

Ghana



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



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INDEX

Introduction.....	P.4
Probabilistic Risk Profile: Methodology.....	P.5
Probabilistic Risk Profile: Components.....	P.6
A Sendai Oriented Risk Profile.....	P.7
Country Socio-Economic Outlook.....	P.8
Country Climate Outlook.....	P.9
Results Floods.....	P.11
Results Droughts.....	P.15
Probabilistic Risk Assessment for Risk Management.....	P.19
Glossary & References.....	P.20

INTRODUCTION

Disasters are on the rise, both in terms of frequency and magnitude.

From 2005-2015, more than 700 thousand people worldwide have lost their lives due to disasters that have affected over 1.5 billion people, with women, children and people in vulnerable situations disproportionately affected. The total economic loss was 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 strong political leadership, commitment, and involvement of all stakeholders at all levels from local to national and international, with a view 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 assessment 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 programme “Building Disaster Resilience to Natural Hazards in Sub-Saharan African Regions, Countries and Communities”, UNISDR engaged 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), Ivory Coast, Namibia, Rwanda, São Tomé and Príncipe, Tanzania, 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 programme “Building Disaster Resilience to Natural Hazards in Sub-Saharan African Regions, Countries and Communities”. The programme is being implemented in Africa by four partners: the African Union Commission, the United Nations Office for Disaster Risk Reduction (UNISDR), 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 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 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).

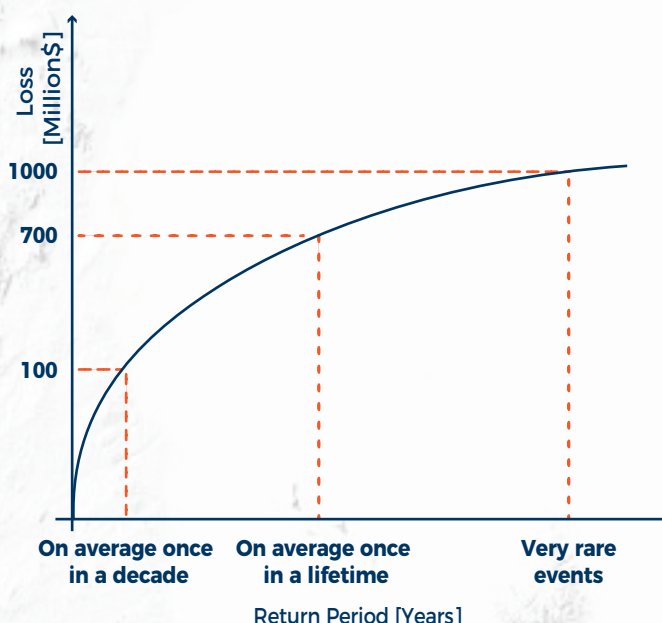
In computing the final metrics (PML, AAL), the uncertainties that permeate the different steps of the computations have been explicitly quantified and taken into account: uncertainties in hazard forcing, uncertainties in exposure values and their vulnerabilities.

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 maximum 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).

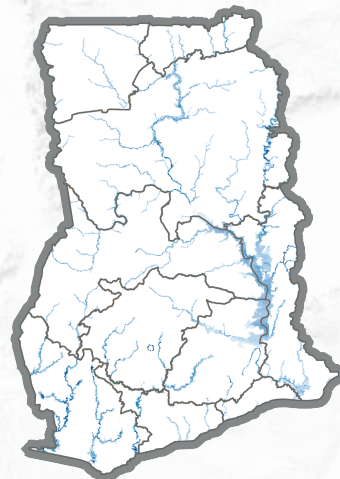


PROBABILISTIC RISK PROFILE: RISK COMPONENTS

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 has been composed of climate, hydrological, and hydraulic models using all the available information, including rainfall, temperature, humidity, wind, and solar radiation. A set of mutually exclusive and collectively exhaustive possible hazard scenarios that may occur in a given region or country has been generated and expressed in terms of frequency, extension of the affected area and intensity at 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

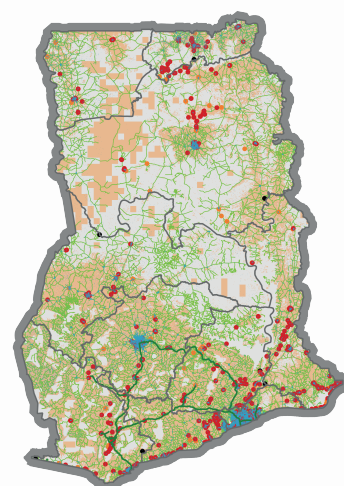
conditions determined by physical, social, economic and environmental factors or processes which increase the susceptibility of an individual, a community, assets or systems to the impacts of hazards.

Direct losses on different elements at risk are evaluated 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 for each typology of exposed elements and take into account local factors, such as typical constructive typologies for infrastructures or crop seasonality for agricultural production. In the case of flooding, vulnerability is a function of water depth. This is with the exception of agricultural production, for which 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 focusses 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 productive and agricultural sectors). Critical sectors are created clustering all of the components, which contribute to a specific function (e.g. the health sector is comprised of hospitals, clinics and dispensaries). Thoroughly generated publicly available global and national data enables a localization 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.










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

GHANA DISASTER RISK PROFILE

A SENDAI ORIENTED RISK PROFILE

The Sendai Framework guides the organisation of the results of the risk profile. Sendai introduced 7 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. Additional indicators, not strictly related with Sendai, are also included into the risk profile in order to obtain a more comprehensive understanding of risk from floods and droughts. The table below summaries the indicators used in the risk profiles as well the climate and socio-economic conditions considered in the estimation of the different risk metrics.

	INDICATORS		FLOOD			DROUGHT			RISK METRICS
			P	F	SEp	P	F	SEp	
SENDAI INDICATORS	B1	 Number of directly affected people attributed to disasters - AAL	Y	Y	Y	Y	Y	Y	Annual Average
	 C1	 C2 Direct agricultural loss attributed to disasters (Crops)	Y	Y		Y	Y		AAL (Average Annual 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					PML (Probable Maximum Loss)
	D1	 D2 Number of destroyed or damaged health facilities	Y	Y					
		 D3 Number of destroyed or damaged educational facilities	Y	Y					
		 D4 Number of other destroyed or damaged critical infrastructure units and facilities	Y	Y					
	D5	 D8 Damage or destroyed transportation system	Y	Y					Annual Average
* 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		

- C1** Direct economic loss attributed to disasters
D1 Damage to critical infrastructure attributed to disasters
D5 Number of disruptions to basic services attributed to disasters

P	F	SEp
Present Climate	Future Climate	Socio Economic projection

COUNTRY SOCIO-ECONOMIC OUTLOOK

OVERVIEW

Ghana sits on the Atlantic Ocean and borders the Republic of Togo, Cote d'Ivoire, and Burkina Faso. It has a population of about 28.2 million (World Bank Data - 2016). Ghana has a young age structure, with approximately 57% of the population under the age of 25 ^[1]. More than half of the country's population (54.4%) is urban ^[2]. After a difficult year in 2016, Ghana's economic performance improved significantly in 2017. Underpinned by serious fiscal consolidation efforts, the fiscal deficit dropped from 9.3% of gross domestic product (GDP) in 2016 to 6% in 2017 ^[3]. Agriculture accounts for some 20% of GDP and employs approximately 40% of the workforce, mainly small landholders. Exports in gold, oil, and cocoa as well as individual remittances are major sources of foreign exchange ^[1]. Expansion of Ghana's nascent oil industry has boosted economic growth, but the fall in oil prices since 2015 reduced Ghana's oil revenue by a half. Nevertheless, based on reports released in April 2018 by the Ghana Statistical Service, the country's economy, driven by the mining and oil sectors, is estimated to have expanded from 3.6% in 2016 to 8.5% in 2017 ^[3].

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 ^[4,5]. Such scenarios range from optimistic trends for human development, with "substantial investments in education and health, rapid economic growth and well-functioning institutions" ^[6], 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 results of this risk profile report refer to the "middle of the road" scenario which envisages that historic development patterns will persist throughout the 21st century. According to such conditions, the population of Ghana in 2050 will increase by about 64% compared to 2016 (World Bank Data), whereas its GDP is expected to increase almost ten-fold.

POPULATION



2016 Projection

28.2

[Million People]

46.4

2050 Projection

GDP



2016 Projection

42.8

[Billion\$]

414.3

2050 Projection



GHANA

AREA : 227.540 km²POPULATION DENSITY : 129 people/km²

MEDIAN AGE : 20.5 years

HDI - HUMAN DEVELOPMENT INDEX : 0.592

LIFE EXPECTANCY AT BIRTH : 63 years

MEAN YEARS OF SCHOOLING : 7.1 years

EMPLOYMENT TO POP. RATIO (AGES > 15) : 75.1%

EMPLOYMENT IN AGRICULTURE : 40.7%

EMPLOYMENT IN SERVICES : 45.2%

data from:
<http://hdr.undp.org/en/countries/profiles/>
<https://data.worldbank.org/indicator/>
<http://www.worldometers.info>

COUNTRY CLIMATE OUTLOOK

OVERVIEW

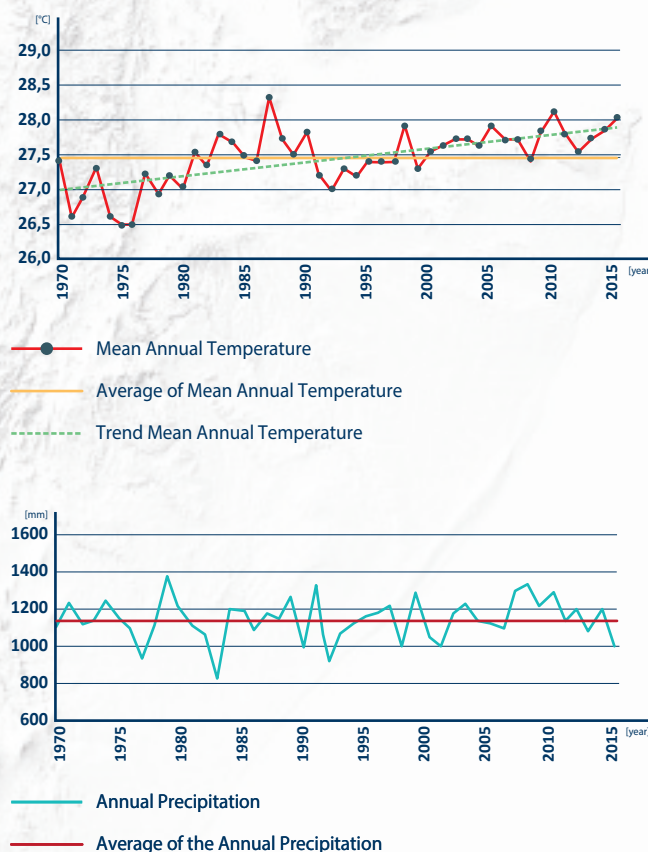
Ghana is characterised by a warm, humid climate. Mean annual temperature ranges from around 26°C near the coast to almost 29°C in the north. The climate of Ghana is tropical with two main seasons: the wet and the dry seasons. Northern Ghana experiences a rainy season from April to mid-October whereas southern Ghana experiences its rainy season from March to mid-November. Ghana's tropical climate is relatively mild for its latitude. The harmattan, a dry desert wind, blows in north-eastern Ghana from December to March, lowering the humidity and causing hotter days with cooler nights ^[7, 8].

CLIMATE TRENDS

Similarly to other West African countries, temperature observations for the recent years indicate that Ghana has experienced a considerable temperature increase. An analysis of climate data from 1970 to 2015 ^[9] shows an average rise of temperature of around 1.0°C. Trends for precipitation are not as clear as those for air temperature, and they are variable in time and space.

Average annual precipitation in Ghana is approximately 1140 mm, while the mean number of wet days is around 143.

TEMPERATURE AND PRECIPITATION TRENDS IN CURRENT CLIMATE



RIVERS OF GHANA

There are three main river systems in the country:

- The Volta river system consists of the Oti and Daka rivers, the White and Black Volta rivers, and the Pru, Sene and Afram rivers. The basin covers 70% of the country's area.

- The south-western river system comprises the Bia, Tano, Ankobra and Pra rivers and covers 22 % of the country's area.

- The coastal river system comprises the Ochi-Nakwa, Ochi Amissah, Ayensu, Densu and the Tordzie rivers, covering 8 % of the country's area.

Wetlands constitute about 10 % of Ghana's total land area and remain highly productive. Ghana is a signatory to the Ramsar Convention, counting five Ramsar sites of international importance: i) Densu Delta; ii) Songor; iii) Keta Complex; iv) Muni-Pomadze; v) Sakumo Lagoons.





These are protected areas and have been gazetted as such. Other wetlands located in the forest and in the wildlife reserves of the Mole National Park, Black Volta, Sene, Bia and Owabi Wildlife Sanctuaries are equally protected. Some wetlands such as the rivers Ankobra and Pra, which fall outside the conservation wetland areas, are subject to traditional conservation practices. Lake Volta and Lake Bosomtwi in the Ashanti region ^[10] are the two most important lakes in the country.

Photo Credit: ZSM - https://commons.wikimedia.org/wiki/File:Ankobra_River,_Ghana.JPG

CLIMATE PROJECTIONS FOR GHANA

Climate projection studies are abundant for multiple time spans and multiple scales. Climate models are tools that the scientific community uses to assess trends in weather conditions over long periods. In a recent study ^[11] Alder, et al., have compared the observed temperature and precipitations for the period 1980-2004 with the estimations of a set of global climate models provide by the Coupled Model Intercomparison Project Phase 5 (CMIP5). Three future periods (2025-2049, 2050-2074 and 2071-2095) have been analyzed for different greenhouse emission scenarios (see IPCC's Emissions Scenarios).

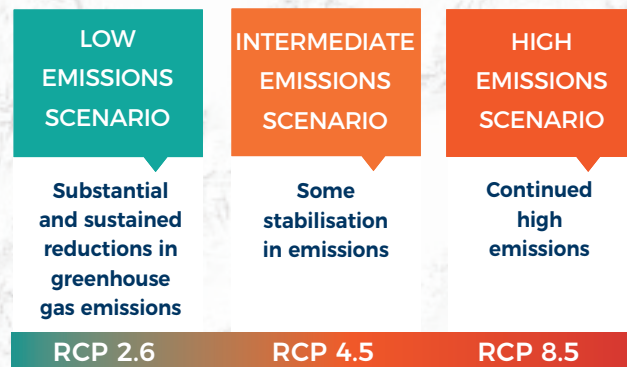
In all periods, models show an increase in temperature in all emission scenarios and for both short and long term periods. The increase of temperature is more evident in high emissions scenarios and long term period projections. In high emission scenarios (RCP8.5), model projections show an increase between about 2°C and 4°C for the mid term period (2050-2074) and an increase between about 2°C and 6°C for the long term period (2071-2095). Future changes in precipitation are much more uncertain, and the models predict on average no change in precipitation for both medium and long term period 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 2°C to 4°C	
	 Divergent change in precipitation (from -20% to +15%)	
Far Future (2071-2095)	 Increase in temperature from 2°C to 6°C	
	 Divergent change in precipitation (from -15% to +15%)	

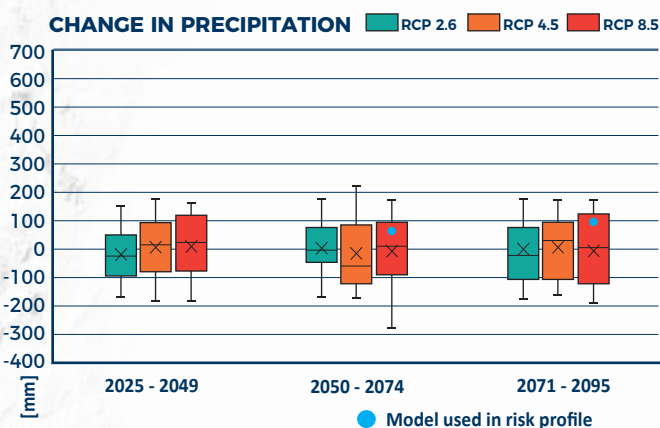
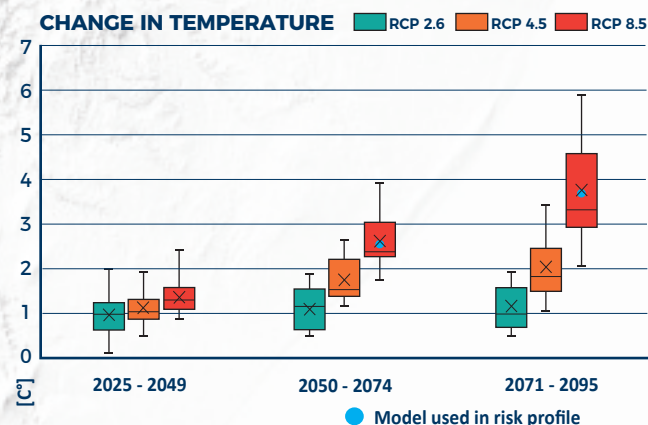
CLIMATE PROJECTIONS USED IN THIS RISK PROFILE

Results presented in the Risk Profile which refer to climate change 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) ^[12, 13, 14].

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 that are in line with the range of variability of global models analyzed in the study by Alder et al. ^[11].

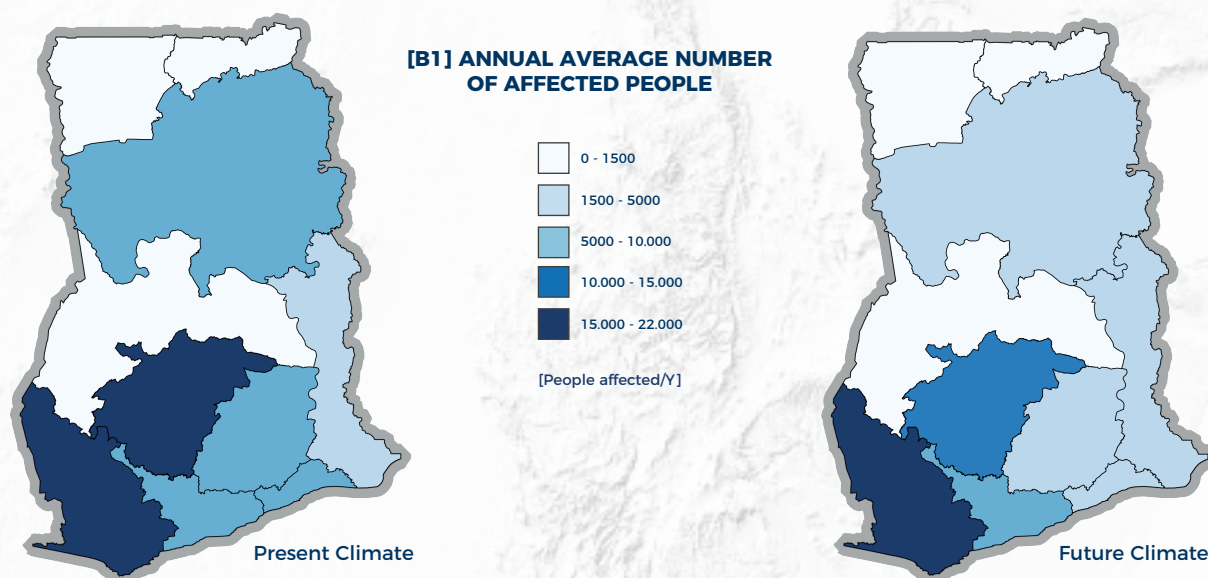


IPCC's Emissions scenarios for Climate Projections



In the specific case of high emission scenario, the Regional model predicts a comparable increase in temperature (close to 3.5°C in the long term period) compared to the global ensemble. With regard to annual precipitation at country level, an increase of 100 mm is predicted by the Regional model for the long-term period (almost +10%).

RESULTS | FLOODS



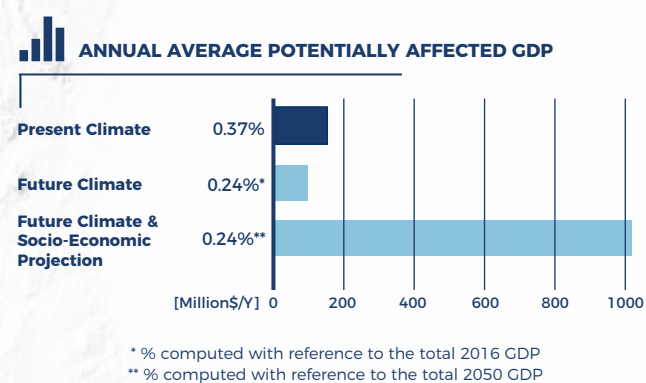
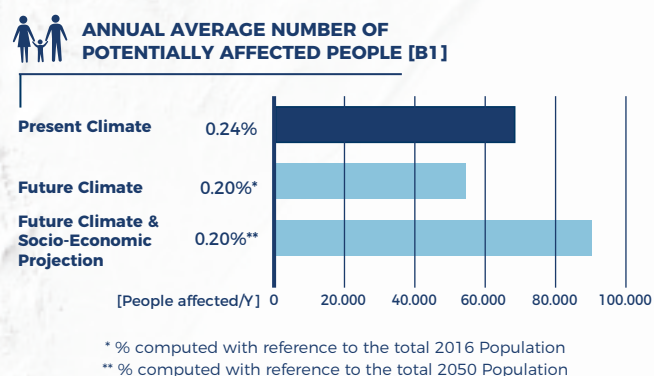
KEY MESSAGES

- Flooding is an impacting natural hazard in Ghana affecting yearly an average of almost 70,000 people which equates to approximately 0.24% of the total population of the country. A majority of the affected people are concentrated in the south-western part of the country and along the coast, one of the most populous regions of Ghana.

- The local economy is highly exposed to floods. Annually, on average about 160 million USD of GDP can be potentially affected by floods. This corresponds to about 0.37% of the total GDP at country level.

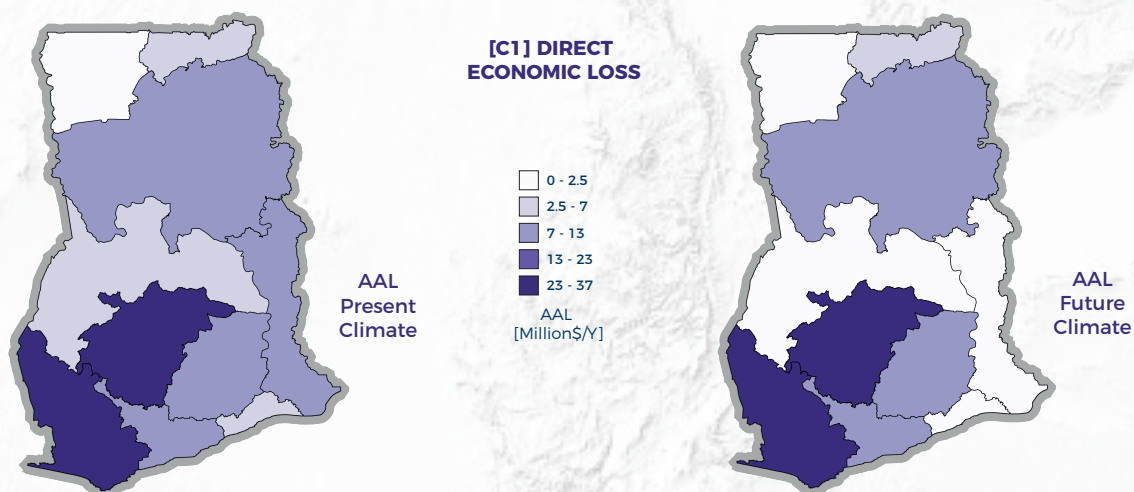
- Under future climate conditions, as climate models predict a significant increase in temperature and a contradicting behaviour for precipitation, the flood-affected population and potentially flood-affected GDP are likely to decrease slightly. However, climate projections remain inherently uncertain and caution is required when considering the above estimations for use in policy.

- When flood-affected population and flood-affected GDP under current climate conditions are compared with estimates under future climate conditions they show a significant increase. A significant increase in flood-affected population and GDP is reproduced when paired with projected socio-economic situation (*). Namely, the flood-affected population increases up to 90,000 persons under future conditions and flood-affected GDP increases 10 times. This is the result of a disproportionate growth projected for the population and for the GDP (population increase of about 30% and GDP by 10-fold)**. Nevertheless, future predictions remain highly uncertain.



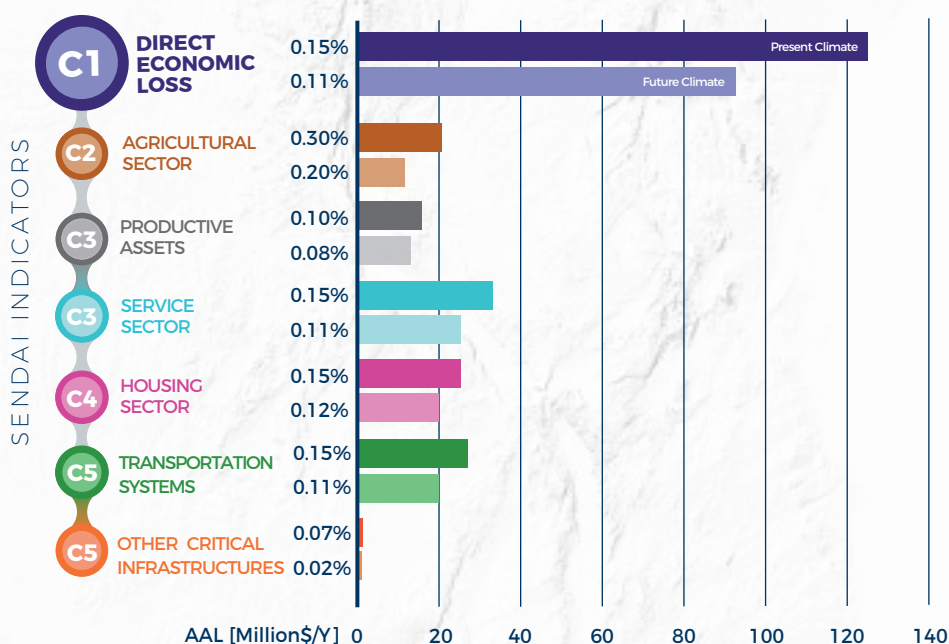
*2016 was taken as a reference year both for GDP and population.
**the Shared Socioeconomic Pathway (SSP) - 2 "mid of the road" (Medium challenges to mitigation and adaptation) has been used to project population and GDP distributions.

RESULTS | FLOODS



KEY MESSAGES

- Direct economic losses in Ghana show a similar pattern to the flood-affected population. Ashanti and the western regions show highest losses. This pattern is confirmed in the future climate, although values are reduced in the eastern part of the country.
- Direct annual economic losses sum up to 125 million of USD, which accounts roughly to 0.15% of the total exposure value under present climate. The losses are evenly distributed among the different sectors.
- Considering the present exposed assets for all sectors, it is likely that average annual losses will decrease under future climate conditions. 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 does 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 [D]



RESULTS | FLOODS

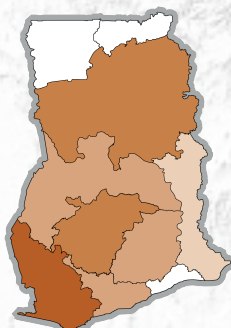
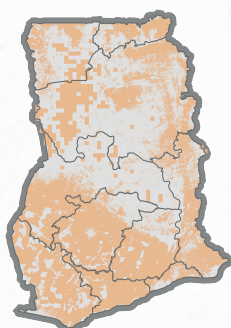
KEY MESSAGES

- The AAL distribution shows differences across each of the sectors considered. The south-western part of Ghana and the coastal areas remain the most impacted, but values distribution depends on distinct sectors.
- Comparison of AALs for all sectors between present and future climate shows that a likely reduction of economic losses can be expected. The pattern indicating a reduction in economic losses is confirmed in all sectors considered.

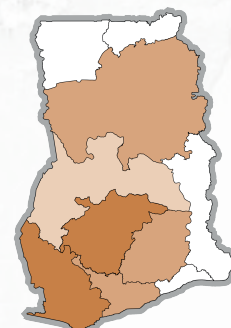
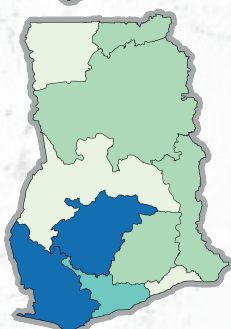
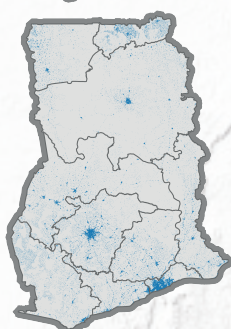
EXPOSURE DISTRIBUTION

AAL - Present Climate

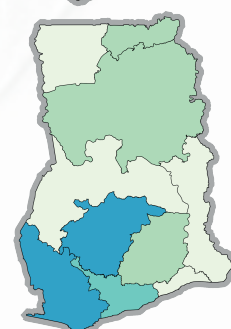
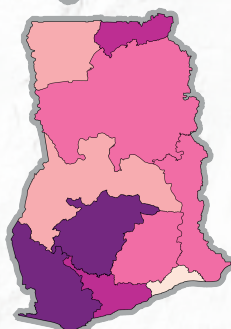
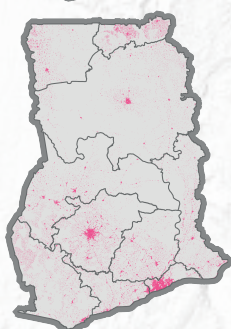
AAL - Future Climate

C2
AGRICOL.
SECTOR

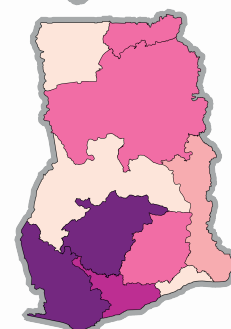
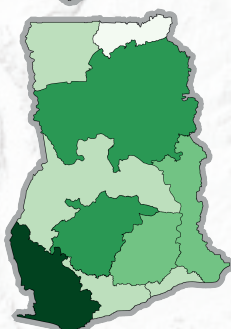
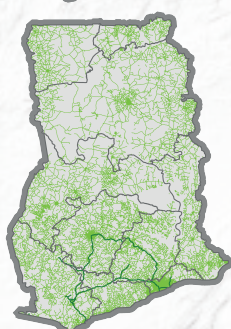
0 - 0.5
0.5 - 1
1 - 2.5
2.5 - 5
5 - 7
AAL
[Million\$/Y]

C3
SERVICES

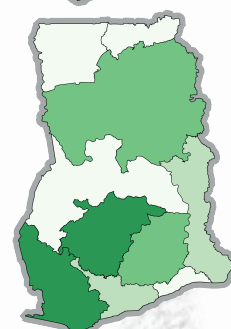
0 - 1
1 - 3
3 - 5
5 - 7
7 - 9
AAL
[Million\$/Y]

C4
HOUSING

0 - 0.5
0.5 - 1
1 - 2.5
2.5 - 5
5 - 7
AAL
[Million\$/Y]

C5
TRANSP.
SYSTEMS

0 - 0.5
0.5 - 1.5
1.5 - 3.5
3.5 - 7
7 - 10
AAL
[Million\$/Y]

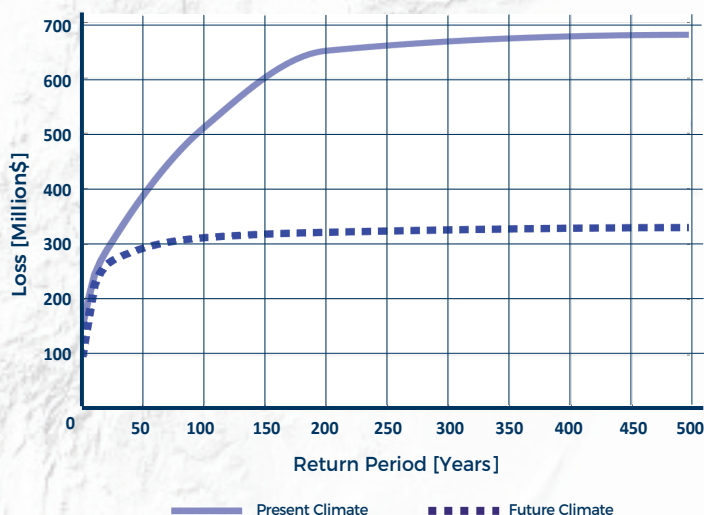


RESULTS | FLOODS

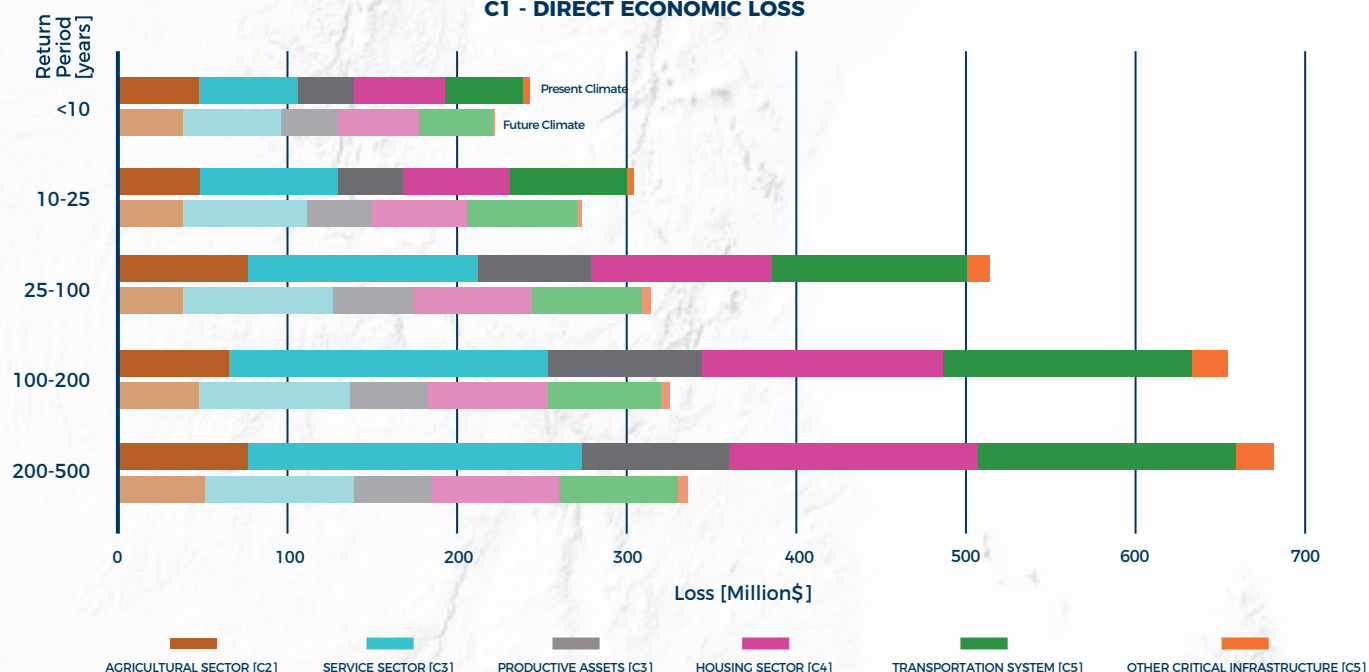
KEY MESSAGES

- Although Average Annual Loss is about 125 million USD, the likelihood of a 300 million loss from floods is on average once every 25 years. This means that considerable losses may be experienced frequently. The likelihood of disaster losses of about 500 million USD is on average once in 100 years. Extremes losses might reach 700 million USD.
- With the exception of the health and the education sector, all remaining sectors contribute evenly to the cumulative losses across all return periods.
- 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 events. Given the high level of uncertainty in future climate prediction, worse scenarios may also be possible (compare climate section on p.8).
- 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**

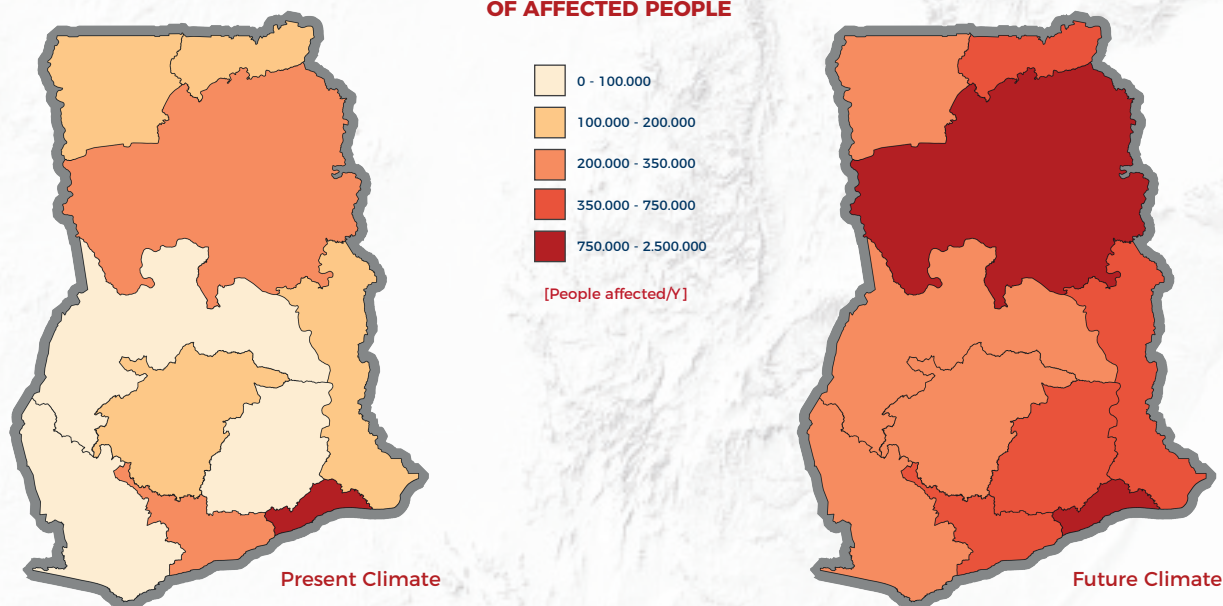


**PROBABLE MAXIMUM LOSS CURVE (PML) ACROSS ALL SECTORS
C1 - DIRECT ECONOMIC LOSS**



RESULTS | DROUGHTS

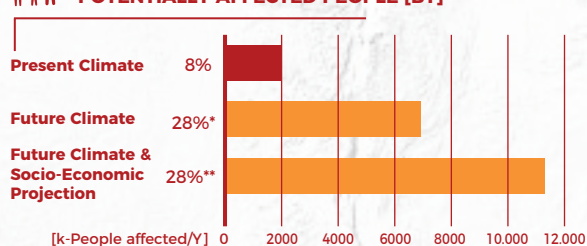
[B1] ANNUAL AVERAGE NUMBER OF AFFECTED PEOPLE



Annually 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]

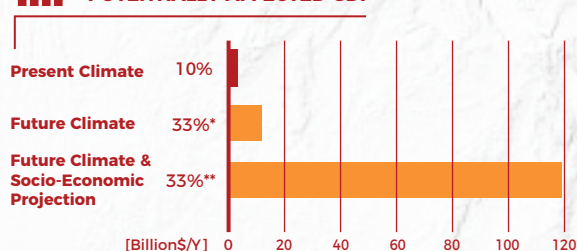


* % computed with reference to the total 2016 Population

** % 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

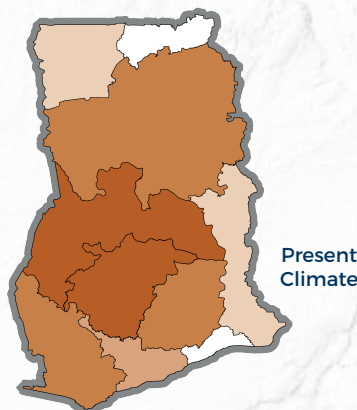
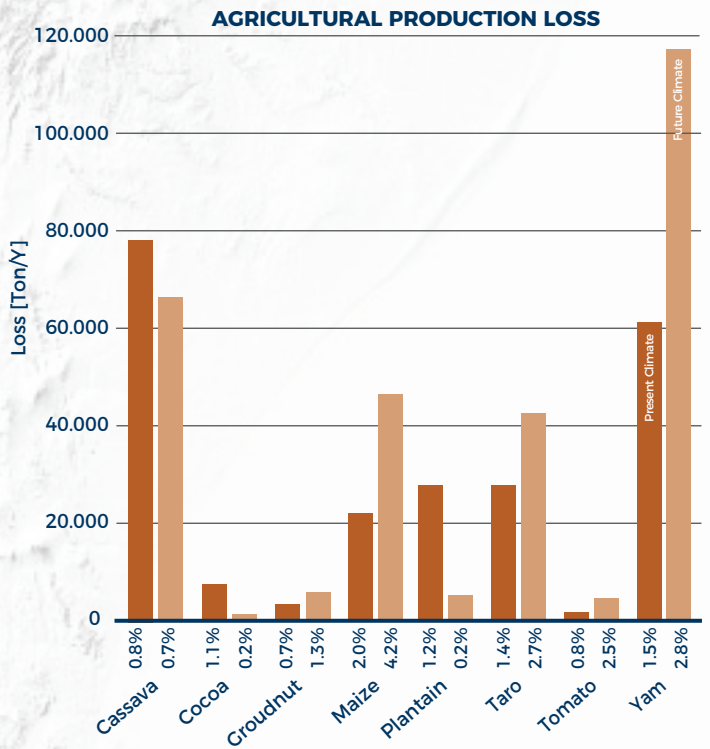
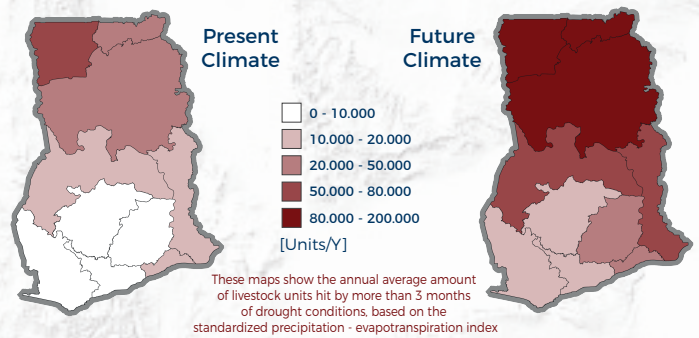
KEY MESSAGES

- With respect to present conditions (1951-2000 climate), the probability of occurrence of severe drought (precipitation - evapotranspiration deficiency) will increase (+19%) under future climate (2050-2100 climate). This increased drought hazard will mainly occur in areas which are currently already hard hit.
- Under present climate, on average some 2 million people (8% of the total 2016 Population) are annually affected by droughts. Under future climate conditions, this number is expected to increase up to 28% (on average 11.3 million people if population growth is accounted for).
- Under present climate, the average annual percentage of drought-affected GDP (i.e. the economic value produced in areas hit by droughts) is about 10% of the total GDP. This is equivalent to 3.7 billion USD per year which could be impacted by droughts. Under future climate conditions, drought-related losses may rise to 33% of the GDP, which could amount to 12 billion or even 119 billion USD per year, if socio-economic projections are included.

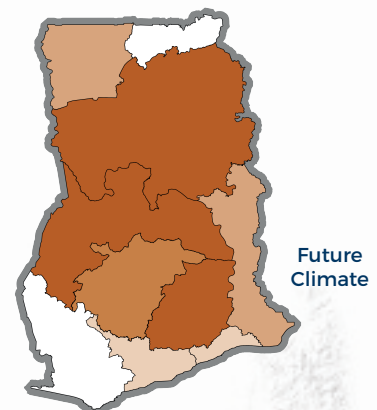
RESULTS | DROUGHTS

KEY MESSAGES

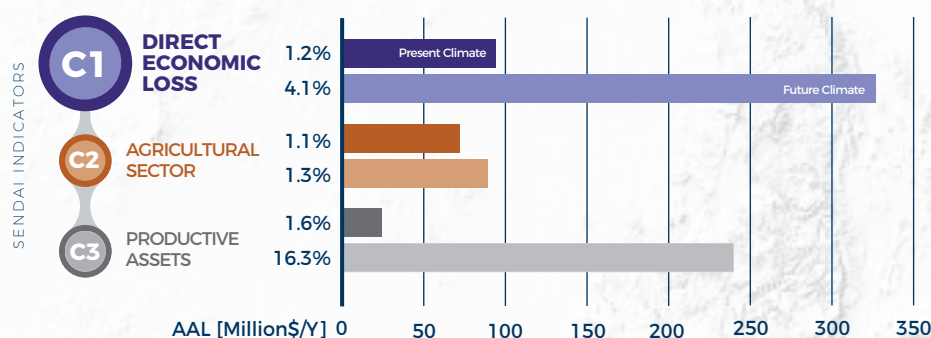
- Under present climate conditions, affected livestock (i.e. animals living in areas hit by droughts) count some 210 thousand livestock units (10%). Under future climate conditions (assuming that there is no increase in livestock), the number of affected livestock is projected to increase up to 740 thousand units (34% of the total). At present, most of the livestock in areas affected by drought is situated in the Upper West region of Ghana, whereas under future climate conditions, the Upper East and Northern regions are also likely to see large numbers of livestock being affected by drought.
- Under present climate, agricultural crop losses are dominated by five crops - cassava, maize, plantain, taro and yam. Under future climate most physical losses come from four crops - cassava, maize, taro and yam. Compared to present climate, losses will decrease under the future climate for three of the crops (cassava, cocoa and plantain), whereas for the other five crops (groundnut, maize, taro, tomato and yam) losses will increase. Highest relative losses relate to maize production and amount to 4% of the average crop production under future climate conditions.
- There is almost no difference in the amount of lost working days between present and future climate. This is because results show that some crop production will increase while other will decrease. In total some 1300 thousand working days are lost, which is less than 0.25% of the average number of working days. This percentage is 4 times higher when focusing only on the harvesting phase.
- Under present climate conditions, the economic crop production losses are concentrated in the central part of Ghana (Ashanti and Brong-Ahafo provinces) . Under future climate conditions, losses increase in the Northern, Eastern Ghana and Volta regions, but decrease in the Ashanti, Central and Western Ghana regions.



C2 - DIRECT AGRICULTURAL LOSS



RESULTS | DROUGHTS

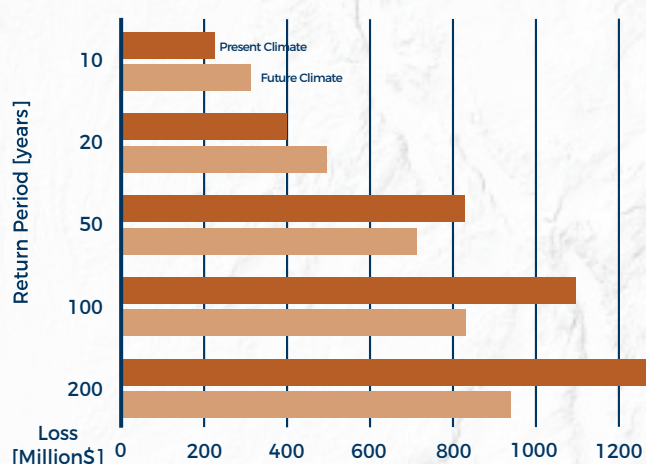
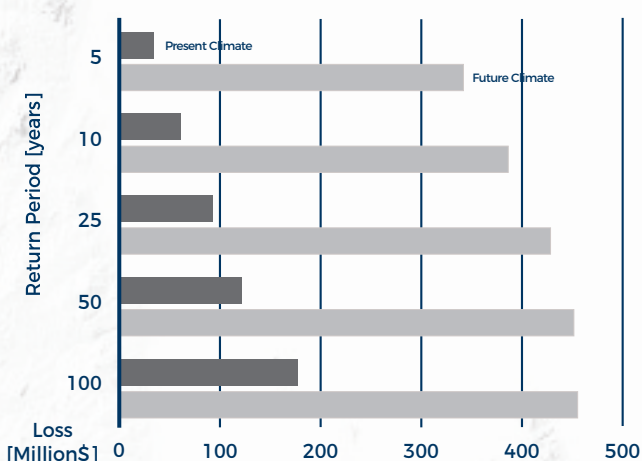


C2 is computed considering only direct loss associated with reference agricultural (crop) production. Reference crops considered in the analysis are the ones which contribute to at least 85% of the total country-level gross crop production value. It might therefore happen that crops which have an important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

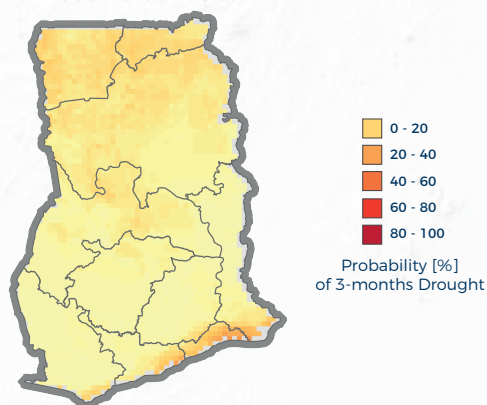
KEY MESSAGES

- Under future climate conditions, annual economic loss due to changes in crop production (C2) increases only slightly from some 72 to 89 million USD. Under both climates, it represents close to 1.2% 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 to 200 years. Under future climate conditions, losses increase for lower return periods which occur more frequently (10 – 20 years) whereas they decrease for higher return periods (50 – 200 years). This indicates that rarer events will have a lower impact on agricultural (crop) income.
- Average annual hydropower losses (C3) from the Akosombo and Kpong dams are projected to increase considerably, overall about 8 times.
- A strong increase in hydropower losses is expected under future climate. Losses will significantly increase for frequent return periods. In future, frequent probable maximum losses (5 year return period) will exceed the probable maximum losses currently experienced once every 100 years.

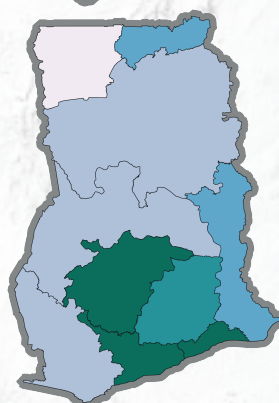
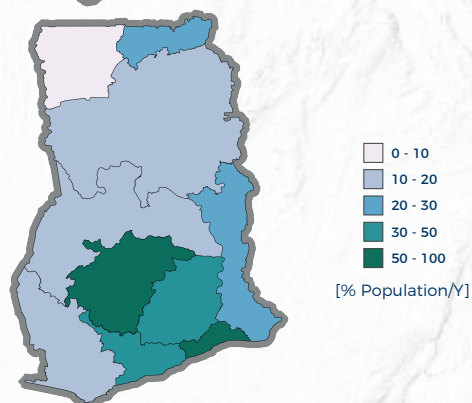
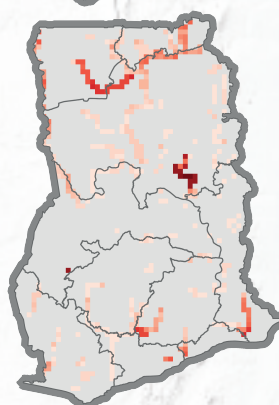
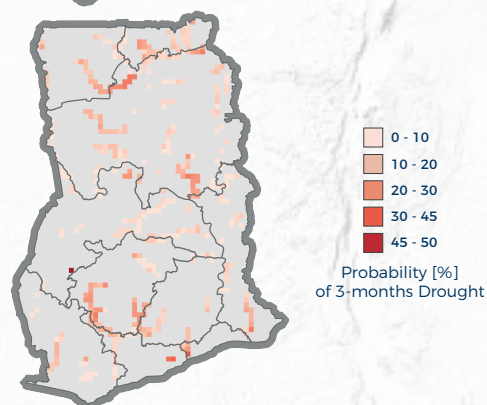
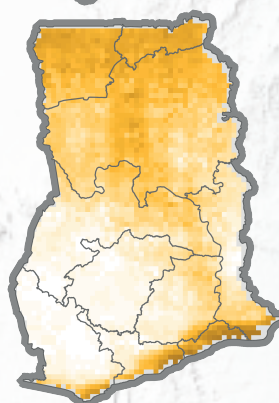
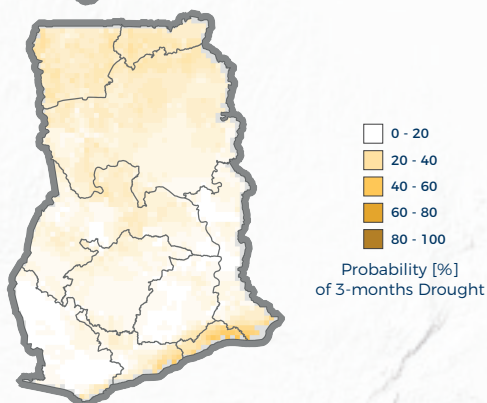
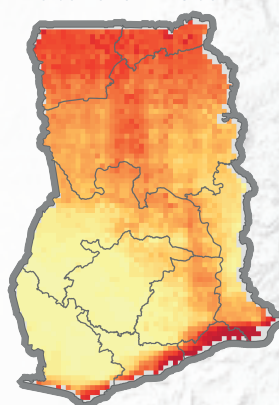
PROBABLE MAXIMUM LOSS (PML)
C2 - AGRICULTURAL LOSSPROBABLE MAXIMUM LOSS (PML)
C3 - PRODUCTIVE ASSETS (HYDROPOWER LOSS)

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). In the Upper West, Upper East and Northern regions as well as along the coast, the probability of severe droughts is the highest. 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). It can be noted that the probability of severe droughts increases most in the north and along the coast of Ghana in a future climate. 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 Kulpawa river and the North West of Lake Volta 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 province experiencing water scarcity, based on the water available (precipitation minus evapo transpiration) 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). Water scarcity is closely related to population density. Currently, the highest percentage of population under water scarcity is in the Ashanti region (with 1.5+ million people - city Kumasi) and in the Greater Accra metropolitan area with about 4 million inhabitants. In the future, the Central region with the city of Cape Coast will have more than 50% of its population unable to be self-sufficient in water.

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 comprising 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 (UNISDR, 2011 and 2013).

The PML curve is particularly useful in order to articulate a full DRR strategy. The PML curve 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

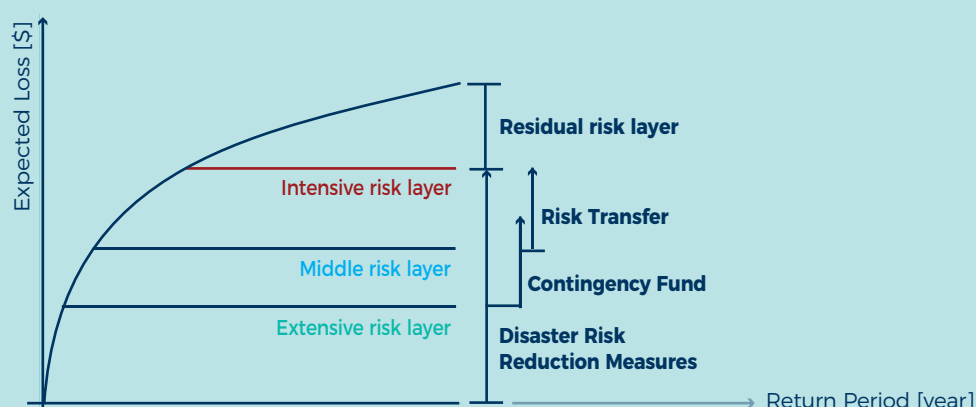
The PML curve can be subdivided into three main layers. The Extensive Risk Layer is typically associated with risk reduction measures (e.g. flood defences, local vulnerability reduction interventions).

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 country level, such as the contingency fund.

Losses which constitute the Intensive Risk Layer (severe and infrequent hazard events) are difficult to finance at 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.

AVERAGE ANNUAL LOSS (AAL)*

Average Annual Loss (also Average Damage per year) is the estimated impact (in monetary terms or number of people) that a specific hazard is likely to cause, on average, in any given year. It is calculated based on losses (including zero losses) produced by all hazard occurrences over many years.

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 indicators, covering a range of drought types. Drought conditions are defined as months with standardised index values below a threshold varying between -0.5 and -2, according to the aridity index of that area. Humid areas have low thresholds, corresponding with the driest 2% of months as found in the period 1951-2000, while semi-arid and arid areas have thresholds linked to respectively the driest 6% and 15% of this reference period (assessed for each month separately).

Droughts are analysed in terms of hazard, exposed population, livestock and GDP, and 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.

PROBABLE MAXIMUM LOSS (PML)*

PML is the value of the largest loss that could result from a disaster in a defined return period such as 1 in 100 years. The term PML is always accompanied by the return period associated with the loss.

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.

*UNISDR 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.

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

- [1] Ghana CIA Factbook <https://www.cia.gov/library/publications/the-world-factbook/geos/gh.html>
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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.unisdr.org

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africa.cimafoundation.org



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