EASTERN ENTRANCE DOUALA PROJECT

Climate Change Risk Assessment

Prepared for:

Magil Construction Corporation

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This document has been prepared by SLR Consulting (Africa) (PTY) LTD. The material and data in this report were prepared under the supervision and direction of the undersigned.

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ACRONYMS

AR	Assessment Report
CCRA	Climate Change Risk Assessment
CMIP5	Coupled Intercomparison Project Phase 5
E&S	Environmental and Social
EHS	Environmental, Health, and Safety
EP	Equator Principles
ESIA	Environmental and Social Impact Assessment
GHG	Greenhouse Gas Emissions
IFC	International Finance Corporation
IPCC	Intergovernmental Panel on Climate Change
MINTP	The Ministry of Public Works of Cameroon
RCP	Representative Concentration Pathways
TCFD	Task Force on Climate-Related Financial Disclosure

1. INTRODUCTION

The Ministry of Public Works (MINTP) of Cameroon is seeking to upgrade the road network titled the East Entrance to Douala Project ("the Project"). This includes lane widening, the construction of five roundabouts, development of urban and public facilities (e.g. bus and taxi stops, parking areas, water and electricity), and replacement of nine hydraulic structures. The Project is of national importance, as Douala firmly establishes itself as Cameroon's economic capital.

MINTP appointed the Magil Construction Corporation ("Magil") in December 2019 to undertake construction of Phase 2 of the Eastern Entrance of Douala, including the area from the Boko-Tradex exchange (PK9 + 925) up to the foot of the Dibamba River bridge (PK18 + 825) (referred herein as the 'Phase 2 Route').

The Project is seeking international financing from UK Export Finance and Standard Chartered Bank, and under the revised Equator Principles[1] (EP) Project Developers are now required to conduct a Climate Change Risk Assessment (CCRA) for all Category A and B projects. The need for this assessment was identified in SLR's Gap Analysis of the existing Environmental and Social Impact Assessment (ESIA) for the Project. SLR has now been contracted by Magil to undertake the CCRA in line with EP4.

Per EP4, the CCRA identifies what the current and future climate risks are for the Project's operations, and what plans, processes, policies, and systems should be in place to manage these risks. The CCRA considers both physical (acute and chronic) and transition (policy and legal, technology, market and reputational) risks, and is aligned to the climate physical and transition risk categories as set out by the Task Force on Climate-Related Financial Disclosure (TCFD).

The CCRA is divided into the following two sections:

- Section 2: CLIMATE HAZARD SCREENING – a high-level assessment of climate physical and transition risks, with the aim of identifying climate hazards which are material to the Project.
- Section 3: CLIMATE CHANGE RISK ASSESSMENT – a detailed analysis of material climate hazards, including evaluating any material change in the increase in magnitude or occurrence of the hazard over time, assessing their effects onto core Project components, identifying potential Project risks, and developing mitigation measures to eliminate, reduce and/or manage these risks.

To note, the CCRA only considers potential Project risks occurring during operations and maintenance. Potential Project risks occurring as a result of construction activities have been scoped out as the construction phase occurs for less than 24 months and it has been determined that climate change effects are not predicted to materially change from the baseline conditions assessed in the ESIA by this time.

The CCRA was developed in compliance with the EP4, TCFD, the World Bank EHS Guidelines and relevant Cameroonian legislation.

[1] Equator Principles revision 4 (EP4) – issued in July 2020 – https://equator-principles.com/wp-content/uploads/2020/05/The-Equator-Principles-July-2020-v2.pdf

2. CLIMATE HAZARD SCREENING

2.1 CLIMATE HAZARD SCREENING APPROACH

To understand which climate-related hazards are material to the Project, the first two steps of the World Bank's Climate & Disaster Risk Screening Tool[2] were utilized (see Figure 1). The first step evaluates the extent to which the Project location will be exposed to different climate hazards, considering the spatial scale of the Project as well as the likelihood and magnitude of the hazards. The second step includes determining potential Project impacts resulting from the identified climate hazards, considering the full lifecycle of the Project.

Figure 1: Two-Step Climate Hazard Screening Approach

As part of the screening process, a scoring method was employed to assess the level of exposure and potential impact of relevant climate physical and transition risks, with the aim of determining the materiality of the risks to the Project – including Project assets, resources, and communities. Table 1 depicts the different ratings and their corresponding definitions. The combination of exposure and potential impact scores will determine the materiality of the risk to the Project. Only climate hazards that score as 'material' or 'somewhat material' will be taken forward for further consideration and detailed analysis in Section 3: Climate Change Risk Assessment.

Table 1: Risk Materiality Scoring Method

EXPOSURE	
Rating	**Definition**
Highly Exposed (3)	Project assets, resources, and communities are highly exposed to the climate hazard or risk. The hazard or risk is high in probability and/or magnitude.
Moderately Exposed (2)	Project assets, resources, and communities are moderately exposed to the climate hazard or risk. The hazard or risk is medium in probability and/or magnitude.
Slightly Exposed (1)	Project assets, resources, and communities are slightly exposed to the climate hazard or risk. The hazard or risk is low in probability and/or magnitude.
Not Exposed (0)	Project assets, resources, and communities are not exposed to the climate hazard or risk. Probability and magnitude are not applicable.

[2] Source: https://climatescreeningtools.worldbank.org/content/home-methodology

POTENTIAL IMPACT	
Rating	**Definition**
High Potential Impact (3)	The climate hazard or risk has the potential to significantly impact Project assets, resources, and communities.
Moderate Potential Impact (2)	The climate hazard or risk has the potential to moderately impact Project assets, resources, and communities.
Low Potential Impact (1)	The climate hazard or risk has the potential to negligibly impact Project assets, resources, and communities.
No Potential Impact (0)	The climate hazard or risk has no potential impact on Project assets, resources, and communities.
RISK MATERIALITY	
Rating	**Definition**
Material (5-6)	The climate hazard or risk is material to Project assets, resources, and communities.
Somewhat material (3-4)	The climate hazard or risk is somewhat material to Project assets, resources, and communities.
Immaterial (0-2)	The climate hazard or risk is immaterial to Project assets, resources, and communities.

2.2 CLIMATE PHYSICAL AND TRANSITION RISKS

Climate change manifests through both physical and transition risks. Physical risks include tangible impacts to assets and facilities, infrastructure, business operations, workforce, supply chain, communities, and raw materials from acute hazards such as heatwaves, floods and wildfire, and chronic hazards such as changes in average precipitation patterns and extreme temperatures. On the other hand, transition risks are associated with policy, legal, technological, reputational, and market responses to climate change, such as changes in demand for products and services, increase in liability risks, and the introduction of carbon taxes.

According to the National Adaptation Plan (2015)[3], the following climate physical risks will be most significant for Cameroon, and will be considered as part of this climate hazard assessment:

- High precipitation
- Flooding
- Temperature rise
- Drought
- Heat waves

[3] Source: Cameroon National Adaptation Plan (unfccc.int)

- Extreme events (e.g., severe storms)
- Sea level rise

Other physical risks that have been identified as relevant to the Project include:

- Landslides and mudslides
- High humidity
- High wind

The following climate transition risks are aligned to TCFD’s categories, and will be considered as part of this climate hazard assessment:

- Policy
- Legal
- Technology
- Market
- Reputational

2.3 CLIMATE HAZARD SCREENING PROCESS

Based on the climate hazard screening approach set out in Section 2, a risk materiality assessment was undertaken for physical (Table 2) and transition (Table 3Table 3) risks.

Table 2: Risk Materiality Assessment – Climate Physical Risks

PHYSICAL RISKS	EXPOSURE	POTENTIAL IMPACT	RISK MATERIALITY
Increase in frequency and severity of extreme rainfall events	Highly Exposed	High Potential Impact	Material Risk
	As a coastal city near the Equator, Douala is highly exposed to precipitation. It experiences 3,600mm of rainfall every year of which the majority falls during the rainy season (i.e. between November and April).[4] The upper bound of modelling from the IPCC's Fifth Assessment Report (AR5) projects that annual precipitation in Cameroon will rise by up to 367.41mm in 2040-2059 under a high emissions scenario (RCP 8.5). However, this does not mean that precipitation will be evenly distributed. When precipitation does occur, it can be expected to be more extreme especially during the rainy season, leading to climate hazards such as flooding and landslides to which Project assets, resources, and communities along the Phase 2 Route will be exposed to operations and maintenance.	• Flood waters damaging Project traffic, material, and machinery; delays in maintenance activities; potential increase in operation costs; and creation of unsafe working conditions. • Wash away of road surface and/or damage to key parts of infrastructure e.g., culverts, pillars, cut-aways, etc. • Increase of seepage and infiltration causing damage to road surface and subsurface layers. • Increase of hydrodynamic pressure on road. • Decrease of soil cohesion and risk of destabilization. • Traffic hindrance; and creation of unsafe travel conditions including potential accidents and injuries. • Shortened life expectancy of the road.	Given the high exposure and high potential impact, **extreme rainfall events** are considered a **material** risk to the Project.
Changes in seasonal and annual average rainfall	Slightly Exposed	High Potential Impact	Somewhat Material Risk
	Due to climate change, precipitation patterns are altering with seasons shifting and rainy seasons becoming longer and wetter. The upper bound of modelling from the IPCC's Fifth Assessment Report (AR5) projects that the Maximum 5-Day Rainfall (25-Yr RL)[5] in Cameroon will rise by up to 192.74mm in 2040-	• Impact on soil moisture levels, affecting the structural integrity of the road and supporting infrastructure such as bridges, culverts, and tunnels. • Damage to roads, e.g. from adverse impact of standing water on the road base, including more frequent repairs and maintenance.	Given the slight exposure and high potential impact, **changes in seasonal and annual rainfall** are considered a somewhat material risk to the Project.

[4] Source: https://www.climatestotravel.com/climate/cameroon

[5] The Maximum 5-Day Rainfall (25-Yr RL) is the maximum precipitation sum over any 5-day period that can be expected once in an average 25-year period.

PHYSICAL RISKS	EXPOSURE	POTENTIAL IMPACT	RISK MATERIALITY
	2059 under a high emissions scenario (RCP 8.5)[6]. Changes in average rainfall vary by region, with the northeast expected to experience the greatest increase, while changes in the southeast, where Douala is located, being much less significant. Therefore, Project assets, resources, and communities are expected to only be slightly exposed to changes in seasonal and annual average rainfall.	• Risk of floods from water runoff, landslides, slope failures and damage to roads.	
Seal level rise	Highly Exposed	High Potential Impact	Material Risk
	Douala is surrounded by several bodies of water – Phase 2 Route is located 3-5 km north of the Wouri River and crosses the Dibamba River, at Dibamba Bridge. Although Douala is located on average ~17m above sea level, the Phase 2 Route is located lower – at ~5m near the middle of the route and only ~1m at the crossing with the Dibamba River. As the effects of sea levels rise become more extreme on Cameroon's coastal cities, like Douala, Project assets, resources, and communities will be highly exposed to associated risks such as flooding. These risks will be felt during operations and maintenance.	• Increase in water level of tidal rivers combining with higher sea level to increase flood risk. • Flood waters damaging Project traffic, material, and machinery; delays in maintenance activities; potential increase in operation costs; and creation of unsafe working conditions. • Wash away of road surface and/or damage to key parts of infrastructure e.g., culverts, pillars, cut-aways, etc. • Increase of seepage and infiltration causing damage to road surface and subsurface layers. • Increase of hydrodynamic pressure on road. • Decrease the cohesion of soil compaction and risk of destabilization. • Traffic hindrance; and creation of unsafe travel conditions including potential accidents and injuries. • Shortened life expectancy of the road.	Given the high exposure and high potential impact, **sea level rise is** considered a **material** risk to the Project.

[6] Source: https://climateknowledgeportal.worldbank.org/country/cameroon/climate-data-projections

PHYSICAL RISKS	EXPOSURE	POTENTIAL IMPACT	RISK MATERIALITY
Increase in frequency and severity of landslides and mudslides	Moderately Exposed	High Potential Impact	Material Risk
	There are several areas along the Phase 2 Route which are over 40m in elevation, posing an increasing risk of landslide and mudslides. This risk is exacerbated by the fact that much of the area along the Phase 2 Route consists of dirt roads and surfaces, and the expected increase in frequency and severity of precipitation.	• Increase in risk of landslides mudslides which may block the road, damage vehicles and lead to injuries and potential death. • Damage to signs and other infrastructure on the road. • Damage to and blocking of drains, which in turn can increase flood risk.	Given the moderate exposure and high potential impact, **landslides and mudslides** are considered a **material** risk to the Project.
Higher maximum temperature and increase in number of hot days (heatwaves)	Moderately Exposed	High Potential Impact	Material Risk
	Given the equatorial location of the Project, maximum temperatures and the number of heatwaves can be expected to increase significantly over the coming decades. The upper bound of modelling from the IPCC's Fifth Assessment Report (AR5) projects that mean annual temperature will rise by up to 2.56°C in 2040-2059 under a high emissions scenario (RCP 8.5). However, the rate of warming is expected to be slower in the coastal regions of Cameroon, including in Douala. As such, Project assets, resources, and communities are expected to only be moderately exposed to higher maximum temperatures and increase in heatwaves.	• Heat stress reducing productivity of workforce during maintenance and any future decommissioning. • Weakening and damaging pavement integrity, e.g. softening, traffic-related rutting, cracking, and migration of liquid asphalt. • Thermal expansion in bridge expansion joints and paved surfaces. • Impact on vegetation growth rates on and adjacent to the road which can lead to visual effects, e.g. affect line of sight and lead to traffic accidents.	Given the moderate exposure and high potential impact, **higher maximum temperature and increase in heatwaves** are considered a **material** risk to the Project.
Increased frequency and length of drought (consecutive dry days)	Highly Exposed	High Potential Impact	Material Risk
	As a country situated in the mid-latitudes, Cameroon is expected to suffer from more frequent and more severe droughts during its summer/dry season (i.e. from November to February). Dry conditions, warmer	• Increased susceptibility to wildfires that can threaten the road directly (e.g. fire, heat, smoke) and indirectly (e.g. landslides in areas deforested by wildfires).	Given the high exposure and high potential impact, **drought** is considered a **material** risk to the Project.

PHYSICAL RISKS	EXPOSURE	POTENTIAL IMPACT	RISK MATERIALITY
	temperatures that produce longer "fire seasons", and changes to ecosystems are expected to generate more and larger wildfires in some areas. The upper bound of modelling from the IPCC's Fifth Assessment Report (AR5) projects that the number of consecutive dry days[7] will rise by up to 45 additional days, with January through to April being the worst months affected in 2040-2059 under a high emissions scenario (RCP 8.5). Project assets, resources, and communities along the Phase 2 Route will be exposed to more frequent and longer droughts during operations and maintenance.	• Reduced levels of water required throughout operations and road maintenance. • Heat stress reducing productivity of workforce and potentially delaying Project activities. • Weakening and damaging pavement integrity, e.g. softening, traffic-related rutting, cracking, and migration of liquid asphalt. • Potential effects due to smog creating health and safety risks due to lack of visibility and worsened air quality.	
Higher maximum humidity levels	Highly Exposed	Moderate Potential Impact	Material Risk
	The average annual relative humidity over Douala is constantly high at around 80 %, with maximum evaporation values in March (133mm) and minimum values in August (72.4mm). Considering the Project is located in an equatorial coastal climate and anticipated climatic changes, maximum humidity levels can be expected to increase significantly in the coming decades.	• Water exposure may weaken concrete by affecting the pH level[8]. Typical cement binding agents have a pH of 11. Water will typically have a pH of 7 or lower, depending on the acidity. As more water interacts with the cement it has the potential to lower its overall pH leading to deterioration. The more concrete deteriorates, the more porous it becomes, leading to further damage. In addition to affecting the integrity, it can weaken the adhesive bond between the concrete and any floor covering. • Decreased compressive strength of the concrete.	Given the high exposure and moderate potential impact, **higher maximum humidity levels** are considered a **material** risk to the Project.

[7] Days without any agriculturally meaningful rainfall (0.1 mm/day),
[8] Source: The Determination of the Influence of pH Value of Curing Conditions on Portland Cement Hydration - ScienceDirect

PHYSICAL RISKS	EXPOSURE	POTENTIAL IMPACT	RISK MATERIALITY
		• Improved conditions for microbial growth (mold, mildew and bacteria) within concrete affecting its strength and durability.	
Increase in maximum wind speed and frequency of days when higher wind speed is reached	Slightly Exposed	Low Potential Impact	Immaterial Risk
	As a coastal city, Douala attracts winds from both the ocean and inland, however winds are rarely extreme in Douala, with land winds being of an average speed of 5 ms-1 and ocean winds having an average speed between 2.5 and 3 ms-1.[9] Therefore, Project assets, resources, and communities along the Phase 2 Route will be only be slightly exposed to high wind speeds.	• Threat to stability of bridge decks. • Damage to signs, lighting fixtures and supporting road infrastructure. • Traffic hindrance and creation of unsafe travel conditions including potential accidents and injuries. • Increase of wind speed causes the dynamic force of water generated by waves on road embankments.	Given the slight exposure and low potential impact, **high wind speeds** are considered an **immaterial** risk to the Project.

Table 3: Risk Materiality Assessment – Climate Transition Risks

TRANSITION RISKS	DESCRIPTION	EXPOSURE	POTENTIAL IMPACT	RISK MATERIALITY
Policy	Relevant climate transition policy actions are those that attempt to constrain actions that contribute to the adverse effects of climate change or those that seek to promote adaptation to climate change.	Slightly Exposed	Low Potential Impact	Immaterial Risk
		Future policies may impact upgrades to the Project infrastructure or its decommissioning. For example, future laws may ban the use of fossil fuels in construction processes or mandate that construction adheres to more stringent climate guidelines. New guidelines could include policies mandating all roads within 20 km of the coastline to be elevated more than 2 m above sea level.	Since the Project is compliant with the policy framework of Cameroon at the time of construction the potential impact is low. The operators of the Project infrastructure should be able to adapt to new policies as and when they become applicable.	Given the low exposure and low potential impact, **policy risk** is considered **immaterial** to the Project.

[9] Source: APAVE ESIA (Djeuda Tchapnga et al, 2006)

TRANSITION RISKS	DESCRIPTION	EXPOSURE	POTENTIAL IMPACT	RISK MATERIALITY
Legal	Relevant legal risks are those associated with climate litigation claims being brought against organizations for failure to mitigate the impacts of climate change, insufficient disclosures around climate risk, etc.	Slightly Exposed Legal challenges could be brought should the stakeholders fail to take into account the climate mitigation and adaptation recommendations from the final Climate Change Risk Assessment report.	No Potential Impact Since it is anticipated that the Project Developer will take into account the findings of the final Climate Change Risk Assessment and make any necessary updates to the Project Plan, there should be no potential impact exposure from litigation.	Immaterial Risk Given the low exposure and lack of potential impact, **legal risk** is considered **immaterial** to the Project.
Technology	New technologies play an important part in how businesses, organizations and projects minimize, eliminate, or adapt to climate change. The development and use of emerging technologies will affect the competitiveness of certain organizations, their production and distribution costs, and ultimately demand for products and services. There are increasingly innovative materials and methods being employed to develop and maintain roads, e.g. eco-friendly asphalt which is manufactured using less fuel and emitting less carbon, and full-depth reclamation (old asphalt is mixed with the underlying gravel) which is less costly and more environmentally friendly than traditional road repair work.	No Potential Impact While it is not anticipated that technology will impact the Project's competitiveness or its usage, the Project's greenhouse gas emissions (GHG) and cost during its construction will be affected by the choice of technology and materials employed in its construction. Likewise, the Project operators have the choice of using processes and technologies which align with a transition to a lower-carbon economy. It is not expected that the emergence of new technologies will impact the Project once it is operational.	No Potential Impact Effects on competitiveness, and production and distribution costs are not relevant to an infrastructure project of this type. Therefore, although there are benefits associated with using eco-friendly materials and methods, it is not anticipated that the technology and materials employed in construction will impact demand for the use of the road.	Immaterial Risk Given the low exposure and lack of potential impact, **technology risk** is considered **immaterial** to the Project.

TRANSITION RISKS	DESCRIPTION	EXPOSURE	POTENTIAL IMPACT	RISK MATERIALITY
Market	While the ways in which markets could be affected by climate change are varied and complex, one of the major ways is through shifts in supply and demand for certain commodities, products, and services as climate-related risks and opportunities are increasingly considered.	No Potential Impact It is not anticipated that the supply of key input materials required for maintenance will be impacted during the design life of the Project.	No Potential Impact It is anticipated that market changes in supply and demand will have a negligible impact on the Project.	Immaterial Risk Given the lack of exposure and no potential impact, **market risk** is considered **immaterial** to the Project.
Reputational	Climate change represents a potential source of reputational risk tied to changing perceptions of an organization's contribution to or detraction from the transition to a lower-carbon economy.	Slightly Exposed There is a slight reputational risk associated with perceptions of road projects because of their association with GHG from road traffic. Large scale and expensive infrastructure projects tend to attract additional scrutiny and comparisons with other projects that could otherwise have been funded, e.g. those which could be deemed to have a greater positive impact in terms of minimizing or adapting to climate impacts. However, these concerns are likely to be offset by the view that the infrastructure is necessary for Cameroon's development.	Low Potential Impact The potential reputation risk for the Project is considered to be low. This is because roads will continue to be a key part of the infrastructure mix in the transition to a lower-carbon economy.	Immaterial Risk Given the slight exposure and low level of potential impact, **reputational risk** is considered **immaterial** to the Project.

Based on the risk materiality assessment undertaken for climate physical and transition risks, seven risks were identified as 'material' or 'somewhat material' to the Project's operations (see Table 4). These risks have been assessed further in Section 3: Climate Change Risk Assessment.

Table 4: Material Climate Risks

PHYSCAL RISKS	EXPOSURE	POTENTIAL IMPACT	RISK MATERIALITY
Increase in frequency and severity of extreme rainfall events	Highly Exposed	High Potential Impact	Material Risk
Changes in seasonal and annual average rainfall	Slightly Exposed	High Potential Impact	Somewhat Material Risk
Seal level rise	Highly Exposed	High Potential Impact	Material Risk
Increase in frequency and severity of landslides and mudslides	Moderately Exposed	High Potential Impact	Material Risk
Higher maximum temperature and increase in number of hot days (heatwaves)	Moderately Exposed	High Potential Impact	Material Risk
Increased frequency and length of drought (consecutive dry days)	Highly Exposed	High Potential Impact	Material Risk
Higher maximum humidity levels	Highly Exposed	Moderate Potential Impact	Material Risk

3. CLIMATE CHANGE RISK ASSESSMENT

3.1 IDENTIFYING THE CURRENT AND FUTURE BASELINE

3.1.1 OVERVIEW OF CAMEROON CLIMATE

Cameroon has a tropical climate owing to its proximity to the equator. It is semi-arid in the North, and humid and rainy in the rest of the country. Douala is situated along the coast in the South-West and as such experiences a longer rainy season than the North and some showers in the winter[10]. The wettest months in Douala are June, July, August, and September where the mean total rainfall for the 1971-2000 period was 354mm, 681mm, 688mm, and 561mm in each month, respectively. The hottest months are typically January, February, March, and April when the average temperatures for the 1971-2000 period exceeded 31°C[11].

3.1.2 OVERVIEW OF HISTORIC CLIMATE-RELATED RISKS

According to the International Disaster Database[12], Cameroon has experienced a number of disasters between the period 1986-2020 (see Table 5). The most frequent disasters have been riverine flood (10), drought (4), flash flood (3) and landslide (2). Riverine flood occurs when a river exceeds its capacity and overflows whereas a flash flood is when a low-lying area is suddenly inundated with water, typically owing to heavy rain.

Table 5: Climate Hazards in Cameroon (1986-2020)

CLIMATE HAZARDS	1986-2020
Riverine Flood	10
Droughts	4
Flash Flood	3
Landslide	2
Wildfire	0
Heatwave	0
Storm	0
Mudslide	0
Coastal flood	0
Earthquake	0

[10] Source: https://climateknowledgeportal.worldbank.org/country/cameroon/climate-data-historical#:~:text=The%20southern%20part%20of%20the,from%2025%2D30%C2%B0C.
[11] Source: http://worldweather.wmo.int/en/city.html?cityId=1513
[12] Source: https://public.emdat.be/

3.1.3 OVERVIEW OF FUTURE CLIMATE PROJECTIONS

As global temperatures increase so do the frequency and intensity of extreme weather events. Therefore, in general, we can expect an increase in the frequency and intensity of the historic climate-related disasters experienced by Cameroon (floods, drought, and landslides). In addition, sea level rise may further contribute to additional riverine flooding for coastal areas, such as where the Phase 2 Route traverses the Dibamba River. Projected future climate risks are discussed in more detail in Tables 6-8.

3.1.4 METHODOLOGY AND DATA SOURCES

The approach employed in this CCRA is based on the IEMA *Environmental Impact Assessment Guide to: Climate Change Resilience & Adaptation*[13]. A baseline for the climate data was established, reputable data sources were used and upper worst-case scenario projections were included.

The most comprehensive and reliable source for the information required for this CCRA is the Intergovernmental Panel on Climate Change (IPCC). The IPCC is the United Nations body for assessing the science related to climate change. Every 6-7 years the IPCC produces a new Assessment Report (AR). The most recently available is the IPCC Fifth Assessment Report (AR5), which was published in 2014. Each of these reports is produced and peer reviewed by the global scientific community, making it the 'gold standard' for climate change science and information concerning future projections.

The main limitation of the data used from the IPCC in this report is that it is over 5 years old. However, it is fit-for-purpose for this CCRA and more up-to-date and comprehensive than the information available in the Cameroon National Adaptation Plan (2015).

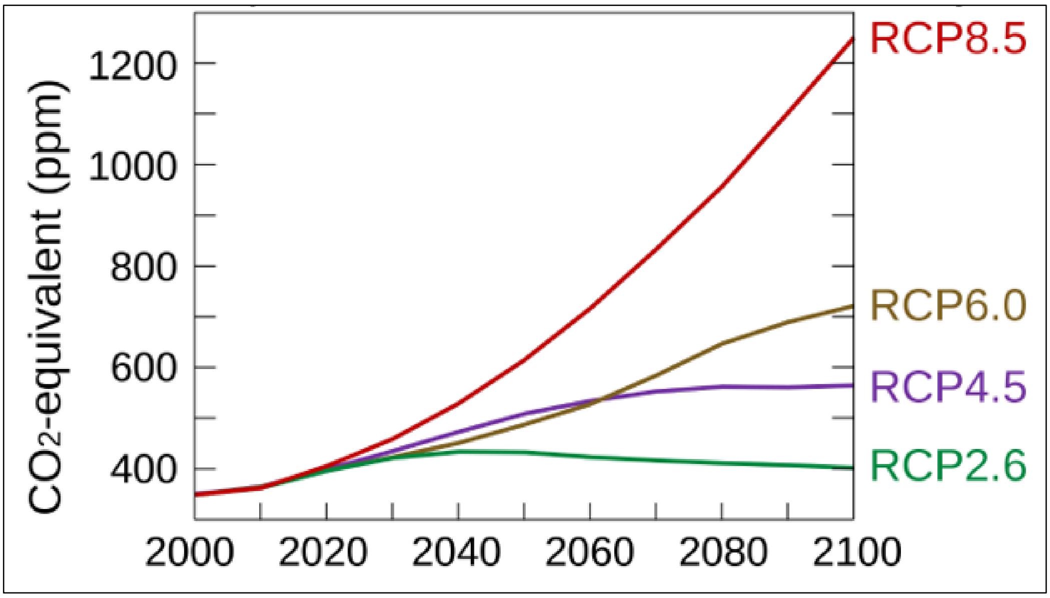
The IPCC AR5 uses four different future emissions scenarios to help planners and policy makers understand potential future climate impacts. These 'Representative Concentration Pathways (RCPs)' indicate the level of warming relative to pre-industrial levels.

RCP8.5 should be regarded as a high-emissions scenario while RCP6.0 can be interpreted as a medium-high emissions scenario, where some level of mitigation measures is achieved to limit global warming. The range of RCPs are depicted in Figure 2 below. It is worth noting that RCP8.5 tracks most closely – within 1% for 2005 to 2020 with total cumulative CO_2 emissions[14].

[13] Source: IEMA. (2020), *Environmental Impact Assessment Guide to: Climate Change Resilience & Adaptation*

[14] Source: Schwalm, C. R., Glendon, S. and Duffy, P. B. (2020) 'RCP8.5 tracks cumulative CO2 emissions', *Proceedings of the National Academy of Sciences of the United States of America*, 117(33), pp. 19656–19657

Figure 2: IPPC Representative Concentration Pathways[15]



The climate projection data used for this CCRA was taken from the World Bank Climate Change Knowledge Portal[16], which is drawn from the Coupled Intercomparison Project Phase 5 (CMIP5). This is the same dataset used by the IPCC for its Fifth Assessment Report (AR5). Of the 35 models from leading meteorological institutes used in the CMIP5 project, the World Bank Climate Change Knowledge Portal tool aggregated 16 of the models which are fully cross-comparable to provide an 'ensemble' (aggregated) model. This 'ensemble' model has been used determine climate projections for Cameroon (see Tables 6-8).

For each projection within each scenario, modelled data is shown representing the median and 90th percentile. The median is representative of the mid-point across all 16 of the models used. The 90th percentile can be understood to be representative of the upper bound (i.e. worst-case scenario) across all 16 of the models used.

3.1.5 REVIEW OF CLIMATE-RELATED RISKS FOR THE PROJECT

Tables 6-8 depicts how relevant climate hazards are projected to change over the medium (2020-2039) and longer-term (2040-2059). For each of the indicators in Tables 6-8 projections are presented for RCP8.5 (high emissions scenario) and RCP6.0 (medium-high emissions scenario). Each of the climate hazards identified as 'material' as part of the Climate Hazard Screening process (see Section 2) – extreme precipitation, changes in seasonal and annual average rainfall, sea level rise, landslides/mudslides, extreme temperature and heatwaves, drought, and humidity – will be directly influenced by the expected changes to the indicators listed in Tables 6-8.

[15] Source: IBID reference 13.
[16] Source: https://climateknowledgeportal.worldbank.org/country/cameroon/climate-data-projections

Table 6: Projected Changes in Climate Hazards – Temperature

						Projected changes							
						Medium-high emissions scenario (RCP 6.0)				High emissions scenario (RCP 8.5)			
						2020-2039		2040-2059		2020-2039		2040-2059	
	Title	**Description**	**Potential impact**	**Baseline**	**Unit**	**Median**	**90th percentile**	**Median**	**90th percentile**	**Median**	**90th percentile**	**Median**	**90th percentile**
Temperature	**Maximum Daily Temperature**	Change in the warmest daily maximum temperature ever reached over the period of interest or in each month relative to the reference period (1986-2005).	Structural integrity, workforce efficacy.	1986-2005	Degrees Celcius (°C)	+0.85°C	+2.57°C	+1.76°C	+3.51°C	+1.09°C	+3.14°C	+2.08°C	+4.20°C
	Number of Hot Days (>35°C)	Change in the total count of days over the period of interest where the daily maximum temperature rose above 35°C relative to the reference period (1986-2005).			Number of days	+10.08	+34.56	+17.75	+49.51	+14.65	+37.55	+32.11	+67.15
	Probability of Heat Wave	Heat waves are defined as a period of 3 or more days when the daily temperature remains above the 95th percentile. A single day often is discomforting, but only after a few days are the health effects significantly increasing. The heatwave probability is thus the daily probability of a sudden heat wave			Probability (%)	+5%	+28%	+11%	+59%	+9%	+16%	+23%	+41%
	Consecutive Dry Days	The maximum length of consecutive dry spell is the number of days in the longest period without significant rainfall of at least 1mm.	Water stress on workforce and operations, increased risk of wildfires.		Number of days	+0.6	+59.18	+0.34	+62.36	-2.88	+45.05	-0.65	+44.68
	Severe Drought Likelihood	The Standardized Precipitation Evapotranspiration Index (SPEI) measures the changes in water balance using both precipitation input and evapotranspiration losses. Positive values indicate positive water balance (or wet) conditions and negative values indicate negative water balance (or dry) conditions. Severe drought is likely once the SPEI drops below -2.			The Standardized Precipitation Evapotranspiratio n Index (SPEI)	0.05	0.31	0.05	0.12	0.06	0.33	0.07	0.42

Table 7: Projected Changes in Climate Hazards – Precipitation

	Title	Description	Potential impact	Baseline	Unit	Projected changes							
						Medium-high emissions scenario (RCP 6.0)				High emissions scenario (RCP 8.5)			
						2020-2039		2040-2059		2020-2039		2040-2059	
Precipitation	**Maximum Daily Rainfall**	Change in the largest single day precipitation per month or year relative to the reference period (1986-2005).	Landslide, mudslides, flooding, waterlogging.	1986-2005	Millimetres (mm)	+0.89mm	+71.23mm	-0.07mm	+71.28mm	+1.33mm	+63.22mm	+2.77mm	+63.86mm
	Maximum 5-day Rainfall	Change in the largest consecutive 5-day cumulative precipitation sum per month or year relative to the reference period (1986-2005).				+10.62mm	+91.58mm	+10.18mm	+95.42mm	+5.86mm	+86.88mm	+8.65mm	+90.18mm
	Maximum Daily Rainfall (10-yr RL)	Rare precipitation events are often referred to as events of a certain return level. A 10-yr return level of daily precipitation is the maximum daily rainfall that can be expected once in an average 10-year period. It is possible that two or more events of that magnitude occur in much shorter intervals. However, such events would only happen about once every 10 years in the long term.				-0.45mm	+123.50mm	+0.80mm	+126.98mm	+3.28mm	+105.00mm	+6.42mm	+108.86mm
	Maximum 5-day Rainfall (10-yr RL)					+7.03mm	+157.50mm	+9.65mm	+168.15mm	+9.23mm	+134.60mm	+15.12mm	+148.95mm
	Maximum Daily Rainfall (20-yr RL interpolated*)	Rare precipitation events are often referred to as events of a certain return level. A 20-yr return level of daily precipitation is the maximum daily rainfall that can be expected once in an average 20-year period. It is possible that two or more events of that magnitude occur in much shorter intervals. However, such events would only happen about once every 20 years in the long term.				+0.38mm	+149.86mm	+0.97mm	+154.04mm	+4.01mm	+128.27mm	+7.70mm	+131.92mm
	Maximum 5-day Rainfall (20-yr RL interpolated*)					+7.90mm	+189.97mm	+10.92mm	+204.51mm	+11.02mm	+160.09mm	+17.17mm	+178.14mm
	Maximum Daily Rainfall (25-yr RL)	Rare precipitation events are often referred to as events of a certain return level. A 25-yr return level of daily precipitation is the maximum daily rainfall that can be expected once in an average 25-year period. It is possible that two or more events of that magnitude occur in much shorter intervals. However, such events would only happen about once every 25 years in the long term.				-0.34mm	+163.04mm	+1.05mm	+167.57mm	+4.37mm	+139.91mm	+8.34mm	+143.45mm
	Maximum 5-day Rainfall (25-yr RL)					+8.33mm	+206.2mm	+11.55mm	+222.69mm	+11.91mm	+172.83mm	+18.20mm	+192.74mm

*20-yr RL data has been interpolated based on a linear progression between the 10 year and 25 year datasets.

Table 8: Projected Changes in Climate Hazards – Sea Level Rise

	Title	Description	Potential impact	Baseline	Unit	Projected changes							
						Medium-high emissions scenario (RCP 6.0)				High emissions scenario (RCP 8.5)			
						2039		2059		2039		2059	
						Ensemble mean	95th percentile	Ensemble mean	95th percentile	Ensemble mean	95th percentile	Ensemble mean	95th percentile
Sea level rise	Sea level rise	The amount the sea level is projected to increase under different scenarios.	Flooding.	1986-2005	Metres (m)	Data unavailable	Data unavailable	Data unavailable	Data unavailable	0.192m	0.261m	0.336m	0.462m

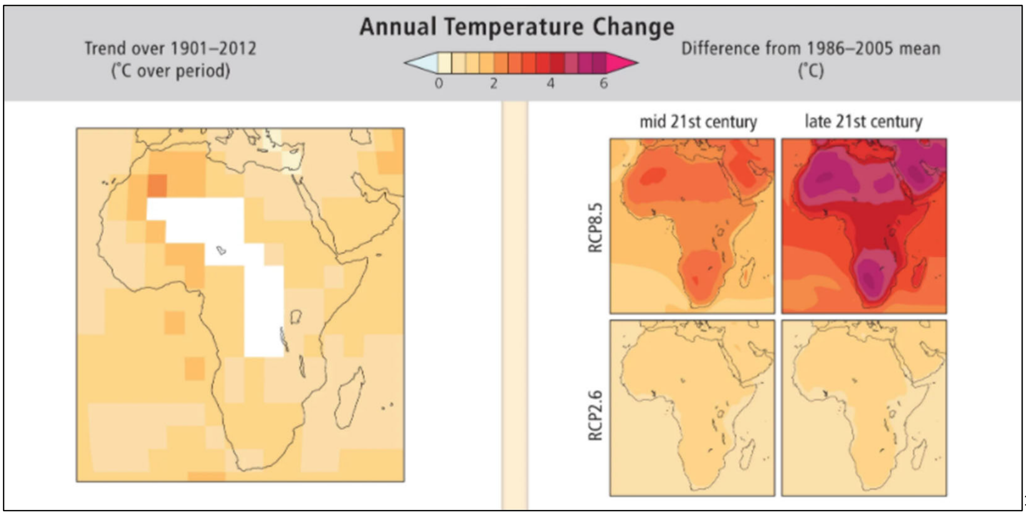
3.1.5.1 Temperature

Between 2020-2039, temperatures are expected to increase, on average, by as much as 2.57°C in the medium-high emissions scenario and 3.14°C in the high-emissions scenario relative to the 1986-2005 baseline. Between 2040-2059, temperatures are expected to increase, on average, by as much as 3.51°C in the medium-high emissions scenario and 4.20°C in the high-emissions scenario relative to the 1986-2005 baseline.

It is important to note that the temperature extremes during the hottest months of the year may exceed the averages. For example, the Number of Hot Days where the temperature is projected to exceed 35°C can be a useful indicator for the number of days during the year when the workforce may struggle to operate effectively.

Of particular importance is ensuring that the specifications of the component materials used in construction are able to function as intended as temperatures increase. For example, as the temperature of the air increases so does its ability to hold water, leading to an increase in humidity which, in turn, has the potential to impact materials such as concrete.

Figure 3: Annual Temperature Change – Cameroon



[17]

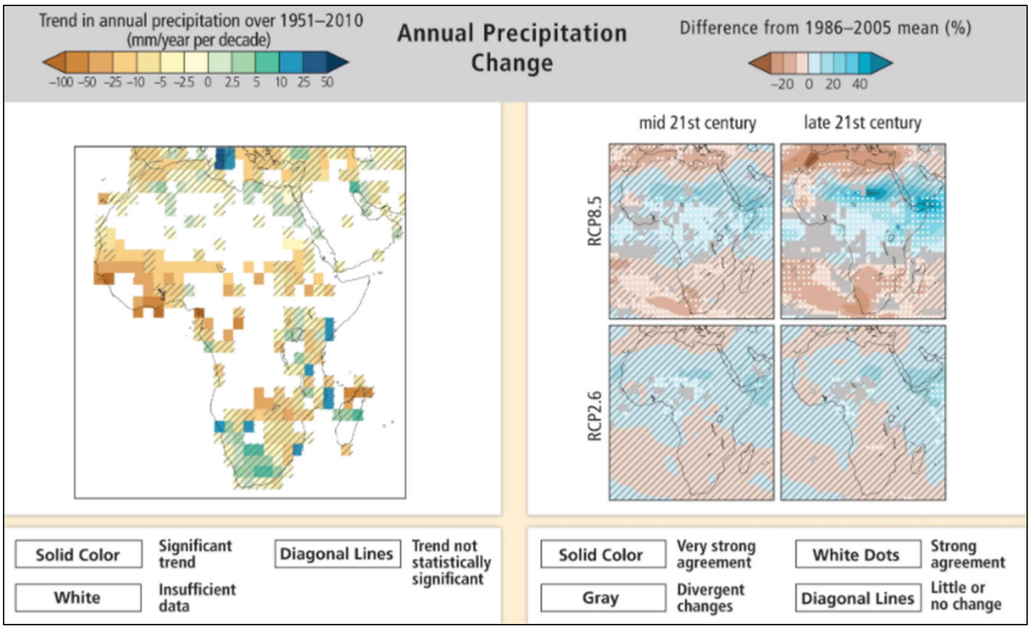
3.1.5.2 Precipitation

Between 2020-2039, maximum daily rainfall is expected to increase by as much as 71.23mm in the medium-high emissions scenario and 63.22mm in the high-emissions scenario relative to the 1986-2005 baseline. Between 2020-2039, maximum daily rainfall is expected to increase by as much as 71.28mm in the medium-high emissions scenario and 63.86mm in the high-emissions scenario relative to the 1986-2005 baseline.

[17] Source: AR5 Climate Change 2014: Impacts, Adaptation, and Vulnerability

Of particular relevance is the projected increase in the amount of precipitation that can occur all at once. The Maximum 5-day Rainfall represents the largest consecutive 5-day cumulative precipitation sum and the Maximum 5-day Rainfall (25-yr RL) represents the maximum daily rainfall that can be expected once in an average 25-year period. These can be useful indicators to review when provisioning for the volume of water that may need to be redirected, drained or otherwise managed to avoid damage or flooding.

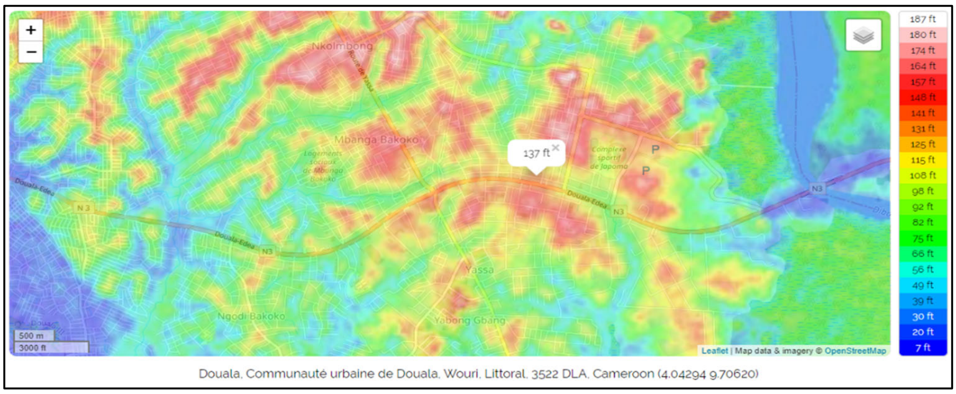
Figure 4: Annual Precipitation Change – Cameroon



[18]

As shown in Figure 5 below, there are stretches of the Phase 2 Route with hills of >40m on either side. Such areas could be susceptible to landslides/mudslides in extreme precipitation events.

Figure 5: Topographical map of Douala[19]



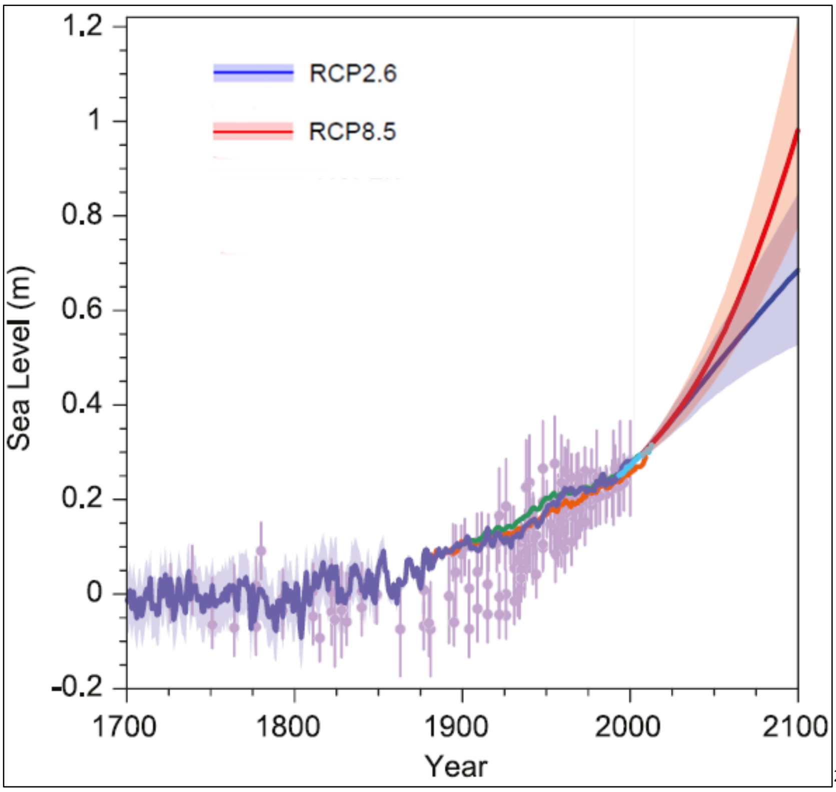
[18] Source: IBID reference 16.
[19] Source: https://en-gb.topographic-map.com/maps/eiff/Douala/

3.1.5.3 Sea Level Rise

By 2039, the sea level along the coast of Cameroon is expected to rise by as much as 0.261m in the high-emissions scenario relative to the 1986-2005 baseline. Data was unavailable for the medium-high emissions scenario. By 2059, the sea level along the coast of Cameroon is expected to rise by as much as 0.462m in the high-emissions scenario relative to the 1986-2005 baseline. Data was unavailable for the medium-high emissions scenario.

Figure 6 below shows the global average sea level rise. However, sea level rise is not distributed evenly and therefore more localized tools were used for this Climate Change Risk Assessment, notably from The Integrated Climate Data Center (ICDC) hosted by the University of Hamburg[20]. For the past, proxy data are shown in light purple and tide gauge data in blue. For the future, the IPCC projections for very high emissions (red, RCP8.5 scenario) and very low emissions (blue, RCP2.6 scenario) are shown.

Figure 6: Past and Future Sea Level Rise

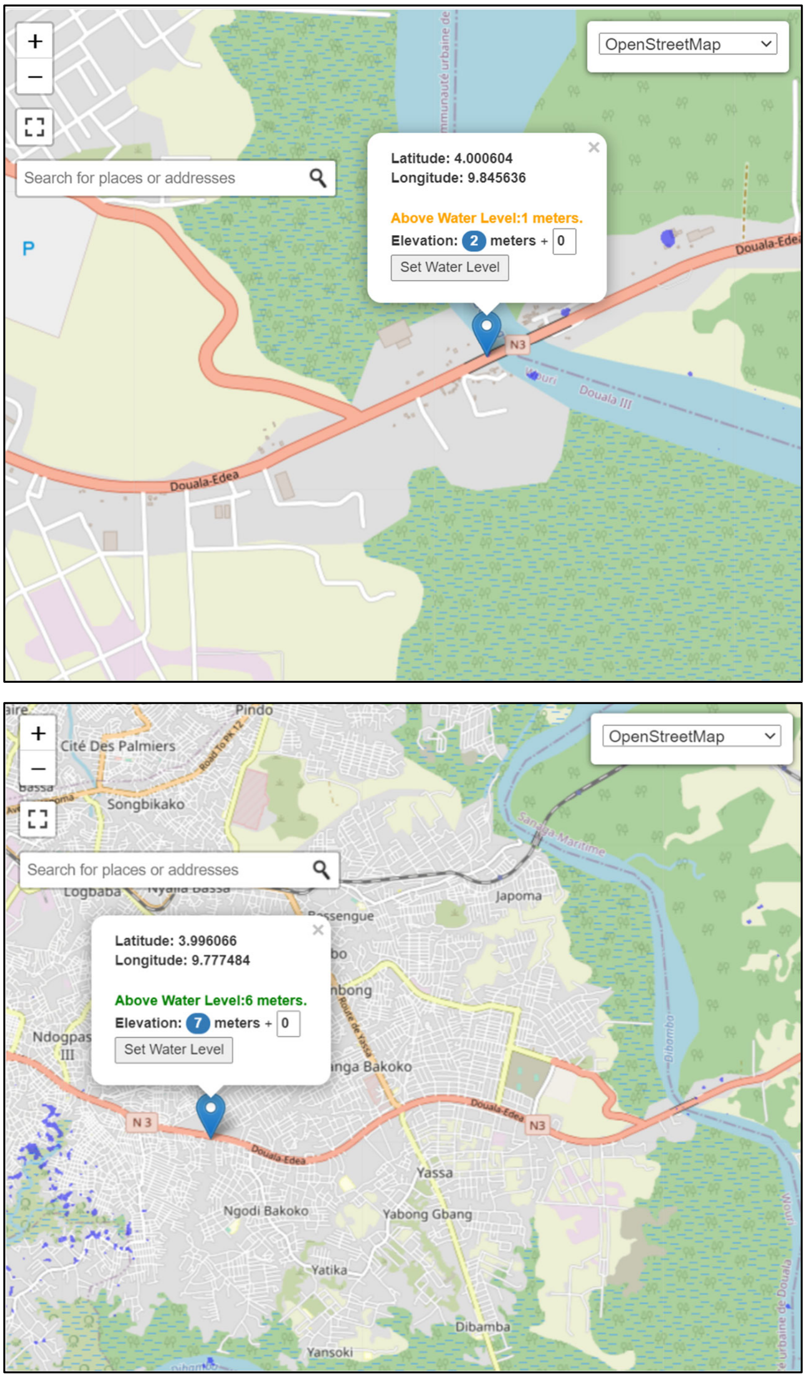


[21]

The online flood map tool, which uses 5 topographical data sources as input data[22], shows that the Phase 2 Route is at its lowest point as it traverses the Dibamba at just 2m above sea level and its next lowest point is at 7m above sea level (see Figure 7).

[20] Source: https://en-gb.topographic-map.com/maps/eiff/Douala/
[21] Source: IPCC AR5 Fig. 13.27.
[22] Source: https://www.floodmap.net/ Data Sources: Mazpzen, TNM, SRTM, GMTED, ETOPO1

Figure 7: Elevation of the Phase 2 Route



3.2 PROJECT COMPONENTS AT RISK

Climate hazards have the potential to detrimentally impact core Project components, i.e. facilities operated and maintained by the Project, and activities directly associated with their operation and maintenance. The following Project components have been identified to be at risk from climate hazards, and will be considered as part of the CCRA:

- Infrastructure assets:
    - Roadway (paved surface and sub-surface layers)
    - Roadway lighting
    - Roadway signage
    - Roundabouts (5)
    - Overpass (1) and underpass (1)
    - Hydraulic structures (9)
    - Urban development features (e.g. pedestrian crossings, bus and taxi stops, parking areas, road signage, speed bumps)
- Landscape and vegetation
- Project workforce
- Project traffic, machinery, and material
- Community assets:
    - Traffic
    - Road users

3.3 POTENTIAL PROJECT RISKS

Taking into account the seven material climate hazards determined as part of the Climate Hazard Screening (see Section 2) and the core Project components at risk, the following effects and associated Project risks have been identified (see Table 9).

Table 9: Potential Project Risks

PROJECT COMPONENT	CLIMATE HAZARD	EFFECTS	RISKS[1]
Infrastructure Assets	Extreme heat	• Weakening and damaging pavement integrity. • Thermal expansion in paved surfaces.	CC01: Damage to the structure, integrity, and durability of pavement and supporting paved infrastructure, and shortened road longevity [O] CC02: Increased maintenance requirements and operating costs [O, M] CC03: Damage to supporting road infrastructure [O] CC04: Unsafe travel conditions and potential injuries [O]
	Drought		
	Humidity	• Water exposure may weaken concrete by affecting the pH level. • Decreased compressive strength of the concrete. • Improved conditions for microbial growth (mold, mildew, and bacteria) within concrete affecting its strength and durability.	
	Changes in average rainfall	• Impact on soil moisture levels, affecting the structural integrity of the road and supporting infrastructure. • Damage to roads, e.g. from adverse impact of standing water.	
	Extreme precipitation	• Wash away of road surface. • Damage to infrastructure assets. • Increase of seepage and infiltration causing damage to road surface and subsurface layers. • Increase of hydrodynamic pressure on road. • Overloading drainage systems.	
	Sea level rise		
	Landslides and mudslides	• Road erosion. • Damage to signs and other infrastructure on the road.	
	Extreme precipitation	• Overgrowth of vegetation in vicinity of roadway infrastructure.	CC04: Unsafe travel conditions and potential injuries [O]
	Changes in average rainfall		
	Humidity		

<table>
<tr><th>PROJECT COMPONENT</th><th>CLIMATE HAZARD</th><th>EFFECTS</th><th>RISKS[1]</th></tr>
<tr><td rowspan="6">Project workforce</td><td>Humidity</td><td rowspan="2">• Extreme temperatures causing heat stress and heat-related illnesses.
•</td><td rowspan="6">CC05: Reduction in productivity and risk of injury of Project workforce
[M]

CC06: Delay in maintenance activities and increase in costs
[M]</td></tr>
<tr><td>Extreme heat</td></tr>
<tr><td>Extreme precipitation</td><td rowspan="4">• Creation of unsafe working conditions, including potential injuries and death from flood waters, landslides, and mudslides.</td></tr>
<tr><td>Changes in average rainfall</td></tr>
<tr><td>Sea level rise</td></tr>
<tr><td>Landslides and mudslides</td></tr>
<tr><td rowspan="7">Project traffic, machinery, and material</td><td>Extreme heat</td><td rowspan="3">• Damage to Project traffic, machinery, and material from extreme heat and humidity.
• Water deficiency, reducing availability of water required for materials and the operation of Project machinery.
•</td><td rowspan="7">CC06: Delay in maintenance activities and increase in costs
[C]

CC07: Damage to Project traffic, machinery, and material
[M]</td></tr>
<tr><td>Drought</td></tr>
<tr><td>Humidity</td></tr>
<tr><td>Extreme precipitation</td><td rowspan="4">• Damage to Project traffic, machinery, and material from flood waters, landslides, and mudslides.</td></tr>
<tr><td>Changes in average rainfall</td></tr>
<tr><td>Sea level rise</td></tr>
<tr><td>Landslides and mudslides</td></tr>
<tr><td rowspan="5">Community Assets</td><td>Extreme precipitation</td><td rowspan="5">Traffic hindrance, increased driving hazards, and unsafe travel conditions including potential accidents and injuries from flood waters, landslides, and mudslides.</td><td rowspan="5">CC04: Unsafe travel conditions and potential injuries
[O]

CC08: Increased journey times
[O]</td></tr>
<tr><td>Changes in average rainfall</td></tr>
<tr><td>Sea level rise</td></tr>
<tr><td>Landslides and mudslides</td></tr>
<tr><td>Drought</td></tr>
<tr><td colspan="4">Notes:
[1]The risks are considered based on the following Project phases: O – operations phase and M – maintenance phase.</td></tr>
</table>

3.4 CLIMATE CHANGE RISK ASSESSMENT APPROACH

To assess the significance of potential Projects risks resulting from material climate hazards, there are several factors which need to be considered (see Figure 8). Magnitude evaluates the severity of consequences, taking into account the sensitivity of the Project components being impacted by climate hazards. Probability is the likelihood of the risk occurring, and duration is the likely length of the impact from the risk.

As part of the Climate Change Risk Assessment process, a scoring method was employed to assess the level of magnitude, probability, and duration of each identified risk. Table 10 details the three factors including their ratings and corresponding definitions.

Risk significance will be assessed according to the 'pre-mitigation' state and the 'post-mitigation' state, following the implementation of the recommended mitigation measures. There are several design features that will aim to improve road pavement thickness as well as water drainage and management. As these features are embedded into the design of the Project, they will not be deemed as mitigation measures and will be considered when undertaking 'pre-mitigation' risk significance analysis. The embedded design features, potential Project risks (CC01-CC08), and recommended mitigation measures are discussed in more detail in Section 3.5 below.

Figure 8: Climate Change Risk Assessment Process

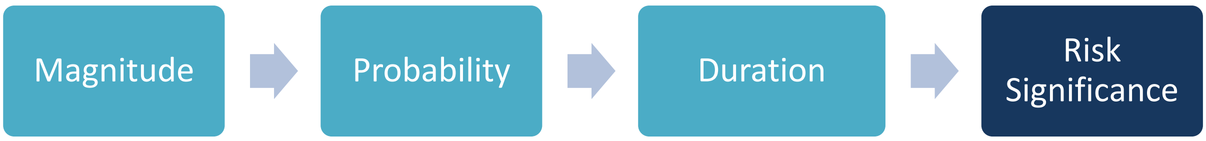


Table 10: Risk Significance Scoring Method

MAGNITUDE	
Rating	**Definition**
High (3)	High severity of consequences, whereby Project activities may cease functioning. Project components have high sensitivity and are not able to respond to or adapt to climate hazards.
Moderate (2)	Moderate severity of consequences, whereby Project activities may cease functioning in part. Project components have moderate sensitivity and limited ability to respond to or adapt to climate hazards.
Low (1)	Low severity of consequences, whereby there is minimal impact on Project components. Project components have low sensitivity and are readily able to respond to or adapt to climate hazards.
Negligible (0)	No consequences and therefore no impacts on Project components. Project components are able to fully respond and adapt to climate hazards.

PROBABILITY	
Rating	**Definition**
Highly likely (3)	The risk occurs frequently (e.g. on an annual basis) and it is highly likely to occur again.
Likely (2)	The risk occurs periodically (e.g. once every few years) and will likely occur again.
Unlikely (1)	The risk occurs infrequently and is unlikely to occur again.
Impossible (0)	The risk has never occurred and will almost certainly not occur.
DURATION	
Rating	**Definition**
Permanent (3)	The risk will have permanent or long-lasting effects on Project components (approximate duration 10 years+).
Medium-term (2)	The risk will have medium-term effects on Project components (approximate duration 5-10 years).
Short-term (1)	The risk will have short-term effects on Project components (approximate duration <5years).
Temporary (0)	The risk will have temporary or very short-term effects on Project components (<1 year).
RISK SIGNIFICANCE	
Rating	**Definition**
Significant (8-9)	The risk poses a significant threat to Project components.
Moderate (5-7)	The risk poses a moderately significant threat to Project components.
Low (3-4)	The risk poses a low threat to Project components.
Insignificant (0-2)	The risk poses an insignificant threat to Project components.

3.5 RISK ASSESSMENT AND MITIGATION MEASURES

3.5.1 CC01: DAMAGE TO THE STRUCTURE, INTEGRITY, AND DURABILITY OF PAVEMENT AND SUPPORTING PAVED INFRASTRUCTURE, AND SHORTENED ROAD LONGEVITY

Extreme and extended periods of heat, extreme precipitation and accompanying large volumes of water, as well as increased levels of humidity have the potential to affect the structure, integrity, and durability of pavement and supporting paved infrastructure, and shorten road longevity.

Excess heat can cause softening, sloughing, pitting corrosion, and cracking of asphalt pavement. Standing water from heavy rain which is not drained away can seep through and cause softening, displacement, and cracking. Moreover, cracks from heat can allow water to infiltrate and cause further damage. Increased humidity as a result of higher temperatures and rain can affect the subbase of the asphalt or concrete. Once cracks have formed water can begin to break down the adhesive cohesion and cause potholes and raveling.

The road will be comprised of five layers, with the thickness and extent varying slightly along the route according to technical and design considerations. These five layers will include:

- Top layer: asphalt wearing course, comprised of BBME bitumen content 5.6% (6cm thickness).
- Base course-binder layer, comprised of EME bitumen content 5.5% (8-14cm thickness).
- Sub-base course layer, comprised of crushed gravel stone (25-30cm thickness).
- Sub-grade Layer I and II, comprised of crushed gravel stone (25cm thickness for each).

There are also a number of embedded design features to improve water drainage and management, including:

- The construction of nine hydraulic structures, at the sites of existing drains/culverts, to replace undersized or defective structures with structures of an appropriate sizing and a longer service life (with the sizing based on a 1:20 year flood return level).
- The installation or retaining walls on overpass and underpass wing walls;
- The construction of a stormwater collection network to collect and drain stormwater from the Phase 2 Route. This will include a network for collecting water from the embankments; longitudinal channel network to collect runoff water generated by the road platform; and a transverse channel network at certain locations (i.e. roundabouts) to connect the branches of the longitudinal network to each other.
- All embankment surfaces along the road will be shaped to manage surface water flow and direct this away from the road. All existing channels/ditches upstream and downstream of the roadway will be cleaned for improved flow of the run-off water.

The embedded five-layer design features will provide the road with a solid thickness, however persistent extreme weather events are likely to impact the structure and durability of the asphalt in the short and medium-term.

Despite guidance from MINTP specifying that road infrastructure must be designed for a 1:10 year flood return level, Magil has designed for a 20-year flood case. As the expected design life for the road is 20 years, SLR agrees that this is an appropriate design basis. If, however, the road is operated beyond the expected 20-year period, when climate change effects will be increasingly severe, additional controls may become necessary.

Given the importance of the structural integrity of paving for a road project and road longevity, the magnitude of the risk is considered high. As Douala already experiences high temperatures, precipitation, and associated humidity, and that these climate variables are expected to increase and intensify in the future (see Tables 6-8**Error! Reference source not found.**), the probability of the risk occurring is likely. Without any mitigation measures the duration of the impacts are likely to be permanent, i.e. ongoing. Therefore, the pre-mitigation level of risk is deemed to be significant (see

Table 11).

To reduce the risk, the following mitigation measures should be implemented:

- Sealcoating during the construction phase to protect asphalt from heat damage and rain.
- Repairing cracks and chips immediately during the maintenance phase to avoid water penetrating beneath the road.
- Adopting a higher softening point of bonding agents for asphalt mixes.
- Reviewing bitumen mix methodology with expected lowering of pH levels as a result of water damage (see Table 2).
- Scheduling regular maintenance, e.g. every year, to check for cracks and repair them before water damage causes further cracks. Sealcoating should be reapplied at regular intervals to stop moisture from penetrating the surface.

The application of mitigation measures will reduce the magnitude or risk from high to moderate, the probability of the risk from likely to unlikely, and the duration of risk will remain short-term, lowering the risk from moderate to low (see

Table 11).

Table 11: Assessment of Risk CC01

	PROJECT COMPONENTS	PROJECT PHASE	ASSESSMENT OF RISK SIGNIFICANCE			
			MAGNITUDE	PROBABILITY	DURATION	SIGNIFICANCE
Pre-Mitigation	Infrastructure assets	Operations	High	Likely	Short-term	**MODERATE**
Post-Mitigation			Moderate	Unlikely	Short-term	**LOW**

3.5.2 CC02: INCREASED MAINTENANCE REQUIREMENTS AND OPERATING COSTS

As discussed in Section 3.5.1, climate hazards have the potential to impact long-term road pavement performance by softening, sloughing, and cracking asphalt and damaging road structure, integrity, and durability. As climate variables are expected to increase and intensify in the future (see Tables 6-8), pavement maintenance activities, such as patching of hard surfaced roads and roadside shoulders, crack and chip sealing, and maintenance of roadside drainage systems, may need to become more frequent, resulting in increased operating costs.

Given the importance of the structural integrity of the road, the magnitude of the risk is considered high. As climate hazards detrimental to road pavement performance become more frequent and extreme, the probability of the risk occurring is highly likely. Without any mitigation measures the duration of the impacts are likely to be permanent, i.e. ongoing. Therefore, the pre-mitigation level of risk is deemed to be significant (see Table 12 The application of mitigation measures will reduce the magnitude of risk from high to moderate, the probability of the risk from highly likely to unlikely, and the duration of risk from permanent to short-term, lowering the risk from significant to low (see

Table **12**).

Table 12).

As the risk of increased maintenance and operating costs is directly tied to risks associated with damage to the road and structures, the mitigation measures listed in Section 3.5.1 will also help mitigate this risk. The application of mitigation measures will reduce the magnitude of risk from high to moderate, the probability of the risk from highly likely to unlikely, and the duration of risk from permanent to short-term, lowering the risk from significant to low (see

Table **12**).

Table 12: Assessment of Risk CC02

	PROJECT COMPONENTS	PROJECT PHASE	ASSESSMENT OF RISK SIGNIFICANCE			
			MAGNITUDE	PROBABILITY	DURATION	SIGNIFICANCE
Pre-Mitigation	Infrastructure assets	Operations; Maintenance	High	Highly likely	Permanent	**SIGNIFICANT**

	PROJECT COMPONENTS	PROJECT PHASE	ASSESSMENT OF RISK SIGNIFICANCE			
			MAGNITUDE	PROBABILITY	DURATION	SIGNIFICANCE
Post-Mitigation			Moderate	Unlikely	Short-term	**LOW**

3.5.3 CC03: DAMAGE TO SUPPORTING ROAD INFRASTRUCTURE

Extreme precipitation can lead to landslides and mudslides on certain sections of the Phase 2 Route (see Figure 5) as well as flooding (see Figure 7). These climate hazards have the potential to damage urban development features and other supporting road infrastructure, for example, by washing away traffic signs, damaging culverts and speed bumps, and rendering the Phase 2 Route overpass and underpass unusable. Additionally, sea level rise will increase the likelihood of riverine flooding occurring along stretches of the Phase 2 Route that traverse the Dibamba River. As noted in Section 333.5.1, the Project is implementing several design features that aim to improve water drainage and management, including constructing new hydraulic structures to replace undersized or defective ones, installation of retail walls on underpass and overpass wingwalls, and designing the embankment surfaces along the road to direct water flow away from the road. These features will contribute to the better management of extreme precipitation and smaller floods.

Given the high severity of impact, whereby the operation of the Phase 2 Route may cease functioning, the magnitude of the risk is considered high. Given higher levels of precipitation are expected as the climate changes (see Table 7), the probability of the risk occurring is likely. The nature of these risks are likely to be short-term. Despite being short-term in nature, the pre-mitigation level of risk is deemed to be significant (see Table 13).

To reduce the risk, the following mitigation measures should be implemented:

- All areas which could be prone to landslide/mudslides should have some or all of the following preventative measures applied (to the extent that they are possible to implement):
    - Maintain as much vegetation as possible on the slope to retain the soil.
    - Create surface and underwater drainage systems to divert water.
    - Create retaining walls using strong materials, e.g. masonry, brick, stone or steel.
- Underpasses should have drainage systems in place to remove excess water after heavy downpours to avoid flooding.
- Stone pitching can be installed around culvert headwalls to protect batters from erosion as a result of concentrated runoff. Examples of areas that will benefit from stone pitching are culverts, driveway access points (rural areas) and in other areas where changes or obstructions in the direction of flow occur. Magil will determine where it is appropriate to install stone pitching based on 1) the soil quality and 2) the proximity of sensitive receptors.

The application of mitigation measures will reduce the magnitude of risk from high to low, and the probability of the risk occurring remaining likely, lowering the risk significance from moderate to low (see Table 13Table 14).

Table 13: Assessment of Risk CC03

	PROJECT COMPONENTS	PROJECT PHASE	ASSESSMENT OF RISK SIGNIFICANCE			
			MAGNITUDE	PROBABILITY	DURATION	SIGNIFICANCE
Pre-Mitigation	Infrastructure assets	Operations	High	Likely	Short-term	**MODERATE**
Post-Mitigation			Low	Likely	Short-term	**LOW**

3.5.4 CC04: UNSAFE TRAVEL CONDITIONS AND POTENTIAL INJURIES

Flash floods, landslides and mudslides caused predominantly by extreme precipitation, can have serious implications on travel conditions on the Phase 2 Route. Water, soil, rock, or debris can overflow onto the road, creating unsafe travel conditions and potentially leading to injuries, including death, and damage to vehicles. As noted in Section 333.5.3, the Project is implementing several design features that aim to improve water drainage and management. These features will contribute to the better management of extreme precipitation and smaller floods. However, they may not be enough to manage larger floods, as well as landslides and mudslides.

As discussed in Section 3.5.1, climate hazards can also weaken and damage pavement integrity. Extreme heat and humidity can soften and crack paved surfaces, while flood waters and humidity can increase water seepage and infiltration into road cavities, causing damage to road surface and subsurface layers. Loss of structural integrity can cause road fractures and deformations, such as potholes and cracks, which are driving hazards, and can lead to the creation of unsafe travel conditions and potential injuries to road users.

Increases in average annual rainfall, extreme precipitation, and humidity can lead to the overgrowth of vegetation that is planned along the shoulders of the service roads and on the central islands of the Phase 2 Route roundabouts. Vegetation overgrowth that is not maintained regularly can obscure or limit visibility of road signs and other road users (e.g. approaching vehicles, pedestrians, and bicycles), impact drainage systems, and create road barriers, impeding traffic flows and contributing to unsafe travel conditions along the road.

Given the potential severity associated with unsafe travel conditions and risk of injury, and that road users, infrastructure and landscape assets are highly sensitive i.e. they have limited or no ability to respond or adapt to these climate hazards, the risk is considered high in magnitude. Douala already experiences extreme precipitation, high temperatures and humidity (see Tables 6-8), therefore the probability of creating unsafe travel conditions from damaged pavement, vegetation overgrowth and floods, landslides, and mudslides is highly likely. While the climate hazard effects vary in duration, the creation of unsafe travel conditions can occur rapidly, and consequently the risk will be very short in duration. Therefore, the pre-mitigation risk is assessed as moderate (see Table 14).

To reduce the risk, the following mitigation measures should be implemented:

- Utilization of durable construction materials that are water resistant and capable of withstanding high temperatures and levels of humidity (i.e. consistent with the future climate projections listed in Tables 6-8).
- Sealcoating during the construction phase to protect asphalt from heat damage and rain.
- Repairing cracks and chips immediately during the maintenance phase to avoid water penetrating beneath the road.
- Scheduling regular maintenance, e.g. every year, to check for cracks and repair them before water damage causes further cracks. Sealcoating should be reapplied at regular intervals to stop moisture from penetrating the surface.
- Implementation of a Roadside Vegetation Management Program that would ensure the regular maintenance of vegetation along the service roads and within the roundabouts, particularly during the rainy seasons. This can include strategies such as mowing, weeding, and brush cutting.

The application of mitigation measures will reduce the magnitude of risk from high to low, and the probability of the risk occurring from highly likely to likely, lowering the significance of the risk from moderate to low (see Table 14).

Table 14: Assessment of Risk CC04

	PROJECT COMPONENTS	PROJECT PHASE	ASSESSMENT OF RISK SIGNIFICANCE			
			MAGNITUDE	PROBABILITY	DURATION	SIGNIFICANCE
Pre-Mitigation	Infrastructure assets Landscape and vegetation Community assets	Operations	High	Highly likely	Temporary	**MODERATE**
Post-Mitigation			Moderate	Likely	Temporary	**LOW**

3.5.5 CC05: REDUCTION IN PRODUCTIVITY AND RISK OF INJURY OF PROJECT WORKFORCE

Workers will be required during road maintenance works. Physical labor coupled with exposure to high temperature and humidity can cause heat stress and heat-related illnesses such as heat exhaustion (headache, dizziness/fainting, weakness, nausea/vomiting), heat cramps, heat rash, and in serious cases heat stroke (fainting, collapsing, seizures)[23]. Project workers that experience heat stress and related illnesses will be less productive as their work time will likely decrease, for example, by requiring more frequent breaks or by having to take medical time off.

Floods, landslides, and mudslides can also pose serious health and safety risks to a Project workforce, they can create threats such as: electrical hazards from downed or damaged power lines; striking or crushing workers from the overflow of soil, rock and debris and falling trees; drowning, hypothermia and exhaustion; chemical and biological hazards especially if the Project is using machinery and materials that contain potentially hazardous materials, chemicals and gases; and the creation of driving hazards. All these risks can cause serious injury, and potentially death, to Project workers. As noted in Section 333.5.3, the Project is implementing several design features that aim to improve water drainage and management, including constructing new hydraulic structures to replace undersized or defective ones, and designing the embankment surfaces along the road to direct water flow away from the road. These features will contribute to the better management of extreme precipitation and smaller floods. However, they may not be enough to manage larger floods, as well as landslides and mudslides.

Considering the potentially serious health and safety risks associated with the aforementioned climate hazards and the high sensitivity of the Project workforce, the anticipated magnitude of this risk is high. As the amount of extreme precipitation and number of hot days over 35°C are expected to increase (see Tables 6-8), the risk is highly likely to occur, while the duration of the risk is expected to be temporary. Therefore, the pre-mitigation risk is assessed as moderate (see Table 15).

To reduce the risk, the following mitigation measures should be implemented:

- Development of an Emergency Response Plan that considers flood, landslide, and mudslide risks.
- Where feasible, avoid scheduling maintenance activities during seasons of high rainfall, when the risk of flooding and mudslides is highest.
- Development of a Workforce Health and Safety Plan that includes the following measures:
    - Plan workforce schedules in advance based on weather forecasts, to limit or eliminate working during extreme heat days and when there may be high risk of climate hazards such as flooding, landslides, and mudslides.
    - Modify work schedules and arrange frequent rest periods with water breaks in shaded or air-conditioned areas.
    - Designate a responsible person to monitor conditions and protect workers who are at risk of heat stress.

[23] Source: https://www.osha.gov/Publications/osha3154.pdf

- Provide appropriate protective personal equipment (PPE) including water- and air-cooled vests, UV-protective and anti-fogging googles, waterproof boots and gloves, and protective headwear.
- Provide training about potential hazards and effects, and how to manage and/or prevent them.

The application of mitigation measures will reduce the magnitude of risk from high to moderate, and the probability of the risk occurring from highly likely to likely, lowering the significance of the risk from moderate to low (see Table 15).

Table 15: Assessment of Risk CC05

	PROJECT COMPONENTS	PROJECT PHASE	ASSESSMENT OF RISK SIGNIFICANCE			
			MAGNITUDE	PROBABILITY	DURATION	SIGNIFICANCE
Pre-Mitigation	Project workforce	Maintenance	Moderate	Likely	Temporary	LOW
Post-Mitigation			Low	Likely	Temporary	LOW

3.5.6 CC06: DELAY IN MAINTENANCE ACTIVITIES AND INCREASE IN COSTS

Flood risks, landslides, and mudslides have the potential to create unsafe working conditions for the Project workforce as well as damage and/or wash-away Project vehicles, machinery, and material required for maintenance, such as compacted soil, natural aggregates, and cement. As noted in Section 333.5.3, the Project is implementing several design features that aim to improve water drainage and management. These features will contribute to the better management of extreme precipitation and smaller floods. However, they may not be enough to manage larger floods, as well as landslides and mudslides, and therefore these hazards may still contribute to delaying maintenance activities and increasing costs.

Extreme temperatures and humidity can cause heat stress and reduce workforce productivity, as well overheat and damage certain Project machinery. The creation of unsafe working conditions, reduction in workforce productivity and damage to Project vehicles, machinery, and material can also create delays in maintenance activities.

Additionally, droughts can lead to water deficiency, reducing the availability of water required for the operation of Project machinery and use in maintenance materials, further contributing to maintenance delays.

There is moderate severity of consequences associated with maintenance delays as Project activities may cease functioning for a period of time and can result in additional costs. The likelihood of this risk occurring in the context of this Project is heightened given the increasing occurrence of climate hazards in Douala that directly contribute to the probability of this risk (see Tables 6-8). Maintenance delays and consequent cost increases will likely be temporary, i.e. less than one year. Therefore, the pre-mitigation risk is assessed as moderate (see

Table 16).

To reduce the risk, the following mitigation measures should be implemented:

- Where feasible, avoid scheduling maintenance activities during seasons of high rainfall, when the risk of flooding and mudslides is highest.
- Development of an Emergency Response Plan that considers flood, landslide, and mudslide risks.
- Development of a Workforce Health and Safety Plan that includes the following measures:
  - Establish emergency protocols in the event of extreme weather and hazards.
  - Plan workforce schedules in advance based on weather forecasts, to limit or eliminate working during extreme heat days and when there may be high risk of climate hazards such as flooding, landslides, and mudslides.
  - Modify work schedules and arrange frequent rest periods with water breaks in shaded or air-conditioned areas.
  - Designate a responsible person to monitor conditions and protect workers who are at risk of heat stress.
  - Provide appropriate protective personal equipment (PPE) including water- and air-cooled vests and UV-protective and anti-fogging googles.
  - Provide training about the hazards leading to heat stress and how to prevent them.

The application of mitigation measures will reduce the magnitude of risk from high to moderate, and the probability of the risk occurring from highly likely to likely, lowering the significance of the risk from moderate to low (see

Table 16).

Table 16: Assessment of Risk CC06

	PROJECT COMPONENTS	PROJECT PHASE	ASSESSMENT OF RISK SIGNIFICANCE			
			MAGNITUDE	PROBABILITY	DURATION	SIGNIFICANCE
Pre-Mitigation	Project workforce	Maintenance	Moderate	Likely	Temporary	LOW

	PROJECT COMPONENTS	PROJECT PHASE	ASSESSMENT OF RISK SIGNIFICANCE			
			MAGNITUDE	PROBABILITY	DURATION	SIGNIFICANCE
Post-Mitigation	Project traffic, machinery, and material		Low	Likely	Temporary	LOW

3.5.7 CC07: DAMAGE TO PROJECT TRAFFIC, MACHINERY, AND MATERIAL

Riverine, coastal, and flash floods, landslides, and mudslides caused by extreme precipitation, changes in average rainfall, and sea level rise can overflow onto the Phase 2 Route, damaging and/or wash-away Project vehicles**,** machinery, and materials. As noted in Section 333.5.3, the Project is implementing several design features that aim to improve water drainage and management, including constructing new hydraulic structures to replace undersized or defective ones, and designing the embankment surfaces along the road to direct water flow away from the road. These features will contribute to the better management of extreme precipitation and smaller floods. However, they may not be enough to manage larger floods, as well as landslides and mudslides, and these hazards can still pose a risk to Project traffic, machinery, and material.

Extreme heat can also damage machinery and material required for road maintenance by overheating them and rendering them unusable.

The magnitude of the risk is considered moderate since Project activities may cease functioning in part, and Project components have limited ability to respond to or adapt to climate hazards. The probability is considered very likely since Douala experiences heavy rain and extreme temperatures frequently and is likely to experience more flooding, droughts, and heat waves in the future due to climate changes (see Tables 6-8). However, effects are expected to be temporary. Therefore, the pre-mitigation risk is assessed as moderate (see Table 17).

To reduce the risk, the following mitigation measures should be implemented:

- Seeding the roadway greenspaces to leave bare soil for as short a time as possible.
- Storing materials carefully to ensure they are not damaged by excessive heat or water.
- Carefully managing maintenance machinery to ensure that it does not overheat during particularly hot spells (e.g. ensuring sufficient water levels for cooling) and avoiding machinery use at peak temperature hours.
- Development of a Traffic Management Plan to manage vehicle use during potentially hazardous conditions.

The application of mitigation measures will reduce the magnitude of risk from moderate to low, and the probability of the risk occurring from highly likely to likely, lowering the significance of the risk from moderate to low (see Table 17).

Table 17: Assessment of Risk CC07

	PROJECT COMPONENTS	PROJECT PHASE	ASSESSMENT OF RISK SIGNIFICANCE			
			MAGNITUDE	PROBABILITY	DURATION	SIGNIFICANCE
Pre-Mitigation	Project traffic, machinery, and materials	Maintenance	Moderate	Likely	Temporary	**LOW**
Post-Mitigation			Low	Likely	Temporary	**LOW**

3.5.8 CC08: INCREASED JOURNEY TIMES

Riverine, coastal, and flash floods, landslides, and mudslides caused by extreme precipitation, changes in average rainfall, and sea level rise can overflow onto the Phase 2 Route and certain sections or the full road may be closed off, hindering traffic, and impacting road users by increasing journey times during the operation of the road. Additionally, standing water from heavy rain which is not drained away can seep through and cause softening, displacement, and cracking, which can contribute to increased journey times for road users.

As noted in Section 333.5.3, the Project is implementing several design features that aim to improve water drainage and management, including constructing new hydraulic structures to replace undersized or defective ones, and designing the embankment surfaces along the road to direct water flow away from the road. These features will contribute to the better management of extreme precipitation and smaller floods. However, they may not be enough to manage larger floods, as well as landslides and mudslides.

Road users have limited ability to respond or adapt to these climate hazards, and as road traffic may cease functioning in part or full, the risk is considered high in magnitude. As global temperatures increase so will the frequency and intensity of extreme weather events (see Tables 6-8). Therefore, we can expect an increase in the frequency and intensity of floods, landslides, and mudslides and the probability of increased journey times as a result of these climate hazards is highly likely. The duration of the risk is expected to be temporary. As such, the pre-mitigation risk is deemed to be moderate (see Table 18).

As the risk of increased maintenance and operating costs is directly tied to the risks associated with damage to the road and supporting structures, the mitigation measures listed in Section 3.5.1 and Section 3.5.3 will also help mitigate this risk.

The application of mitigation measures will reduce the magnitude of risk from moderate to low, and the probability of the risk occurring from highly likely to likely, lowering the significance of the risk from moderate to low (see Table 18).

Table 18: Assessment of Risk CC08

	PROJECT COMPONENTS	PROJECT PHASE	ASSESSMENT OF RISK SIGNIFICANCE			
			MAGNITUDE	PROBABILITY	DURATION	SIGNIFICANCE
Pre-Mitigation	Community assets	Operation	High	Highly likely	Temporary	MODERATE
Post-Mitigation			Moderate	Likely	Temporary	LOW

4. CONCLUSIONS

This report presents the results of the Climate Change Risk Assessment, which was undertaken in compliance with the Equator Principles (Revision 4), the Task Force on Climate-Related Financial Disclosure, the World Bank EHS Guidelines and relevant Cameroonian legislation.

Following an initial Climate Hazard Screening, seven climate hazards were identified as material or somewhat material to the Project, including:

- Increase in frequency and severity of extreme rainfall events.
- Changes in seasonal and annual average rainfall.
- Seal level rise.
- Increase in frequency and severity of landslides and mudslides.
- Higher maximum temperature and increase in number of hot days (heatwaves).
- Increased frequency and length of drought (consecutive dry days).
- Higher maximum humidity levels.

These climate hazards were subsequently analyzed based on their potential impact on core Project components, i.e. facilities operated and maintained by the Project, and activities directly associated with their operation and maintenance. The following potential Project risks were identified, pertaining to Project operations and maintenance:

- CC01: Damage to the structure, integrity, and durability of pavement and supporting paved infrastructure, and shortened road longevity.
- CC02: Increased maintenance requirements and operating costs.
- CC03: Damage to supporting road infrastructure.
- CC04: Unsafe travel conditions.
- CC05: Reduction in productivity and risk of injury of Project workforce.
- CC06: Delay in maintenance activities and increase in costs.
- CC07: Damage to Project traffic, machinery, and material.
- CC08: Increased journey times.

A risk assessment approach was utilized to assess the abovementioned Project risks. The approach considered magnitude, probability, and duration of the potential Project risk to determine its significance, i.e. the level of threat posed by the climate hazards onto Project components. Prior to any mitigation being implemented, risks CC01 and CC02 were deemed significant, while risks CC03, CC04 and CC08 were deemed moderately significant. CC05 - CC07 were considered to be of low significance without any additional mitigation. The risk assessment puts forward a suite of mitigation measures for each potential Project risk, with the aim of lowering the risk significance to low. The analysis of the risks is summarized in Table 19 below.

Table 19: Climate Change Risk Analysis Summary

<table>
<tr><th rowspan="2">IMPACT</th><th rowspan="2">EMBEDDED MITIGATION</th><th colspan="4">PRE-MITIGATION</th><th rowspan="2">ADDITIONAL MITIGATION</th><th colspan="4">POST-MITIGATION</th></tr>
<tr><th>MAGNITUDE</th><th>PROBABILITY</th><th>DURATION</th><th>INITIAL RISK</th><th>MAGNITUDE</th><th>PROBABILITY</th><th>DURATION</th><th>RESIDUAL RISK</th></tr>
<tr><td>CC01: Damage to the structure, integrity, and durability of pavement and supporting paved infrastructure, and shortened road longevity [O]</td><td rowspan="2">• Development of five-layer pavement
• Construction of hydraulic structures
• Construction of stormwater collection network
• Embankment surfaces shaped to direct water away from road</td><td>High</td><td>Highly likely</td><td>Permanent</td><td>SIGNIFICANT</td><td rowspan="2">• Review flood planning specification and consider revising design to 1:25 flood return
• Sealcoating during construction
• Prompt repair of cracks
• Adopt a higher softening point of bonding agents for asphalt mixes
• Schedule regular maintenance</td><td>Moderate</td><td>Unlikely</td><td>Short-term</td><td>LOW</td></tr>
<tr><td>CC02: Increased maintenance requirements and operating costs [O, M]</td><td>High</td><td>Highly likely</td><td>Permanent</td><td>SIGNIFICANT</td><td>Moderate</td><td>Unlikely</td><td>Short-term</td><td>LOW</td></tr>
<tr><td>CC03: Damage to supporting road infrastructure [O]</td><td>• Construction of hydraulic structures
• Construction of stormwater collection network
• Embankment surfaces shaped to direct water away from road</td><td>High</td><td>Highly likely</td><td>Short-term</td><td>MODERATE</td><td>• Installation of stone pitching where erosion risks are highest (e.g. culverts and driveway access points)
• Landslide/mudslide preventative measures, e.g. creation of retaining walls and underwater drainage system
• Extra attention made to placement of infrastructure, e.g. elevation of road infrastructure
• Development of drainage systems for underpasses</td><td>Low</td><td>Likely</td><td>Short-term</td><td>LOW</td></tr>
</table>

IMPACT	EMBEDDED MITIGATION	PRE-MITIGATION				ADDITIONAL MITIGATION	POST-MITIGATION			
		MAGNITUDE	PROBABILITY	DURATION	INITIAL RISK		MAGNITUDE	PROBABILITY	DURATION	RESIDUAL RISK
CC04: Unsafe travel conditions and potential injuries [O]	• Construction of hydraulic structures • Construction of stormwater collection network • Embankment surfaces shaped to direct water away from road	High	Highly likely	Temporary	**MODERATE**	• Utilization of durable construction materials • Sealcoating during construction • Prompt repair of cracks • Roadside Vegetation Management Program • Schedule regular maintenance	Moderate	Likely	Temporary	**LOW**
CC05: Reduction in productivity and risk of injury of Project workforce [M]		Moderate	Likely	Temporary	**LOW**	• Flood and Landslide Evacuation and Emergency Plans • Workforce Health and Safety Plan Avoid scheduling maintenance during peak rainfall periods •	Low	Likely	Temporary	**LOW**
CC06: Delay in maintenance activities and increase in costs [M]		Moderate	Likely	Temporary	**LOW**	• Utilization of durable construction materials • Avoid scheduling maintenance during peak rainfall periods • Flood and Landslide Evacuation and Emergency Plans • Workforce Health and Safety Plan	Low	Likely	Temporary	**LOW**
CC07: Damage to Project traffic, machinery, and material [M]	• Construction of hydraulic structures • Construction of stormwater collection network • Embankment surfaces shaped to direct water away from road	Moderate	Likely	Temporary	**LOW**	• Seeding roadway greenspaces • Careful storage of materials and maintenance of Project machinery • Avoiding machinery use at peak temperature hours • Development of a Traffic Management Plan	Low	Likely	Temporary	**LOW**

IMPACT	EMBEDDED MITIGATION	PRE-MITIGATION				ADDITIONAL MITIGATION	POST-MITIGATION			
		MAGNITUDE	PROBABILITY	DURATION	INITIAL RISK		MAGNITUDE	PROBABILITY	DURATION	RESIDUAL RISK
CC08: Increased journey times [O]		Moderate	Highly likely	Temporary	**MODERATE**	• Sealcoating during construction • Prompt repair of cracks • Schedule regular maintenance • Landslide/mudslide preventative measures, e.g. creation of retaining walls and underwater drainage system • Attention made to placement of infrastructure, e.g. elevation of road infrastructure	Low	Likely	Temporary	**LOW**

LIMITATIONS

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This work product presents professional opinions and findings of a scientific and technical nature. The work product shall not be construed to offer legal opinion or representations as to the requirements of, nor the compliance with, environmental laws rules, regulations, or policies of federal, state or local governmental agencies.

The assessment did not include a detailed engineering review of the proposed design to verify the stated design basis provided by Magil.

This assessment did not include flood modeling as part of the agreed scope.