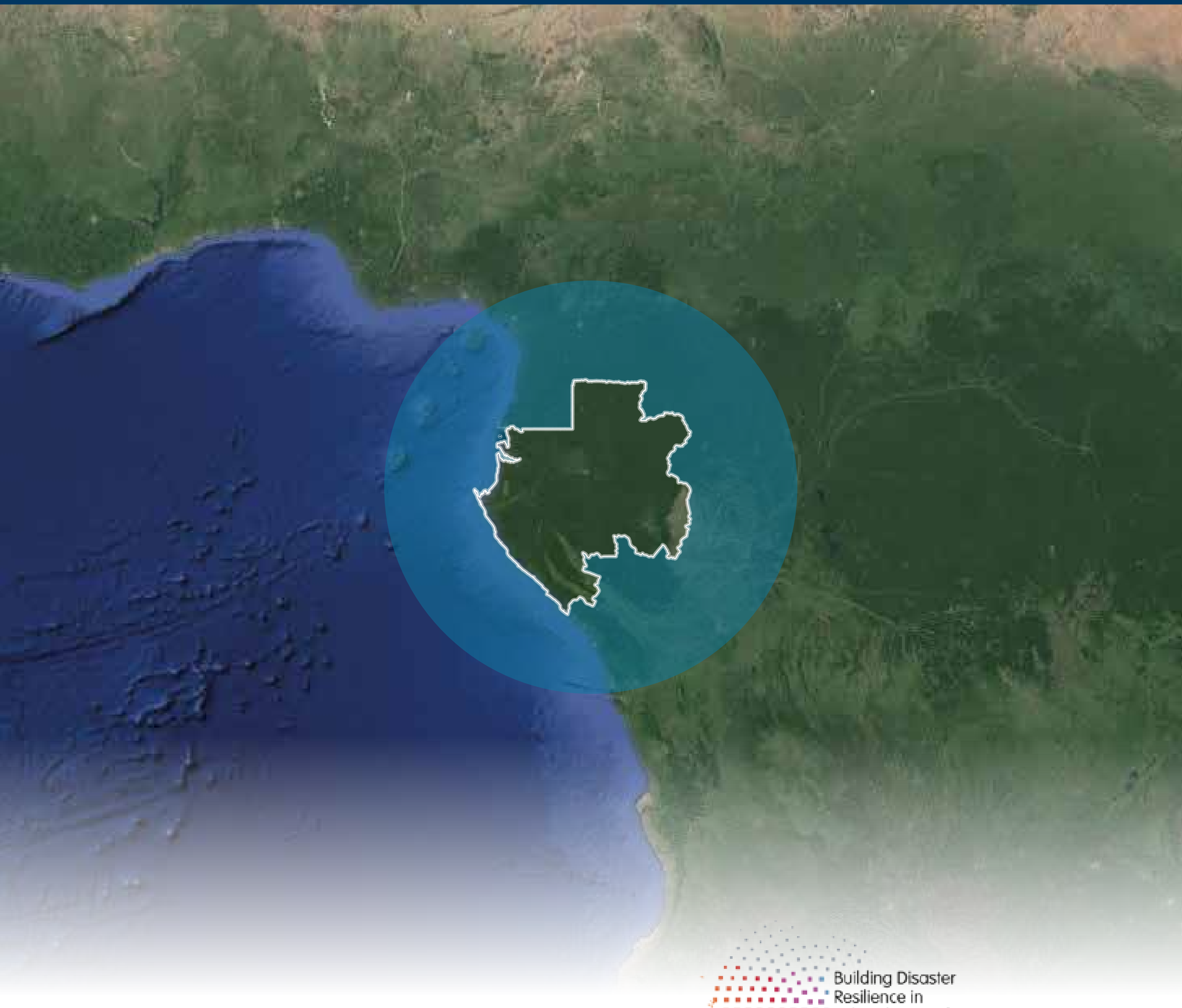
2019

DISASTER RISK PROFILE

Flood Drought

Gabon



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

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UNDRR
UN Office for Disaster Risk Reduction

cima RESEARCH FOUNDATION

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2019 - Review

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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.

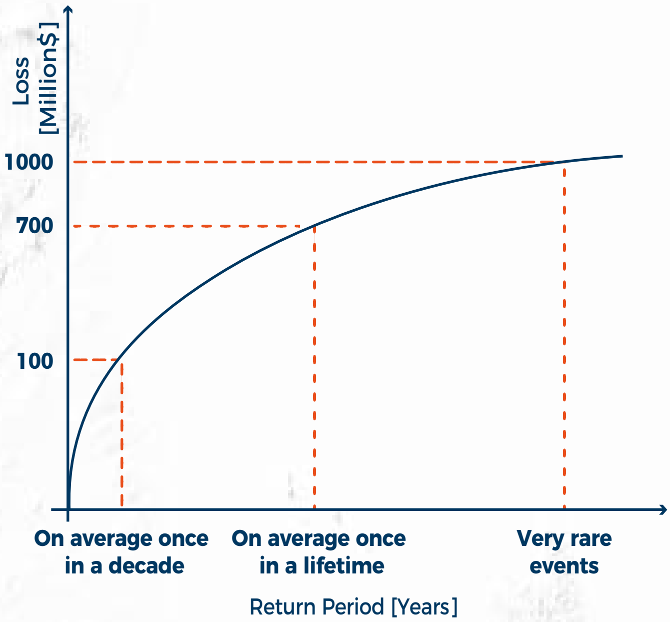
This disaster risk profile for floods and droughts is based on probabilistic risk assessment. Awareness of possible perils that may threaten human lives primarily derives from experience of past events. In theory, series of historical loss data long enough to be representative of all possible disastrous 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

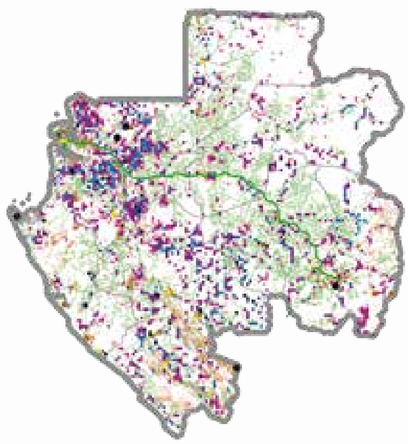
conditions determined by physical, social, economic and environmental factors or processes which increase the susceptibility of an individual, a community, assets or systems to the impacts of hazards.

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

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

COUNTRY SOCIO-ECONOMIC OUTLOOK

OVERVIEW

Gabon is a central-western African country bordering Cameroon, Equatorial Guinea, and the Republic of Congo. With a population of only 2 million people, Gabon is sparsely populated, with forests covering 85% of the territory [1]. It has one of the highest urbanization rates in Africa: 79.4% [2].

Gabon is an upper-middle-income country and it is the fifth largest oil producer in Africa. The largest part of its economy is based on the oil extraction that drove the strong economic growth over the past decade, together with manganese production. On average, over the past five years, the oil sector has accounted for 80% of exports, 45% of GDP, and 60% of fiscal revenue [1]. GDP has grown nearly 6% per year over the 2010-14 period, but it has slowed down significantly since then to just 1% in 2017, as oil prices declined [3]. Growth rose again in 2018, driven instead by the non-extractive sectors, in particular agribusiness and the upgraded transportation and communication systems [1]. Continued sustained growth and development is at risk of being impacted by climate change. The flood and drought risk assessments presented in this report show the potential impacts, and can be used as a guide for future development. This report argues therefore that a thorough understanding of risk is essential to the healthy future development of the country.

SOCIO-ECONOMIC PROJECTIONS

Recently, climate scientists and economists have formulated a range of new "pathways" that examine how national and global societies, demographics and economics might lead to different plausible future development scenarios over the next hundred years [4,5]. The scenarios range from relatively optimistic trends for human development, with "substantial investments in education and health, rapid economic growth and well-functioning institutions" [6], to more pessimistic economic and social stagnation, with little investment in education or health in poorer countries, coupled with a fast-growing population and increasing inequalities.

PROJECTIONS USED IN THE RISK PROFILE

The "middle of the road" scenario envisages that recent development patterns will persist throughout the 21st century. Following these projections, Gabon's population will increase by 16% between 2016 and 2050 (World Bank Data), and GDP will increase almost fivefold.

POPULATION	GDP
2016 Projection	2016 Projection
2.0	**14.0**
[Million People]	[Billion$]
2.3	**67.7**
2050 Projection	2050 Projection

GABON

AREA : 267.667 km² *(STAT-GABON.ORG)*

POPULATION DENSITY : 8 people/km²

MEDIAN AGE : 22 years *(DGSTAT-GA)*

HDI - HUMAN DEVELOPMENT INDEX : 0.702 *(UNDP - 2017)*

LIFE EXPECTANCY AT BIRTH : 66.5 years *(UNDP - 2017)*

MEAN YEARS OF SCHOOLING : 8.2 years *(UNDP - 2017)*

EMPLOYMENT TO POP. RATIO (AGES > 15) : 41.3% *(WB - 2017)*

EMPLOYMENT IN AGRICULTURE : 41.9% *(WB - 2017)*

EMPLOYMENT IN SERVICES : 45.6% *(WB - 2017)*

data from:
http://hdr.undp.org/en/countries/profiles/
https://data.worldbank.org/indicator/
http://www.stat-gabon.org/ - http://dgstat.ga/

COUNTRY CLIMATE OUTLOOK

OVERVIEW

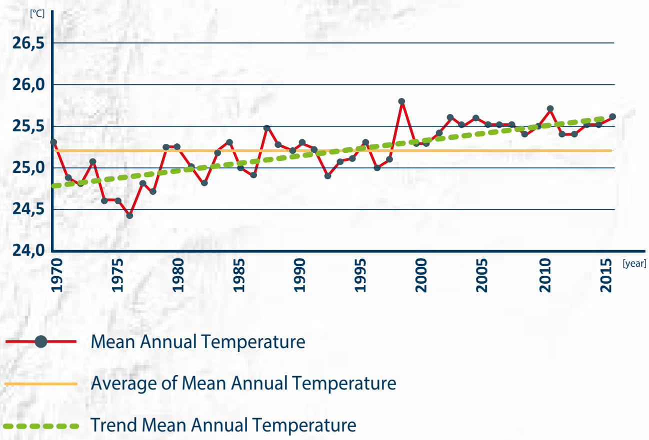
Gabon is located on the western coast of southern Africa, straddling the Equator. The coastal plains of Gabon continue around 300 km inland, beyond which a number of mountain ranges rise. The climate is typically tropical, with high average temperatures year-round and a single rainy season between October and May [7,8]. According to the distribution and the rate of precipitation, the country has three main climates: the pure equatorial climate, the equatorial climate of transition of the central zone, and the equatorial climate of the south-west and the central Atlantic littoral [9].

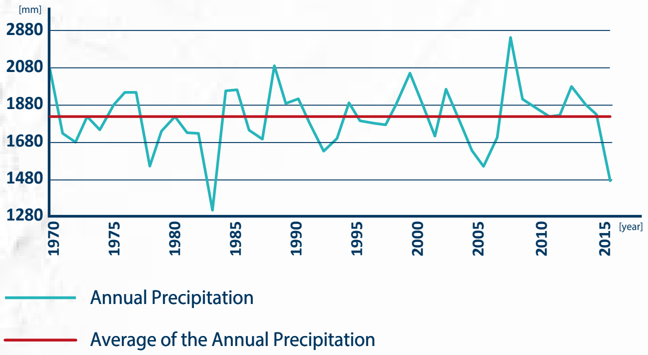
Average annual precipitation for Gabon is approximately 1800 mm, while the mean number of wet days is around 140.

CLIMATE TRENDS

As in other western and central African countries, temperature observations indicate that Gabon has experienced a considerable increase in temperature over the past five decades. An analysis of climate data from 1970 to 2015 [10] shows a rise in temperature of about 1˚C. Trends for precipitation are not as clear as those for air temperature, with high variability in time and space.

TEMPERATURE AND PRECIPITATION TRENDS IN CURRENT CLIMATE





RIVERS OF GABON

Gabon has a dense hydrographic system that is composed of an abundant network of permanent streams. The large catchment area of Ogooué dominates the smaller ones of the Nyanga and Komo coastal rivers. Only the lower reaches of the largest rivers are navigable all year round: the Komo river from Kango to Libreville and the Ogooué river from Ndjolé to Port-Gentil. There are 3,000 km of waterways that are potentially usable [11]. The Ogooué basin drains 215,000 km² of which almost 90% are in Gabon. It is confined to the east by the Congo Basin, to the south by the Niari and Nyanga basins, and to the west and north by the coastal river basins. Traveling about 1,000 km, Ogooué has its source in Congo. Ivindo, its most important tributary, drains the north-east quarter of the country. Ngounié, second tributary, drains 33,100 km² in the south. Nyanga is the second largest river in Gabon. It is the southernmost of the country, which flows to a lesser extent in Congolese territory (80%). Komo is the third largest Gabonese river. It is born in Equatorial Guinea, but the largest part of its watershed is in Gabonese territory. Its main course covers an area of approximately 3,200 km² [11].

Photo Credit: Di Susi4 - Opera propria, CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=4757608

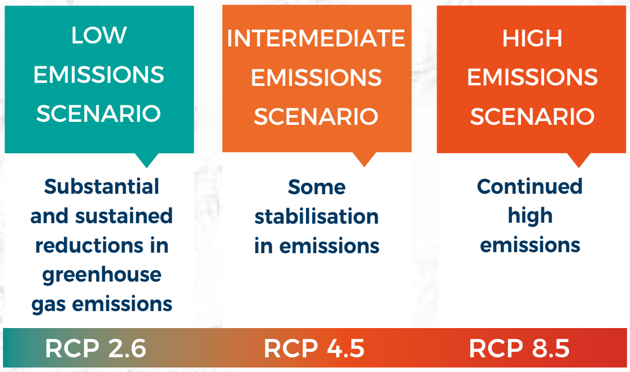
CLIMATE PROJECTIONS FOR GABON

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 [12] 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). Model simulations showed an increase in temperature in all future projections and emission scenarios. The increase of temperature was more evident in high emissions scenarios and long term period projections. In high emission scenarios (RCP8.5), model projections show an increase between 1.5˚C and 3.5˚C for the mid term (2050-2074) and an increase between 2˚C and 5˚C for the long term (2071-2095). Future changes in precipitation are much more uncertain, however the models predict a slightly increase in precipitation for both medium and long term and for all different emission scenarios.

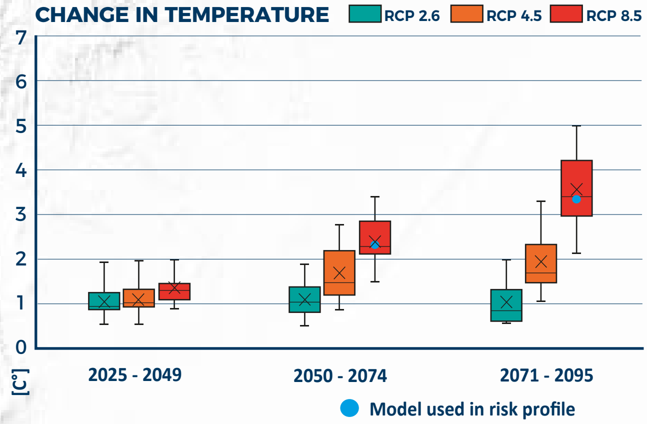
Time Frame	Climate Projections (RCP 8.5 - High emission scenario)
Mid-term Future (2050-2074)	Increase in temperature from 1.5˚C to 3.5˚C Very likely precipitation increase (up to 10%)
Far Future (2071-2095)	Increase in temperature from 2˚C to 5˚C Very likely precipitation increase (up to 14%)

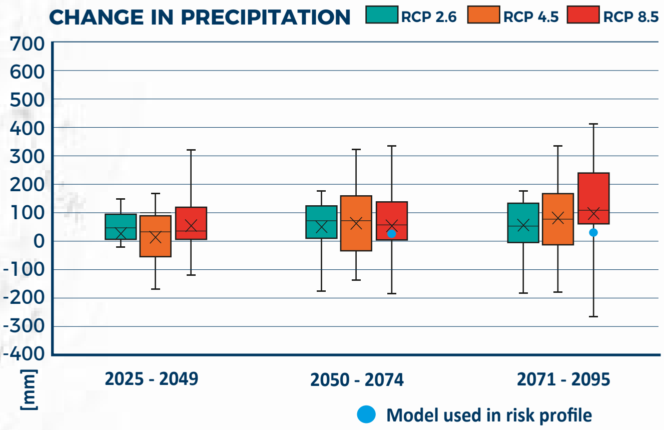
CLIMATE PROJECTIONS USED IN THIS RISK PROFILE

Results presented in the Risk Profile regarding climate change effects have been obtained using a Regional 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) [13, 14, 15]. This high resolution model has been accurately calibrated for the African domain. This allows for a better capture of local climate variability which is key in assessing extremes. Regional model projections were also checked for consistency against a full ensemble of global models available for the area. Projected changes in temperature and annual precipitation from the Regional model are in line with the range of variability of global models analyzed in the study by Alder et al. [12].



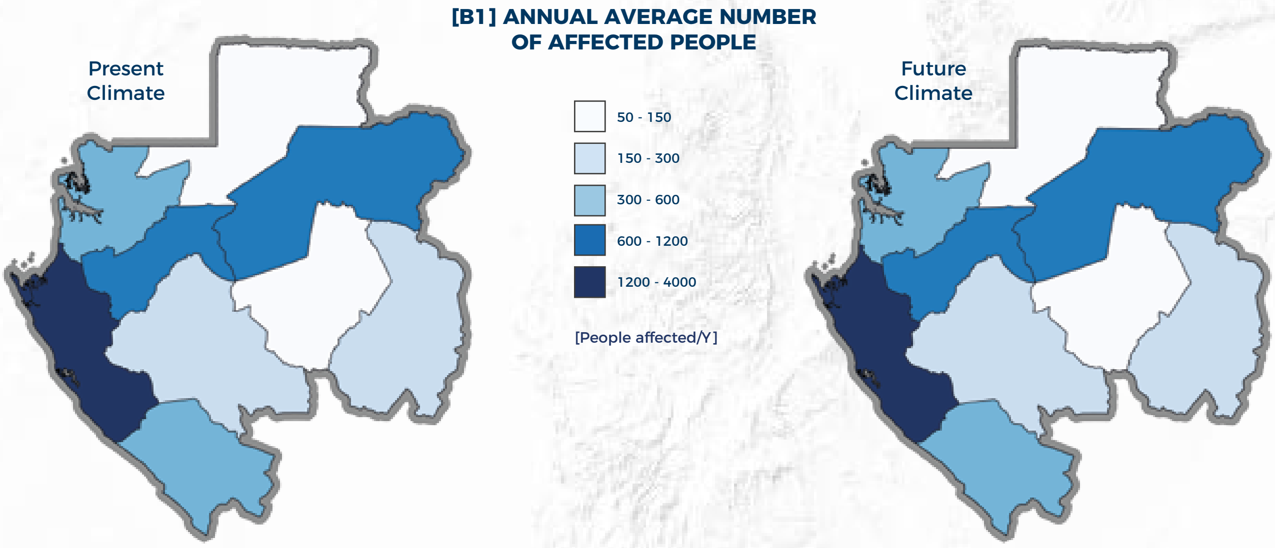
IPCC's Emissions scenarios for Climate Projections





However, in the specific case of high emission scenario, the Regional model predicts a moderate increase in temperature (something less than 3.5˚C in the long term period) in line with the global ensemble. As regards to annual precipitation at the country level, almost no changes are predicted by the Regional model in the long-term period.

RESULTS | FLOODS



KEY MESSAGES

● Floods affect on average, about 0.33% of the total population of the country.

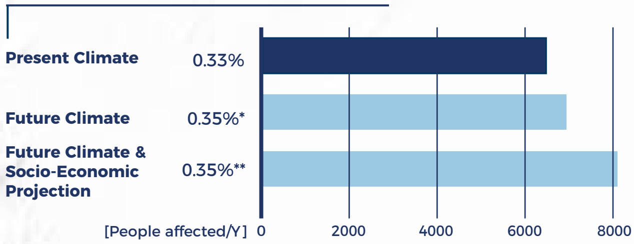
● The potentially affected people distribution shows two hotspots in Ogooué-Maritime, Moyen-Ogooué and Ogooué-Ivindo. This pattern is confirmed in the future climate.

● The local economy is also exposed to floods. On a yearly average, the areas that are affected by floods produce about 0.34% of the national GDP which corresponds to about 50 million USD per year.

● It is likely that, under future climate conditions, the population affected increases, but in a way that is not statistically significant. However, as shown in the climate section, climate projections are inherently uncertain and this should be considered when using these estimations in policy development. Similar behavior is expected for the potentially affected GDP.

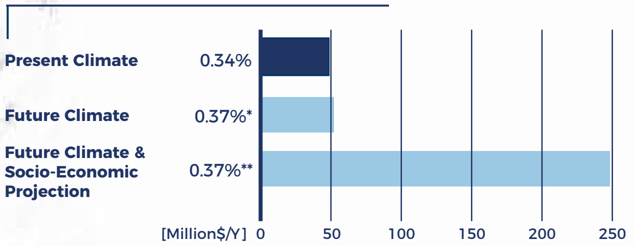
● When population and GDP potentially affected for current climate conditions are compared with estimates under future climate conditions paired with the projected socio-economic situation (*), they show a likely increase that in the case of GDP is a significant one. Specifically, potentially affected GDP increases up to five times with respect to estimates in the present climate. As has already been mentioned, the future prediction is affected by uncertainty.

ANNUAL AVERAGE NUMBER OF POTENTIALLY AFFECTED PEOPLE [B1]



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

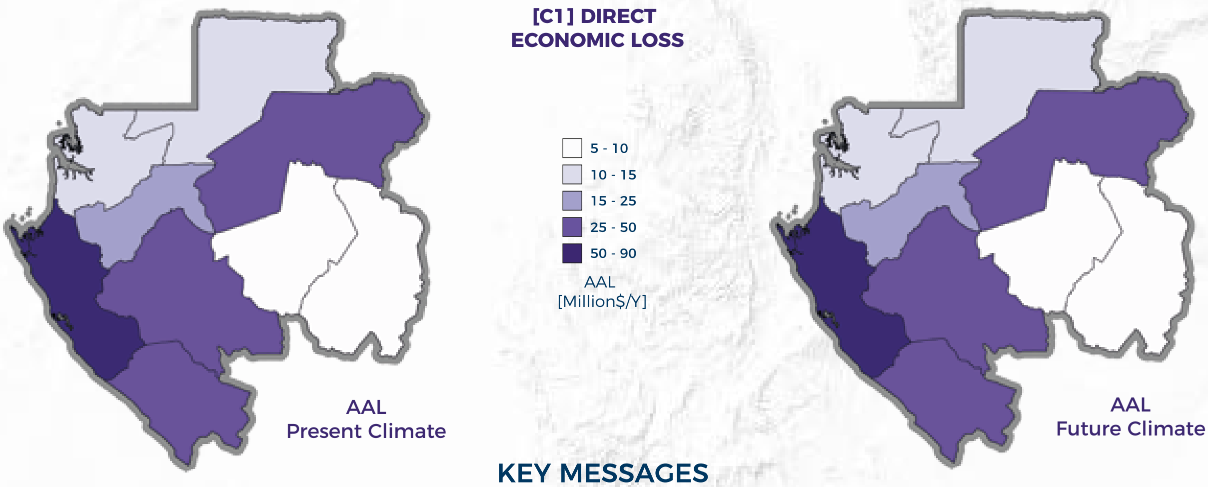
ANNUAL AVERAGE POTENTIALLY AFFECTED GDP



* % 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



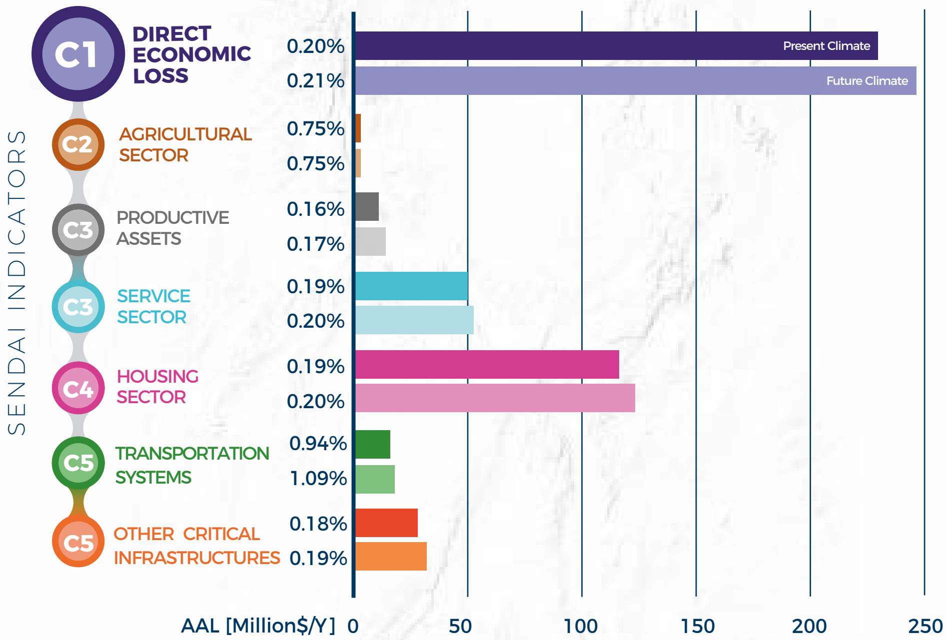
KEY MESSAGES

● The direct economic losses in Gabon are the result of a complex combination of geographically distributed hazard and exposure. The regions more significantly affected by floods are concentrated in the central part of the country along the Ogooué river. The pattern is confirmed under future climate conditions with one hotspot that stands out clearly in the Ogooué-Maritime province.

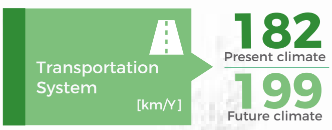
● The value of direct economic losses in terms of AAL amounts to 225 millions of USD, which roughly amounts to 0.20% of the total stock value in the present climate. The larger portion of losses is due to the housing sector followed by the service sector. The agricultural sector shows a small impact in absolute terms.

● In relative terms, the most affected sectors are the agricultural and the transport sectors.

● Even considering the presently exposed assets, without socio-economic development, the direct economic loss increases slightly when climate change is considered. This increase is even accross all sectors. The socio-economic projections are likely to increase this figure even more, depicting a strongly enhanced risk scape for Gabon in the next 30 years.



AFFECTED INFRASTRUCTURES [D4]

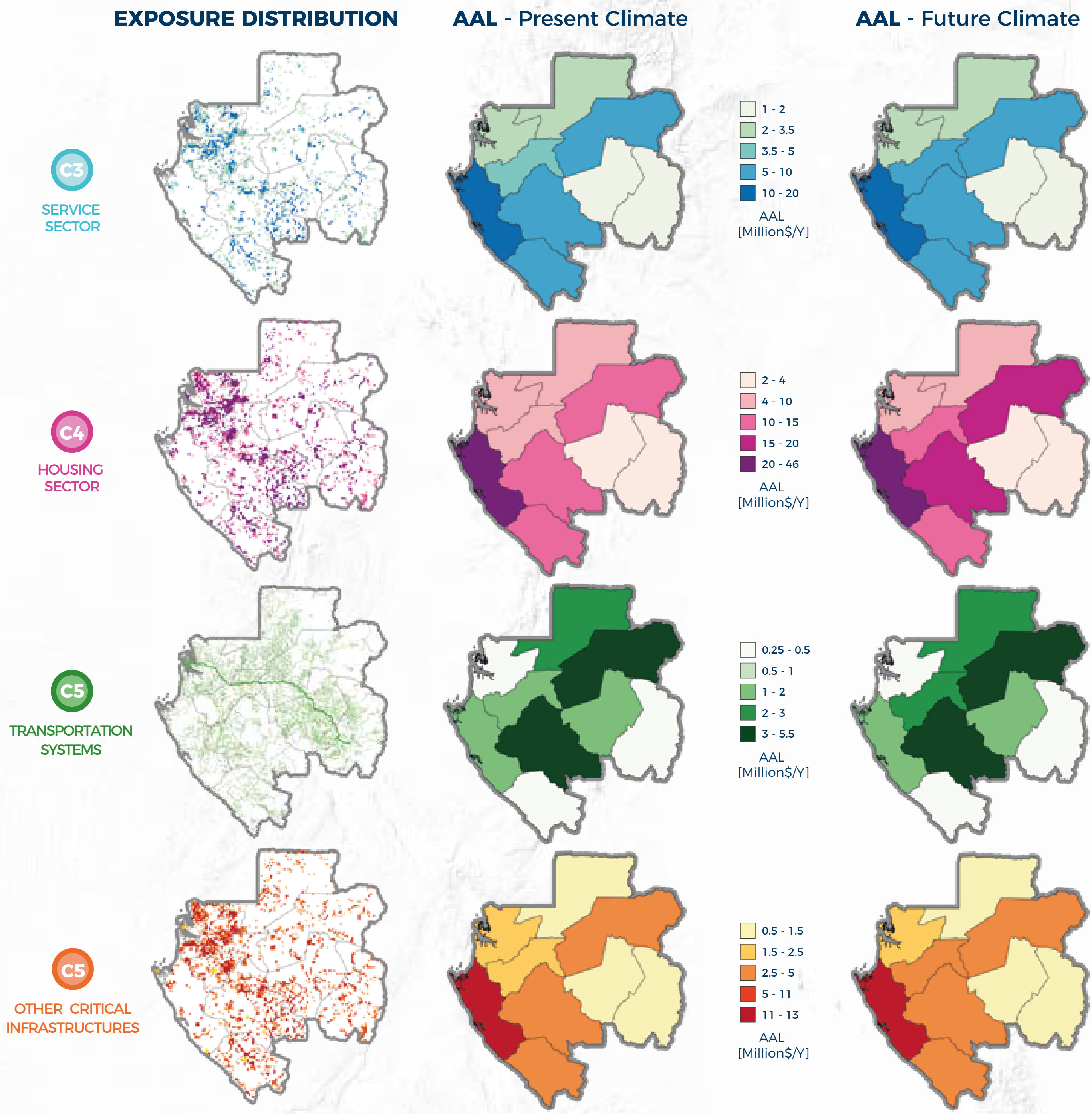


RESULTS | FLOODS

KEY MESSAGES

- The AAL distribution shows minor differences across the sectors considered, depending on the exposure distribution. Ogooué - Maritime remains the most impacted province across all sectors except for transport where the the pattern of risk changes significantly.

- Comparison of AALs for all sectors between the present and the future climate shows that a slight increase is to be expected in all provinces.



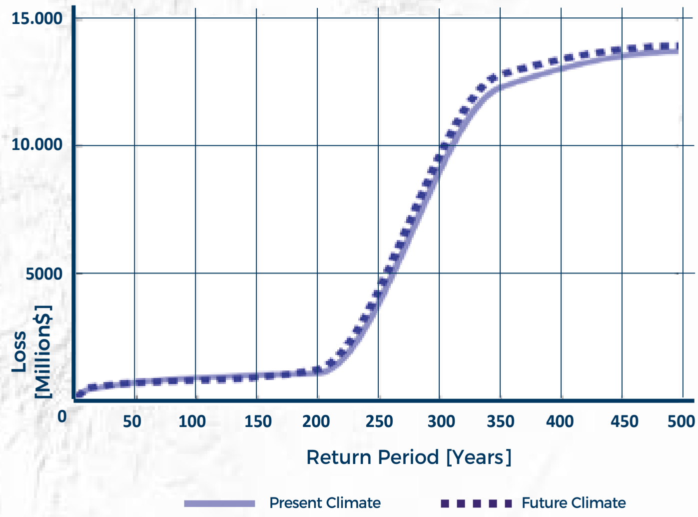
RESULTS | FLOODS

KEY MESSAGES

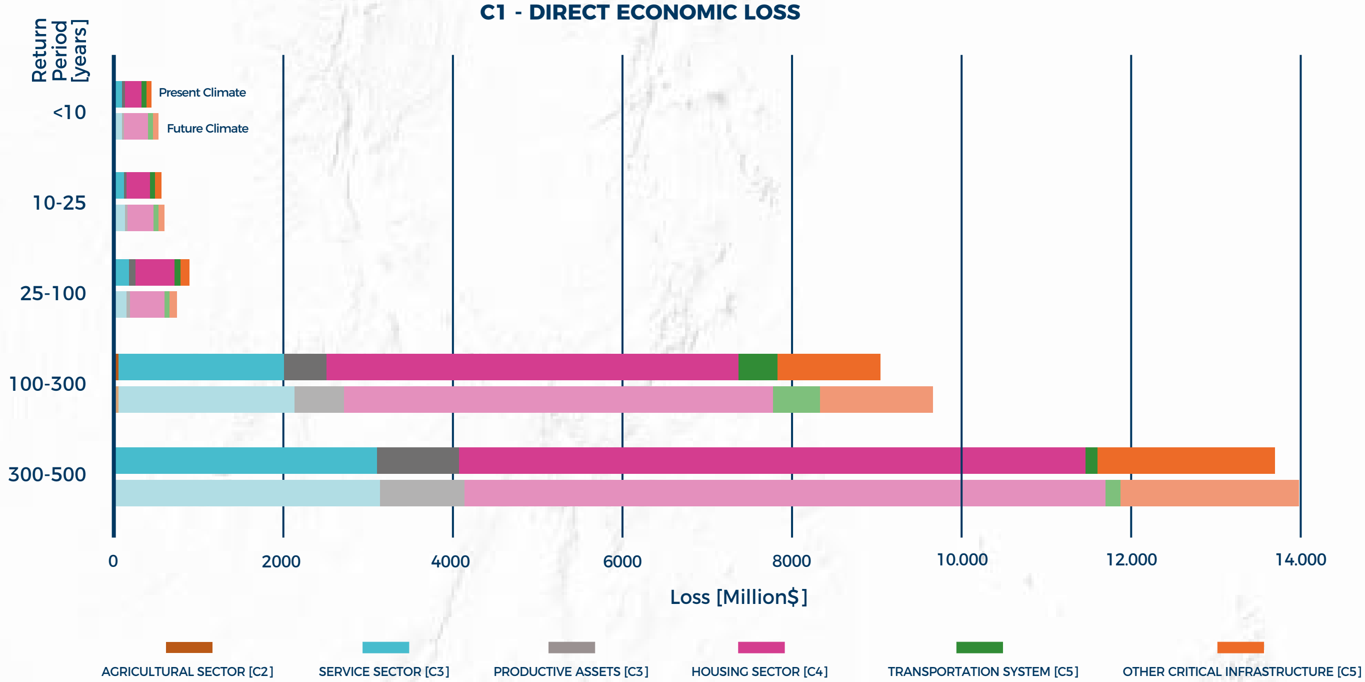
● Although Average Annual Loss is about 225 million USD, very rare events losses can reach up to 10 billion USD.

● The sectors that are most affected by both frequent, very frequent and extreme losses are the housing and service sectors. The share for health and education facilities is also significant throughout the different frequencies.

● It is likely that both frequent and extreme flood-related losses will increase slightly under future climate conditions, and there will be greater differences between rare and very rare loss events. Given the high level of uncertainty in future climate predictions, worse scenarios may also be possible (compare climate section on p.8).

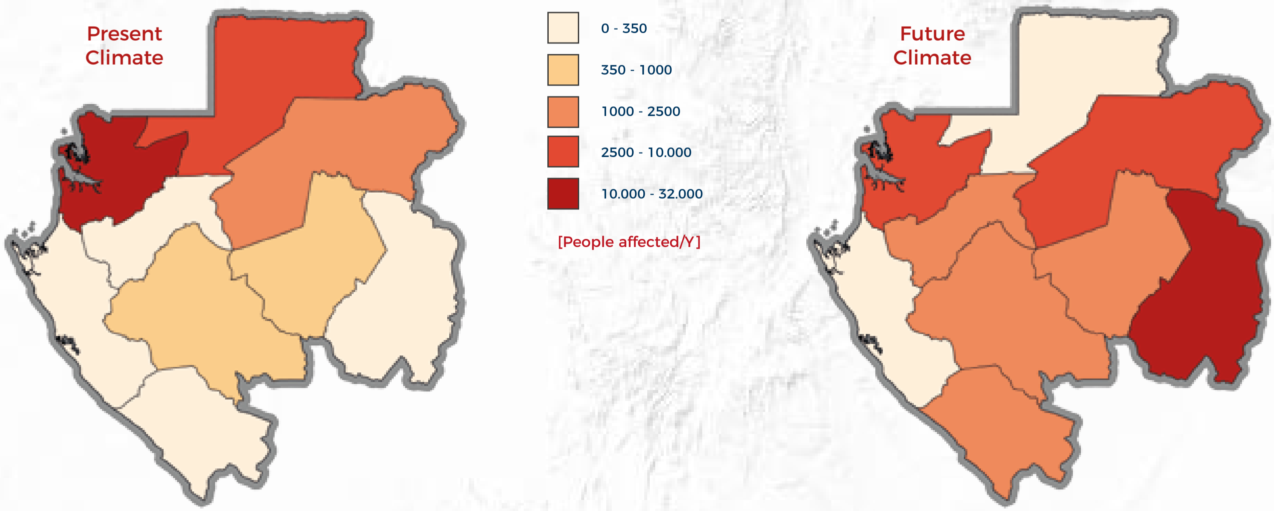


PROBABLE MAXIMUM LOSS CURVE (PML) ACROSS ALL SECTORS
C1 - DIRECT ECONOMIC LOSS



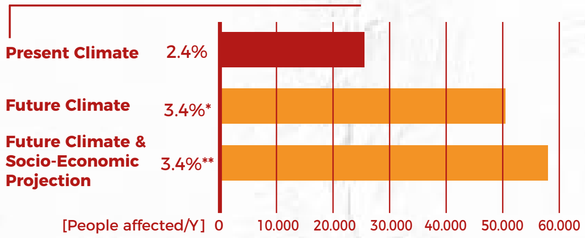
RESULTS | DROUGHTS

[B1] ANNUAL AVERAGE NUMBER OF AFFECTED PEOPLE



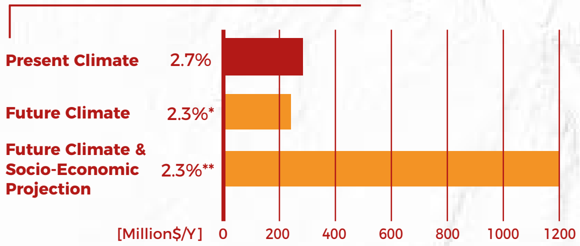
Annual average of population potentially affected by at least three months of drought conditions, as calculated using the standardized precipitation-evapotranspiration index (SPEI) and using a 3-month accumulation period.

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 precipitation deficiencies will slightly decrease, while the probability of effective precipitation (precipitation – evapotranspiration) deficiencies will increase in the future (2050-2100 climate).

- Presently, on average about 25.000 people (2.4% of the total 2016 Population) are annually affected by droughts. Under future climate conditions, this number is expected to increase to 3.4% (on average 58.000 people if population growth is accounted for).

- The average percentage of GDP potentially affected by droughts (i.e. the economic value produced in areas hit by droughts) is about 2.7% of the total GDP. This is equivalent to 284 million USD per year. Under future climate conditions, this may rise to 2.3% of the GDP, which amounts to 1.2 billion USD if socio-economic projections are included.

RESULTS | DROUGHTS

KEY MESSAGES

● Approximately 1.6% of the country's total livestock is affected by drought under current climate conditions , while under future climate conditions (but keeping the current amount of livestock), it is projected to increase up to 4.8%. Currently, most of the livestock affected by droughts is situated in Ngounié, while in the future, large numbers of livestock will also be affected in the Nyanga, Haut-Ogooué and Ogooué-Ivindo provinces.

● Under present climate conditions, agricultural crop losses are dominated by four crops (cassava, plantain, sugarcane and yam). In the future, a significant physical loss has been projected for only two crops (cassava and groundnut). In relative units (compared to the average crop production), losses of most crops are very small in the present climate, and even decrease to zero under the selected future climate. Only groundnut crops see an increase in relative losses from 2.5% (present) to 3.0% (future).

● Economic crop production losses are concentrated in the south-eastern part of Gabon under present climate conditions. Under future climate conditions, losses decrease substantially in all regions towards zero. This is caused by the higher production in the future climate compared to the present climate, combined with a low variation of the production among years in the future, while taking the situation of the present climate as a reference for defining crop losses. Given the high level of uncertainty in the future climate prediction, worse scenarios may also be possible (compare climate section on p.8).

● Consistent with the decrease in crop production losses, the amount of lost working days also decreases between present and future climates. In total about 35.000 (present) and 5.000 (future) working days are lost, which is about 0.13% and 0.02% 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 five times higher.

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

35 | 0.13%
Present climate

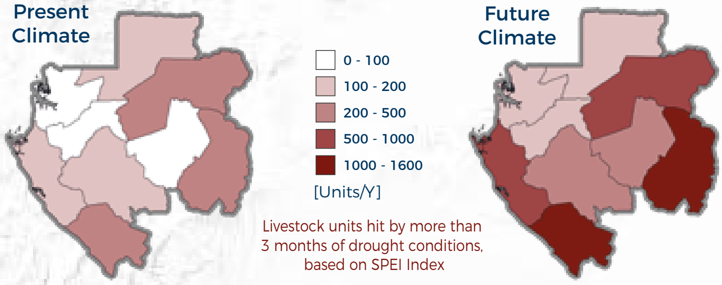
5 | 0.02%
Future climate

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

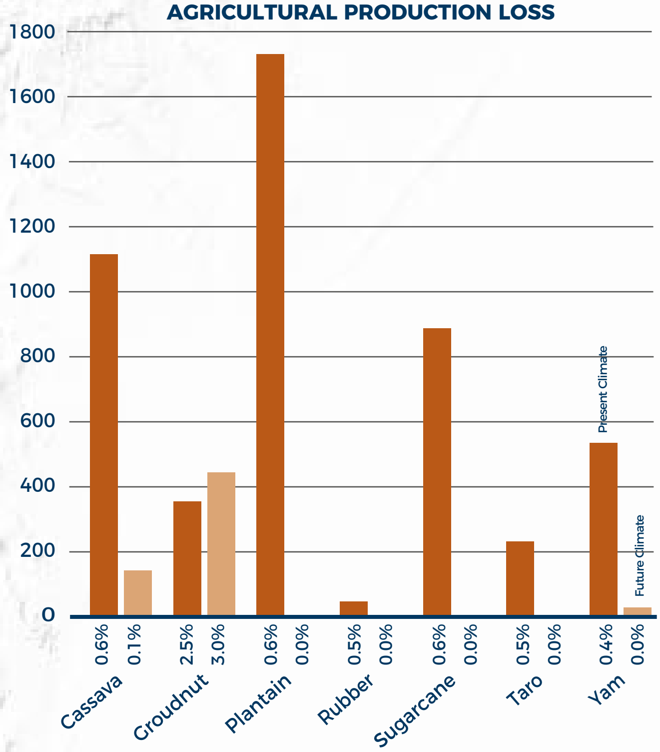
1860 | 1.6%
Present climate

5460 | 4.8%
Future climate

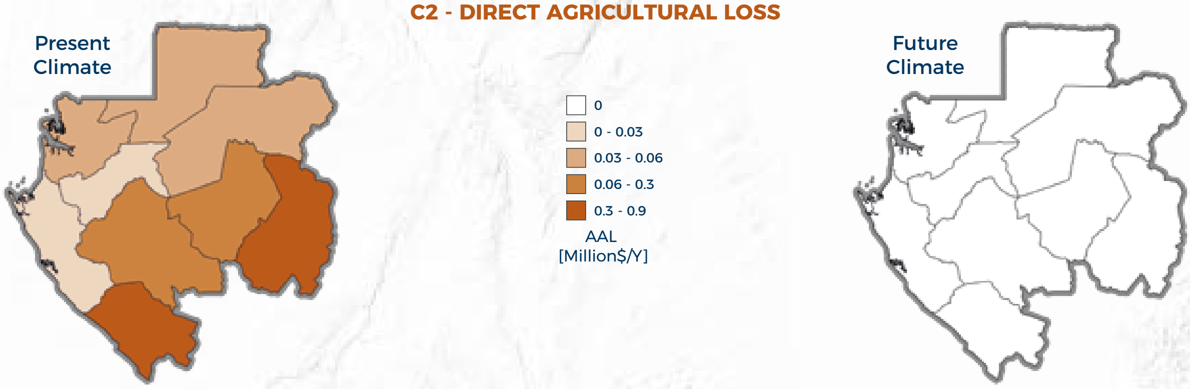
*Livestock is a summation of all livestock animals (referred to as livestock units) using FAO conversion factors



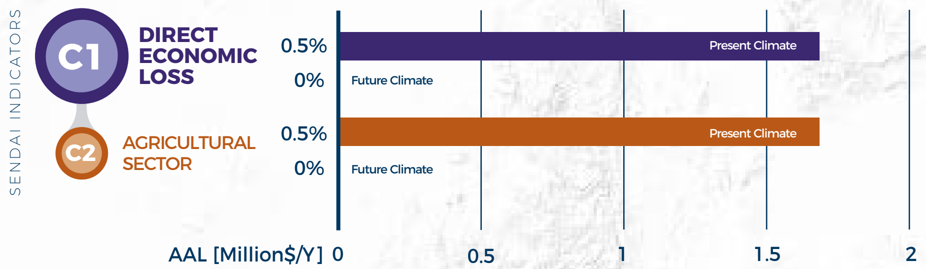
AGRICULTURAL PRODUCTION LOSS



C2 - DIRECT AGRICULTURAL LOSS



RESULTS | DROUGHTS

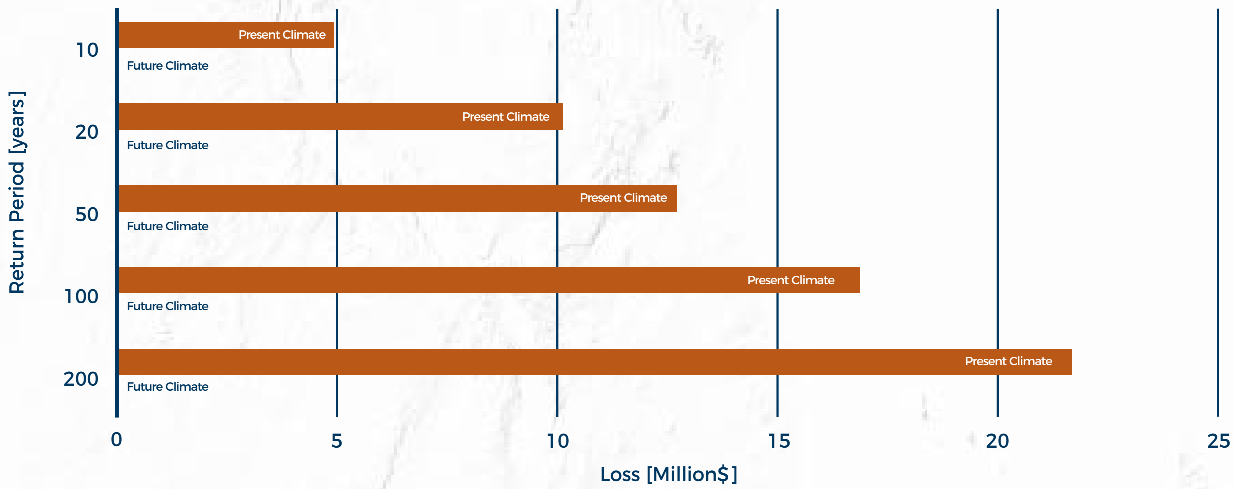


C2 is computed considering only direct loss associated with reference agricultural (crop) production. Reference crops considered in the analysis are the ones which contribute to at least 85% of the total country-level gross crop production value. It might therefore happen that crops which have an important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

KEY MESSAGES

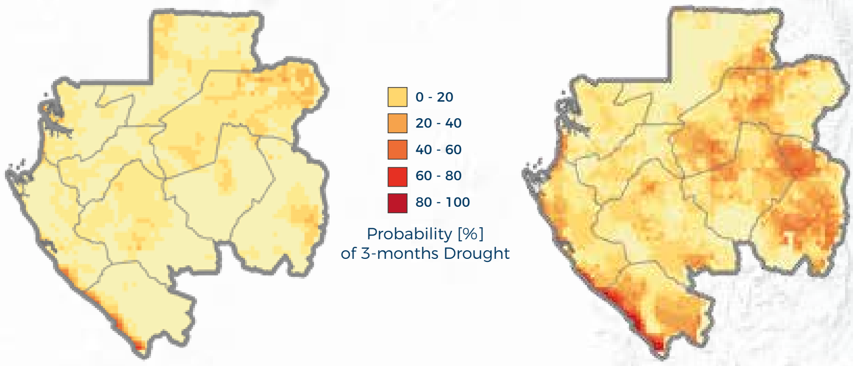
- Average annual economic crop production loss (C2) decreases from more than 1.5 million USD under present climate conditions to 0 million USD under future climate conditions. Losses in the present climate represent 0.5% of the average economic value of crop production.
- Under current climate conditions, a gradual increase in agricultural (crop) income loss is expected when return periods go up from 10 years (loss of 5 million USD) to 200 years (loss of >20 million USD). Under future climate conditions, losses are estimated at zero for all return periods (up to 200 years).

PROBABLE MAXIMUM LOSS (PML) C2 - AGRICULTURAL LOSS



RESULTS | DROUGHTS

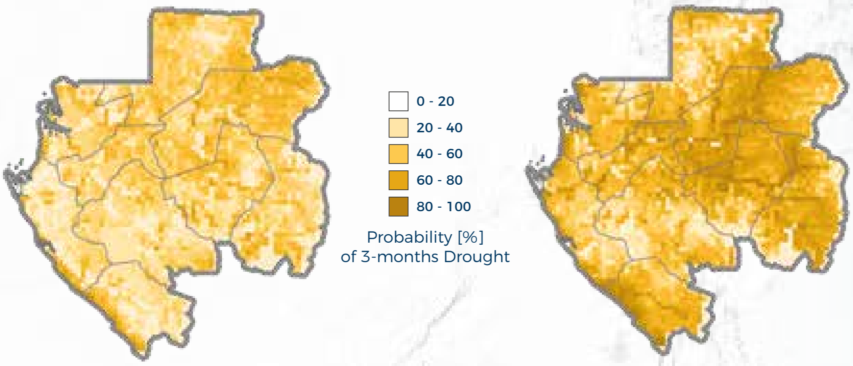
Present Climate | Future Climate



SPEI

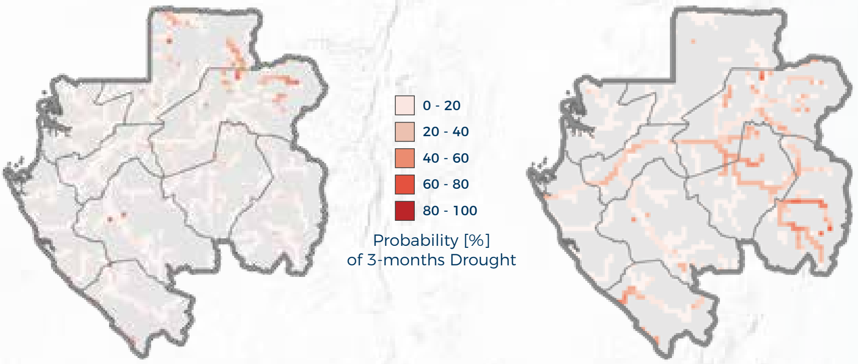
Standardised Precipitation-Evapotranspiration Index

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 in a future climate increases for some areas, but the overall probability remains rather low. This is particularly important for areas dependent on rainfall for their water resources.



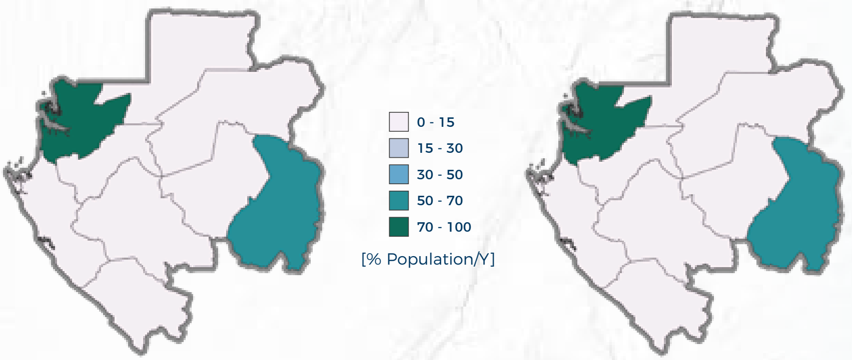
SSMI - Standardised Soil Moisture Index

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).
Currently, some areas have up to a 20 % chance of facing a drought in any given year; this could rise to 80% in the future. This is particularly important for agricultural areas and nature.



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 Ogooué river 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 m³/person/year). Water scarcity indicates that a population depends on water resources from outside their immediate region (~85 km²).
Haut-Ogooué and Estuaire provinces, the two most densely populated provinces, have to deal with a certain level of water scarcity, both in the current and in a future climate.

PROBABILISTIC RISK ASSESSMENT FOR RISK MANAGEMENT

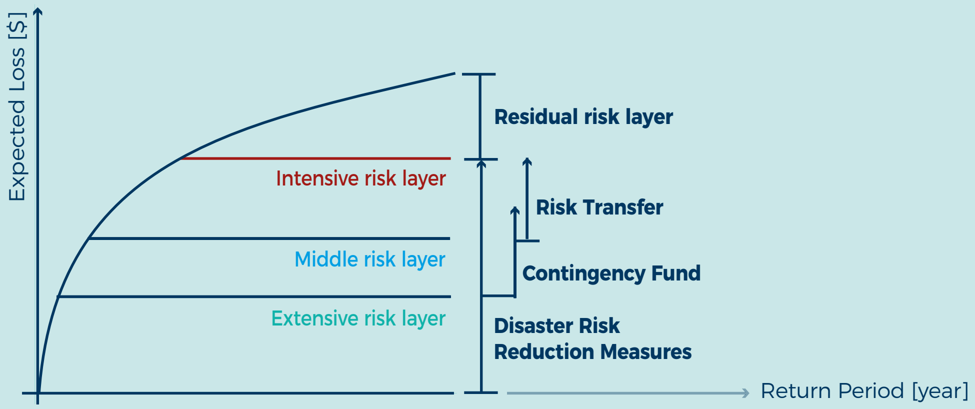
METRICS FOR RISK MANAGEMENT

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] WorldBank, Gabon Overview, https://www.worldbank.org/en/country/gabon/overview

[2] Gabon CIA Factbook https://www.cia.gov/llibrary/publications/the-world-factbook/geos/gb.html

[3] http://www.worldometers.info/world-population/gabon-population/

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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

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riskprofilesundrr.org

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