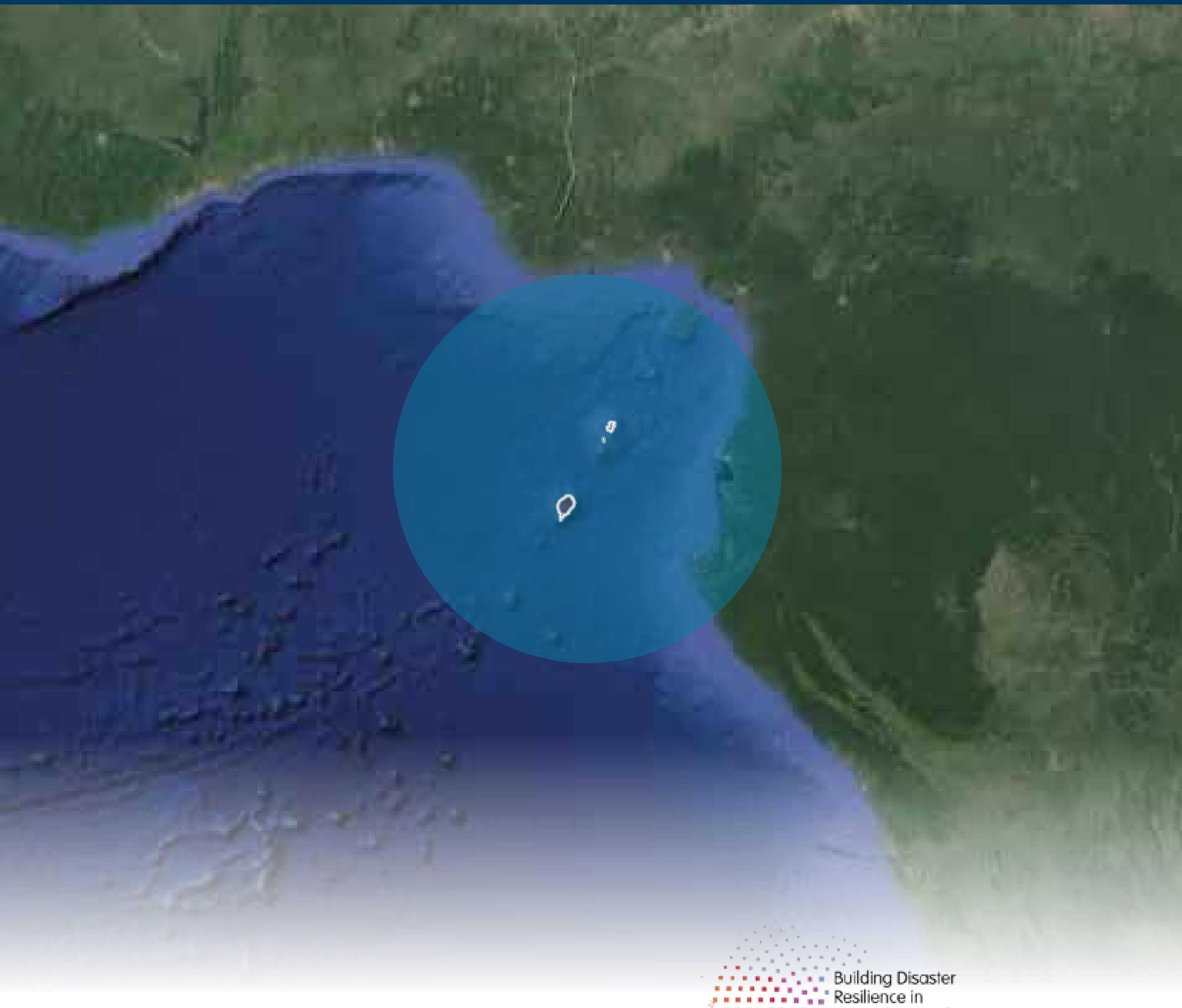
2019

DISASTER RISK PROFILE

Flood   Drought

São Tomé and Príncipe



Building Disaster Resilience in Sub-Saharan Africa

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

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

This project is funded by the European Union

UNDRR
UN Office for Disaster Risk Reduction

cima RESEARCH FOUNDATION

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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 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 in 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 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.

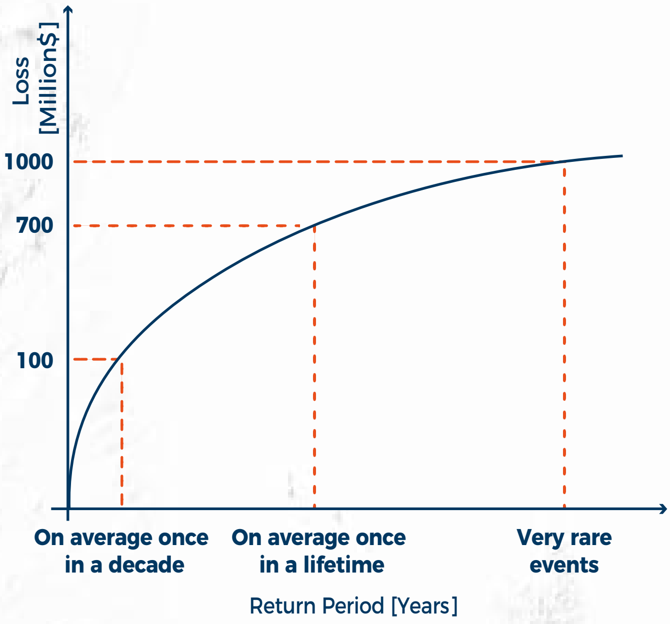
This disaster risk profile for floods and droughts is based on probabilistic risk assessment. Awareness of possible perils that may threaten human lives primarily derives from experience of past events. In theory, series of historical loss data long enough to be representative of all possible disastrous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

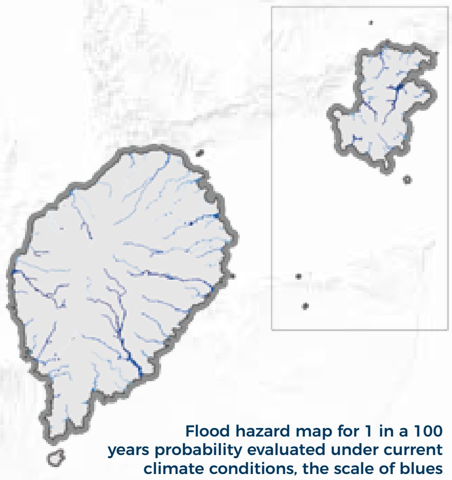


PROBABILISTIC RISK PROFILE: RISK COMPONENTS

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 to best predict possible flood and drought scenarios. 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 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.

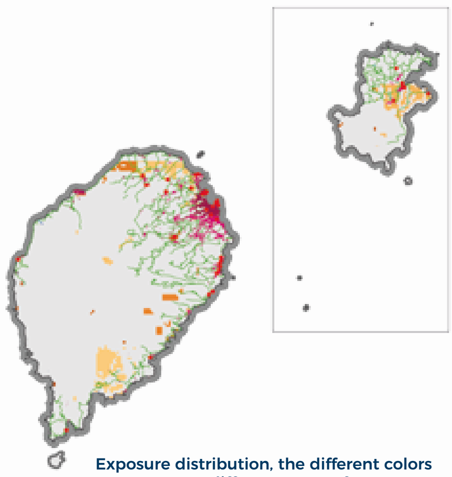
Direct losses on different elements at risk are evaluated applying vulnerability functions. This links hazard intensity to the expected loss (economic loss or number of affected people) while counting for associated uncertainty. Vulnerability functions are differentiated for each typology of exposed elements and take into account local factors, such as typical constructive typologies for infrastructures or crop seasonality for agricultural production. In the case of 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.

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

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). The sectors are created clustering all 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.

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 into 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 the climate and socio-economic conditions considered in the estimation of the different risk metrics.

	INDICATORS			FLOOD			DROUGHT			
				P	F	SEp	P	F	SEp	RISK METRICS
SENDAI INDICATORS	B1		Number of directly affected people	Y	Y	Y	Y	Y	Y	Annual Average
SENDAI INDICATORS	C1 Direct economic loss attributed to disasters	C2	Direct agricultural loss (Crops)	Y	Y		Y	Y		AAL (Average Annual Loss) PML (Probable Maximum Loss)
		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					
SENDAI INDICATORS	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		
		SPI	Standardised Precipitation Index*				Y	Y		
		WCI	Water Crowding Index*				Y	Y		

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

COUNTRY SOCIO-ECONOMIC OUTLOOK

OVERVIEW

The Republic of São Tomé and Príncipe is a developing small island state with an economy based mainly on agricultural production and, in particular, on the export of cocoa beans and coconut [1,2]. Cocoa production has substantially declined in recent years because of drought. The median age in the country is 20 years and 67.6% of the population is urban [3].

The country depends heavily on imports for food, fuels, and most manufactured and consumer goods. It faces challenges that are typical of small states and affect its ability to deal with shocks and achieve a balanced budget [2]. Gross domestic product (GDP) growth has been relatively steady and having grown at an average rate of 4.5% since 2009, with a mild deceleration since 2014 [1]. Changes in the climate, such as drought increases, are already affecting the country's economy. In planning for Sao Tomé's continued sustained growth and development, climate change must therefore be accounted for. The flooding and drought risk assessments presented in this report show the various potential economic and social impacts of floods and droughts in both the present and estimated future climate. Thus, they offer an important understanding of risk, 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 ell-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 used in this risk profile envisages that the historical patterns of development are continued throughout the 21st century. Following this projection, the population of the Republic of São Tomé and Príncipe will increase by 3% between 2016 and 2050 (World Bank Data), whereas GDP is expected to increase more than twelvefold.

POPULATION	GDP
2016 Projection	2016 Projection
195	354
[k-People]	[Million$]
206	4.520
2050 Projection	2050 Projection

SÃO TOMÉ AND PRÍNCIPE

AREA : 1001 km² (INE.ST)

POPULATION DENSITY : 195 people/km²

MEDIAN AGE : 20 years

HDI - HUMAN DEVELOPMENT INDEX : 0.589 (UNDP - 2017)

LIFE EXPECTANCY AT BIRTH : 67.7 years (UNDP - 2017)

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

EMPLOYMENT TO POP. RATIO (AGES > 15) : 50.3% (WB - 2017)

EMPLOYMENT IN AGRICULTURE : 17.1% (WB - 2017)

EMPLOYMENT IN SERVICES : 68.8% (WB - 2017)

data from:
https://www.ine.st/
http://hdr.undp.org/en/countries/profiles/
https://data.worldbank.org/indicator/

COUNTRY CLIMATE OUTLOOK

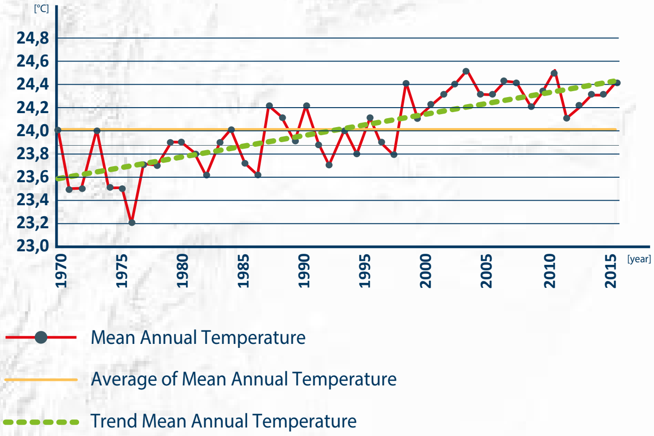
OVERVIEW

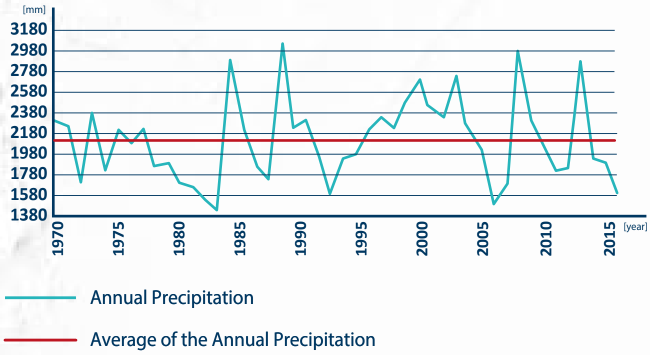
The islands of São Tomé and Príncipe are part of a string of extinct volcanic islands off the west coast of Africa, in the Gulf of Guinea. The climate is typically equatorial, with high temperatures and humidity throughout the year. Mean temperatures vary by one or two degrees throughout the course of the year [7,8]. The rains are abundant almost the whole year, with the exception of the months from June to August, when a decrease in precipitation and temperature occurs, with winds blowing from the south-southwest quadrant. Due to the characteristics of the relief, there are many micro-climates, especially in the highest parts, with high rainfall [9]. Average annual precipitation for São Tomé and Príncipé is more than 2100 mm, while the mean number of wet days is 163.

CLIMATE TRENDS

Similarly to other western African countries, temperature observations indicate that São Tomé and Príncipe has experienced a considerable increase in temperature in recent years. An analysis of climate data from 1970 to 2015 [10] shows an average rise of around 1 °C. Trends for precipitation are not as clear as those for air temperature, and are variable in time and space.

TEMPERATURE AND PRECIPITATION TRENDS IN CURRENT CLIMATE





RIVERS OF SÃO TOMÉ AND PRÍNCIPE

The rivers in São Tomé and Príncipe generally begin in the centre of the islands and go towards the coast. The network has more than 50 waterways. The main rivers are [10]:

- Ió Grande: it is the largest river of São Tomé and its main tributaries are Rio Ana Chaves, Rio João and Rio Umbugo;

- Do Ouro: part of its course is diverted for irrigation and community water supply; its volume decreases significantly in the dry season;

- Manuel Jorge and Abade: the first has some tributaries on the right bank on its upper and middle course, but only one on the left bank on its lower course;

- Quija and Xufexufe: the two rivers, which intersect at 400 m from the mouth, form flood plains;

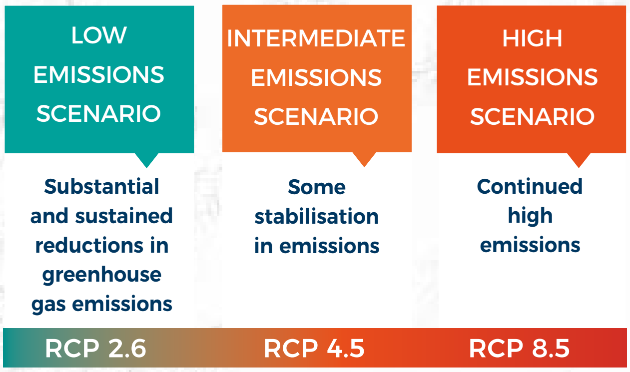
- Papagaio: it is the largest river of the island of Príncipe; it has several tributaries on the left bank, including Rio Buanga.

Photo Credit: Arquitecto Neco Bragança - http://st.geoview.info/rio_io_grande,9567274p

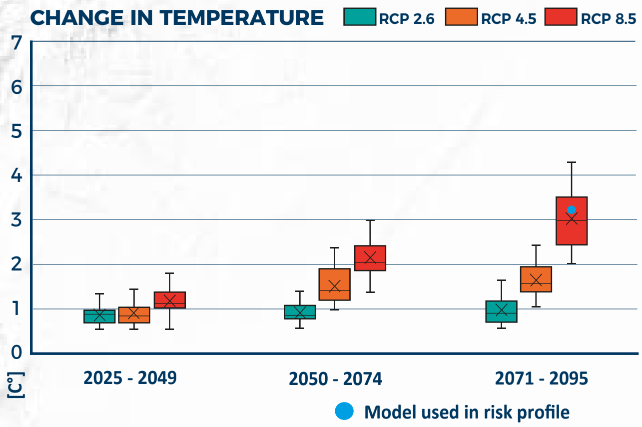
CLIMATE PROJECTIONS FOR SÃO TOMÉ AND PRÍNCIPE

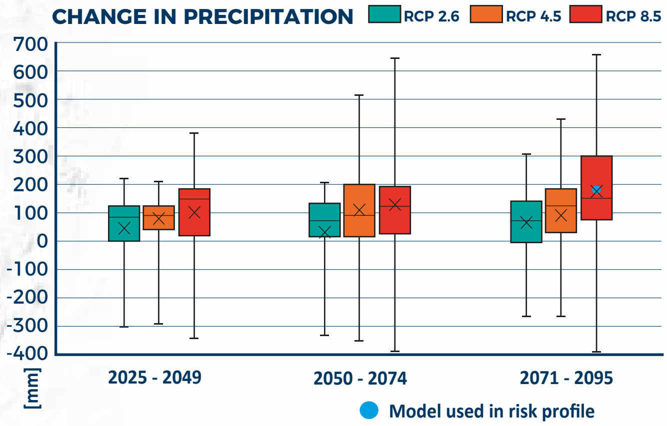
Climate projection studies are abundant for multiple different time spans and with various scales. Climate models are tools that the scientific community uses to assess trends in weather conditions over long periods. In a recent study [12] Alder, et al., compared the observed temperature and precipitations 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). In all periods and emission scenarios, models showed an increase in temperature. The temperature increases were more evident in high emission scenarios and long-term period projections. In high emission scenarios (RCP8.5), model projections showed an increase of between about 1.5˚C and 3˚C for the mid-term period (2050-2074) and an increase of between about 2˚C and 4.5˚C for the long-term period (2071-2095). Future changes in precipitation are much more uncertain, however the models predict a likely increase in precipitation for all time periods 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˚C uncertain variations in precipitation, with possible increase
Far Future (2071-2095)	Increase in temperature from 2˚C to 4.5˚C uncertain variations in precipitation, with possible increase



IPCC's Emissions scenarios for Climate Projections





CLIMATE PROJECTIONS USED IN THIS RISK PROFILE

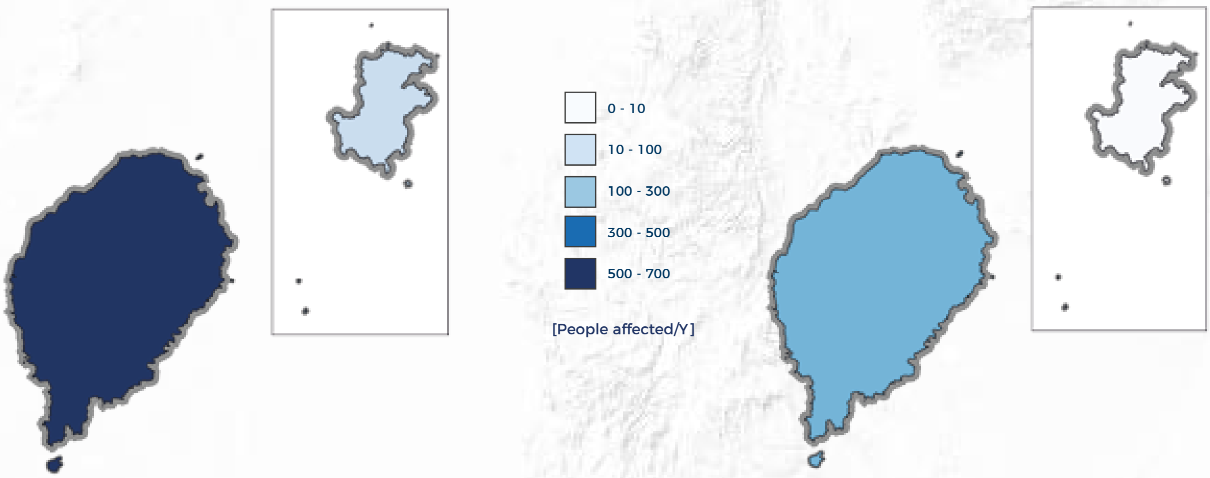
Results presented in the risk profile which refer to climate change have been obtained using a climate projection model based on a high emission scenario (SMHI-RCA4 model, grid spacing 0.44˚ about 50 km - driven by the ICHEC-EC-EARTH model, RCP 8.5, 2006-2100) [13,14,15].

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.[12].

In the specific case of a high emission scenario, the regional model predicts an increase in temperature (just over 3˚C in the long term period) comparable to the global ensemble. As regards to annual precipitation at the country level, the regional model predicts, in the long-term period, a precipitation increase of about 8%, comparable with the average increase of the global ensemble.

RESULTS | FLOODS

[B1] ANNUAL AVERAGE NUMBER OF AFFECTED PEOPLE



KEY MESSAGES

● Floods affect on average about 700 people per year in São Tomé, about 0.36% of the total population.

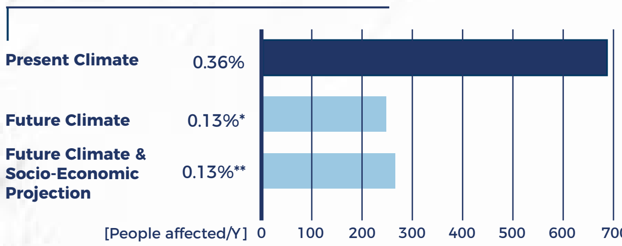
● The distribution of the potentially affected people is concentrated on the most populous island. This pattern is confirmed in the future climate.

● The local economy is heavily exposed to floods. On a yearly average, the areas that are affected by floods produce about 1.42% of the national GDP which corresponds to about 5 million USD per year.

● It is likely that, under future climate conditions, the affected population will decrease compared to the value evaluated under current climate conditions. However, as shown in the climate section, climate projections are inherently uncertain especially at the scales here considered and this should be taken into account when using these estimations in policy development. Similar behavior is expected for the potentially affected GDP.

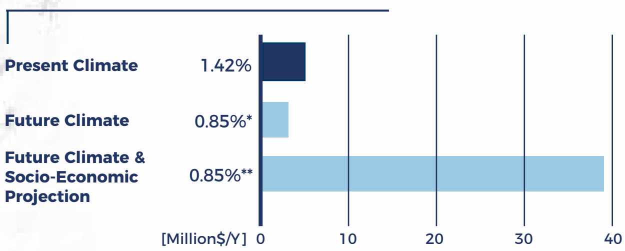
● When potentially affected GDP for current climate conditions is compared with estimates under future climate conditions paired with the projected socio-economic situation (*), it shows a likely significant increase. Specifically, affected GDP increases almost 8 times with respect to estimates in the present climate. The future prediction is affected by uncertainty, however this behaviour calls for a careful planning of the near future development of São Tomé that limits the creation of new risk in the country.

ANNUAL AVERAGE NUMBER OF POTENTIALLY AFFECTED PEOPLE [B1]



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

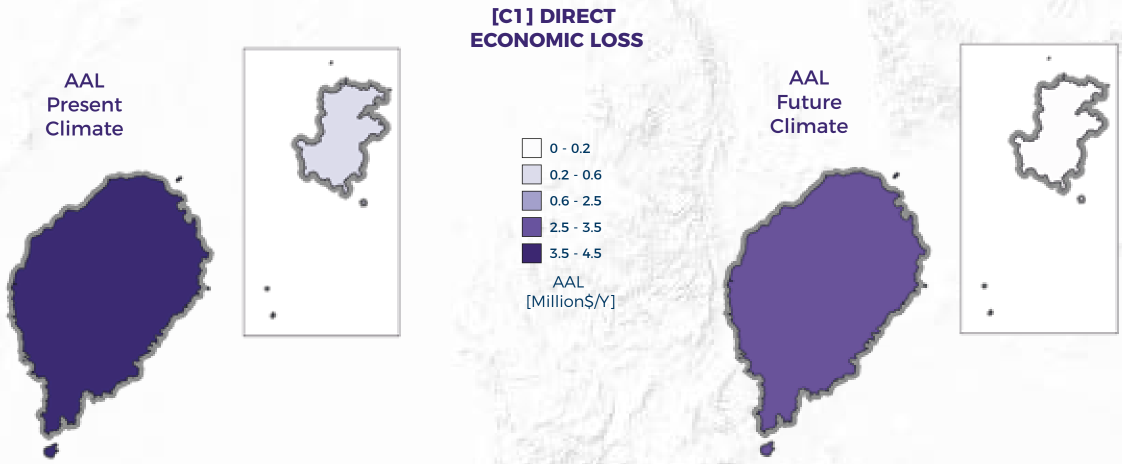
ANNUAL AVERAGE POTENTIALLY AFFECTED GDP



* % 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



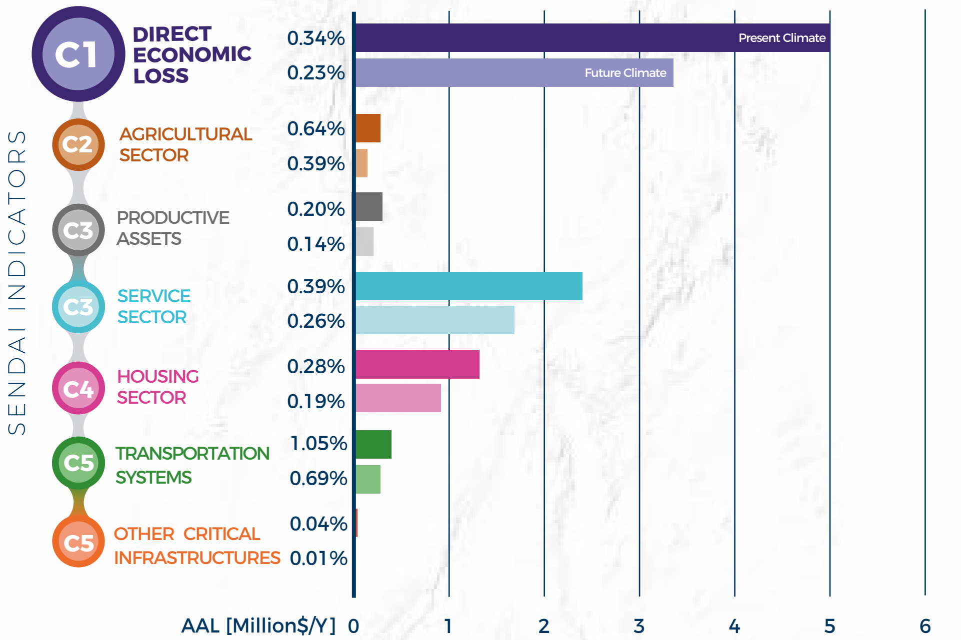
KEY MESSAGES

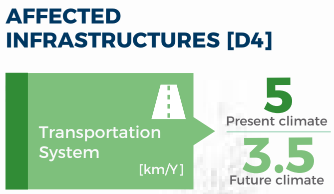
- The direct economic losses in São Tomé result from a complex combination of geographically distributed hazard and exposure. The island of São Tomé has the highest losses. The pattern is confirmed under future climate conditions with a general decrease in the losses on both islands.

- Under present climate conditions, the value of direct economic losses, in terms of AAL, amounts to 5 million USD, roughly 0.34 % of the total capital stock value. The largest portion of losses is attributable to the service sector followed by the housing sector.

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

- When considering the present exposed assets, without socio-economic development, the direct economic loss shows a decrease when climate change is considered, this decrease is evenly observable across all sectors. However, the socio-economic projections are likely to increase this figure, calling for a special attention in the development pattern of São Tomé and Príncipe.





RESULTS | FLOODS

KEY MESSAGES

- The AAL distribution does not show differences across the considered sectors. São Tomé always remains the most impacted province and this pattern is confirmed in all sectors, as well as when the future climate is considered.
- The comparison of AALs for all sectors between present and future climates shows that a decrease is to be expected in both São Tomé and Príncipe.

EXPOSURE DISTRIBUTION | **AAL** - Present Climate | **AAL** - Future Climate

RESULTS | FLOODS

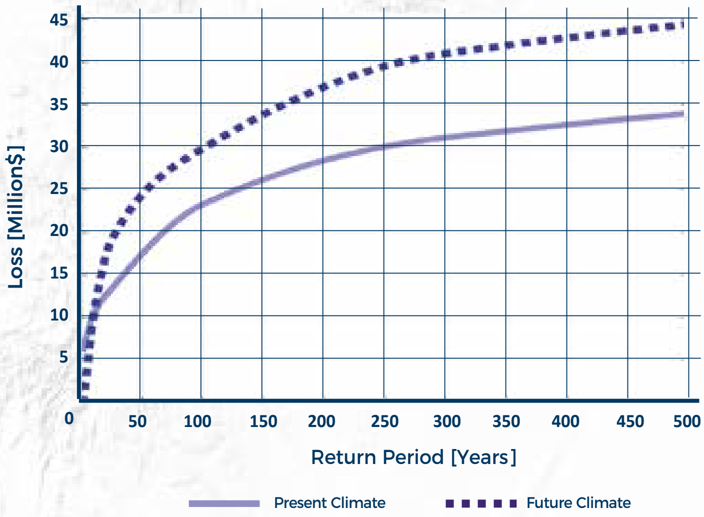
KEY MESSAGES

- Although Average Annual Loss is about 5 million USD, the likelihood of a 10 million USD loss from floods is on average of once every 10 years. This means that considerable losses may be experienced frequently. The likelihood of disaster losses of about 25 million USD is on average of one every 150 years.

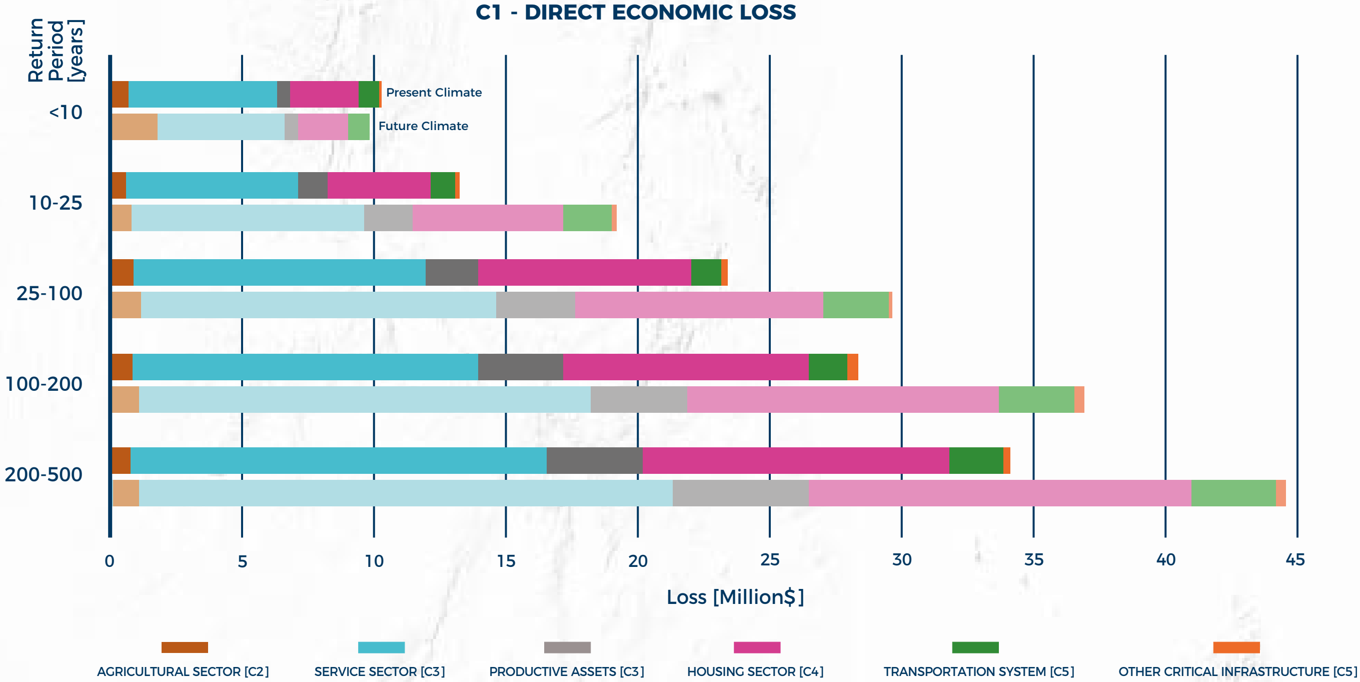
- The sectors that are most affected in all frequencies are the services and housing sectors. When lower frequencies are considered, the productive sector increases in importance. Very frequent losses are predicted to decrease under future climate conditions, which is the reason why the AAL reduces when future conditions are considered. For all other frequencies the losses are predicted to increase markedly. Resilience of the country should therefore be analysed with increasing attention under future climate conditions. However, given the high level of uncertainty in the future climate prediction, worse scenarios may also be possible (compare climate section on p.8).

- The shape of the PML curves 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. Under future climate conditions, a combination of DRR investment and risk transfer solutions will be needed to face the increased risk figures.

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

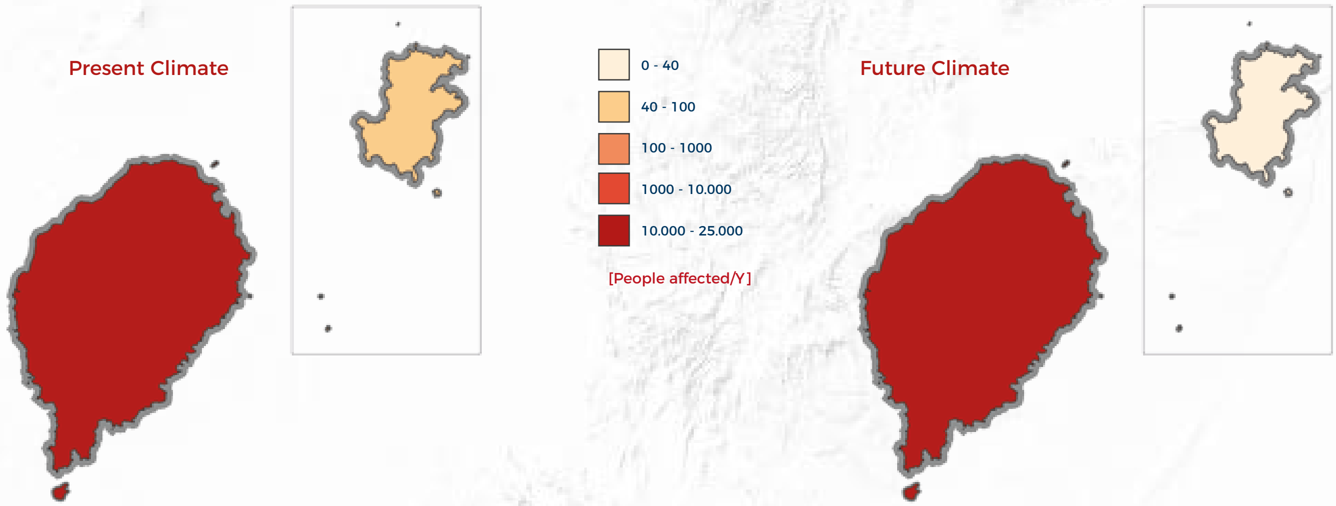


PROBABLE MAXIMUM LOSS CURVE (PML) ACROSS ALL SECTORS
C1 - DIRECT ECONOMIC LOSS



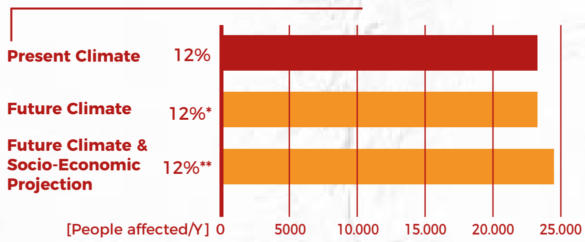
RESULTS | DROUGHTS

[B1] ANNUAL AVERAGE NUMBER OF AFFECTED PEOPLE



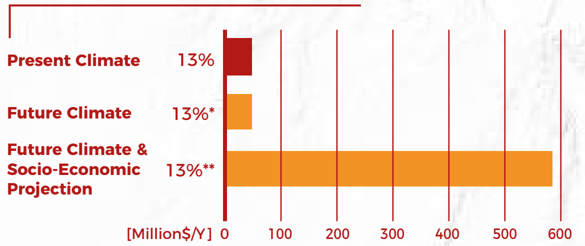
Annual average of population potentially affected by at least three months of drought conditions, as calculated using the standardized precipitation-evapotranspiration index (SPEI) and using a 3-month accumulation period.

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 droughts (precipitation – evapotranspiration deficiency) is expected to decrease in the future (2050-2100 climate).

- Under present climate conditions, on average 23.000 people (12% of the total 2016 population) are annually affected by droughts. Under future climate conditions, this number is expected to remain the same on São Tomé, and to decrease on Príncipe. This is a net result of decreased drought conditions on Príncipe, and stable drought conditions on São Tomé.

- Under present climate conditions, the average annual percentage of drought-affected GDP (i.e. the economic value produced in areas hit by droughts) is about 13% of the total GDP. This is equivalent to about 47 million USD of potentially affected GDP. Under future climate conditions, GDP affected by drought could amount to 600 million USD, if socio-economic projections are included.

RESULTS | DROUGHTS

KEY MESSAGES

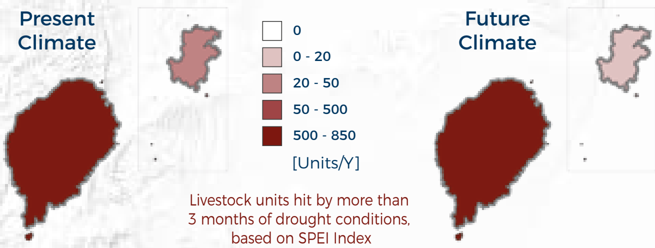
- Under present climate conditions, affected livestock (i.e. animals living in areas hit by droughts) numbers 14% of the total livestock. Under future climate conditions, the number of affected livestock is projected to decrease slightly in comparison with current climate conditions.

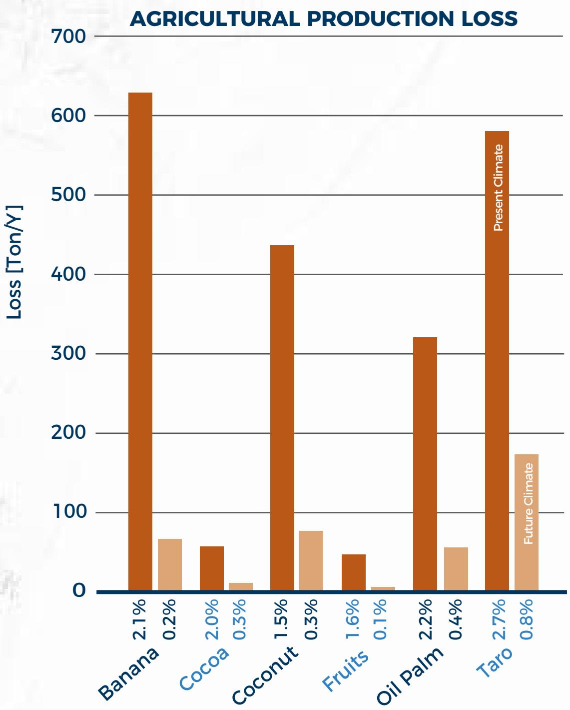
- Under both present and future climate conditions, physical crop losses are dominated by four crops (banana, coconut, oil palm and taro). The agricultural production losses attributable to droughts decrease under future climate conditions for all six crops. Under present climate conditions, the production of taro experiences the highest relative losses, up to 2.7% of the average total crop production.

- Under present climate conditions, the direct economic crop production loss on the island of São Tomé (more than 0.5 million USD) is higher than the loss on the island of Príncipe (between 0.1 and 0.2 million USD). Under future climate conditions, the agricultural loss decreases on both islands.

- The amount of lost working days amounts to 9200 under present climate conditions, and decreases to almost 1200 under future climate conditions. Under present climate conditions, 0.28% of the average number of working days in crop cultivation are lost due to decreased harvests, and this percentage decreases to 0.04% under future climate conditions.

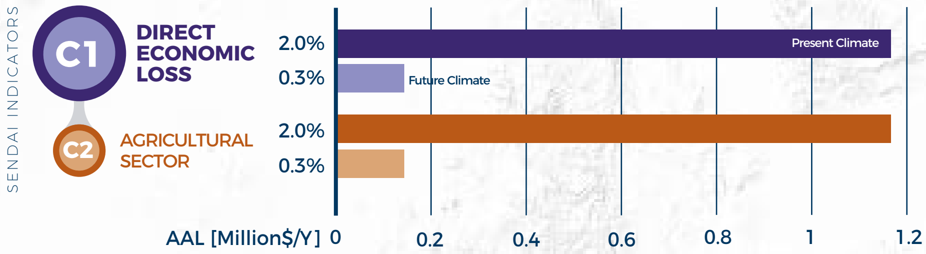
*Livestock is a summation of all livestock animals (referred to as livestock units) using FAO conversion factors





C2 - DIRECT AGRICULTURAL LOSS

RESULTS | DROUGHTS

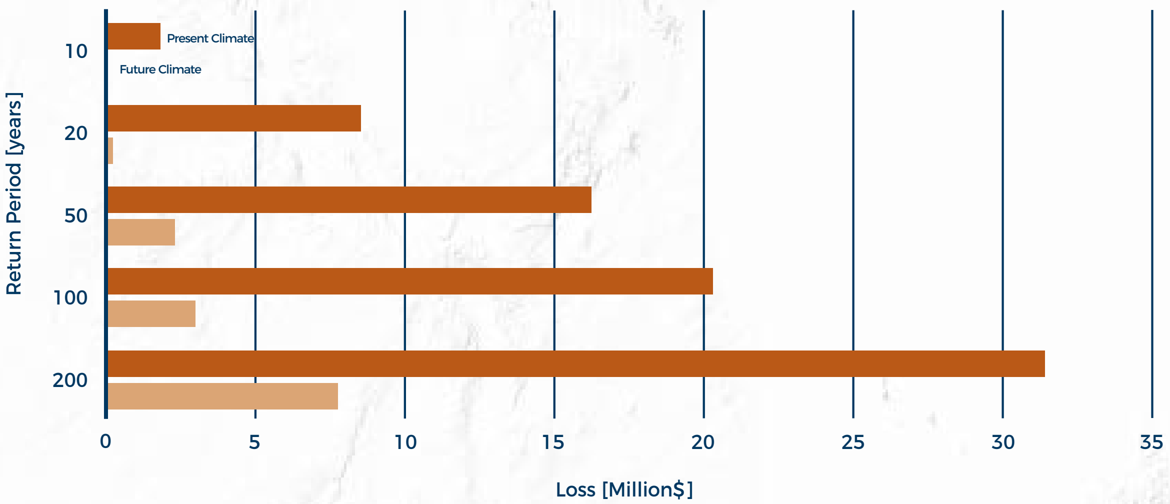


C2 is computed considering only direct loss associated with reference agricultural (crop) production. Reference crops considered in the analysis are the ones which contribute to at least 85% of the total country-level gross crop production value. It might therefore happen that crops which have an important 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 almost 1.2 million USD under present climate conditions to less than 0.2 million USD under future climate conditions. These losses represent 2% and 0.3% of the average total economic value of crop production, respectively for present and future climate conditions.
- Under present 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, substantially lower losses are projected. No significant losses are expected up to a return period of 20 years.

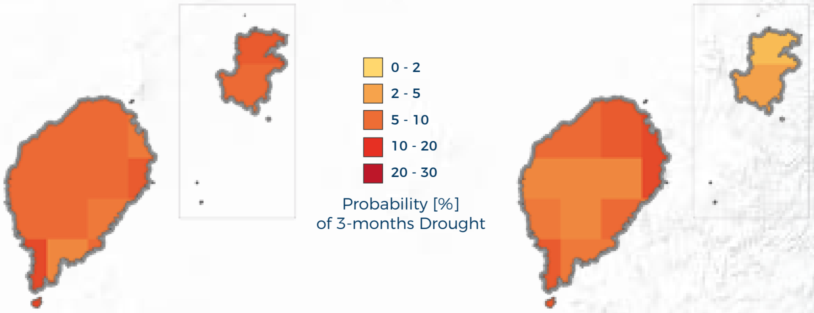
PROBABLE MAXIMUM LOSS (PML)
C2 - AGRICULTURAL LOSS



RESULTS | DROUGHTS

Present Climate

Future Climate

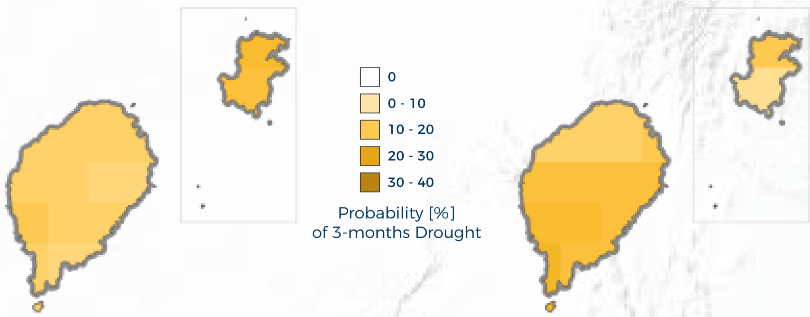


SPEI

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).

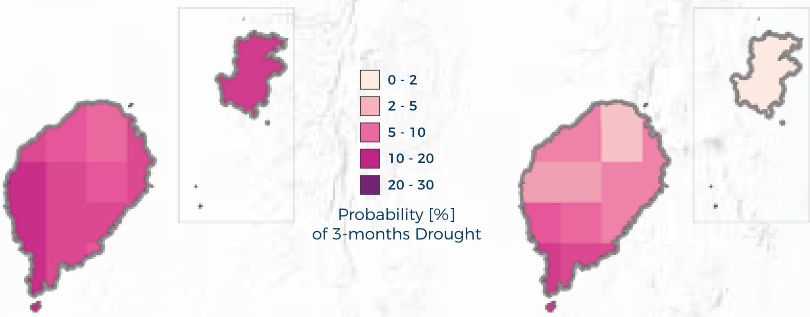
It can be noted that the probability of droughts is the highest on São Tomé, but will generally decrease on both islands in the future. This is particularly important for areas dependent on rainfall for their water resources.



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).

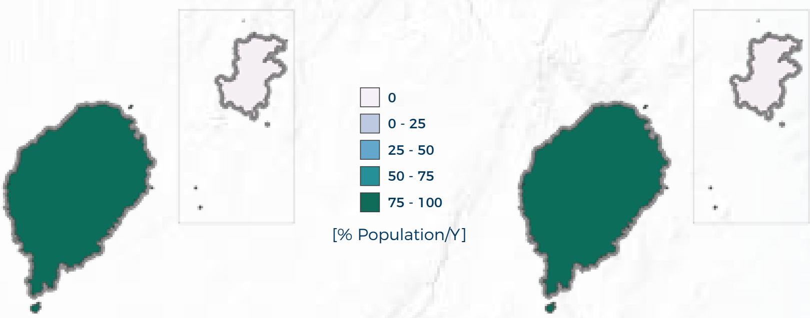
This is particularly important for agricultural areas and nature. We can see that the soil moisture drought probability slightly increases on both islands.



SPI - Standardised Precipitation Index

These maps denote the average annual chance of a meteorological drought occurring (%). Droughts are defined precipitation levels considerably below normal conditions, calculated through the Standardized Precipitation Index (SPI; see 'Drought' in Glossary).

The probability of experiencing 3-months of precipitation levels considerably below normal conditions decreases under future conditions on both islands.



WCI - Water Crowding Index

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

Due to the high population density on the island, São Tomé has not enough rainfall to secure water for its whole population. This means people on São Tomé have to rely on other sources of water too.

PROBABILISTIC RISK ASSESSMENT FOR RISK MANAGEMENT

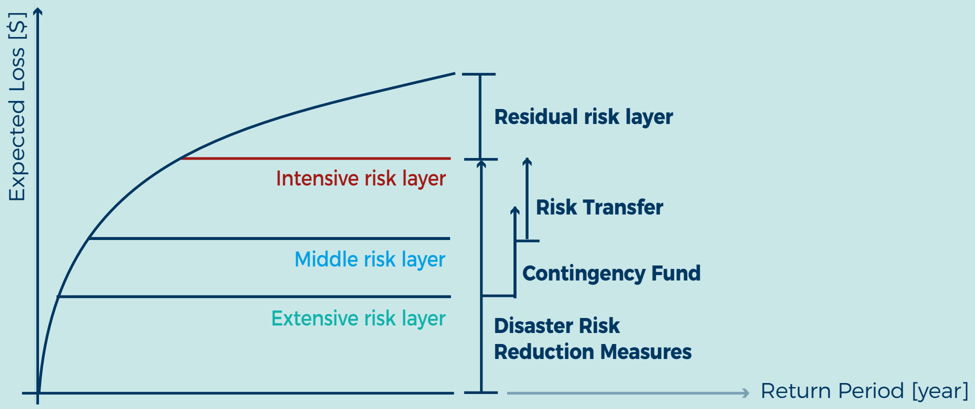
METRICS FOR RISK MANAGEMENT

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, São Tomé and Príncipe Overview, https://www.worldbank.org/en/country/saotome/overview

[2] São Tomé and Príncipe CIA Factbook https://www.cia.gov/library/publications/the-world-factbook/geos/tp.html

[3] https://www.ine.st/

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

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

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

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

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

[9] Climate Change Adaptation,UNDP, : São Tomé and Príncipe https://www.adaptation-undp.org/explore/middle-africa/sao-tome-and-principe

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

[11] FAO (2005). Aquastat, São Tomé and Príncipe http://www.fao.org/nr/water/aquastat/countries_regions/STP/indexfra.stm

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

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

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

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

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

www.preventionweb.net/resilient-africa

www.undrr.org

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riskprofilesundrr.org

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