrastructure, Food Systems, Global Finance and Economy, Environment and Health, and Land, Society and Governance.

https://www.eci.ox.ac.uk/

Grantham Research Institute on Climate Change and Environment

Established by the London School of Economics and Political Science in 2008 to create a world-leading multidisciplinary centre for policy-relevant research and training on climate change and the environment, bringing together international expertise from across LSE and beyond.

https://www.lse.ac.uk/granthaminstitute/

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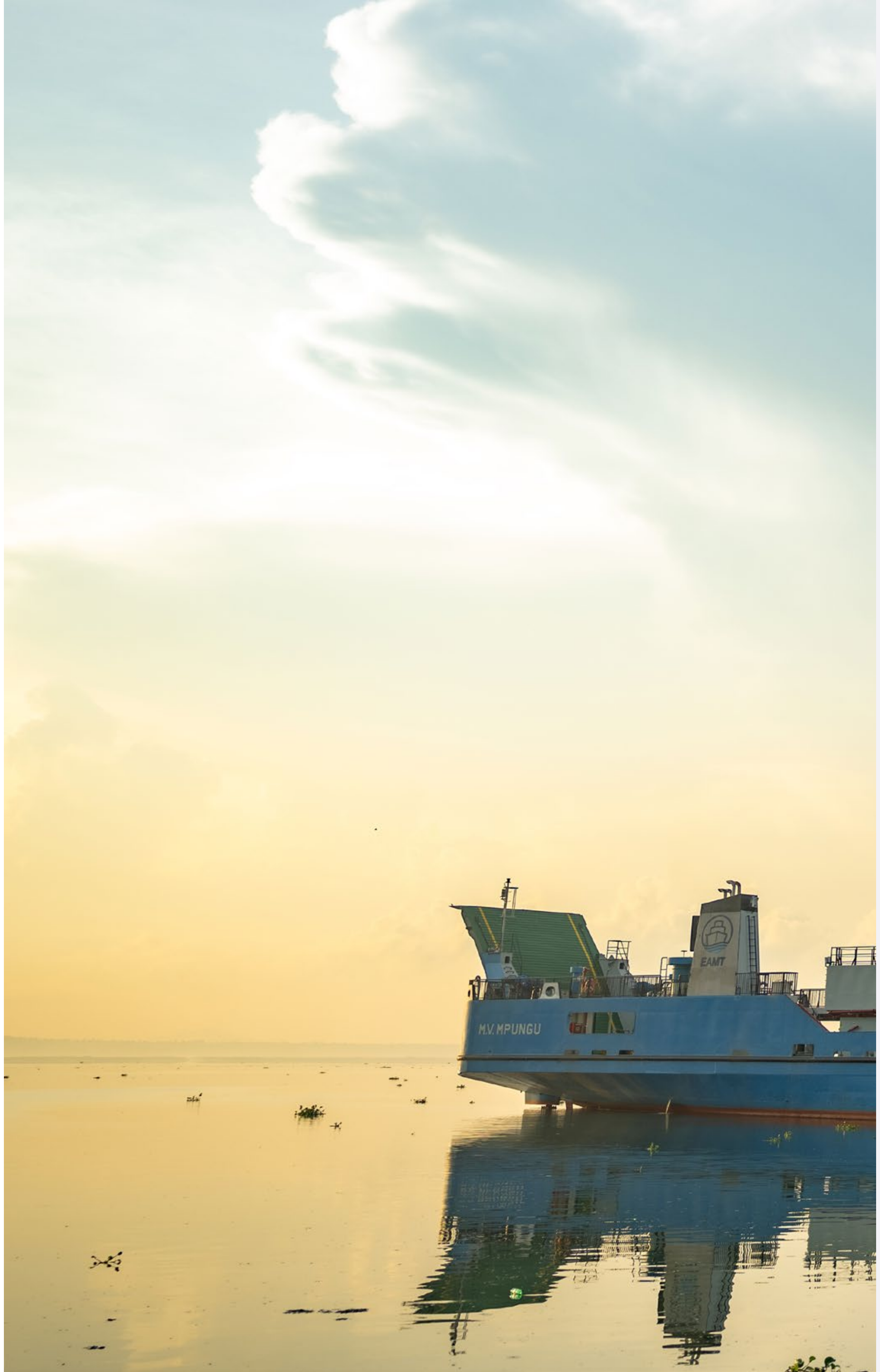

Glossary

Internal rate of return (IRR)	A metric used in financial analysis to estimate the profitability of potential investments. Annual return that makes the net present value (NPV) equal to zero or is the annual rate of growth that an investment is expected to generate.
General circulation model (GCM)	A simulation that represents the Earth's climate system, including the atmosphere, oceans, land surface, and ice, to project past, present, and future climate conditions.
Representative Concentration Pathways (RCPs)	Standardised greenhouse gas concentration trajectories used in climate modelling to project potential future climate outcomes. Each RCP is defined by its radiative forcing level in the year 2100, measured in watts per square meter (e.g., RCP4.5, RCP8.5).
Climate projection	The simulated response of the climate system to a scenario of future emission or concentration of greenhouse gases (GHGs) and aerosols, generally derived using climate models. Climate projections are distinguished from climate predictions by their dependence on the emission/concentration/radiative forcing scenario used, which is in turn based on assumptions concerning, e.g. future socioeconomic and technological developments that may or may not be realised (IPCC 2018).
CORDEX (Coordinated Regional Climate Downscaling Experiment)	An international initiative that provides high-resolution regional climate projections by downscaling global climate model outputs. It aims to improve the representation of local climate processes and support climate impact and adaptation studies.
Base, climate and resilience cases	Base case evaluations are a part of scenario analysis, which helps decision-makers visualize and compare the most realistic outcomes for a business. With foresight into all possible outcomes, an organization can greatly improve its financial planning and modelling, allowing management to make decisions with confidence. The base case represents the current financial model assumptions, the climate case represents future scenario(s) with no investment in resilience and the adaptive case represents the future scenario(s) with investment in resilience where required.
Capital expenditure (CAPEX)	The funds a company or project spends to acquire, build, or upgrade physical assets such as infrastructure, buildings, equipment, or technology. In project finance and infrastructure, CAPEX usually refers to the upfront investment cost required to develop and construct the project.
P50 (50th percentile, central or median estimate)	A statistical measure indicating the value at which there is a 50% probability that actual outcomes will be higher and a 50% probability they will be lower.

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