

Date
July 2025

Ramboll Project Number
329001389

Intended for
**Subdirección General de Instrumentos Financiero para la Internacionalización
(SGIFI)**

On behalf of
Centunion, Española De Coordinación Técnica y Financiera, S.A.

THIRD-PARTY INDEPENDENT REVIEW OF CONTRIBUTION TO CLIMATE CHANGE ADAPTATION KATUNGURU BRIDGE - UGANDA

THIRD-PARTY INDEPENDENT REVIEW OF CONTRIBUTION TO CLIMATE CHANGE ADAPTATION KATUNGURU BRIDGE - UGANDA

Version **V2**
Date **25/07/2025**
Prepared by **Francesca Casale, Cillian Cunningham, Luca Colaianni**
Checked by **Rita Gimeno**
Approved by **Silvia Hernando**
Description **Evaluation of contribution to climate change adaptation**
Company **Ramboll Iberia, S.L.U.**
www.ramboll.com

Project Number **329001389**

This report is produced by Ramboll at the request of the client for the purposes detailed herein, using reasonable skill, care and diligence. This report and accompanying documents are intended solely for the use and benefit of the client for this purpose only. Disclosure of this Report pursuant to these provisions shall be on a non-reliance basis only and, as such, Ramboll neither owes nor accepts any duty to any third party and shall not be liable for any loss, damage or expense of whatsoever nature which is caused by their reliance on the information contained in this report.

Ramboll disclaims any responsibility to the Client and others in respect to any matters outside the agreed scope of the Services.

Revision	Date	Prepared by	Checked by	Approved by	Description
1	13/06/2025	FC; CC; LC	RG	SH	Draft
2	25/07/2025	FC; CC; LC	RG	SH	Draft

CONTENTS

EXECUTIVE SUMMARY	4
1. INTRODUCTION, SCOPE OF WORK AND APPROACH	8
1.1 Introduction	8
1.2 Scope of Work and Methodology	8
1.3 Reliance and General Limitations	9
1.4 Duty of Care and Terms & Conditions	10
2. PROJECT INFORMATION	11
3. EVALUATION OF CONTRIBUTION TO CLIMATE CHANGE ADAPTATION	13
3.1 Phase 1 – Vulnerability review	13
3.1.1 Fathom flood hazard assessment	14
3.1.2 Vulnerability analysis and results	22
3.2 Phase 2 – Risk Analysis and Contribution to Adaptation	29
3.2.1 Summary of required measures for the resilience of the Project	38
4. CONCLUSIONS	39

Appendices

Appendix 1 - List of documents for the assessment

Appendix 2 - Overview of main reference guidelines

EXECUTIVE SUMMARY

Ramboll has performed an assessment related to the *climate resilience* and *contribution to adaptation* for the project of reconstruction of a new bridge in Katunguru, Uganda (replacing an existing smaller bridge). In particular, this is an independent third-party review required by Appendix II of 'The Renewable Energy, Climate Change Mitigation and Adaptation and Water Projects Sector Understanding (CCSU)' rule within the Organization for Economic Co-operation and Development (OECD)'s Arrangement on Officially Supported Export Credits for climate change adaptation projects (hereinafter the "CCSU rule") and it is requested by the Subdirección General de Instrumentos Financieros para la Internacionalización (Deputy Directorate General for Financial Instruments for Internationalization, or SGIFI).

The project consists of constructing a climate-resilient bridge at Katunguru, replacing the existing 60-meter structure with a new 225-meter bridge over the Kazinga Channel River. This upgrade is essential to maintain connectivity along the Kikorongo–Ishaka Road, a critical trade and tourism route in Uganda's Western Region.

The "APPENDIX II: Eligibility Criteria for Climate Change Adaptation Projects" of the CCSU OECD document does not provide sufficient specificity on how to assess whether the project '*reduces the location-specific context of vulnerability to climate change*'. Ramboll has developed a methodology, previously agreed with the Lender (SGIFI) and shared with the EPC Contractor (Centunion S.A., herein and after Centunion), consisting in the application of the *sustainability proofing* guidelines' requirements: "Technical guidance on climate-proofing of infrastructure projects for the period 2021-2027" published by the European Commission and the Annex II of the EU Taxonomy's Delegated Regulation 2021/2139 (for climate change adaptation part).

The scope of the present assessment encompasses the evaluation of the sensitivity, exposure and vulnerability of the infrastructure to physical climate-related hazards. This is aimed at identifying and assessing potential physical climate change-related risks, both current and future. Subsequently, the pertinent hazards related to vulnerability are analyzed to assess the relative risk level before and after the new bridge's construction. This is conducted to verify the bridge's resilience to these risks and to evaluate the infrastructure's contribution to the local community's and territory's adaptation to climate change.

Ramboll's assessment is based on the screening and review of public information and tools, as well as information and reports provided by Centunion regarding physical climate-related hazards for the area of interest.

Overview of project phases:

Phase 1: Ramboll consulted publicly available tools and documentation received from Centunion to classify physical climate-related hazards in Uganda considering three levels of sensitivity and exposure. The guidelines issued by the European Commission, specifically the criteria indicated in the *sustainability proofing* guidelines and the "Technical guidance on climate-proofing of infrastructure projects for the period 2021-2027" were utilized to score the different hazards, resulting in a vulnerability matrix for the project.

Phase 2: Ramboll carried out a high-level risk assessment to evaluate the likelihood of occurrence and the potential impact of each relevant hazard (medium or high vulnerability) identified in phase 1. The potential impact was assessed for two conditions, before and after the construction of the new bridge. This was done to distinguish the level of risk following the completion of the project and to confirm the project's contribution to reducing the risk level. This step took into account the technical information provided by Centunion for the project.

Outcomes:

Phase 1: based on Ramboll’s expert opinion and the information available from the provided documents, the vulnerability of the project, evaluated as the combination of sensitivity and exposure, is as follows:

- high vulnerability to inland flooding and extreme temperatures;
- medium vulnerability to extreme precipitation events, extreme wind conditions and soil erosion;
- low vulnerability to wildfires, drought and subsidence.

Phase 2: based on the region-specific information and on the technical project information provided by Centunion, the following risk levels have been identified for the existent Katunguru bridge and for the new one. This evaluation considers the likelihood of occurrence and potential impact (rated on five levels each, as outlined by the *sustainability proofing* guidelines):

Risk matrix under current condition

RISK MATRIX						
		OVERALL IMPACT				
		1 INSIGNIFICANT	2 MINOR	3 MODERATE	4 MAJOR	5 CATASTROPHIC
LIKELIHOOD	1 RARE					
	2 UNLIKELY			Extreme wind conditions Soil erosion		
	3 MODERATE		Extreme precipitation events			
	4 LIKELY			Inland flooding		
	5 ALMOST CERTAIN		Extreme temperature			

Risk matrix after new bridge construction

RISK MATRIX						
		OVERALL IMPACT				
		1 INSIGNIFICANT	2 MINOR	3 MODERATE	4 MAJOR	5 CATASTROPHIC
LIKELIHOOD	1 RARE					
	2 UNLIKELY		Extreme wind conditions	Soil erosion		
	3 MODERATE	Extreme precipitation events				
	4 LIKELY	Inland flooding				
	5 ALMOST CERTAIN		Extreme temperature			

The construction of the new bridge, which will replace the existing one, contributes positively to reducing the inland flooding risks, particularly river flooding. The risk assessment for the existing bridge indicates a high risk, while the new bridge is rated at a medium risk level.

The new bridge is designed to mitigate the potential impact of floods on the infrastructure itself by increasing both its height and the length. This design would prevent clogging due to limited clearance, submergence of the bridge, and overcoming possible flooded areas in the vicinity.

Moreover, this project enhances the region’s resilience and supports the population in adapting to climate change effects, particularly extreme flood events. Unlikely the existing bridge, the new bridge does not obstruct the normal water flow of the river. The current bridge often causes clogging from vegetation or debris, which is especially problematic during flood events, as it increases the river flow triggers flooding in surrounding areas.

By improving the resilience of the infrastructure itself and minimizing the bridge’s impact on the territory during flood events, the new bridge enhances the local communities’ adaptative capacity and reduces their vulnerability to flood hazards, as highlighted in Appendix II of the OECD CCSU.

Ramboll’s analysis aimed to evaluate the necessary adaptation measures to be incorporated into the project design (currently not available) to address and mitigate the identified potential climate-related risks. This will support alignment with adaptation requirements and enhance the infrastructure’s resilience to such events. Specifically:

- for extreme temperatures and heatwaves: select construction materials and structural design features that can withstand high maximum temperatures and frequent heatwaves. This facilitates that the bridge remains safe and durable under thermal stress conditions, accounting for increased temperature projections in the region;
- for extreme precipitation events: include the use of draining asphalt to avoid localized flooded areas;

- for extreme wind conditions: wind-resistant design measures should be incorporated to ensure long-term resilience, particularly for exposed components such as lighting poles and signage;
- for soil erosion: consider measures in the design of the bridge's pillars, both in the river channel and on land, to increase stability against the effect of soil erosion related to water action and debris transport in the river.

It is expected that the conclusions of this report are considered for the detailed Project design and thus the bridge will be constructed following "state-of-the-art" practices and applicable best practices. This approach will incorporate necessary adjustments to prevent or reduce the impact of the abovementioned physical climate-related hazards.

1. INTRODUCTION, SCOPE OF WORK AND APPROACH

1.1 Introduction

Ramboll was retained by Centunion Española De Coordinación Técnica Y Financiera SA (hereinafter "Centunion" or the "EPC contractor") to conduct an independent third-party review of the "**Katunguru (Kazinga) Bridge**" project (hereinafter the "Project" or the "bridge") comprising the upgrading and enhancing of an existent bridge of 60 meters to a new bridge of 225 meters of length on the Kazinga Channel that connects Lake George and Lake Edward, located at Ntungamo - Katunguru Rd, within Katunguru in Rubirizi District, Uganda approximately 41 km south of the nearest largest town Kasese.

The independent third-party review is required by Appendix II of 'The Renewable Energy, Climate Change Mitigation and Adaptation and Water Projects Sector Understanding (CCSU)' rule within the Organization for Economic Co-operation and Development (OECD)'s Arrangement on Officially Supported Export Credits for climate change adaptation projects (hereinafter the "CCSU rule") and is requested by the Subdirección General de Instrumentos Financieros para la Internacionalización (Deputy Directorate General for Financial Instruments for Internationalization "SGIFI" or "the Lender").

According to Centunion ToR ("*KATUNGURU - Climate Resilient Bridges Studies - TOR request information*"), the current alignment of the road (Kikorongo-Ishaka Road) serves as the primary connectivity route between five districts in Western Uganda within the Rwenzori sub-region. This route completes the western spur of the Northern Corridor Route (NCR), which links the port of Mombasa through the Malaba/Busia border posts to the eastern Democratic Republic of Congo (DRC) via the strategic border towns of Mpondwe and Ishasha, located approximately 50 km and 90 km respectively from the Kazinga Channel Bridge.

There are two critical nodes in this regional connectivity: the crossing at the Kazinga Channel and the connections toward the Mpondwe and Ishasha border points. The Kazinga Channel Bridge at Katunguru, located within Queen Elizabeth National Park, is a very important crossing between Lake George and Lake Edward. Its location within Uganda's most scenic and visited park makes it a key driver of the tourism economy, while also supporting significant regional trade flow.

The Mpondwe border alone handles over 25% of Uganda's exports and ranks as the third most important border post after Busia and Malaba. Thus, the Kazinga Channel Bridge is of paramount importance — not only as an infrastructural asset enabling efficient transport and trade — but also key in Uganda's regional integration and economic development agenda.

The objective of the assessment is to verify whether the Project is eligible as climate change adaptation project according to the requirements of the CCSU rule and, thus, can be considered as 'green' and qualify for a financing instrument (hereinafter, FIEM) managed by the SGIFI.

The present Third-Party Review of Contribution to Climate Change Adaptation has been carried out by Ramboll on a desk-based analysis of the Project documents made available by the Client and of the climate-related information publicly available.

1.2 Scope of Work and Methodology

Ramboll reviewed the documentation provided, in particular:

- documentation and information of the Project provided by the Client, including answers by Centunion to specific questions;
- documentation and information regarding the Project location or region, publicly available;

- additional flood hazard assessment by Fathom¹.

The list of documents reviewed is included in Appendix 1.

Considering that the "APPENDIX II: Eligibility Criteria for Climate Change Adaptation Projects" of the CCSU OECD document does not provide sufficient specificity on how to assess whether the project '*reduces the location-specific context of vulnerability to climate change*' by the "independent third-party reviewers", Ramboll has agreed with Centunion and with SGIFI the following methodology, consisting in the application of reasonable available best practices and recognized guidelines.

In particular the "Technical guidance on climate-proofing of infrastructure projects for the period 2021-2027" by the European Commission, and the Annex II of the EU Taxonomy's Delegated Regulation 2021/2139 were considered as reference, due to their recognized value for assessing projects to be financed as well as their applicability to infrastructure project such as the bridge proposed by Centunion.

In order to assess the "location-specific context of vulnerability to climate change" mentioned in the CCSU, a vulnerability review to climate change physical risk was carried out, identifying climate-related hazards and the project sensitivity and combining them to obtain a vulnerability level; both acute and chronic hazards were considered.

Subsequently, a review of the available project-specific information was conducted to assess the relevant climate-related vulnerabilities. This review aimed to establish the "direct link between the climate vulnerability context and the specific project adaptation activities that address the climate vulnerability". In other words, the review evaluated whether and to what extent the Project mitigates the vulnerability of the site and region to physical climate change. It also assessed how the Project enhances resilience to physical climate change, thereby contributing to climate change adaptation.

It should be noted that physical climate-related factors are only considered under these methodologies to assess climate change adaptation contribution, whereas other environmental matters (e.g. biodiversity, pollution, water resources, etc) and the comply of the bridge with the do no significant harm technical screening criteria are not included in Ramboll review. Further information on the perimeter of the assessment and on the methodology can be found in Appendix 2.

The application of the proposed methodology has been implemented by Ramboll as described in the following chapters and sections of the present document.

1.3 Reliance and General Limitations

The evaluation presented in this report represent Ramboll's best professional judgment based upon the information available and conditions existing as of the date of the review. In performing its assignment, Ramboll must rely upon information provided by the EPC Contractor, publicly available information, and information provided by third parties.

Accordingly, the outcomes of the study performed for this report are valid only to the extent that the information provided to Ramboll was accurate and complete. This review is not intended as legal advice, nor is it an exhaustive review of Project conditions or Project compliance. Ramboll makes no representations or warranties, express or implied, about the conditions of the Project.

¹ Fathom is a global leader service that provides information of flood area and maximum water level under climate change projections and for multiple time periods, making scientifically rigorous water and climate information available for the benefit of businesses and communities worldwide.

Ramboll's scope of work for this assignment is limited to a desktop review and a virtual interview with Centunion, and did not include performing site visits, field topographic, hydraulic, weather or climate site-specific observations; as such, this review cannot rule out the existence of latent conditions, and is intended, consistent with normal standards of practice and care, to assist the Client in identifying the risks of such conditions.

1.4 Duty of Care and Terms & Conditions

Ramboll's duty of care is to SGIFI.

Applicable Terms & Conditions are as per the signed contract (Proposal N° 219835, issue N° 3, dated 23/04/2025).

2. PROJECT INFORMATION

The Katunguru Bridge Project, located on the Kikorongo–Ishaka Road, serves as a critical road link connecting five districts in Uganda’s Western Region, within the Rwenzori sub-region. This route completes the western spur of the Northern Corridor Route (NCR), which extends from the port of Mombasa through the Malaba/Busia border posts to the eastern Democratic Republic of Congo via key border towns such as Mpondwe and Ishasha, located approximately 50 km and 90 km respectively from the Kazinga Channel Bridge. The existing Katunguru Bridge crosses the Kazinga Channel within Queen Elizabeth National Park—Uganda’s most visited and biodiverse conservation area—linking Lake George and Lake Edward. The bridge therefore serves as a key economic enabler for both regional trade and tourism.

A preliminary assessment of the existing structure was indicated in the document “*KATUNGURU – Climate resilient bridge – TOR request information*” provided by Centunion (see Appendix 1, document #4) and has identified several critical concerns, including erosion of foundations, vegetation clogging the openings, and the reduction of freeboard clearance due to projected rising lake levels. The insufficient vertical clearance of the bridge is critical during extreme precipitation events, after the increase of water level, due to insufficient space for the water flow, potentially resulting in the overtake of the river and the overflow into the surrounding area. The existing bridge is therefore not resilient to the rising water level during extreme rainfall events and increases the exposure of the surrounding area. These vulnerabilities could severely disrupt connectivity and economic activities, such as fishing and tourism in the channel area, and potentially render the crossing impassable during flood events.

To address these issues, the construction of a climate-resilient replacement bridge was reportedly deemed essential. According to the information provided by Centunion, the proposed preliminary design reflects a significant upgrade in resilience and functionality, with key specifications including:

- **Waterway vertical clearance:** raised from 3 meters (m) to 7 m;
- **Waterway horizontal opening:** widened from 60 m to 225 m;
- **Bridge length:** increased from 60 m (existing) to 225 m;
- **Carriageway width:** expanded from 5 m to 7 m;
- **Sidewalks:** two sidewalks of 1.7 m each (none exist currently).

The new bridge preliminary design aims to restore the natural river width by removing existing man-made causeways, thereby reducing ecological disruption.

The Katunguru Bridge is situated at approximately 0°08'49.0"S, 30°03'46.0"E, spanning the Kazinga Channel within Queen Elizabeth National Park. The location is represented in [Figure 1](#).

Figure 1 - Location of the proposed Katunguru bridge



Source: Google Earth

3. EVALUATION OF CONTRIBUTION TO CLIMATE CHANGE ADAPTATION

3.1 Phase 1 – Vulnerability review

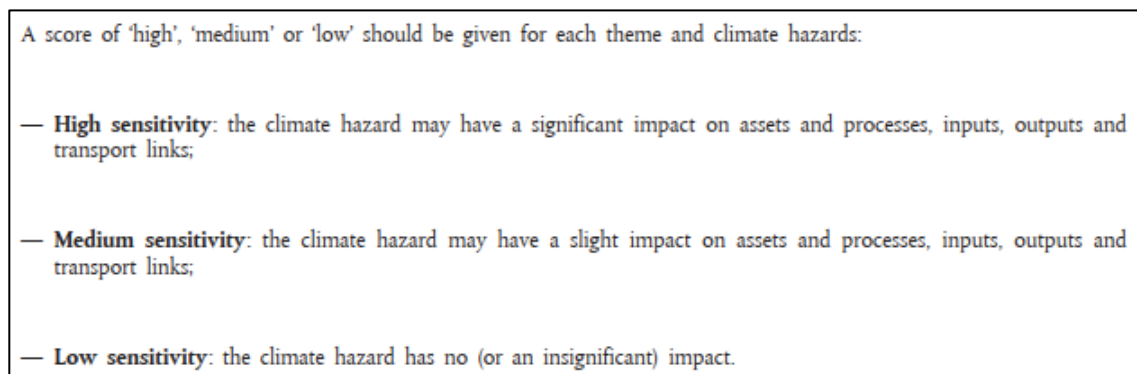
The scope of the assessment encompasses the evaluation of sensitivity, exposure and vulnerability to physical climate-related hazards within the Project area. This evaluation aims to identify and assess vulnerability to potential climate related hazards, both current and future (here long term to 2080).

Ramboll has conducted a preliminary evaluation of the sensitivity and exposure of the bridge using a three-level assessment framework. This framework is grounded in expert opinion, inhouse-sector specific knowledge and hazard exposure databases for screening purposes. The evaluation adheres to the guidelines released by the European Commission, specifically the criteria set forth in the “Technical guidance on climate-proofing of infrastructure projects for the period 2021-2027” and the Delegated Act (EU) 2021/2139, which supplements the European Regulation on Taxonomy 2020/852 concerning activities that contribute substantially to climate change mitigation and adaptation.

The present assessment focuses on climate change physical adaptation and considers the physical climate-related hazards that are deemed applicable for the Site location (see Appendix 2 for further information).

It is important to note that the exposure analysis identifies relevant hazards to the planned Project location, irrespective of the project type and specifications, in both current and future climate conditions. Instead, sensitivity assesses the degree to which a system is affected by climate variability or change, independent of the location, as shown in the figure below.

Figure 2 - Criteria for the score of sensitivity



Source: Commission Notice “Technical guidance on sustainability proofing for the InvestEU Fund” (2021/C 280/01).

Subsequently, the vulnerability analysis integrates the outcomes from both sensitivity and exposure analyses to pinpoint the most pertinent hazards for the proposed Project. These are identified as vulnerabilities with a 'Medium' or 'High' ranking, in accordance with the criteria specified in the “Technical guidance on climate-proofing of infrastructure projects for the period 2021-2027” and shown in the figure below:

Figure 3 - Vulnerability matrix as combination of exposure and sensitivity scores, as defined in the Commission Notice “Technical guidance on the climate proofing of infrastructure in the period 2021-2027”

Indicative vulnerability table:		Exposure (current + future climate)			Legend: Vulnerability level
		High	Medium	Low	
Sensitivity (highest across the four themes)	High				High
	Medium				Medium
	Low				Low

Source: Prepared by Ramboll based on Commission Notice “Technical guidance on the climate proofing of infrastructure in the period 2021-2027” (C(2021) 5430).

Two climate change scenarios from IPCC (SSP2-4.5 and SSP5-8.5) have been considered for the long-term future time horizon (2080), considering the expected life span of the new bridge.

The results are provided in the present Chapter.

3.1.1 Fathom flood hazard assessment

Fathom overview

Ramboll used flood maps developed by Fathom as reference for evaluating flood hazard. Fathom has developed a global hydraulic model to simulate flood areas and corresponding water levels across various return periods, climate scenarios and time horizons.

The latest version of the Fathom flood hazard dataset (“Global Flood Map”) includes a new terrain model, the FABDEM+, offering ~30m resolution globally and ~10m resolution for regions with enhanced data².

The data encompass inundation depths for inland and coastal flooding at ~30m resolution globally. The inland flooding hazard is categorized into fluvial flooding, stemming from rivers or stream overflows (i.e. main water courses), and pluvial flooding, resulting from direct heavy rainfall and/or flooding of the minor hydrographic network and/or reclamation water network, and/or sewage network.

Rainfall boundary conditions used within the Fathom model are reproduced using the so-called “Intensity-Duration-Frequency” (IDF) relationships. For rainfall event durations of 1, 3, 6 hours gauge-based rainfall intensities are derived from the Global Sub-Daily Rainfall (GSDR) data set of Lewis et al. (2019)³, which includes precipitation records from 23,687 measurement stations with an average record length of 13 years.

Regarding water propagation across the Earth’s surface, Fathom employs a hydrodynamic modeling suite that simulates hydrodynamic phenomena, including flash-flooding, riverine flooding and coastal inundation.

Fathom limitations:

- Fathom does not directly include the sewage network in its flood model;

² US, UK and Japan

³ Lewis, E., Fowler, H., Alexander, L., Dunn, R., McClean, F., Barbero, R., ... & Blenkinsop, S. (2019). GSDR: a global sub-daily rainfall dataset. *Journal of Climate*, 32(15), 4715-4729.

- Fathom model results were not calibrated using site-specific historical flooding data because such data do not exist⁴;
- Fathom's global flood map considers current land use (indirectly parameterized considering urbanized settlement only⁵) and elevation without giving the option to change these factors as would be necessary to accurately assess the effects induced by new project scenarios.

The inland fluvial/pluvial flood depth data are available for 5, 10, 20, 50, 100, 200, 500 and 1000 years return periods with a horizontal resolution of 1 arcsecond (about 30 meters).

In this case, the climate scenario SSP5-8.5 is considered to evaluate the flood hazard for the Katunguru bridge, and the years 2020 and 2080 are considered as reference for the baseline and the future conditions, according to the expected life of the infrastructure.

Considered return periods are 20, 50, 100, 200 and 500 years, corresponding to high, medium and low risk areas, as reported below.

The return period is linked to a certain value of precipitation intensity and consequent water discharge, river level and flooded area. Risk levels correspond to different return periods basing on the frequency of occurrence of the corresponding precipitation/flood events: low return periods (e.g. 20 and 50 years) correspond to frequent flood events, so the area is subject to a high risk of flooding; on the contrary high return periods (e.g. 500 years) correspond to rare flood events, so the area is under a low risk.

Climate change can potentially influence the frequency of precipitation events with a certain intensity with consequences on the frequency of flood events of a certain magnitude. Reason why a defined event can change the return period of reference, or for a certain return period events of different intensity can occur. A baseline (year 2020 as reference) and a future (year 2080 as reference) condition are evaluated here to identify differences and climate change effects on the extreme precipitation events and flood events occurrences.

In this paragraph results of Fathom are reported, while in the next chapter an analysis of the exposure for present and future condition is reported.

Flood hazard results – Inland flood

Results are aggregated by analyzing the percentage of the area of interest affected by fluvial and pluvial flooding across various return periods. Specifically, percentages of the area under low, medium, and high hazard levels are evaluated, taking into account both average and maximum water depths for each hazard condition.

- The area under high hazard is characterized by events with a return period of 20 and 50 years.
- The area under medium hazard is characterized by events with a return period of 100 and 200 years.
- The area under low hazard is characterized by events with a return period of 500 years.

Table 1 presents the results of Fathom simulations for the pluvial flood hazard in the current condition (year 2020). The table details the percentage of the area subject to flooding, categorized by water depths below and above 20 cm. **Figure 4** includes the maps of areas under pluvial flood hazards for each return period in the present condition (year 2020). **Table 2** and **Figure 5** present the results of Fathom simulations for pluvial flood hazard under future conditions (year 2080).

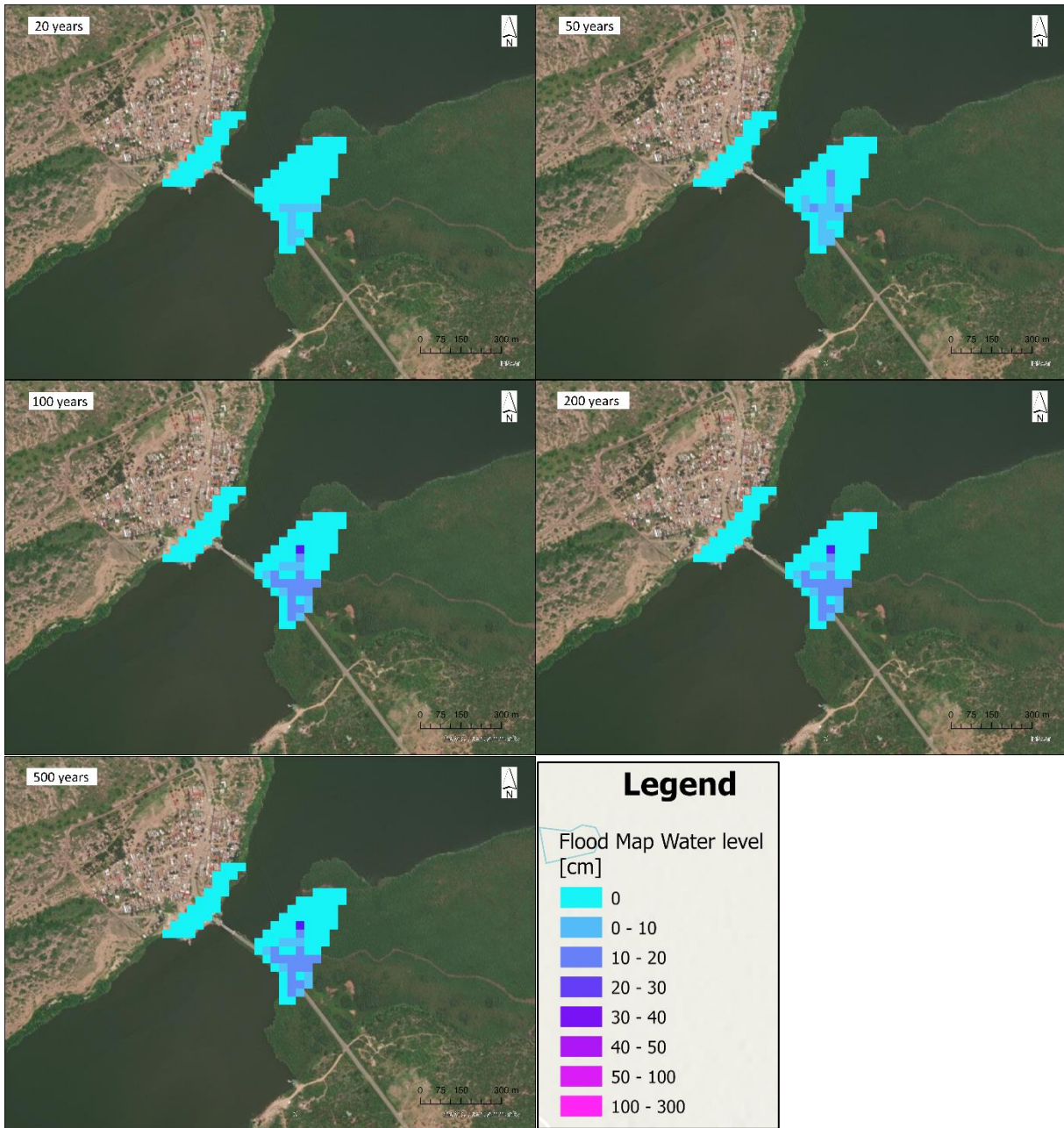
⁴ Fathom is a global model, validated using observed flooding data where available and designed to model flood areas when no historical data exist.

⁵ Global Human Settlement Layer available at <https://human-settlement.emergency.copernicus.eu/>.

Table 1 – Pluvial flood hazard results according to Fathom simulation for 2020

Hazard score	Return period [years]	Percentage subject to flooding 0-20 cm	Percentage subject to flooding >20 cm	Average water depth within the area [cm]	Max water depth within the area [cm]
High	20	9%	0%	0.6	9
	50	17%	0%	1.5	20
Medium	100	22%	1%	2.8	24
	200	22%	1%	2.8	24
Low	500	22%	1%	2.8	24

Figure 4 - Pluvial flood hazard in the area of Katunguru bridge for the year 2020 for return periods equal to 20, 50, 100, 200, 500 years

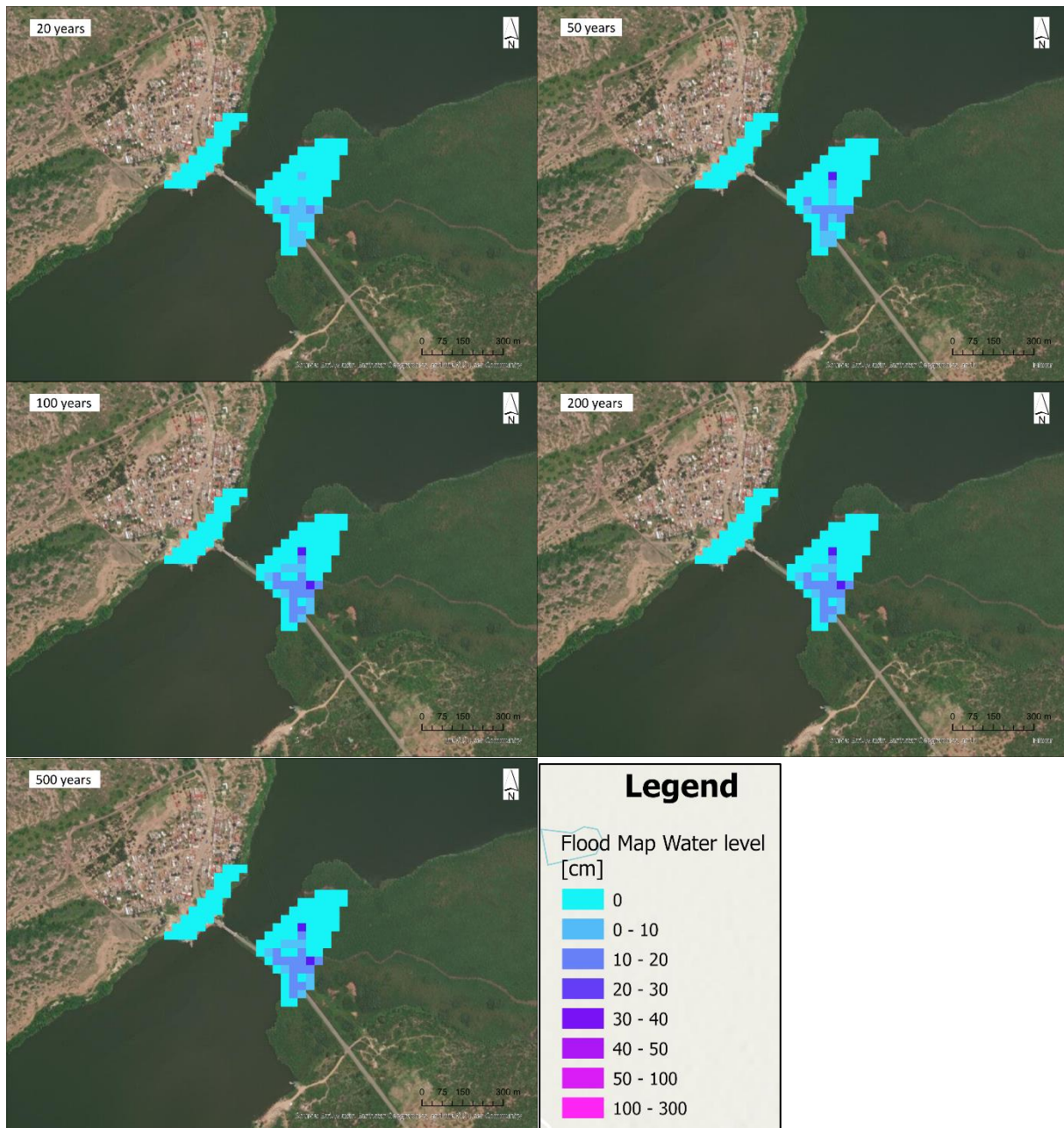


Source: Fathom Global Flood Map

Table 2 – Pluvial flood hazard results according to Fathom simulation for 2080

Hazard score	Return period [years]	Percentage subject to flooding 0-20 cm	Percentage subject to flooding >20 cm	Average water depth within the area [cm]	Max water depth within the area [cm]
High	20	15%	0%	1.3	12
	50	16%	1%	2.1	22
Medium	100	21%	2%	2.8	24
	200	21%	2%	2.8	24
Low	500	21%	2%	2.8	24

Figure 5 - Pluvial flood hazard in the area of Katunguru bridge for the year 2080 for return periods equal to 20, 50, 100, 200, 500 years



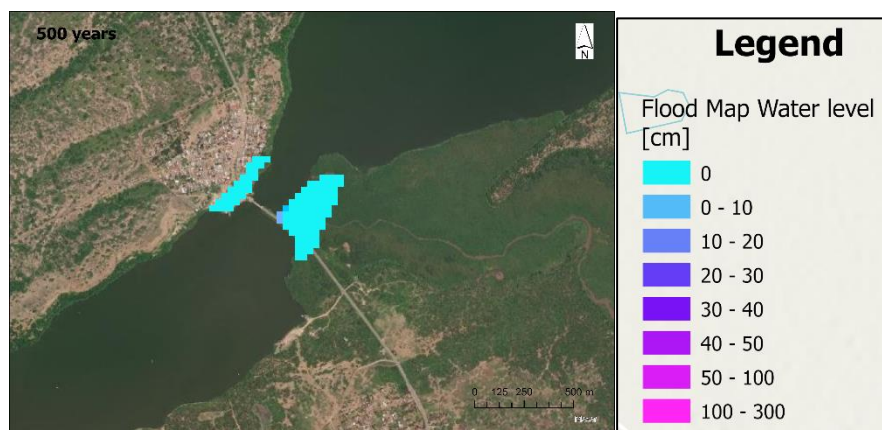
Source: Fathom Global Flood Map

Table 3 presents the results of Fathom simulations for the fluvial flood hazard in the current condition (year 2020). In **Figure 6** the maps of areas under fluvial flood hazards are reported for return period of 500 years in present condition (year 2020). **Table 4** and **Figure 7** present the results of Fathom simulations are reported for the fluvial flood hazard under future conditions (year 2080).

Table 3 – Fluvial flood hazard results according to Fathom simulation for 2020

Hazard score	Return period [years]	Percentage subject to flooding 0-20 cm	Percentage subject to flooding >20 cm	Average water depth within the area [cm]	Max water depth within the area [cm]
High	20	0%	0%	0	0
	50	0%	0%	0	0
Medium	100	0%	0%	0	0
	200	0%	0%	0	0
Low	500	2%	1%	0.4	21

Figure 6 - Fluvial flood hazard in the area of Katunguru bridge for the year 2020 for return period equal to 500 years

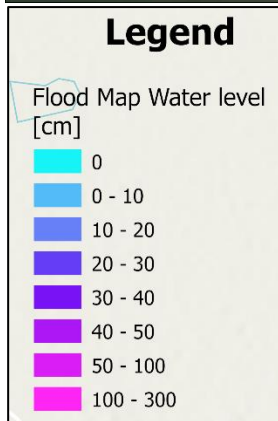


Source: Fathom Global Flood Map

Table 4 – Fluvial flood hazard results according to Fathom simulation for 2080

Risk score	Return period [years]	Percentage subject to flooding 0-20 cm	Percentage subject to flooding >20 cm	Average water depth within the area [cm]	Max water depth within the area [cm]
High	20	0%	0%	0	0
	50	4%	0%	0.4	20
Medium	100	11%	2%	1.5	34
	200	15%	5%	3.0	44
Low	500	15%	9%	5.5	54

Figure 7 - Fluvial flood hazard in the area of Katunguru bridge for the year 2080 for return periods equal to 50, 100, 200, 500 years



Source: Fathom Global Flood Map

3.1.2 Vulnerability analysis and results

Hazard	Exposure	Sensitivity	Vulnerability
<p>a. Fluvial & pluvial Flooding</p>	<p>Based on the Fathom simulations, 17% of the analyzed area is currently (year 2020 is considered as baseline) classified as having a high hazard for pluvial flooding, while 23% is categorized under medium and low hazard conditions. Looking ahead to the SSP5-8.5 scenario for the year 2080, the percentage of the area under high hazard for pluvial flooding remains at 17%, with the area under medium and low hazard expected to increase to 24%.</p> <p>No significant differences are observed between the medium and low hazard areas concerning pluvial flooding; thus, under a return period of 500 years, no changes are anticipated compared to lower return periods of 100 and 200 years. Furthermore, no substantial changes are expected between the present and future scenarios.</p> <p>Maximum water depth of 24 cm is expected in the area in the future for long return periods for pluvial flood.</p> <p>According to Fathom simulations, the present condition reveals that only 3% of the area is subject to fluvial flood hazard, classified under low hazard with a return period of 500 years and a maximum water depth of 21 cm.</p> <p>However, in the future, fluvial flood hazard is expected to increase significantly for both short and long return periods. Specifically, the area may experience more frequent flooding with a return period of 50 years, involving 4% of the area classified as high hazard. There will also be an increase in the area classified under medium and low hazard categories. Notably, 24% of the area is projected to be subject to low</p>	<p>Structural damage to the bridge might occur due to direct impact with water in case of strong water currents during river flooding events.</p> <p>In addition, the bridge functions would be subject to interruption and damage in case of flooding and water overflowing.</p> <p>For these reasons the sensitivity is also deemed high.</p>	<p>HIGH</p>

Hazard	Exposure	Sensitivity	Vulnerability
	<p>hazard with a return period of 500 years, where the water depth could reach up to 54 cm.</p> <p>For these reasons exposure is evaluated as high⁶.</p>		
<p>b. Extreme precipitation events</p>	<p>From the National Adaptation Plan for the Agricultural Sector of Uganda, emerges that extreme precipitation, followed by potential flooding events, occurs relatively frequently and is linked with El Niño/La Niña.</p> <p>According to the World Bank country profile, trends in extreme rainfall conditions occurred in the last years are difficult to define due to the lack of data and high seasonal variability in precipitation. However, more erratic onsets and ends to rainfall seasons, and heavier and more violent rainfall events have been seen in recent years, and the occurrence of heavy precipitation events is expected to increase, increasing the risk of disasters such as floods.</p> <p>Under a high-emission scenario, monthly annual precipitation is expected to increase in the second half of the century. Differently, the greatest change in the intensity and frequency of extreme rainfall events is likely to take place between the current and the mid-century period.</p> <p>There is a likely increase for the number of consecutive wet days (daily accumulation of rainfall larger than 1mm per day) throughout the year expected for the future. Also, the number of days with precipitation greater than 20mm will increase in each of the two rainy seasons (to May and September to December).</p>	<p>Possible adverse effect related to precipitation excess is deemed to possibly affect the Project, in particular, it would be subject to interruption and damage in case of excess precipitation water runoff and ponding.</p> <p>However, the sensitivity is deemed low.</p>	<p>MEDIUM</p>

⁶ It has to be noted that the reported possible level increase of Lake Edward (located downstream of the Bridge) does not have a climate-related origin and therefore has not been considered in the present assessment.

Hazard	Exposure	Sensitivity	Vulnerability
	<p>The increase in extreme precipitation events is also connected to the increase in frequency of floods.</p> <p>Based on these considerations, exposure is evaluated high.</p> <p>The above assessment is based on the average of existing climate projections on precipitations.</p>		
<p>c. Extreme wind conditions</p>	<p>According to the World Bank Climate Risk Country Profile (2021) and Uganda National Meteorological Authority (UNMA), Uganda does not experience tropical cyclones. However, the Katunguru Bridge Project site can still be affected by strong winds, particularly during convective storms that are common during the wet seasons (March–May and September–November⁷).</p> <p>Local meteorological reports (Uganda National Meteorological Authority) indicate that average daily wind speeds in the Katunguru District typically range between 10 and 15 km/h, but according to local studies⁸ for a 100-year return period (i.e., a 1% annual chance), during intense thunderstorms wind gusts can reach or exceed 25 m/s (90 km/h) in the region. These events can be particularly challenging for bridge operations and maintenance, requiring appropriate design considerations to ensure structural resilience.</p> <p>Historical records confirm that while southwestern Uganda experiences less frequent high wind events than the northern region, occasional convective storms can cause localized damage—such as fallen trees, damage to roofs, and utility failures. While the bridge is inland and not exposed to tropical cyclones, convective storms can produce high wind speeds</p>	<p>The Katunguru Bridge site is moderately sensitive to strong wind hazards. According to the description on the TOR document and the bridge design as reported in Paragraph Error! Reference source not found., the bridge’s large and exposed structure can experience wind-induced stresses on its superstructure and supporting elements. Surrounding vegetation and utility poles can contribute to the risk of secondary damage from falling debris during severe storms. While modern design can incorporate features to manage wind loads, some infrastructure components — such as lighting poles and signage — remain vulnerable.</p> <p>Overall, sensitivity is rated as medium, given the potential for damage under intense wind events.</p>	<p>MEDIUM</p>

⁷ <https://unfccc.int/sites/default/files/resource/Final%20TNC%20Uganda.pdf>

⁸ <https://wwfafrica.awsassets.panda.org/downloads/nbs-brief-and-rights-booklet.pdf>

Hazard	Exposure	Sensitivity	Vulnerability
	<p>that pose risks to the bridge’s superstructure and ancillary components, particularly when combined with heavy rainfall that may destabilize soils around piers and embankments.</p> <p>Climate models indicate that average wind speeds are not expected to change significantly throughout the century. However, under high-emission scenarios, the frequency and intensity of convective storms could increase by 2050 and 2090, raising the likelihood of damaging winds in the region.</p> <p>For these reasons, exposure is evaluated as medium.</p>		
<p>d. Wildfires</p>	<p>According to the ThinkHazard! tool (Global Facility for Disaster Reduction and Recovery - GFDRR) and the NEMA (National Environment Management Authority) Annual Environment Management Report (2020/21), the Katunguru Bridge Project area is classified as high hazard for wildfires, with a greater than 50% chance of encountering weather conditions that could support significant fires during the dry season. Modelled projections of future climate identify a likely increase in the frequency of fire-prone conditions in this region during the dry season, driven by rising temperatures, higher evapotranspiration, and greater rainfall variability.</p> <p>However, according to regional and local studies⁹, and the NEMA report note that the primary fire hazard in the Katunguru area comes from seasonal grassland fires and agricultural burning, rather than large-scale forest fires. The area is predominantly agricultural and semi-rural, with scattered vegetation and grasslands rather than dense forests.</p>	<p>Fires can occur near the bridge and embankments, potentially affecting access and visibility. The bridge itself, constructed from concrete and steel, is not highly flammable, but maintenance activities and nearby vegetation could be impacted during fire events. This could affect bridge access, embankments, or local utilities, posing operational and safety risks.</p> <p>Sensitivity is deemed medium.</p>	<p>LOW</p>

⁹ <https://nema.go.ug/sites/all/themes/nema/docs/Lead%20Agency%20edit%20Fina%2003%2001%202023.pdf>

Hazard	Exposure	Sensitivity	Vulnerability
	<p>Considering that the Katunguru Bridge is located in a semi-rural area with mixed agricultural and natural land uses, exposure to wildfire hazard is evaluated as low.</p>		
<p>e. Extreme temperatures – maximum temperature and heatwaves</p>	<p>According to the World Bank country profile and its Climate Change Knowledge Portal, Uganda’s temperatures are projected to increase by more than +1°C by midcentury (relative to the historical baseline) and potentially exceed +3°C by the end of the century under the high-emission scenario SSP5-8.5. The largest increases are expected during the traditionally cooler months of June to September¹⁰.</p> <p>By midcentury, Uganda is likely to experience both higher minimum and maximum temperatures, with more frequent occurrences of days where apparent temperatures (heat index) exceed 35°C. The number of days with high heat index conditions is projected to increase significantly compared to historical averages, with corresponding rises in the number of tropical nights (minimum temperatures above 25°C). This trend is expected to worsen under higher emission scenarios (SSP3-7.0 and SSP5-8.5), increasing the hazard of heat-related stress for both the population and critical infrastructure¹¹.</p> <p>Under these projected trends, maximum temperatures could exceed 42°C during the hottest months (January to March) by end-century. The bridge site, while not in a major urban heat island, can still be affected by these high temperatures, which may impact bridge materials and worker safety during construction.</p>	<p>High temperatures can cause thermal expansion and stress in construction materials of the bridge, leading to cracking or degradation over time. Workers are also at risk of heat stress, affecting health and productivity.</p> <p>Sensitivity is classified as medium.</p>	<p>HIGH</p>

¹⁰ <https://climateknowledgeportal.worldbank.org/country/uganda/climate-data-projections>

¹¹ https://ccd.go.ug/wp-content/uploads/2019/10/Uganda-Strategic-Programme-for-Climate-Resilience_May_2017.pdf

Hazard	Exposure	Sensitivity	Vulnerability
	Exposure to extreme temperatures and heatwaves is therefore evaluated as high .		
f. Extreme temperatures - cold waves	<p>Being near the equator and at moderate altitude (~800–900 m), Katunguru maintains relatively consistent temperatures year-round. Average lows range from 17°C to 23°C even in the coolest months. There is no record of temperatures dropping below 10°C or evidence of frost or freezing events.</p> <p>Exposure is thus evaluated as not applicable.</p>	-	N/A
g. Drought	<p>According to the Standardized Precipitation-Evapotranspiration Index (SPEI) from the Climate Change Knowledge Portal, the Katunguru Bridge Project area does not experience significant annual drought hazard, with average rainfall balancing evapotranspiration rates. However, the region experiences a pronounced dry season (June–August and December–February). Climate models project an increase in the number of consecutive dry days during these periods due to higher temperatures and variable rainfall.</p> <p>Although the site is inland and not affected by coastal drought dynamics, episodic dry spells can still affect agriculture and water supply, indirectly impacting construction and maintenance activities.</p> <p>Exposure to seasonal drought hazard is therefore evaluated as low.</p>	<p>The bridge construction phase has medium sensitivity to drought hazards: construction activities like concrete mixing, dust suppression, and embankment compaction require reliable water supply, which may be limited during dry spells. During the operational phase sensitivity is deemed to be negligible.</p> <p>Sensitivity is thus classified as low.</p>	LOW
h. Landslides	<p>Considering the morphology of the Project area, it is considered to be not likely subject to landslides in the present or in the future.</p> <p>Exposure is thus evaluated as not applicable.</p>	-	N/A

Hazard	Exposure	Sensitivity	Vulnerability
<p>i. Soil erosion</p>	<p>According to the global GloSEM 1.3 database, which provides indicators on estimated rates (Mg/ha year) of soil displacement by water by 2070, the baseline for the area of the Project (2019) is between ~5 Mg/ha (to the South of the riverbank) and <30 Mg/ha (to the North of the riverbank) per year of displaced soil; in the future (2070) the values of displaced soil are not expected to change for scenario RCP 2.6 and to experience little increase for RCP 8.5. These values are considered between medium-low (5 Mg/ha) and high (30 Mg/ha).</p> <p>The possible increase in future soil erosion is also related to the increase in frequency expected for extreme precipitation events and consequent flood events, that can accelerate the process of erosion. Intense precipitation can increase soil erosion on land for the effect of rainfall on the transport of superficial soil, while inland flooding can cause a diffuse flood on the surrounding area increasing the action of water.</p> <p>Exposure is thus evaluated as medium.</p>	<p>The hazard has potential to negatively impact the Project considering structural damages to the bridge and other related activities and structures along the riverbanks.</p> <p>The sensitivity is classified as medium.</p>	<p>MEDIUM</p>
<p>j. Subsidence</p>	<p>Due to the complexity of the phenomenon, it is difficult to determine future changes in the subsidence rate under different climate scenarios. The present analysis therefore considers the current subsidence rates according to the global analysis carried out by Davydzienka (2024)¹². The average subsidence rate in the area of the Project is of the order of 10⁻⁴ mm/year. This value is considered low.</p> <p>Also due to possible future worsening under climate change (in the absence of precise projections), exposure is evaluated as low.</p>	<p>The hazard has reduced potential to negatively impact the Project considering structural damages to the bridge and the new road segments.</p> <p>The sensitivity is classified as medium.</p>	<p>LOW</p>

¹² Davydzienka, T., Tahmasebi, P., & Shokri, N. (2024). Unveiling the global extent of land subsidence: The sinking crisis. *Geophysical Research Letters*, 51, e2023GL104497, <https://doi.org/10.1029/2023GL104497>

3.2 Phase 2 – Risk Analysis and Contribution to Adaptation

Building on the results of the phase 1, Ramboll carried out a high-level risk assessment to evaluate the likelihood of occurrence and the potential impact of each relevant hazard (classified as medium or high), in accordance with the guidelines released by the European Commission. Specifically, this evaluation follows the criteria outlined by the sustainability proofing guidelines and the “Technical guidance on climate-proofing of infrastructure projects for the period 2021-2027 (section 3.3.2.1 page 35):

Figure 8 - Criteria for the scores of likelihood and impact. Below the risk matrix as combination of likelihood and impact, as defined in the Commission Notice “Technical guidance on the climate proofing of infrastructure in the period 2021-2027”

LIKELIHOOD ANALYSIS			IMPACT ANALYSIS				
Indicative scale for assessing the likelihood of a climate hazard (example):			Indicative scale for assessing the potential impact of a climate hazard (example)				
Term	Qualitative	Quantitative (*)	Insignificant	Minor	Moderate	Major	Catastrophic
Rare	Highly unlikely to occur	5%					
Unlikely	Unlikely to occur	20%					
Moderate	As likely to occur as not	50%					
Likely	Likely to occur	80%					
Almost certain	Very likely to occur	95%					
The output of the likelihood analysis may be summarised in a qualitative or quantitative estimation of the likelihood for each of the essential climate variables and hazards. (*) Defining the scales requires careful analysis for various reasons including e.g. that the likelihood and impacts of the essential climate hazards may change significantly during the lifespan of the infrastructure project among other due to climate change. Various scales are referred to in the literature.			Risk areas: Asset damage, engineering, operational Safety and health Environment, cultural heritage Social Financial Reputation Any other relevant risk area(s) Overall for the above-listed risk areas				
			The impact analysis provides an expert assessment of the potential impact for each of the essential climate variables and hazards.				
Indicative risk table:		Overall impact of the essential climate variables and hazards					Legend: Risk level
		Insignificant	Minor	Moderate	Major	Catastrophic	
Likelihood	Rare						
	Unlikely						
	Moderate						
	Likely						
	Almost Certain						

Source: Prepared by Ramboll based on Commission Notice “Technical guidance on the climate proofing of infrastructure in the period 2021-2027” (C(2021) 5430).

The indicative scale for likelihood presented in the guidance has been considered, along with different risk areas listed to assess the potential impact level.

Based on project-specific information provided by Centunion and expert judgment, risk levels have been identified by evaluating the likelihood of occurrence and potential impact (using a 5-level scale as indicated by the *sustainability proofing* guidelines). The results are presented in the table below.

In the second phase of the assessment, only climate hazards deemed relevant to the Project are analyzed, specifically those hazards to which the Project exhibits medium to high vulnerability.

Hazard	LIKELIHOOD [L]	IMPACT under current condition [I]	IMPACT after new bridge construction [I2]	RISK LEVEL after new bridge construction [L x I2]	PROJECT CONTRIBUTION to reduce and ADAPT to the identified risk & recommended measures for RESILIENCE of the Project
<p>a. Fluvial & pluvial Flooding</p>	<p>Likely (4/5)</p> <p>Upon analysing the site to inland flooding, according to the simulation, it has been determined that the area frequently experiences pluvial flooding under both current conditions and future projections (year 2080 is considered for long-term time horizon. Additionally, the site is expected to be subject to relevant fluvial flood events in the future.</p> <p>Consequently, the likelihood of occurrence of flood is likely for the study area.</p>	<p>Moderate (3/5)</p> <p>In the past there are no recorded events of floods overtopping the existing bridge, but it has experienced periodically raise of the water level.</p> <p>The current bridge vertical clearance is lower than 3 meters, and it is expected to decrease due to debris accumulation, closing the existing waterway opening. Moreover, vegetation often clogs the channel and prevents boat navigation between the lakes and the Kazinga channel.</p> <p>For this reason, a potential flood in the near future, according to projections expected by climate scenarios reported above, can have impact on the existing bridge for the</p>	<p>Insignificant (1/5)</p> <p>A potential flood occurring in the future is not expected to impact the new bridge. The vertical clearance of the new bridge has been proposed at 7 m, which is more than double the clearance of the present bridge. Under these conditions, the raise of water level in the channel during flood events will not affect the bridge.</p> <p>Additionally, the increased clearance facilitates that no debris and vegetation could clog the channel, continuing to have sufficient vertical height for navigation and for the water flow during extreme events, reducing the probability of occurrence of flood in the surrounding areas and on the riverbank.</p>	<p>MEDIUM</p>	<p>The current risk of inland flooding is high.</p> <p>However, the construction of the new bridge reduces this risk level to medium.</p> <p>The new bridge is meant to provide a sufficient vertical clearance for the water flow under normal condition and in case of extreme precipitation events and consequent risk of flood.</p> <p>Indeed, the height of the bridge is meant to avoid the clogging of debris and vegetation.</p> <p>This is a necessary condition to avoid clogging during flood events. The normal flow of water during extreme events is necessary to avoid the flood of surrounding territory and of riverbanks.</p>

Hazard	LIKELIHOOD [L]	IMPACT under current condition [I]	IMPACT after new bridge construction [I2]	RISK LEVEL after new bridge construction [L x I2]	PROJECT CONTRIBUTION to reduce and ADAPT to the identified risk & recommended measures for RESILIENCE of the Project
		<p>reduced vertical clearance. Additionally, high water level in the river can flood in the surrounding area.</p> <p>If the bridge and the surrounding area will be subject to flood there are not alternative crossings for the Kazinga channel, implying the circumnavigation of the Lake George for hundreds of kilometers.</p>	<p>The continuity in the service of the bridge to cross the channel is important for transportation between the two banks of the river.</p> <p>Representatives of local communities have repeatedly expressed their eagerness to improve or replace the existing bridge over the channel crossing.</p> <p>The new bridge can improve the security and the economy of the area, providing more continuity of transportation and the movement of goods and people. During flood events, the use of the bridge should not pose danger to people.</p>		<p>Moreover, the height is sufficient to avoid the flood of the bridge itself, continuing to let the transit and transportation also during events of increased water level.</p> <p>This infrastructure is important for local communities because it is the unique cross of the river, and the continuity of service improves their condition reducing the necessity to circumnavigate the lake to cross the river.</p> <p>The development of this bridge will play an important role in enabling local communities to access essential services, including during emergencies, reducing their isolation and improving economy.</p>

Hazard	LIKELIHOOD [L]	IMPACT under current condition [I]	IMPACT after new bridge construction [I2]	RISK LEVEL after new bridge construction [L x I2]	PROJECT CONTRIBUTION to reduce and ADAPT to the identified risk & recommended measures for RESILIENCE of the Project
					<p><u>For these reasons the new Katunguru Bridge is considered to significantly contribute to the adaptation of the area and local communities to the effects of climate change on flooding events.</u></p>
<p>b. Extreme precipitation events</p>	<p>Moderate (3/5) Extreme precipitation events are frequent in the area, also considering the significant amount of total precipitation during the year. Moreover, in the future they are expected to become more frequent. Extreme precipitations are strictly connected with the increase in flood hazard. However, climate projections in terms of extreme precipitation are still uncertain.</p>	<p>Minor (2/5) With the existent bridge, under present and future climate conditions, extreme precipitation is deemed to bring only a limited impact on the Project area, with possible effects on transit and transportation continuity, local communities and safety of bridge users during extreme rainfall events, considering the age and condition of the existing bridge. No structural damage is expected. The impact is</p>	<p>Insignificant (1/5) Extreme precipitation events are directly correlated with the occurrence of inland floods, whose impacts on the new bridge infrastructure are insignificant, as the new bridge is deemed to be much more reliable than the existing one under extreme rainfall events. The new bridge will be more resilient to the increase of water level and will reduce the stop of debris and vegetation thanks to the</p>	<p>LOW</p>	<p>The current risk of extreme precipitation is medium, whereas the expected risk after the construction of the new bridge is low. <u>The new bridge is expected to be more resilient to the occurrence of extreme precipitation events, and it does not worsen their impacts on the population and the territory.</u> <u>However, it is important that the material used for the construction is resilient to rainfall, in particular to</u></p>

Hazard	LIKELIHOOD [L]	IMPACT under current condition [I]	IMPACT after new bridge construction [I2]	RISK LEVEL after new bridge construction [L x I2]	PROJECT CONTRIBUTION to reduce and ADAPT to the identified risk & recommended measures for RESILIENCE of the Project
		principally related to the increase in river water level during rainfall events and in the increase in transport of debris in the river, with consequent potential for vertical clearance clogging and reduction in the possibility to navigate the river.	greater vertical and horizontal clearances. This condition will avoid the possibility of interruption in river uses, like navigation and fishing, during events of increased water level. However, intense precipitation can make asphalt slippery or create localized water ponding. For this reason, it is necessary to include the use of draining asphalt or comparable material to ensure the bridge is resilient to this kind of impact.		<u>intense and prolonged rainfall events.</u>
c. Extreme wind conditions	Unlikely (2/5) The probability of severe windstorms occurring in the Katunguru area is considered medium-low. Based on historical records and analysis from the Uganda National	Moderate (3/5) The impact of strong winds is generally deemed medium, as strong winds have the potential to cause minor asset damages to the bridge and its usage, directly or indirectly due to	Minor (2/5) Strong winds from convective storms can occasionally cause minor structural damage also to the new bridge infrastructure, both directly to the asset and localized	LOW	The risk of damage from strong winds at the Katunguru Bridge site is currently medium for the existent bridge, and low in the future after the construction of the new bridge, in light of the entire

Hazard	LIKELIHOOD [L]	IMPACT under current condition [I]	IMPACT after new bridge construction [I2]	RISK LEVEL after new bridge construction [L x I2]	PROJECT CONTRIBUTION to reduce and ADAPT to the identified risk & recommended measures for RESILIENCE of the Project
	<p>Meteorological Authority, the strongest wind gusts (≥ 25 m/s) are estimated to have a return period of approximately 100 years. Although convective storms with high winds occasionally occur, they are not as frequent or intense as coastal tropical cyclones in other regions.</p>	<p>fallen trees and power lines, which could lead to temporary service interruptions or damage to users and transportation, also considering the age and the wear of the existing bridge.</p>	<p>damage to bridge railings and power lines, and indirectly due to fallen trees or external structures, which could lead to temporary service interruptions as well as on bridge users and transportation.</p> <p>However, in the event that the new bridge design specifications and materials take into account strong wind conditions, the impact would be considered minor.</p> <p>It is important to consider the maximum expected wind speeds associated with severe convective storms when designing the bridge to ensure its resilience to potential impacts from extreme wind events.</p>		<p>replacement of the existing structure with a new and bigger one.</p> <p><u>As preventive action against extreme events, wind-resistant design measures should be incorporated to ensure long-term resilience, particularly for exposed components such as lighting poles and signage.</u></p>
<p>d. Extreme temperature – maximum</p>	<p>Almost certain (5/5) Climate projections indicate significant increases in</p>	<p>Minor (3/5) The current mode of transit and transportation on the</p>	<p>Minor (2/5) Extreme temperatures and heatwaves can cause minor</p>	<p>HIGH</p>	<p>The current risk from extreme temperatures at the Katunguru Bridge site is</p>

Hazard	LIKELIHOOD [L]	IMPACT under current condition [I]	IMPACT after new bridge construction [I2]	RISK LEVEL after new bridge construction [L x I2]	PROJECT CONTRIBUTION to reduce and ADAPT to the identified risk & recommended measures for RESILIENCE of the Project
temperature and heatwaves	maximum and average temperatures across Uganda, including southwestern areas near Lake Edward. Heatwaves — defined as consecutive days with temperatures above critical thresholds — are projected to increase in frequency and duration, especially during the dry season.	existing bridge is limitedly vulnerable to extreme heat impacts with regards to heat stress, users’ fatigue, social stress and costs from heat conditions. Also, the existent bridge can be subject to structural problems due to its historical exposure to extreme and prolonged heat.	structural impacts to the bridge infrastructure: it is important to consider the potential for thermal stress in the design and selection of construction materials to ensure the bridge’s resilience to prolonged high temperatures. Other types of impact (safety, social, economic) are also deemed minor.		similar to the expected risk after construction of the new bridge, being assessed as high (despite minor impact, due to very high likelihood). <u>It is important to consider extreme temperature conditions in the design of the bridge — particularly in choosing construction materials and expansion joints — to ensure the bridge’s long-term resilience against high temperatures and heatwaves.</u>
e. Soil erosion	Unlikely (2/5) The soil erosion has a chronic effect, and its occurrence is continuous but with low efficacy. According to the data and projections reported above, it is unlikely that a bursting event of crash or collapse can occur	Moderate (3/5) Soil erosion can have moderate impacts on the existing bridge, in particular due to the excavation by water near the river banks in proximity of the pillars. The bridge's access from a tongue of land makes it	Moderate (3/5) Soil erosion can have moderate impacts also on the new bridge, in particular due to the possible excavation processes by water flow in proximity of the pillars located in the	MEDIUM	The current risk from soil erosion at the Katunguru Bridge site is similar to the expected risk after construction of the new bridge, being assessed as medium .

Hazard	LIKELIHOOD [L]	IMPACT under current condition [I]	IMPACT after new bridge construction [I2]	RISK LEVEL after new bridge construction [L x I2]	PROJECT CONTRIBUTION to reduce and ADAPT to the identified risk & recommended measures for RESILIENCE of the Project
	<p>but considering the long lifetime of the bridge a limited probability of occurrence has to be considered.</p> <p>The likelihood is also related to the increase in frequency expected for extreme precipitation events and consequent flood events under climate change, that can accelerate the process of erosion.</p>	<p>particularly vulnerable to soil erosion, due principally to the water action.</p> <p>Moreover, the accumulation of vegetation and debris can increase the effect of erosion on the pillars of the bridge.</p>	<p>river channel, on the riverbanks and on the land.</p> <p>The accumulation of vegetation and debris in proximity of the pillars will be reduced, thanks to the widening of the bridge and height increase, but will remain possible and it can increase the effect of erosion. On the other hand, the increase of the number of pillars to be installed inside the river (due to increased length of the bridge) increases the possible impact of erosion on the bridge structure.</p> <p>It is important to consider measures to increase the stability of the bridge pillars both in the river channel and on land to prevent problems related to soil erosion. Robust pillar stability will help maintain</p>		<p><u>It is important to consider improvement measures in the design of the bridge's pillars, both in the river channel and on land, to increase the stability of the structure against the effect of soil erosion related to water action and debris transport in the river.</u></p>

Hazard	LIKELIHOOD [L]	IMPACT under current condition [I]	IMPACT after new bridge construction [I2]	RISK LEVEL <u>after</u> new bridge construction [L x I2]	PROJECT CONTRIBUTION to reduce and ADAPT to the identified risk & recommended measures for RESILIENCE of the Project
			the integrity and longevity of the bridge by mitigating erosion-related concerns.		

3.2.1 Summary of required measures for the resilience of the Project

The risk analysis included an evaluation of how the new Katunguru Bridge Project can contribute to mitigating local climate-related physical risks and strengthening the resilience of nearby communities and territories against climate change impacts, with a focus on flooding. Furthermore, the analysis identified specific measures that need to be integrated into the project design (currently not available) and construction of the bridge to ensure the project's resilience to the identified relevant climate hazards.

Specifically, these measures are:

- for extreme temperatures and heatwaves (high residual risk): it is important to select construction materials and structural design features that can withstand high maximum temperatures and frequent heatwaves. This ensures that the bridge remains safe and durable under thermal stress conditions, accounting for increased temperature projections in the region;
- for extreme precipitation events (low residual risk): it is suggested for the project of the bridge to include the use of draining asphalt as well as other draining systems to avoid localized water ponding or flooded areas and ensure its resilience to this kind of risk;
- for extreme wind conditions (low residual risk): as a preventive measure against extreme events, wind-resistant design measures should be incorporated to ensure long-term resilience, particularly for exposed components such as lighting poles and signage;
- for soil erosion (medium residual risk): it is suggested to consider some measures in the design of the bridge's pillars, both in the river channel and on land, for the increase of stability against the effect of soil erosion related to water action and debris transport in the river.

It is expected that the conclusions of this report are considered for the detailed Project/Bridge design and thus it will be constructed following "state-of-the-art" practices and applicable best practices. This approach will incorporate necessary adjustments to prevent or reduce the impact of these hazards.

4. CONCLUSIONS

Physical climate-related risks associated with the Project for the construction of a new bridge (replacing an existing smaller bridge) in Katunguru - Uganda have been evaluated.

Following the vulnerability analysis carried out in Phase 1, the likelihood of occurrence and potential impact have been assessed in Phase 2 for hazards to which the Project exhibits medium or high vulnerability. This risk analysis was performed under two conditions: prior and following the construction of the new infrastructure. This approach enabled the evaluation of the bridge's contribution climate adaptation, and recommendations were developed to integrate measures into the project to ensure the infrastructure's resilience to climate risks.

The identified risk levels for the current condition are:

- high risk to inland flooding and extreme temperature;
- medium risk to extreme precipitation events, extreme wind conditions and soil erosion.

While the identified risk levels after the new Bridge construction are:

- high risk to extreme temperature;
- medium risk to inland flooding and soil erosion;
- low risk to extreme precipitation events and extreme wind conditions.

The construction of the new Katunguru bridge contributes positively to the reduction of risk levels for inland flooding. This project enhances the resilience of the territory and provides a service that assists the population in to adapting to the effects of climate change, particularly concerning extreme flood events. Additionally, the new bridge is expected to be more resilient to extreme precipitation events and extreme wind conditions.

Ramboll's analysis also aimed to provide a high-level evaluation of the adaptation measures to be integrated into the project design in order to mitigate the identified potential climate-related risks, ensuring the infrastructure's resilience to such events. These requirements are summarized in section 3.2.1.

From the National Adaptation Plan for the agricultural sector (Uganda currently lacks a National Adaptation Plan and instead has sector-specific plans, such as the one for agriculture), it is evident that transport infrastructure is highly vulnerable to extreme weather events, flooding, and other climate change impacts. Specifically, roads, bridges and railways are often damaged or destroyed by floods and storms, which significantly hinders the marketing of agricultural products. Additionally, aging and poorly maintained infrastructure further impedes access to markets. Therefore, strategic planning and investment in rural transport infrastructure, such as the new Katunguru bridge, is a government priority under the adaptation strategy. These efforts aim to enhance connectivity between rural and urban areas and improve market accessibility. In particular, the climate-proofing of these infrastructures to withstand increasing climate variability is crucial.

Final statement

The construction of the new bridge is reportedly aimed at ensuring service continuity and avoid damages during river flood events, which is particularly relevant given the projected increase in frequency and intensity of floods due to climate change in the future. Currently, the population is dependent on an old bridge with a vertical clearance that does not guarantee the water flow during extreme events of

precipitation with consequent water level rise and flood risk, and a sufficient height for navigation on the river. This is due in particular to the clogging of debris and vegetation, also due to the artificial narrowing of the river occurred for the first bridge construction. The construction of the bridge will strengthen the existing network for connection with other cities and communities, facilitating the movement of people and the transportation of goods, both during normal condition and during possible flood events. This improvement will enhance the economy and access to services for the population, including health services.

However, specific measures should be incorporated in the project's design to ensure the bridge's resilience and eligibility for adaptation to climate change also to additional hazards, including extreme precipitation events, extreme temperatures and extreme wind. These events could affect the bridge and/or its functions, making it essential to employ a meticulous approach in design and material selection to endure potential future extremes in temperature, rainfall and wind.

In conclusion, **the new Katunguru bridge infrastructure is considered to contribute to the adaptation of local communities to the effects of climate change on flood events.** The new bridge is reportedly aimed at ensuring service continuity and reducing damage during river flood events, which is particularly relevant considering the projected increase in frequency and intensity of floods due to climate change in the future. Furthermore, by incorporating the resilience measures mentioned above into the design, **the project is also deemed resilient to the additional residual climate-related risks.**

APPENDIX 1 - LIST OF DOCUMENTS FOR THE ASSESSMENT

1. World Bank Group. (2021). Uganda Climate Risk Country Profile. Washington, DC: World Bank.
2. National Technical Task Team on Government Response to Flooding in Uganda. (2020, October). Report on Joint Field Trip to Evaluate Flood Impacts in Uganda. Kampala: Government of Uganda.
3. Additional information provided by Centunion following a list of preliminary questions sent by Ramboll.
4. KATUNGURU - Climate Resilient Bridges Studies - TOR request information
5. Joint field trip on: the assessment of the impacts of rising water levels and flooding in various parts of Uganda - National Technical Task Team on Government Response to Flooding in Uganda (2020)
6. Status of Water Levels in Major Water Bodies in Uganda - Government of Uganda (2021)
7. Gebrechorkos, S. H., Taye, M. T., Birhanu, B., Solomon, D., & Demissie, T. (2023). Future changes in climate and hydroclimate extremes in East Africa. *Earth's Future*, 11(2), e2022EF003011. Research article: "Future Changes in Climate and Hydroclimate Extremes in East Africa" (2023)
8. Uganda National Environment Management Authority. (2021). Annual Environment Management Report 2020/21. Kampala: NEMA.
9. Tumusiime, D., et al. (2022). Regional projections of extreme heat, wind speeds, and fire risks in northern Uganda. *Journal of Climate Risk and Resilience*, 5(1), 123-137.
10. The Republic of Uganda – Ministry of Agriculture, Animal industry and Fisheries. (2018, November). National Adaptation Plan for the Agricultural Sector.

APPENDIX 2 - OVERVIEW OF MAIN REFERENCE GUIDELINES

The present Appendix provides further details on the reference guidelines adopted by Ramboll for the independent third-party review. Considering that the “APPENDIX II: Eligibility Criteria for Climate Change Adaptation Projects” of the CCSU OECD document does not provide sufficient specificity on how to assess whether the project ‘reduces the location-specific context of vulnerability to climate change’ by the “independent third-party reviewers”, Ramboll has agreed with the EPC Contractor and the Lender a methodology consisting in the application of reasonable available best practices and recognized guidelines.

In particular the “Technical guidance on climate-proofing of infrastructure projects for the period 2021-2027” by the European Commission (adopted for the Climate resilience proofing within the Invest EU Sustainability proofing), and the Annex II of the EU Taxonomy’s Delegated Regulation 2021/2139 were considered as reference, due to their recognized value for assessing projects to be financed as well as their applicability to infrastructure project such as the bridge proposed by Centunion.

1. EC Technical Guidance on Climate Proofing of Infrastructure

1.1. Overview

On July 29, 2021, the European Commission released a technical guidance on climate-proofing infrastructure projects for the 2021-2027 period¹³. This guidance aims to ensure infrastructure projects are compatible with the Paris Agreement and EU climate objectives. It focuses on integrating climate change mitigation and adaptation into project development, enabling informed decisions by investors.

The guidance meets the following requirements laid down in the legislation for several EU funds, notably InvestEU, Connecting Europe Facility (CEF), European Regional Development Fund (ERDF), Cohesion Fund (CF), and the Just Transition Fund (JTF):

- It is consistent with the Paris Agreement and EU climate objectives, which means it is consistent with a credible greenhouse gas (GHG) emission reduction pathway in line with the EU’s new climate targets for 2030 and climate neutrality by 2050, as well as with climate-resilient development.
- It follows the principle ‘energy efficiency first’, which is defined in Article 2(18) of Regulation (EU) 2018/1999.
- It follows the principle ‘do no significant harm’, which is derived from the EU’s approach to sustainable finance and enshrined in Regulation (EU) 2020/852 (Taxonomy Regulation).

Key aspects of the guidance include:

- Two pillars:
 - Mitigation (reducing greenhouse gas emissions) and Adaptation (building resilience to climate impacts).
- Two phases:
 - Screening and detailed analysis. Screening determines if a detailed analysis is needed, while detailed analysis assesses climate-related risks.
- Integration with other processes:

¹³ <https://ec.europa.eu/newsroom/cipr/items/722278/en>

- The guidance integrates climate-proofing with project cycle management (PCM), environmental impact assessments (EIA), and strategic environmental assessments (SEA).
- Scope:
 - The guidance covers a wide range of infrastructure, including buildings, network infrastructure, and built systems and assets.
- Target audience:
 - The guidance is primarily for project promoters and experts but can also be a useful reference for public authorities, implementing partners, investors, and stakeholders

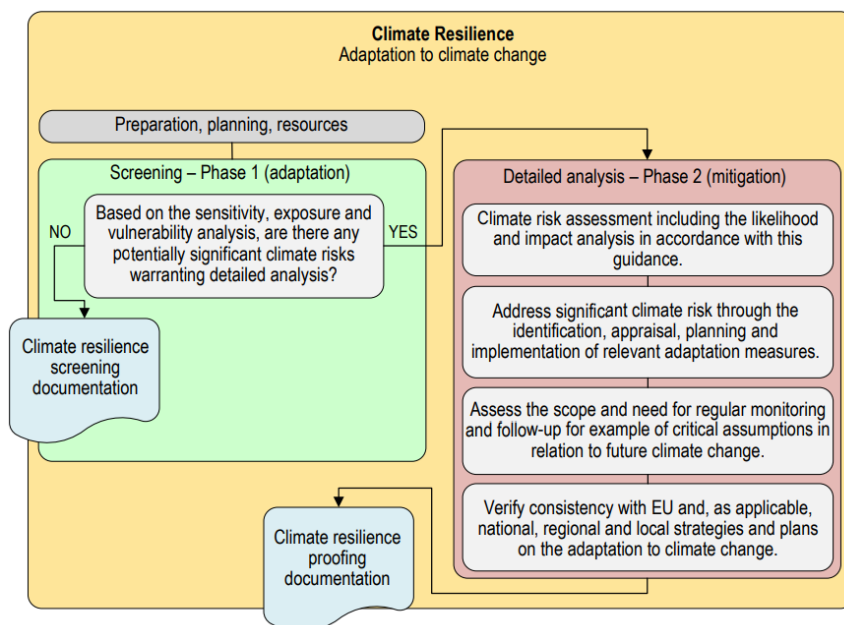
1.2. Adaptation to climate change (climate resilience)

As the APPENDIX II of the CCSU OECD document is targeted on Climate adaptation, other climate or environmental topics (such as GHG emissions, pollution, water resources or biodiversity) are not considered.

Infrastructure is usually long-lasting and may be exposed for many years to a changing climate with increasingly adverse and frequent extreme weather and climate impacts.

The climate vulnerability and risk assessment help identifying the significant climate risks. It is the basis for identifying, appraising and implementing targeted adaptation measures. This will help reduce the residual risk to an acceptable level.

Figure 9 – Overview of the climate adaptation-related process for climate proofing



Source: EC Technical Guidance on Climate Proofing of Infrastructure

Climate change adaptation measures for infrastructure projects focus on ensuring a suitable level of **resilience to the impacts of climate change**, which include **acute events** such as more intense **floods, droughts, heatwaves, wildfires, storms and landslides** and **hurricanes**, as well as **chronic events** such as projected **sea-level rise** and changes in average **precipitation** and **temperature**. In

addition to enhancing the project's own climate resilience, **it is essential to ensure that it does not increase the vulnerability of surrounding economic and social systems.**

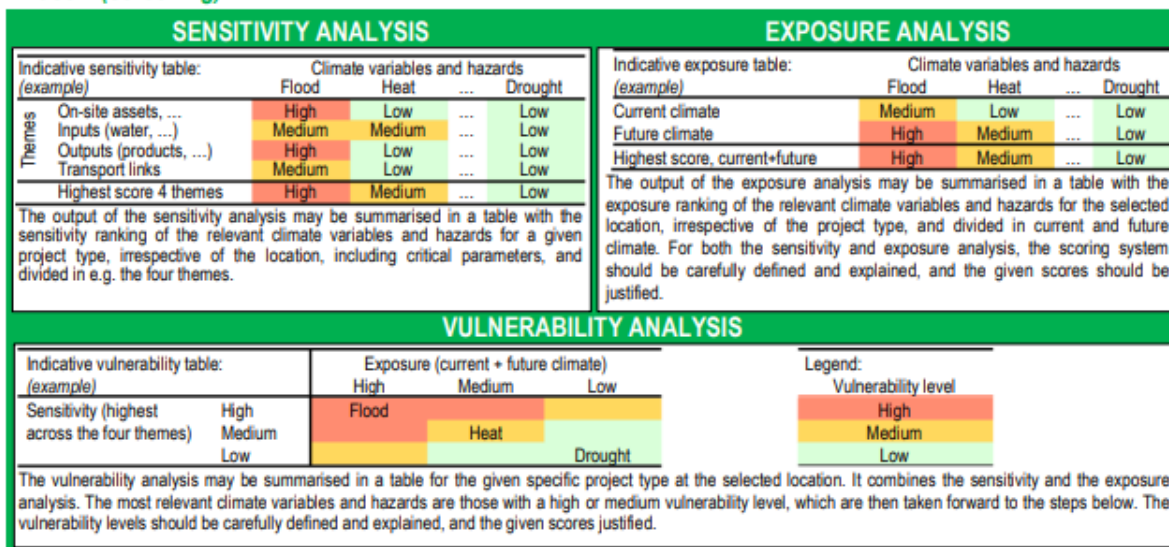
The climate change adaptation assessment is distributed in the following phases:

- Phase 1 (screening):
 - Sensitivity analysis
 - Exposure analysis
 - Vulnerability analysis
- Phase 2 (subject to the outcome of phase 1):
 - Likelihood analysis
 - Impact analysis
 - Risk assessment
 - Identification and appraisal of adaptation options and plan

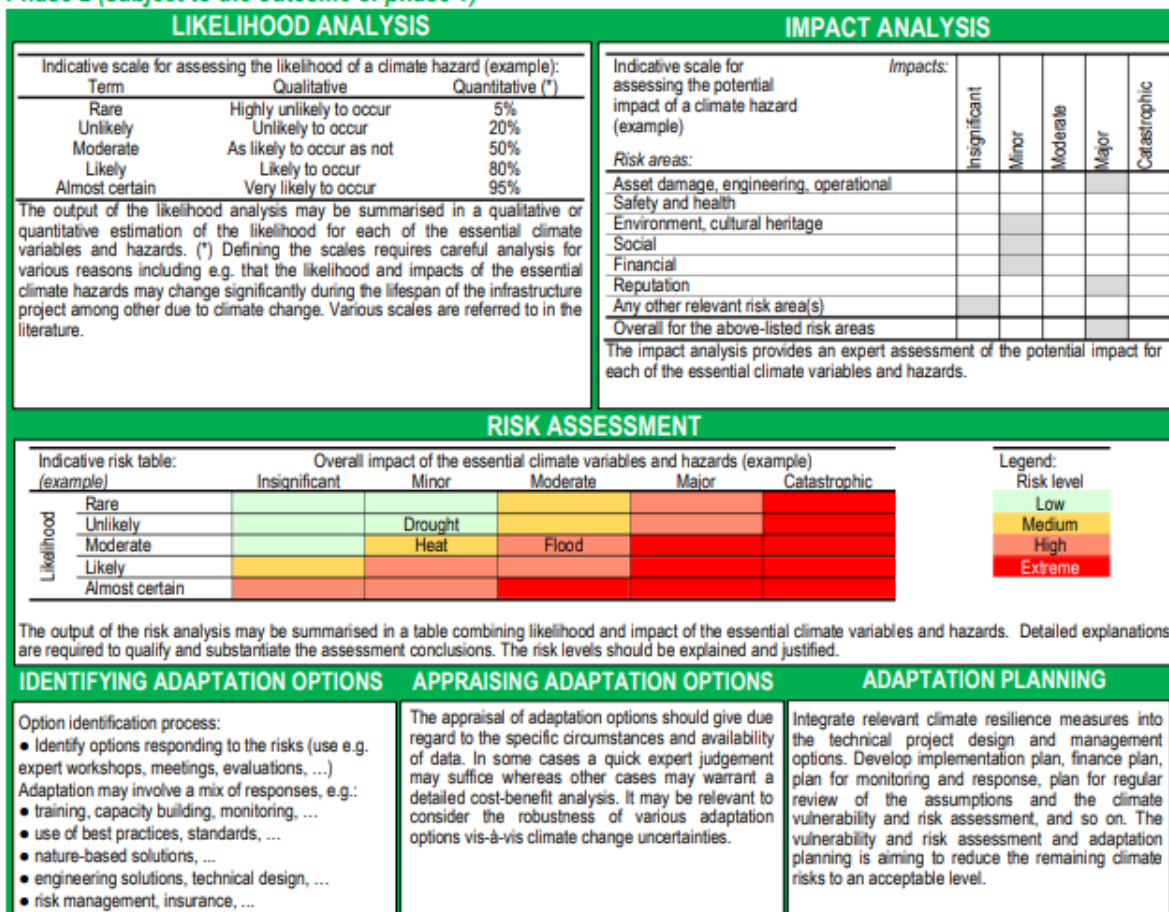
The figure on the following page, taken from the official guidance document, provides an overview of the methodology used in the two phases, outlines the levels of assessment adopted for vulnerability and risk evaluation, and includes illustrative example.

Figure 10 - Indicative overview of the climate vulnerability and risk assessment, and the identification, appraisal and planning/integration of relevant adaptation measures

Phase 1 (screening)



Phase 2 (subject to the outcome of phase 1)



Source: EC Technical Guidance on Climate Proofing of Infrastructure

2. Annex II of the EU Taxonomy's Delegated Regulation 2021/2139

2.1. Overview

The EU Taxonomy Regulation (Regulation (EU) 2020/852) establishes a framework for defining environmentally sustainable economic activities within the EU. It sets the stage for green investments by classifying activities that contribute to six environmental objectives. The regulation outlines four key conditions for an activity to be considered environmentally sustainable: make a substantial contribution to at least one objective, do no significant harm to the others, comply with minimum social safeguards, and meet the technical screening criteria.

Key elements of the EU Taxonomy Regulation:

- Purpose:
 - The regulation aims to promote sustainable investments and align them with the EU's climate and energy targets, as outlined in the European Green Deal.
- Environmental Objectives:
 - The taxonomy defines six environmental objectives: climate change mitigation, **climate change adaptation**, sustainable use of water and marine resources, transition to a circular economy, pollution prevention and control, and the protection and restoration of biodiversity and ecosystems.
- Technical Screening Criteria:
 - The European Commission develops specific technical criteria for each objective, determining which activities substantially contribute and which do not significantly harm.
- Minimum Safeguards:
 - Activities must comply with minimum social safeguards.
- Reporting Obligations:
 - Companies are required to assess how their activities perform against the taxonomy criteria and disclose these results. The specific reporting requirements vary depending on whether the company is a financial or non-financial undertaking.
- Scope:
 - The regulation applies to measures adopted by the EU or Member States regarding financial products and corporate bonds labelled as environmentally sustainable, as well as to financial market participants and certain undertakings subject to non-financial reporting obligations.

2.2. Technical screening criteria for determining the conditions under which an economic activity qualifies as contributing substantially to climate change adaptation

On December 9, 2021, the European Commission published the Commission Delegated Regulation (EU) 2021/2139 of 4 June 2021 supplementing Regulation (EU) 2020/852 of the European Parliament and of the Council by establishing the technical screening criteria for determining the conditions under which an economic activity qualifies as contributing substantially to climate change mitigation or climate change

adaptation and for determining whether that economic activity causes no significant harm to any of the other environmental objectives¹⁴.

Annex II of the Delegated Regulation sets out the technical screening criteria for determining when an economic activity qualifies as contributing substantially to climate change adaptation, and for assessing whether it causes no significant harm to the other environmental objectives.

Specifically, the construction and modernisation of bridges is included within category '6.15 **Infrastructure enabling road transport and public transport**' and **applicable technical screening criteria for the substantial contribution to climate change adaptation** is as follows:

1. *The economic activity has implemented physical and non-physical solutions ('adaptation solutions') that substantially reduce the most important physical climate risks that are material to that activity.*
2. *The physical climate risks that are material to the activity have been identified from those listed in Appendix A to this Annex by performing a robust climate risk and vulnerability assessment with the following steps:*

(a) screening of the activity to identify which physical climate risks from the list in Appendix A to this Annex may affect the performance of the economic activity during its expected lifetime;

(b) where the activity is assessed to be at risk from one or more of the physical climate risks listed in Appendix A to this Annex, a climate risk and vulnerability assessment to assess the materiality of the physical climate risks on the economic activity;

(c) an assessment of adaptation solutions that can reduce the identified physical climate risk.

The climate risk and vulnerability assessment is proportionate to the scale of the activity and its expected lifespan, such that:

(a) for activities with an expected lifespan of less than 10 years, the assessment is performed, at least by using climate projections at the smallest appropriate scale;

(b) for all other activities, the assessment is performed using the highest available resolution, state-of-the-art climate projections across the existing range of future scenarios consistent with the expected lifetime of the activity, including, at least, 10-to-30-year climate projections scenarios for major investments.

3. *The climate projections and assessment of impacts are based on best practice and available guidance and take into account the state-of-the-art science for vulnerability and risk analysis and related methodologies in line with the most recent Intergovernmental Panel on Climate Change reports, scientific peer-reviewed publications and open source or paying models.*

4. *The adaptation solutions implemented:*

(a) do not adversely affect the adaptation efforts or the level of resilience to physical climate risks of other people, of nature, of cultural heritage, of assets and of other economic activities;

(b) favour nature-based solutions or rely on blue or green infrastructure to the extent possible;

(c) are consistent with local, sectoral, regional or national adaptation plans and strategies;

(d) are monitored and measured against pre-defined indicators and remedial action is considered where those indicators are not met;

¹⁴ <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32021R2139>

(e) where the solution implemented is physical and consists in an activity for which technical screening criteria have been specified in this Annex, the solution complies with the do no significant harm technical screening criteria for that activity.

As the APPENDIX II of the CCSU OECD document is targeted only on the contribution to Climate adaptation, other environmental objectives of the EU Taxonomy (such as GHG emissions, pollution, water resources or biodiversity) are not considered.

The following figure contains a table of all the physical climate-related hazards listed by the EU Taxonomy Delegated Regulation; please note that a preliminary screening has been carried out for the Project/Bridge of interest, selecting only the hazards with a minimum degree of applicability based on their geographic location.

Figure 11 – Classification of climate-related hazards

Appendix A

CLASSIFICATION OF CLIMATE-RELATED HAZARDS (1)

	Temperature-related	Wind-related	Water-related	Solid mass-related
Chronic	Changing temperature (air, freshwater, marine water)	Changing wind patterns	Changing precipitation patterns and types (rain, hail, snow/ice)	Coastal erosion
	Heat stress		Precipitation or hydrological variability	Soil degradation
	Temperature variability		Ocean acidification	Soil erosion
	Permafrost thawing		Saline intrusion	Solifluction
			Sea level rise	
			Water stress	
Acute	Heat wave	Cyclone, hurricane, typhoon	Drought	Avalanche
	Cold wave/frost	Storm (including blizzards, dust and sandstorms)	Heavy precipitation (rain, hail, snow/ice)	Landslide
	Wildfire	Tornado	Flood (coastal, fluvial, pluvial, ground water)	Subsidence
			Glacial lake outburst	

Source: Commission Delegated Regulation (EU) 2021/2139