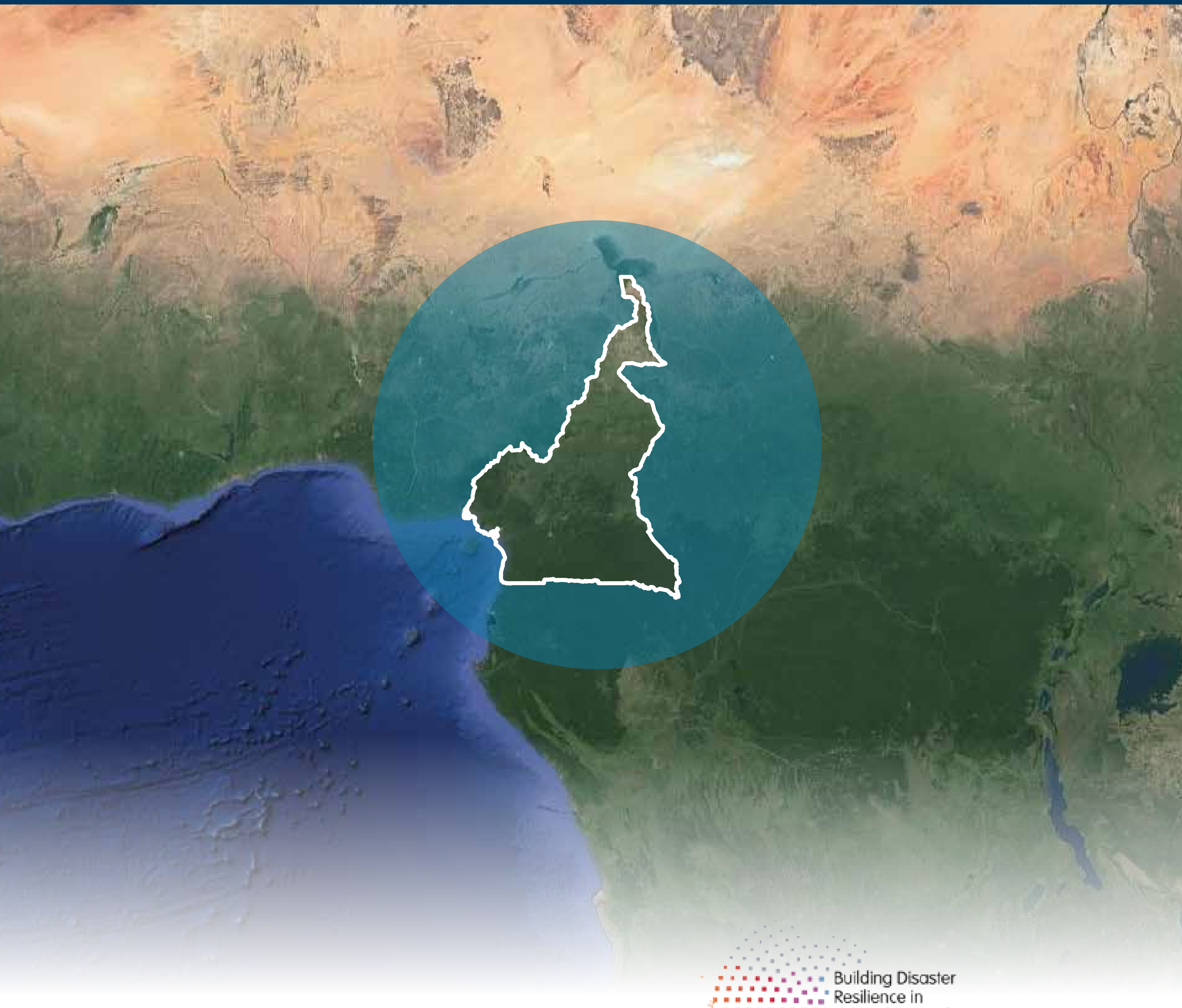
2019

DISASTER RISK PROFILE

Flood Drought

Cameroon



Building Disaster Resilience in Sub-Saharan Africa

Building Disaster Resilience to Natural Hazards in Sub-Saharan African Regions, Countries and Communities

An initiative of the African, Caribbean and Pacific Group of States funded by the European Union

This project is funded by the European Union

UNDRR
UN Office for Disaster Risk Reduction

cima RESEARCH FOUNDATION

International Centre on Environmental Monitoring
Via Magliotto 2. 17100 Savona. Italy
2019 - Review

Africa Disaster Risk Profiles are co-financed by the EU-funded ACP-EU Natural Disaster Risk Reduction Program and the ACP-EU Africa Disaster Risk Financing Program, managed by UNDRR.

Design and layout: CIMA Research Foundation
Video Production: Don’t Movie, Italy

In collaboration with:

PROJECT TEAM

Authors
Roberto Rudari [1]
Amjad Abbashar [2]
Sjaak Conijn [4]
Silvia De Angeli [1]
Hans de Moel [3]
Auriane Denis-Loupot [2]
Luca Ferraris [1;5]
Tatiana Ghizzoni [1]
Isabel Gomes [1]
Diana Mosquera Calle [2]
Katarina Mouakkid Soltesova [2]
Marco Massabò [1]
Julius Njoroge Kabubi [2]
Lauro Rossi [1]
Luca Rossi [2]
Roberto Schiano Lomoriello [2]
Eva Trasforini [1]

Scientific Team
Nazan An [7]
Chiara Arrighi [1;6]
Valerio Basso [1]
Guido Biondi [1]
Alessandro Burastero [1]
Lorenzo Campo [1]
Fabio Castelli [1;6]
Mirko D'Andrea [1]
Fabio Delogu [1]
Giulia Ercolani [1;6]
Elisabetta Fiori [1]
Simone Gabellani [1]
Alessandro Masoero [1]
Enrico Ponte [1]
Ben Rutgers [4]
Franco Siccardi [1]
Francesco Silvestro [1]
Andrea Tessore [1]
Tufan Turp [7]
Marthe Wens [3]

Editing and Graphics
Adrien Gignac-Eddy [1]
Rita Visigalli [1]

Supporting Team
Simona Pozzati [1]
Luisa Colla [1]
Monica Corvarola [1]
Anduela Kaja [1]
Iain Logan [8]
Rich Parker [9]
Tatiana Perrone [1]
Elisa Poggi [1]
Martino Prestini [1]
Maria Ravera [1]

With the support of the UNDRR Regional Office for Africa

CIMA Research Foundation [1] UNDRR [2]
Vrije Universiteit Amsterdam [3] Wageningen University & Research [4]
Università di Genova [5] Università di Firenze [6]
Bogazici University [7] GEG [8] Training in Aid [9]

INDEX

INTRODUCTION

Disasters are on the rise, both in terms of frequency and magnitude. From 2005-2015, more than 700.000 people worldwide lost their lives due to disasters that affected over 1.5 billion people, with women, children and people in vulnerable situations disproportionately affected. The total economic loss amounted to more than US$ 1.3 trillion. Disasters inordinately affect lower-income countries. Sub-Saharan Africa, where two-thirds of the world's least developed countries are located, is prone to recurrent disasters, largely due to natural hazards and climate change.

The Sendai Framework for Disaster Risk Reduction 2015 – 2030 emphasises the need to manage risk rather than disasters, a theme already present in its predecessors, the Yokohama Strategy and the Hyogo Framework for Disaster Risk Reduction. Specifically, the Sendai Framework calls for the strong political leadership, the commitment, and the involvement of all stakeholders, at all levels, from local to national and international, to *"prevent new and reduce existing disaster risk through the implementation of integrated and inclusive economic, structural, legal, social, health, cultural, educational, environmental, technological, political, and institutional measures that prevent and reduce hazard exposure and vulnerability to disaster, increase preparedness for response and recovery, and thus strengthen resilience"*.

Understanding disaster risk is the Sendai Framework's first priority for action: *"policies and practices for disaster risk management should be based on an understanding of disaster risk in all its dimensions of vulnerability, capacity, exposure of persons and assets, hazard characteristics and the environment"*. The outputs of disaster risk assessment should be the main drivers of the disaster risk management cycle, including sustainable development strategies, climate change adaptation planning, national disaster risk reduction across all sectors, as well as emergency preparedness and response.

As part of the "Building Disaster Resilience to Natural Hazards in Sub-Saharan African Regions, Countries and Communities" programme, UNDRR hired CIMA Research Foundation for the preparation of 16 Country Risk Profiles for floods and droughts for the following countries: Angola, Botswana, Cameroon, Equatorial Guinea, Gabon, Gambia (Republic of The), Ghana, Guinea Bissau, Kenya, Eswatini (Kingdom of), Côte d'Ivoire, Namibia, Rwanda, São Tomé and Príncipe, Tanzania (United Republic of), and Zambia.

The Country Risk Profiles provide a comprehensive view of hazard, risk and uncertainties for floods and droughts in a changing climate, with projections for the period 2050-2100. The risk assessment considers a large number of possible scenarios, their likelihood, and associated impacts.
A significant amount of scientific information on hazard, exposure, and vulnerabilities has been used to simulate disaster risk.

The EU PROGRAMME "Building Disaster Resilience to Natural Hazards in Sub-Saharan African Regions, Countries and Communities"

In 2013, the European Union approved 80 million EUR financing for the *"Building Disaster Resilience to Natural Hazards in Sub-Saharan African Regions, Countries and Communities"* programme. It is being implemented in Africa by four partners: the African Union Commission, the United Nations Office for Disaster Risk Reduction (UNDRR), the World Bank's Global Facility for Disaster Reduction and Recovery (WB/GFDRR), and the African Development Bank's ClimDev Special Fund (AfDB/CDSF). The programme provides analytical basis, tools and capacity, and accelerates the effective implementation of an African comprehensive disaster risk reduction and risk management framework.

PROBABILISTIC RISK PROFILE: METHODOLOGY

PROBABILISTIC RISK ASSESSMENT

Understanding disaster risk is essential for sustainable development. Many different and complementary methods and tools are available for analysing risk. These range from qualitative to semi-quantitative and quantitative methods: probabilistic risk analysis, deterministic or scenario analysis, historical analysis, and expert elicitation.

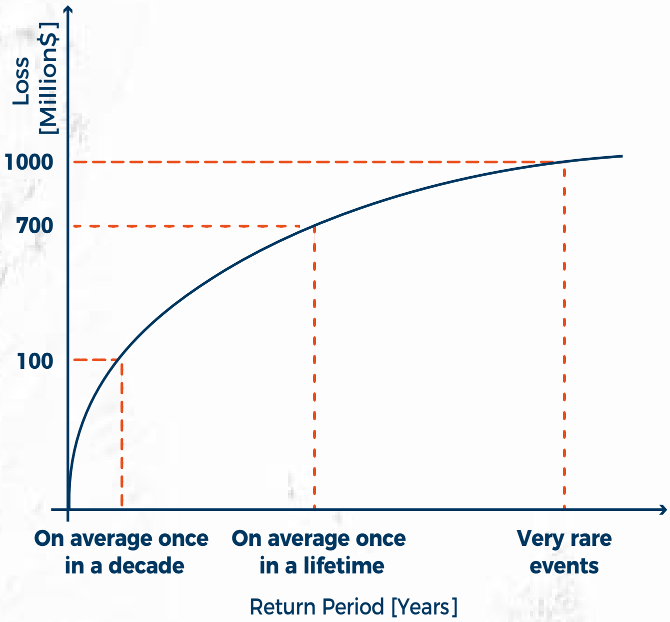
This disaster risk profile for floods and droughts is based on probabilistic risk assessment. Awareness of possible perils that may threaten human lives primarily derives from experience of past events. In theory, series of historical loss data long enough to be representative of all possible disastrous events that occurred in a portion of territory would provide all of the necessary information for assessing future loss potential. Unfortunately, the availability of national historical information on catastrophic natural hazard events is limited, and data on the economic consequences is even less common.

In the absence of extensive historical data, a modelling approach is needed to best predict possible present and future scenarios, taking into consideration the spatial and temporal uncertainties involved in the analysed process.
This profile simulates a realistic set of all possible hazardous events (scenarios) that may occur in a given region, including very rare, catastrophic events. Potential impacts were computed for each event, taking into consideration associated economic losses or the number of people and assets affected. Publicly available information on hazard, exposure, and vulnerability was used in the analysis. Finally, statistics of losses were computed and summarised through proper quantitative economic risk metrics, namely Annual Average Loss (AAL) and Probable Maximum Loss (PML).
In computing the final metrics (PML, AAL), the uncertainties that permeate the different steps of the computations have been explicitly quantified and taken into account: uncertainties in hazard forcing, uncertainties in exposure values and their vulnerabilities.

Average Annual Loss (AAL) is the expected loss per year, averaged over many years. While there may actually be little or no loss over a short period of time, AAL also accounts for much larger losses that occur less frequently. As such, AAL represents the funds which are required annually in order to cumulatively cover the average disaster loss over time.

Probable Maximum Loss (PML) describes the loss which could be expected corresponding to a given likelihood. It is expressed in terms of annual probability of exceedance or its reciprocal, the return period. For instance, in the figure below, the likelihood of a US$ 100 million loss is on average once in a decade, a loss of US$ 1 billion is considered a very rare event. Typically, PML is relevant to define the size of reserves which, insurance companies or a government should have available to manage losses.

The methodology is also used to simulate the impact of climate change [SMHI-RCA4 model, grid spacing 0.44° - about 50 km - driven by ICHEC-EC-EARTH model, RCP 8.5, 2006-2100 and, future projections of population and GDP growth (SSP2, OECD Env-Growth model from IIASA SSP Database)].
Results are disaggregated by different sectors, using the categories of Sendai Framework indicators: direct economic loss (C1), agricultural sector (C2), productive asset and service sector (C3), housing sector (C4), critical infrastructures and transportation (C5).



PROBABILISTIC RISK PROFILE: RISK COMPONENTS

HAZARD

process, phenomenon or human activity that may cause loss of life, injury or other health impacts, property damage, social and economic disruption or environmental degradation.

In order to best predict possible flood and drought scenarios, a modelling chain composed of climate, hydrological, and hydraulic models combined with available information on rainfall, temperature, humidity, wind and solar radiation, has been used. A set of mutually exclusive and collectively exhaustive possible hazard scenarios that may occur in a given region or country, including the most catastrophic ones, is generated and expressed in terms of frequency, extension of the affected area and intensity in different locations.

Flood hazard map for 1 in a 100 years probability evaluated under current climate conditions, the scale of blues represents different water depth values.

VULNERABILITY

conditions determined by physical, social, economic and environmental factors or processes which increase the susceptibility of an individual, a community, assets or systems to the impacts of hazards.

Direct losses on different elements at risk are evaluated by applying vulnerability functions. This links hazard intensity to the expected loss (economic loss or number of affected people) while counting for associated uncertainty. Vulnerability functions are differentiated by the typology of exposed elements, and also take into account local factors, such as typical constructive typologies for infrastructures or crop seasonality for agricultural production. In the case of floods, vulnerability is a function of water depth. For agricultural production, the vulnerability is a function of the season in which a flood occurs. In the case of agricultural drought, losses are computed in terms of lack of production for different crops from a nominal expected production. A similar approach is used for hydrological drought, the evaluation of which focuses on loss of hydropower production.

EXPOSURE

people, property, systems, or other elements present in hazard zones that are thereby subject to potential losses.

Losses caused by floods and droughts are assessed in relation to population, GDP and a series of critical sectors (education, health, transport, housing, and the productive and agricultural sectors). The sectors are created by clustering all of the different components, which contribute to a specific function (e.g. the health sector is comprised of hospitals, clinics and dispensaries). Publicly available global and national data, properly generated, enables the location of these elements at high resolution, e.g. 90 metres or lower, for the whole country. The total number of people and the national GDP (in US$) are considered in both current (2016) and future (2050) scenarios. The critical sectors are characterised in terms of their economic value (in US$), using the most updated information available.

Exposure distribution, the different colors represent different types of assets.

UNDRR terminology on Disaster Risk Reduction: https://www.unisdr.org/we/inform/publications/7817

A SENDAI ORIENTED RISK PROFILE

The Sendai Framework guides the organisation of the results of the risk profile. Sendai introduced seven global targets and several indicators for monitoring their achievements. The indicators are common standards for a consistent measurement of progress towards the global targets across countries and over the duration of the Sendai Framework and Sustainable Development Goals. The Risk Profile presents the results of the assessment, mostly referring to indicators for the Target B on the affected people, Target C on direct economic losses and Target D on damage and disruption of basic service. Seven additional indicators are included in the risk profile in order to obtain a more comprehensive understanding of risk from floods and droughts. The table below summarises the indicators used in the risk profiles, as well as the climatic and socio-economic conditions considered in the estimation of the different risk metrics.

	INDICATORS			FLOOD			DROUGHT			
				P	F	SEp	P	F	SEp	RISK METRICS
SENDAI INDICATORS	B1		Number of directly affected people	Y	Y	Y	Y	Y	Y	Annual Average
SENDAI INDICATORS	C1 Direct economic loss attributed to disasters	C2	Direct agricultural loss (Crops)	Y	Y		Y	Y		AAL (Average Annual Loss) PML (Probable Maximum Loss)
SENDAI INDICATORS	C1 Direct economic loss attributed to disasters	C3	Direct economic losses to productive asset (Industrial Buildings + Energy Facilities)	Y	Y		Y	Y		AAL (Average Annual Loss) PML (Probable Maximum Loss)
SENDAI INDICATORS	C1 Direct economic loss attributed to disasters	C3	Direct economic losses in service sector	Y	Y					AAL (Average Annual Loss) PML (Probable Maximum Loss)
SENDAI INDICATORS	C1 Direct economic loss attributed to disasters	C4	Direct economic losses in housing sector	Y	Y					AAL (Average Annual Loss) PML (Probable Maximum Loss)
SENDAI INDICATORS	C1 Direct economic loss attributed to disasters	C5	Direct economic losses to transportation systems (Roads + Railways)	Y	Y					AAL (Average Annual Loss) PML (Probable Maximum Loss)
SENDAI INDICATORS	C1 Direct economic loss attributed to disasters	C5	Direct economic losses to other critical infrastructures (Health + Education Facilities)	Y	Y					AAL (Average Annual Loss) PML (Probable Maximum Loss)
SENDAI INDICATORS	D1 Damage to critical infrastructure attributed to disasters	D2	Number of destroyed or damaged health facilities	Y	Y					Annual Average
SENDAI INDICATORS	D1 Damage to critical infrastructure attributed to disasters	D3	Number of destroyed or damaged educational facilities	Y	Y					Annual Average
SENDAI INDICATORS	D1 Damage to critical infrastructure attributed to disasters	D4	Number of other destroyed or damaged critical infrastructure units and facilities (Transportation systems)	Y	Y					Annual Average
* No official Sendai indicators	Agricultural & Economic Indicators		GDP of affected areas*	Y	Y	Y	Y	Y	Y	Annual Average
* No official Sendai indicators	Agricultural & Economic Indicators		Number of potentially affected livestock units*				Y	Y		Annual Average
* No official Sendai indicators	Agricultural & Economic Indicators		Number of working days lost*				Y	Y		Annual Average
* No official Sendai indicators	Hazard Index	SPEI	Standardised Precipitation-Evapotranspiration Index*				Y	Y		
* No official Sendai indicators	Hazard Index	SSMI	Standardised Soil Moisture Index*				Y	Y		
* No official Sendai indicators	Hazard Index	SSFI	Standardised StreamFlow Index*				Y	Y		
* No official Sendai indicators	Hazard Index	WCI	Water Crowding Index*				Y	Y		

P Present Climate | **F** Future Climate | **SEp** Socio Economic projection

COUNTRY SOCIO-ECONOMIC OUTLOOK

OVERVIEW

Cameroon is a country of 22.8 million people that borders Chad, the Central African Republic, Equatorial Guinea, Gabon, and Nigeria. The country is endowed with significant natural resources, including oil and gas, high-value timber species, minerals, and agricultural products such as coffee, cotton, cocoa, maize, and cassava. Oil, however, remains Cameroon's main export commodity, accounting for nearly 40% of all exports. Recently, the country has been affected by falling global oil prices, slowing economic growth. This trend could potentially continue in the long term if the world transitions away from fossil fuels. [1]

As the country adapts to a changing world, its development could be impacted. The flooding and drought risk assessments presented in this report show the potential impacts of climate change on various sectors of the economy, and highlight vulnerable areas. It is argued that a thorough understanding of risk is essential to the healthy future development of the country.

SOCIO-ECONOMIC PROJECTIONS

Climate scientists and economists have recently built a range of new "pathways" which examine ways in which over the next hundred years national and global societies, demographics and economics may lead to alternative plausible future development scenarios [2,3]. Such scenarios range from optimistic trends for human development, with "substantial investments in education and health, rapid economic growth and well-functioning institutions" [4], to more pessimistic outlooks for low-income countries, indicating low levels of economic and social development, limited investment in education or health, coupled with a fast-growing populations and increasing inequalities.

PROJECTIONS USED IN THE RISK PROFILE

The "middle of the road" scenario used in this risk profile envisages that the historical patterns of development are continued throughout the 21st century. Following this projection, the population of Cameroon is expected to increase by about 42% between 2016 and 2050 (World Bank Data), whereas GDP is expected to increase almost tenfold.

POPULATION	GDP
2016 Projection	2016 Projection
22.8	32.2
[Million People]	[Billion$]
32.2	318.2
2050 Projection	2050 Projection

CAMEROON

AREA : 475.650 km² *(STATISTICS-CAMEROON.ORG)*

POPULATION DENSITY : 52 people/km²

MEDIAN AGE : 17.7 years *(CENSUS - STATISTICS-CAMEROON.ORG - 2010)*

HDI - HUMAN DEVELOPMENT INDEX : 0.556 *(UNDP - 2017)*

LIFE EXPECTANCY AT BIRTH : 58.6 years *(UNDP - 2017)*

MEAN YEARS OF SCHOOLING : 6.3 years *(UNDP - 2017)*

EMPLOYMENT TO POP. RATIO (AGES > 15) : 73.0% *(WB - 2017)*

EMPLOYMENT IN AGRICULTURE : 62.0% *(WB - 2017)*

EMPLOYMENT IN SERVICES : 28.7% *(WB - 2017)*

data from:
http://hdr.undp.org/en/countries/profiles/
https://data.worldbank.org/indicator/
http://www.statistics-cameroon.org

COUNTRY CLIMATE OUTLOOK

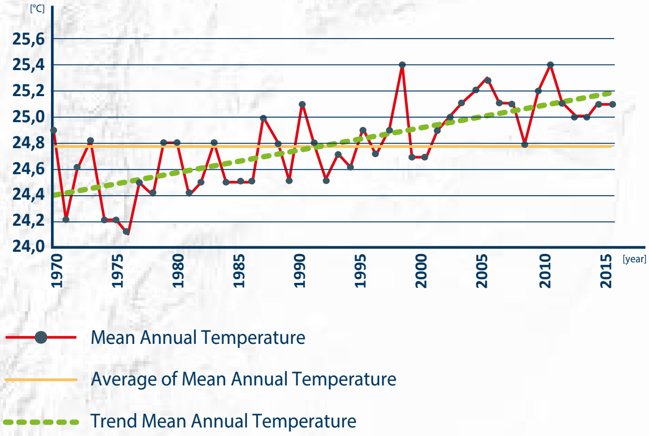
OVERVIEW

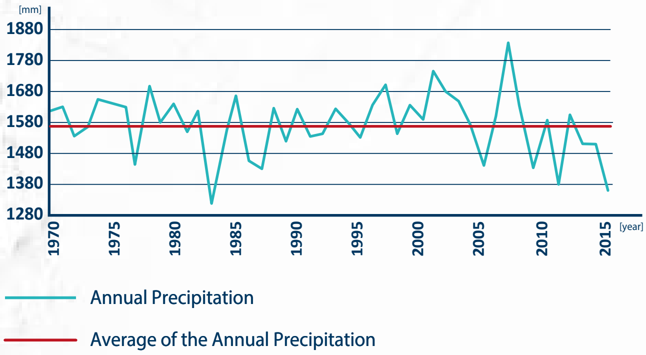
Cameroon is located in western central Africa, on the coast of the Gulf of Guinea. The southern regions of Cameroon are humid and equatorial, but the climate becomes semi-arid in the northern regions. The geography of Cameroon is highly diverse and its topographic features superimpose climatic variations on this north-south gradient. The semi-arid north of Cameroon is the hottest and driest part of the country. Temperatures in the southern regions depend largely on altitude, with less seasonal variability. The highest annual rainfalls are in the coastal and mountainous regions. The main wet season lasts between May and November for most of the country, when the West African Monsoon winds blow from the south-west, bringing moist air from the ocean [5,6].

CLIMATE TRENDS

Similarly to other western African countries, temperature observations indicate that Cameroon has experienced a considerable increase in temperature in recent years.
An analysis of climate data from 1970 to 2015 [7] shows an average rise in temperature of around 1°C. Trends for precipitation are not as clear as those for air temperatures, and are variable in time and space. Average annual precipitation for Cameroon is approximately 1568 mm, while the mean number of wet days is around 138.

TEMPERATURE AND PRECIPITATION TRENDS IN CURRENT CLIMATE





RIVERS OF CAMEROON

The hydrographic network of river basins in Cameroon is constituted by [8]:
- Logone and its tributaries, which drains the extreme north towards Lake Chad, covering 11% of the country;
- Benoué and its tributaries (Faro, Mandara, Alantika and Mayo Kebi), which drains the north towards the Niger River and occupies 19% of the country;
- The Kadei and Ngoko rivers in the southeast to Sangha tributary of the Congo, covering 20% of the country;
- The main rivers of the centre and the west, that flow towards the Atlantic are: the Sanaga, the longest river of the country (920 km) whose basin extends on 140.000 km^2; the Nyong, the Ntem, the Mungo and the Wouri.

Photo Credit: Awah Nadege - https://commons.wikimedia.org/wiki/File:River_Sanaga.jpg

CLIMATE PROJECTIONS FOR CAMEROON

Climate projection studies are abundant for multiple different time spans and with various scales. Climate models are tools that the scientific community uses to assess trends in weather conditions over long periods. In a recent study [9] Alder, et al., compared the observed temperature and precipitations of the 1980-2004 period with the estimations of a set of global climate models provided by the Coupled Model Intercomparison Project Phase 5 (CMIP5). Three future periods (2025-2049, 2050-2074 and 2071-2095) were then analyzed for different greenhouse emission scenarios (see IPCC's Emissions Scenarios).

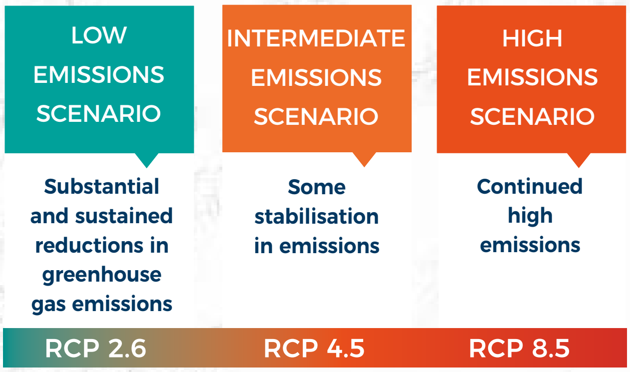
In all periods and all emission scenarios, models showed an increase in temperature.The increase in temperature was more evident in high emissions scenarios and long term period projections. In high emission scenarios (RCP8.5), model projections showed an increase between 1.5˚C and 4˚C for the mid term period (2050-2074) and an increase between 2.5˚C and 5.5˚C for the long term period (2071-2095). Though changes in precipitation are much more uncertain, it is very likely that average precipitation will increase for both medium and long term periods and for all emission scenarios.

Time Frame	Climate Projections (RCP 8.5 - High emission scenario)
Mid-term Future (2050-2074)	Increase in temperature from 1.5˚C to 4˚C Very likely precipitation increase (up to 10%)
Far Future (2071-2095)	Increase in temperature from 2.5˚C to 5.5˚C Very likely precipitation increase (up to 15%)

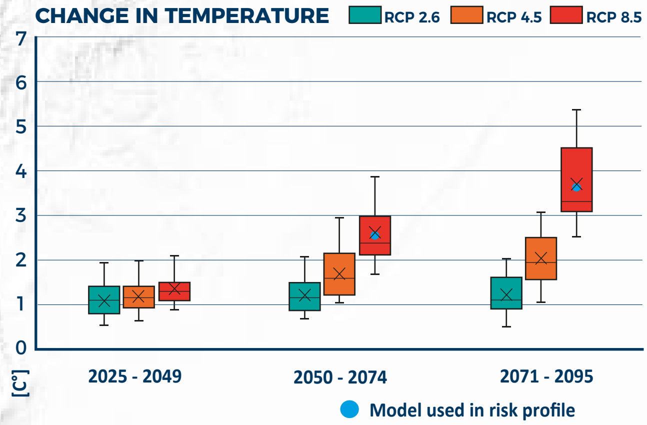
CLIMATE PROJECTIONS USED IN THIS RISK PROFILE

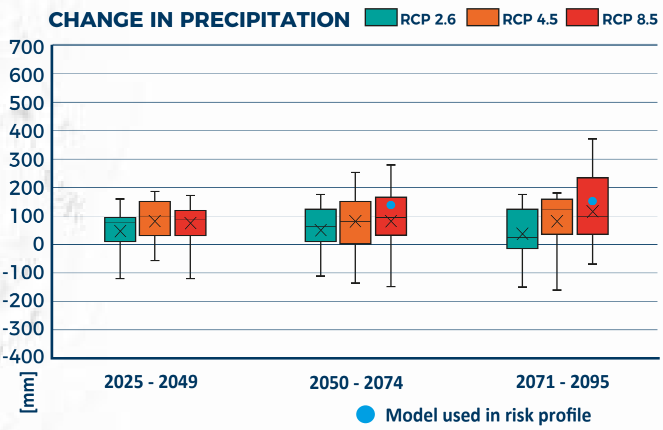
Results presented in the Risk Profile have been obtained using a climate projection model based on a high emission scenario (SMHI-RCA4 model, grid spacing 0.44˚ about 50 km- driven by the ICHEC-EC-EARTH model, RCP 8.5, 2006-2100) [10,11,12].

This study uses a high-resolution model which has been accurately calibrated for the African domain. This allows for a better capture of climate variability, which is key in assessing extremes. Regional model projections were checked for consistency against a full ensemble of global models available for the area. The Regional model forecasts changes in temperature and annual precipitation are fully in line with the range of variability of global models analyzed in the study by Alder et al. [9].



IPCC's Emissions scenarios for Climate Projections

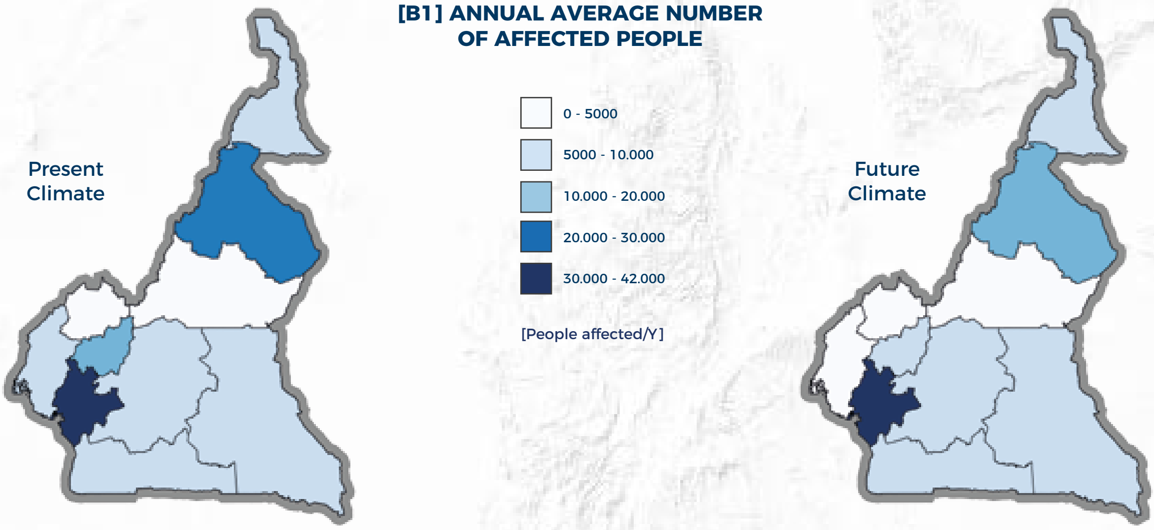




In the specific case of a high emission scenario, the regional model predicts an increase in temperature of about 3.5˚C for the long term period; in line with the global ensemble.

As regards to annual precipitation at country level, an increase is predicted by the regional model in the long-term period.

RESULTS | FLOODS



KEY MESSAGES

● Floods affect on average about 120.000 people every year, about 0.5% of the total population of the country.

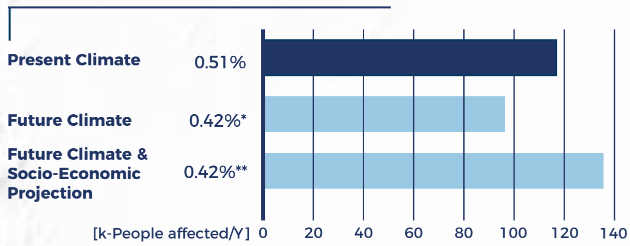
● Most of the potentially affected people are concentrated in the Littoral and Adamaoua/Adamawa regions.

● The local economy is also exposed to flooding. On average, the areas potentially affected by floods produce about 0.29% of the national GDP which corresponds to about 100 Million USD per year.

● It is likely that under future climate conditions, the affected population and potentially affected GDP will not change significantly compared to the value evaluated under current climate conditions. However, as shown in the climate session, climate projections are inherently uncertain and this should be considered when using these estimations in policy development.

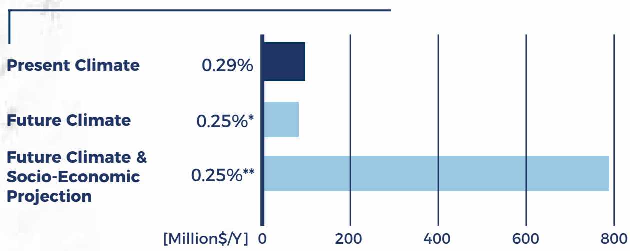
● When population and potentially affected GDP are compared with estimates of future climate conditions and socio-economic development, (*), they show a likely increase. Affected GDP increases significantly, up to 0.8 Billion USD per year. This prediction is somewhat uncertain.

ANNUAL AVERAGE NUMBER OF POTENTIALLY AFFECTED PEOPLE [B1]



* % computed with reference to the total 2016 Population
** % computed with reference to the total 2050 Population

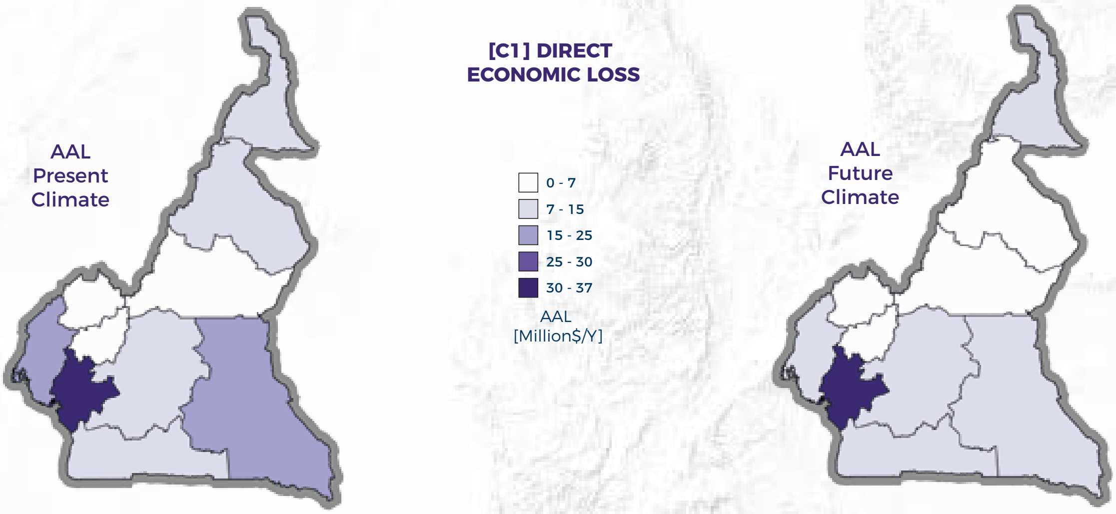
ANNUAL AVERAGE POTENTIALLY AFFECTED GDP



* % computed with reference to the total 2016 GDP
** % computed with reference to the total 2050 GDP

*2016 was taken as a reference year both for GDP and population.
**the Shared Socioeconomic Pathway (SSP) - "mid of the road" (Medium challenges to mitigation and adaptation) has been used to project population and GDP distributions.

RESULTS | FLOODS



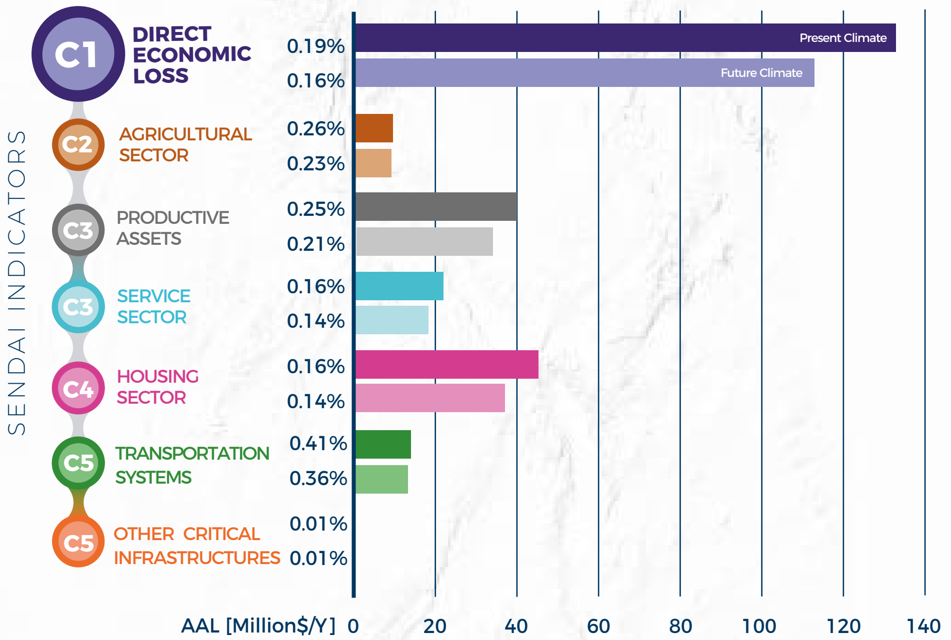
KEY MESSAGES

- The direct economic loss in Cameroon is the result of a complex combination of hazard and exposure geographical distribution. The southern central regions as well as the northern regions show the greatest loss. This pattern is confirmed under future climate conditions.

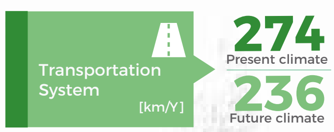
- The average yearly value of direct economic loss in the present climate is of 130 millions USD, which roughly amounts to 0.19% of the total stock value. The housing, productive and service sectors have the highest proportion of loss.

- When considering the present exposed assets, it is not likely that average annual loss will change significantly under future climate conditions, for all sectors. However, this estimation does not consider socio-economic projections that can possibly overturn the future projections.

- The proportion of different sectors in the overall loss will not change under future climate conditions. As highlighted above, climate projections are inherently uncertain and this should be considered when using these estimations in policy development.



AFFECTED INFRASTRUCTURES [D4]

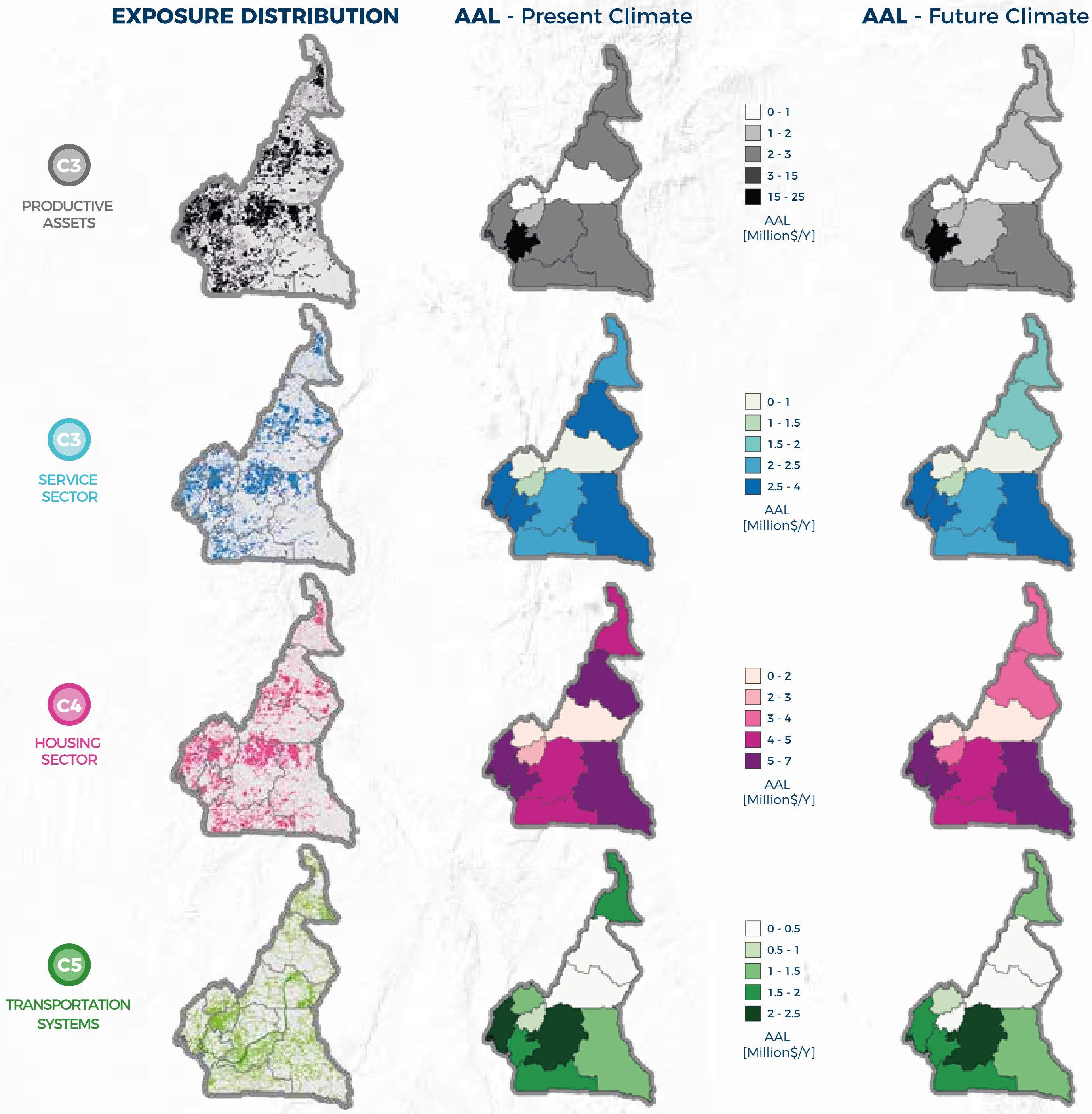


RESULTS | FLOODS

KEY MESSAGES

● The AAL distribution shows differences across each of the sectors considered. The southwestern part of Cameroon and the north remain the most impacted, but the distribution of values depend on distinct sectors. The littoral region is an evident hotspot for the industrial sector, while the southwest and central regions are the most impacted when the transport sector is considered.

● Comparison of AALs for all sectors between present and future climates shows that no significant changes are expected in economic losses according to spatial distribution, with only a slight decrease of losses estimated for the northern region.



RESULTS | FLOODS

KEY MESSAGES

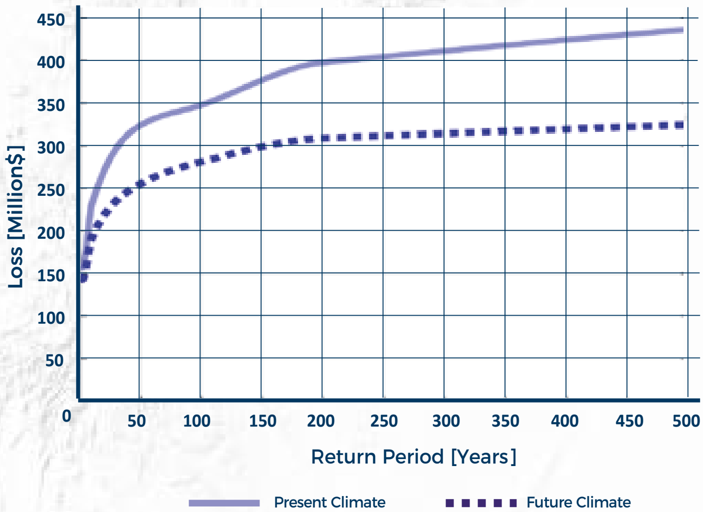
● Although Average Annual Loss is of about 130 million USD, the likelihood of a 250 million loss from floods is on average of once every decade under present climate conditions. This means that considerable losses may be experienced frequently. The likelihood of disaster losses of about 350 million USD is on average once in 100 years. Extreme losses could exceed 400 million USD.

● The sectors that are most affected for both frequent, very frequent and extreme losses are housing, productive assets and services.

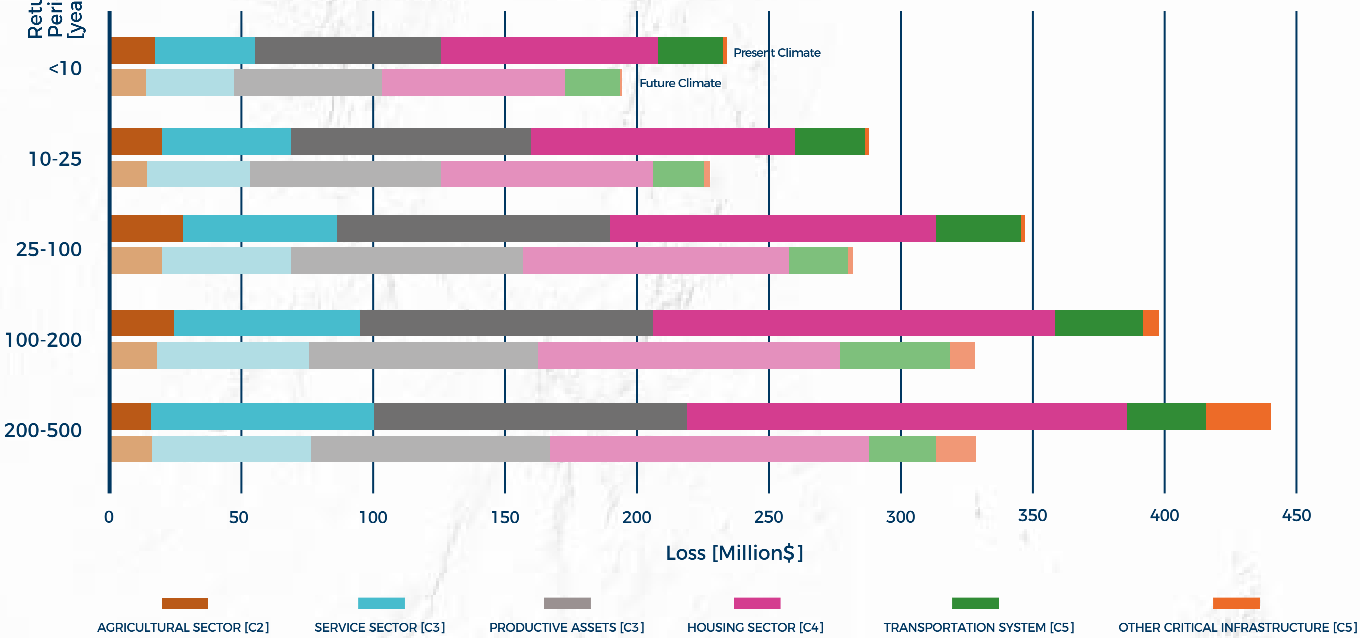
● It is likely that both frequent and extreme flood-related losses will decrease under future climate conditions and greater differences are observed for rare and very rare losses. Given the high level of uncertainty in climate prediction, worse scenarios may also be possible.

● The specific shape of the PML curve shows that flood risk can be considerably reduced by strategically minimizing the impact of very frequent and frequent disaster events, hence by investing in disaster risk reduction.

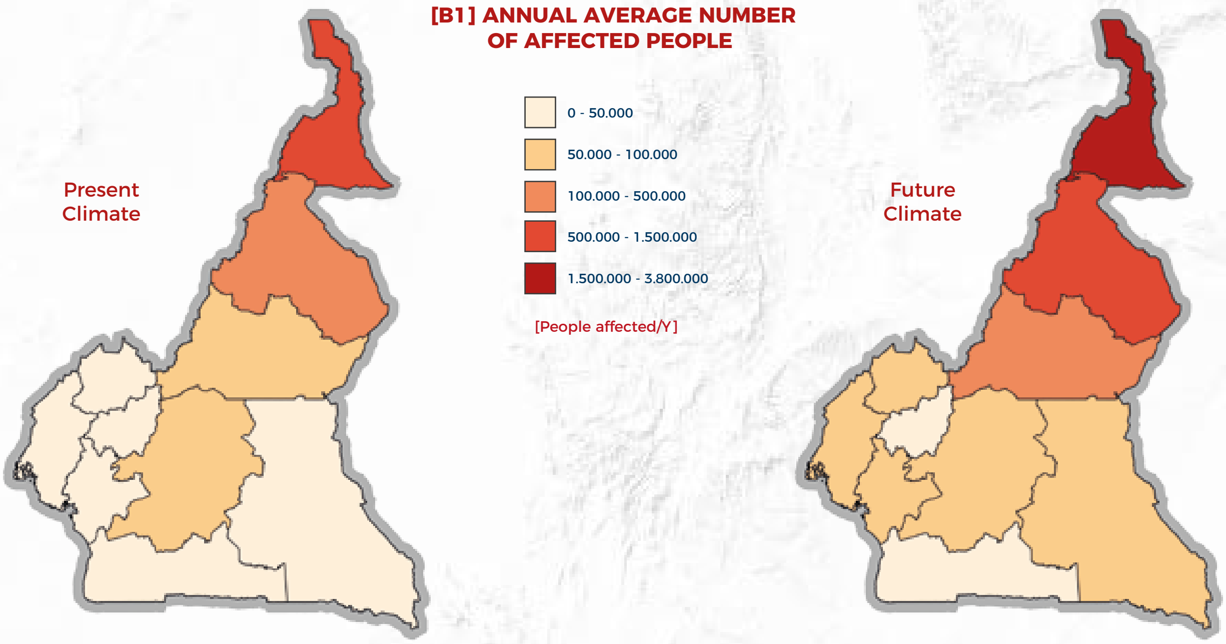
PROBABLE MAXIMUM LOSS CURVE (PML)
C1 - DIRECT ECONOMIC LOSS



PROBABLE MAXIMUM LOSS CURVE (PML) ACROSS ALL SECTORS
C1 - DIRECT ECONOMIC LOSS

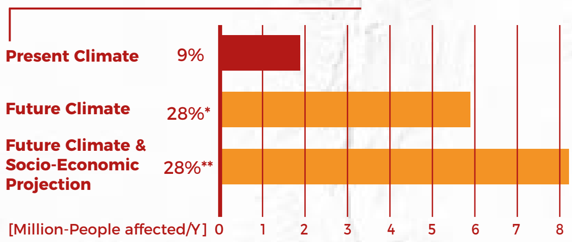


RESULTS | DROUGHTS



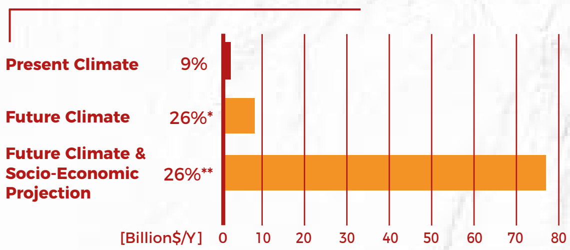
Annual average of population potentially affected by at least three months of drought conditions, as calculated using the standardized precipitation-evapotranspiration index (SPEI) and using a 3-month accumulation period.

ANNUAL AVERAGE NUMBER OF POTENTIALLY AFFECTED PEOPLE [B1]



* % computed with reference to the total 2016 Population
** % computed with reference to the total 2050 Population

ANNUAL AVERAGE POTENTIALLY AFFECTED GDP



* % computed with reference to the total 2016 GDP
** % computed with reference to the total 2050 GDP

KEY MESSAGES

- With respect to present conditions (1951-2000 climate), the probability of occurrence of severe droughts (precipitation – evapotranspiration deficiency) will increase under future climate conditions (2050-2100 climate). This increased drought hazard will mainly occur in the northern areas.

- Under present climate conditions, on average almost 2 million people (9% of the total 2016 Population) are annually living in drought-hit areas. Under future climate conditions, this number is expected to increase to 26% (on average more than 8 million people if population growth is accounted for).

- Under present climate conditions, the average percentage of potentially affected GDP (i.e. the economic value produced in areas hit by droughts) is about 8% of the total GDP. This is equivalent to 2.7 billion USD per year which could be impacted by droughts. Under future climate conditions, this may rise to 25% of the GDP, which could amount to 8 billion USD.

RESULTS | DROUGHTS

KEY MESSAGES

● The affected livestock under current climate conditions is about 1.2 million livestock units (34% of the total livestock), while under future climate conditions (but keeping the current amount of livestock), it is projected to increase up to 2.6 million units (71% of the total). Currently, most of the livestock affected by droughts is situated in the north of Cameroon, where droughts are the most frequent. In a future climate, livestock more to the south, could be potentially affected by droughts.

● Under present climate conditions, agricultural crop losses are dominated by seven crops (banana, cassava, maize, oil palm, plantain, sorghum and taro), and in the future most physical losses will come from four crops (maize, oil palm sorghum and taro). For ten crops, the losses will decrease, whereas for only two crops (groundnut and sorghum) they will increase in the future climate. Highest relative losses amount to 2.4% of the average crop production (sorghum).

● Economic crop production losses are concentrated in the lower half of Cameroon under present climate conditions. Under future climate conditions, losses decrease substantially in this part, but increase in the two northern regions of the country.

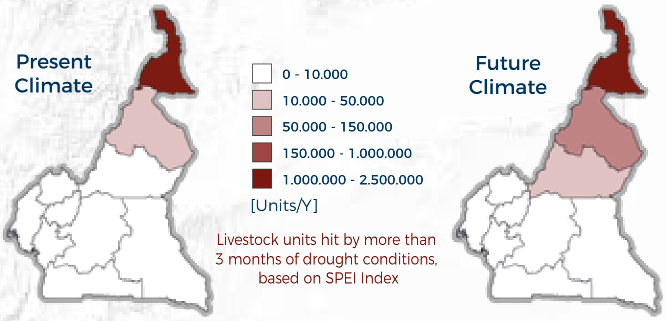
● Consistent with the decreases in crop production losses, the amount of lost working days also decreases between present and future climate. In total about 740.000 (present) and 450.000 (future) working days are lost, which is less than 0.25% and 0.15% of the average number of working days. However, the number of working days lost, expressed as a percentage of the average amount of days required for harvesting, is approximately four times higher.

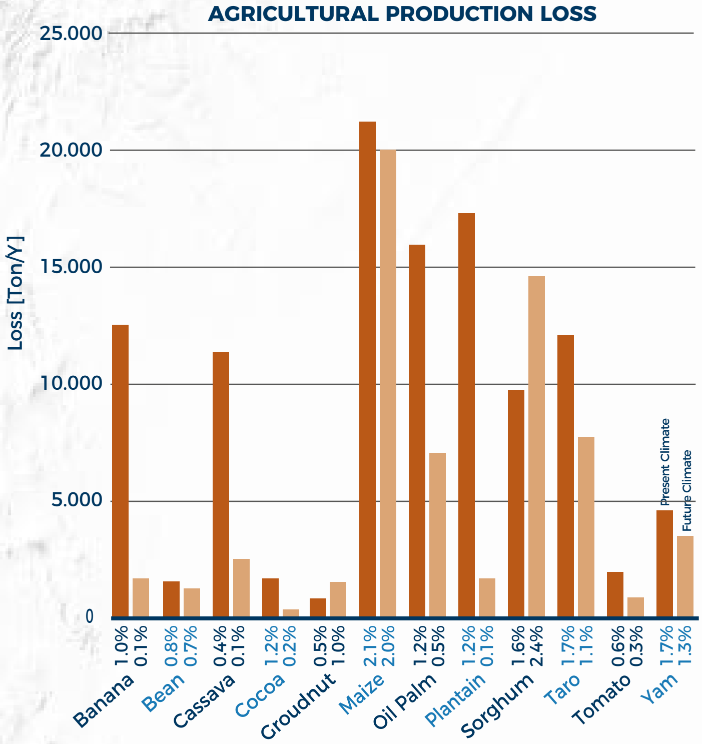
ANNUAL AVERAGE NUMBER OF POTENTIALLY AFFECTED LIVESTOCK UNITS* [k-Livestock units]

1265 | 34% — Present climate

2620 | 71% — Future climate

*Livestock is a summation of all livestock animals (referred to as livestock units) using FAO conversion factors

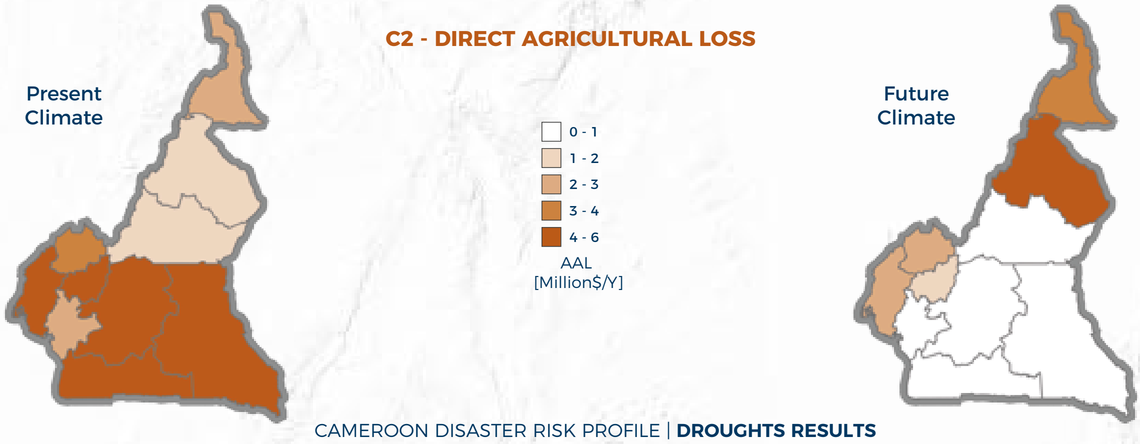




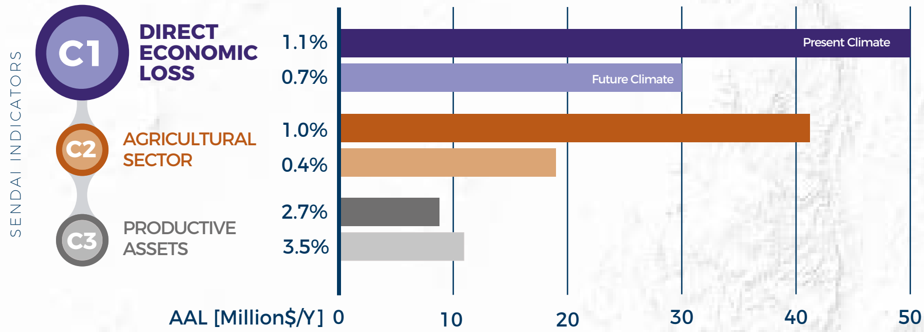
ANNUAL AVERAGE NUMBER OF WORKING DAYS LOST [k-Days]

740 | 0.24% — Present climate

450 | 0.15% — Future climate



RESULTS | DROUGHTS



C2 is computed considering only direct loss associated with reference agricultural (crop) production. Reference crops considered in the analysis are the ones which contribute to at least 85% of the total country-level gross crop production value. It might therefore happen that crops which have an important role in local commercial or subsistance agriculture can be neglected in the overall analysis.
C3 is computed considering exclusively losses in hydropower production. These are defined as production below levels with average reservoir conditions.

KEY MESSAGES

- The direct economic loss (C1), expressed as average annual value, is dominated by the loss in the agricultural sector (C2), and therefore also decreases under the future climate conditions compared to present climate conditions.

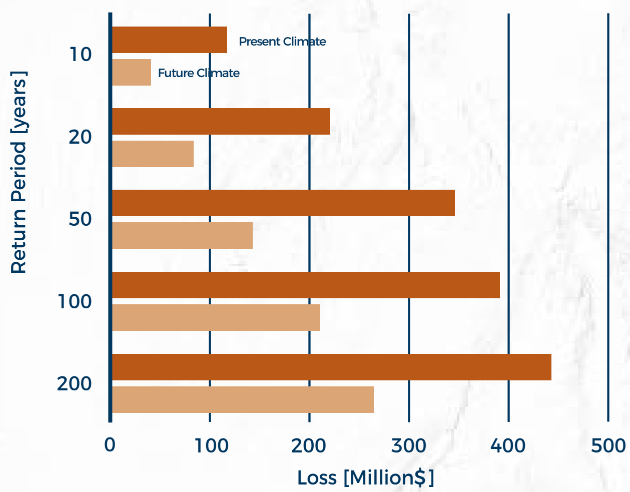
- Average annual economic crop production loss (C2) decreases from more than 40 million USD under present climate conditions to less than 20 million USD under future climate conditions. These losses represent 1% and 0.4% of the average economic value of crop production, respectively for present and future climate conditions.

- Average annual hydropower losses (C3) due to droughts is estimated to be 8.4 million USD per year. The loss from the Lagdo dam is projected to increase considerably, about 8 times, due to climate change. However, annual losses from hydropower produced at other dams (Edea, M'Bakaou, Mape, Bamendjin) will decrease. Overall, a small net increase in losses is projected for future conditions.

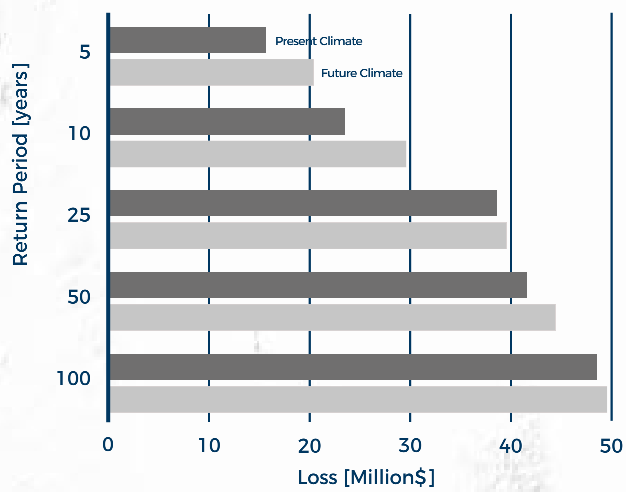
- Under current climate conditions, a gradual increase in agricultural (crop) loss is expected when return periods go up from 10 to 200 years. Under future climate conditions, significantly lower losses are expected for all return periods, where the more frequent losses (return periods of 10 to 50 years) are more than halved, compared to the present climate.

- A modest increase in hydropower losses is expected under future climate conditions. This is mainly for frequent return periods (5 years return period) as losses for high return periods (25 to 100 years) only increase slightly.

PROBABLE MAXIMUM LOSS (PML)
C2 - AGRICULTURAL LOSS

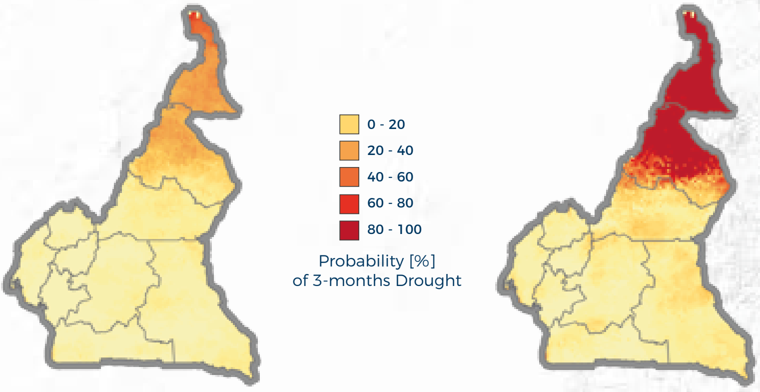


PROBABLE MAXIMUM LOSS (PML)
C3 - PRODUCTIVE ASSETS (HYDROPOWER LOSS)



RESULTS | DROUGHTS

Present Climate | Future Climate

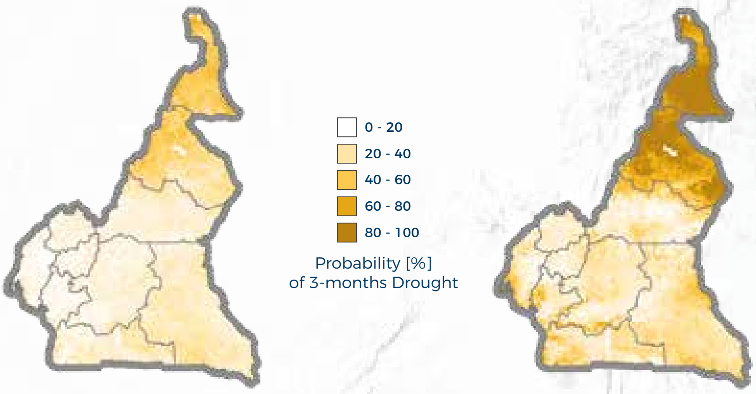


SPEI

Standardised Precipitation-Evapotranspiration Index

These maps denote the average annual chance of a meteorological drought occurring (%). Droughts are defined as 3 months of precipitation minus evapotranspiration values considerably below normal conditions; calculated through the Standardized Precipitation - Evapotranspiration Index (SPEI; see 'Drought' in Glossary).

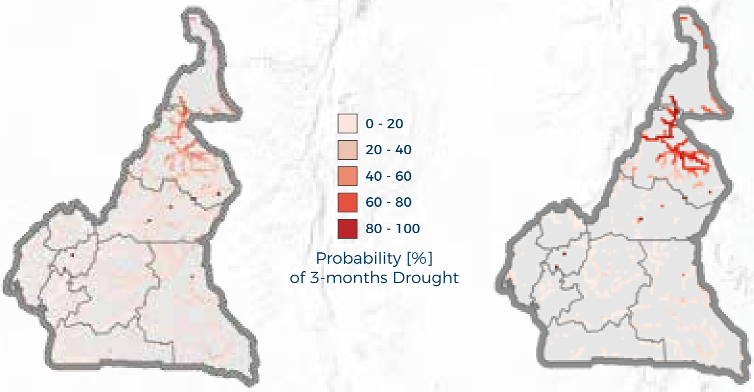
It can be noted that the probability of droughts is the highest in the two most northern regions. . This is particularly important for areas dependent on rainfall for their water resources.



SSMI - Standardised Soil Moisture Index

These maps denote the average annual chance of a subsurface drought occurring (%). Droughts are defined as 3 months of soil moisture conditions considerably below normal conditions; calculated through the Standardized Soil Moisture Index (SSMI; see 'Drought' in Glossary).

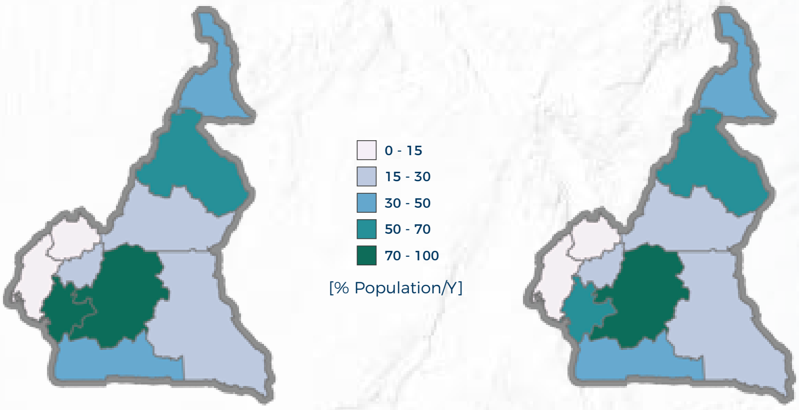
In a future climate, the north as well as some areas in the east and west will see an increase in droughts. This is particularly important for agricultural and natural areas.



SSFI - Standardised Streamflow Index

These maps denote the average annual chance of a hydrological drought occurring (%). Droughts are defined as 3 months of stream flow levels considerably below normal conditions; calculated through the Standardized StreamFlow Index (SSFI; see 'Drought' in Glossary).

Mainly the Logone and rivers around Reservoir de Lagdo will face a higher chance of droughts in a future climate. This is particularly important for areas dependent on rivers for their water resources.



WCI - Water Crowding Index

These maps show the percentage of the population per region experiencing water scarcity, based on the water available (precipitation minus evapotranspiration) per person per year (<1000 m^3/person/year). Water scarcity indicates that a population depends on water resources from outside their immediate region (~85 km^2).

The percentage of people dealing with water scarcity is the highest in the drier north and the highly populated centre of Cameroon.

PROBABILISTIC RISK ASSESSMENT FOR RISK MANAGEMENT

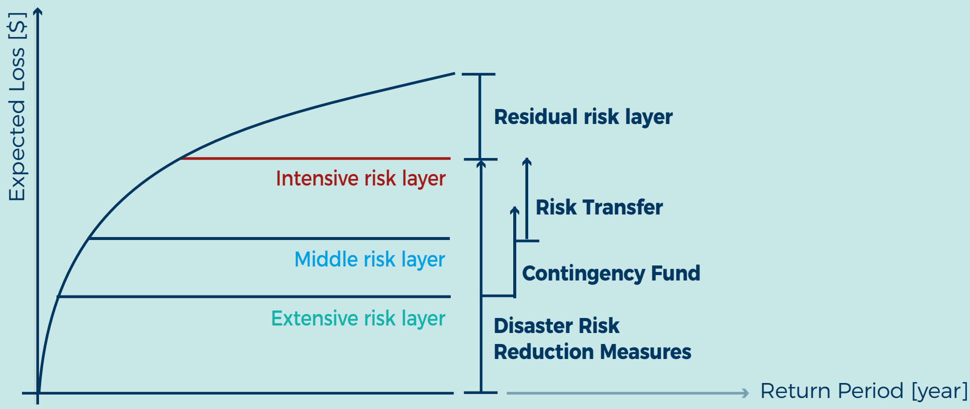
METRICS FOR RISK MANAGEMENT

Risk information may be used to put in place a broad range of activities to reduce risk. Such measures range from improving building codes and designing risk reduction measures, to undertaking macro-level risk assessments used to prioritise investments. Risk metrics help discern the risk contribution of different external factors (such as demographic growth, climate change, urbanization expansion, etc.). They also provide a net measure of progress in the implementation of disaster risk reduction policies. Average Annual Loss (AAL) can be interpreted as an opportunity cost. This is because resources set aside to cover disaster losses could be used for development. Monitoring AAL in relation to other country economic indicators – such as the GDP, capital stock, capital investment, reserves, and social expenditure – provides an indication of a country's fiscal resilience, broadly defined as holding internal and external savings to buffer against disaster shocks. Economies can be severely disrupted if there is a high ratio of AAL to the value of capital stock. Similarly, future economic growth can be compromised if there is a high ratio of AAL to capital investment and reserves. Social development will be challenged if there is a high ratio of AAL to social expenditure. Moreover, limited ability to recover quickly may significantly increase indirect disaster losses. Countries that already have compensatory mechanisms such as effective insurance in place and that can rapidly compensate for losses will recover far more quickly than those that do not. Such mechanisms may include insurance and reinsurance, catastrophe funds, contingency financing arrangements with multilateral finance institutions, and market-based solutions such as catastrophe bonds (UNDRR, 2011 and 2013).

The PML curve is particularly useful in order to articulate a full DRR strategy. It describes the loss that can be experienced for a given return period. Knowing the different level of losses expected on a certain frequency can help to understand how to organise a strategy combining different risk reduction, mitigation, or avoidance actions.

PML CURVE

The PML curve can be subdivided into three main layers. The Extensive Risk Layer is typically associated with risk reduction measures (e.g. flood defences, local vulnerability reduction interventions). The Mid Risk Layer captures cumulative losses from higher impact events. Losses within this layer are commonly mitigated using financial funds which are managed at the country level, such as the contingency fund. Losses which constitute the Intensive Risk Layer (severe and infrequent hazard events) are difficult to finance at the country level. Mechanisms of risk transfer are therefore required to address losses associated with this Intensive Risk layer (e.g. insurance and reinsurance measures). The remaining layer of the curve is Residual Risk (catastrophic events). It is the risk that is considered acceptable/tolerable due to the extreme rarity of such events and associated loss levels. Given its rarity, there are no concrete actions to reduce risk beyond preparedness (e.g. civil protection actions, humanitarian aid coordination).



GLOSSARY & REFERENCES

AFFECTED PEOPLE and GDP
Affected people are the ones that may experience short-term or long-term consequences to their lives, livelihoods or health and in the economic, physical, social, cultural and environmental assets. In the case of this report "affected people from Floods" are the people living in areas experiencing a flood intensity (i.e. a flood water level) above a certain threshold. Analogously, in this report "affected people from Droughts" are the people living in areas experiencing a drought intensity (i.e. a SPEI value) below a certain threshold. The GDP affected has been methodologically defined using the same thresholds both for floods and droughts.

CLIMATE MODEL*
A numerical representation of the climate system based on the physical, chemical and biological properties of its components, their interactions and feedback processes, and accounting for some of its known properties. Climate models are applied as a research tool to study and simulate the climate, and for operational purposes, including monthly, seasonal, and interannual climate predictions.

DISASTER RISK*
The potential loss of life, injury, or destroyed, or damaged assets which could occur to a system, society, or a community in a specific period of time, determined probabilistically as a function of hazard, exposure, vulnerability, and capacity.

DROUGHT
Droughts, defined as unusual and temporary deficits in water supply, are a persistent hazard, potentially impacting human and environment systems. Droughts, which can occur everywhere, should not be confused with aridity, a permanent climate condition. in this profile drought hazard is denoted by various indices, covering a range of drought types (meteorological, hydrological and soil moisture droughts) and standardised using seasonal data (i.e. values accumulated over 90 days). A drought is defined as at least three consecutive months with standardised index values below a certain drought threshold, indicating conditions that are significantly dryer than normal given the reference period 1951-2000.
This drought threshold varies between -0.5 and -2, according to the aridity index of that area: the dryer the area, the less extreme the water deficit needs to be be in order to be considered 'a drought'. droughts are analysed in terms of hazard, exposed population, livestock, and GDP. drought induced losses are explicitly estimated for crop production and hydropower generation.

FLOOD*
Flood hazard in the risk assessment includes river (fluvial) flooding and flash flooding. This risk profile document considers mainly fluvial flooding and flash floods in the main urban centres. Fluvial flooding is estimated at a resolution of 90 m using global meteorological datasets, a global hydrological model, a global flood-routing model, and an inundation downscaling routine. Flash flooding is estimated by deriving susceptibility indicators based on topographic and land use maps. Flood loss curves are developed to define the potential damage to the various assets based on the modelled inundation depth at each specific location.

LOSS DUE TO DROUGHT (CROPS)
Economic losses from selected crops result from multiplying gross production in physical terms by output prices at farm gate. Losses in working days have been estimated as function of crop-specific labour requirements for the cultivation of selected crops. Annual losses have been computed at Admin 1 level as the difference relative to a threshold, when an annual value is below this threshold. The threshold equals the 20% lowest value from the period 1951-2000 and has also been applied for the future climate. Losses at national level have been estimated as the sum of all Admin 1 losses.

RESIDUAL RISK*
The disaster risk that remains in unmanaged form, even when effective disaster risk reduction measures are in place, and for which emergency response and recovery capacities must be maintained.

RESILIENCE*
The ability of a system, community or society exposed to hazards to resist, absorb, accommodate, adapt to, transform, and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions through risk management.

RETURN PERIOD*
Average frequency with which a particular event is expected to occur. It is usually expressed in years, such as 1 in X number of years. This does not mean that an event will occur once every X numbers of years, but is another way of expressing the exceedance probability: a 1 in 200 years event has 0.5% chance to occur or be exceeded every year.

**UNDRR terminology on Disaster Risk Reduction: https://www.unisdr.org/we/inform/publications/7817*

GLOSSARY & REFERENCES

RISK*
The combination of the probability of an event and its negative consequences. While in popular usage the emphasis is usually placed on the concept of chance or possibility, in technical terms the emphasis is on consequences, calculated in terms of "potential losses" for some particular cause, place, and period. It can be noted that people do not necessarily share the same perception of the significance and underlying causes of different risks.

RISK TRANSFER*
The process of formally or informally shifting the financial consequences of particular risks from one party to another, whereby a household, community, enterprise, or State authority will obtain resources from the other party after a disaster occurs, in exchange for ongoing or compensatory social or financial benefits provided to that other party.

**UNDRR terminology on Disaster Risk Reduction: https://www.unisdr.org/we/inform/publications/7817*

[1] Cameroon CIA Factbook https://www.cia.gov/library/publications/the-world-factbook/geos/cm.html

[2] Keywan Riahi et al., The Shared Socioeconomic Pathways and their energy, land use, and greenhouse gas emissions implications: An overview, Global Environmental Change, Volume 42, January 2017, Pages 153-168

[3] Richard H. Moss et al., The next generation of scenarios for climate change research and assessment, Nature volume 463, pages 747–756 (11 February 2010)

[4] Brian C. O'Neill et al., The Scenario Model Intercomparison Project (ScenarioMIP) for CMIP6, Geosci. Model Dev., 9, 3461–3482, 2016, doi:10.5194/gmd-9-3461-2016

[5] McSweeney, C., New, M. & Lizcano, G. 2010. UNDP Climate Change Country Profiles: Cameroon, Available: https://www.geog.ox.ac.uk/research/climate/projects/undp-cp/UNDP_reports/Cameroon/Cameroon.lowres.report.pdf

[6] McSweeney, C., New, M., Lizcano, G. & Lu, X. 2010. The UNDP Climate Change Country Profiles Improving the Accessibility of Observed and Projected Climate Information for Studies of Climate Change in Developing Countries. Bulletin of the American Meteorological Society, 91, 157-166.

[7] Harris, I. P. D. J., Jones, P. D., Osborn, T. J., & Lister, D. H. (2014). Updated high-resolution grids of monthly climatic observations-the CRU TS3. 10 Dataset. International Journal of Climatology, 34(3), 623-642.

[8] FAO (2005). Aquastat, Cameroon, http://www.fao.org/nr/water/aquastat/countries_regions/CMR/index.stm

[9] Alder, J. R., & Hostetler, S. W. (2015). Web based visualization of large climate data sets. Environmental Modelling & Software, 68, 175-180.

[10] Abba Omar, S. & Abiodun, B.J., How well do CORDEX models simulate extreme rainfall events over the East Coast of South Africa? Theor Appl Climatol (2017) 128: 453. https://doi.org/10.1007/s00704-015-1714-5

[11] Nikulin, G., Jones, C., Giorgi, F., Asrar, G., Büchner, M., Cerezo-Mota, R., ... & Sushama, L. (2012). Precipitation climatology in an ensemble of CORDEX-Africa regional climate simulations. Journal of Climate, 25(18), 6057-6078.

[12] Nikulin G, Lennard C, Dosio A, Kjellström E, Chen Y, Hänsler A, Kupiainen M, Laprise R, Mariotti L, Fox Maule C, van Meijgaard E, Panitz H-J, Scinocca J F and Somot S (2018) The effects of 1.5 and 2 degrees of global warming on Africa in the CORDEX ensemble, Environ. Res. Lett., doi:10.1088/1748-9326/aab2b4

The results presented in this report have been elaborated to the best of our ability, optimising the publicly data and information available. All geographic information has limitations due to scale, resolution, data and interpretation of the original sources.

www.preventionweb.net/resilient-africa

www.undrr.org

RISK PROFILES ARE AVAILABLE AT:

riskprofilesundrr.org

This publication has been produced with the assistance of the European Union.
The contents of this publication are the sole responsibility of CIMA Research Foundation and can in no way be taken to reflect the views of the European Union.