DISASTER RISK PROFILE

Flood Drought

# Eswatini (Kingdom of)

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

Building Disaster Resilience in Sub-Saharan Africa

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

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# 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 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 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, Ghana, Guinea Bissau, Kenya, Kingdom of Eswatini, 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.

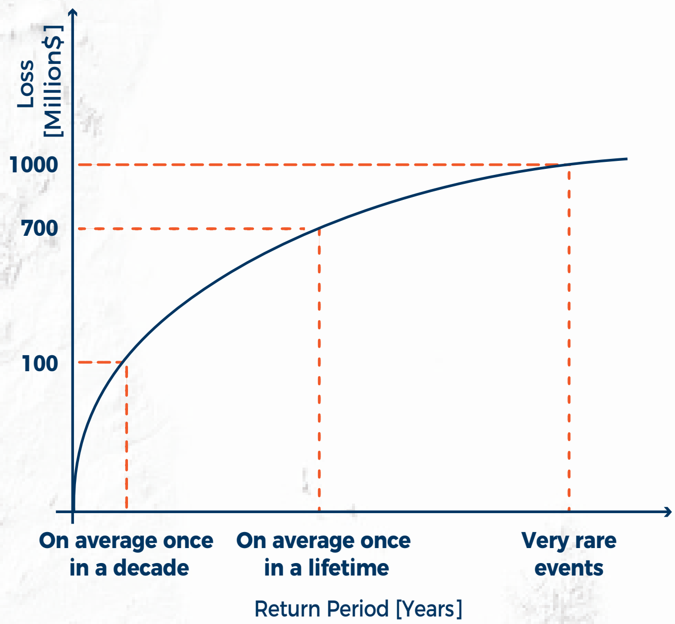
This disaster risk profile for floods and droughts is based on probabilistic risk assessment. Awareness of possible perils that may threaten human lives primarily derives from experience of past events. In theory, series of historical loss data long enough to be representative of all possible disastrous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

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. A realistic set of all possible hazardous events (scenarios) that may occur in a given region, including very rare, catastrophic events, is simulated. For each event, potential impacts are computed in terms of economic losses or number of people and assets affected, considering publicly available information on Hazard, Exposure, and Vulnerability. Finally, statistics of losses are computed and summarised through proper quantitative economic risk metrics, such as: 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 are explicitly quantified and taken into account: uncertainties in the hazard forcing, uncertainties in the 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, the AAL also accounts for much larger losses that occur less frequently. As such, AAL represents the funds that would be required annually in order to cumulatively cover the average disaster loss over time.

**Probable Maximum Loss (PML)** describes the maximum loss that could be expected corresponding to a given likelihood, expressed in terms of annual probability of exceedance or its reciprocal, the return period. For example, 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 that, for instance, 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 same 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.*

A modelling chain composed of climate, hydrological, and hydraulic models using all the available information, in terms of rainfall, temperature, humidity, wind, and solar radiation, 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

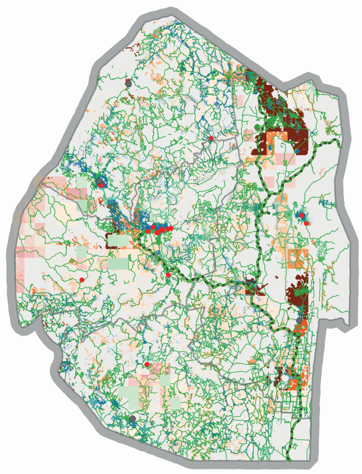
*conditions determined by physical, social, economic and environmental factors or processes which increase the susceptibility of an individual, a community, assets or systems to the impacts of hazards.*

The direct losses on the different elements at risk are evaluated applying vulnerability functions, which link the hazard intensity to the expected loss (economic loss or number of affected people), considering also the associated uncertainty. Vulnerability functions are differentiated for each typology of exposed element and take into account local factors, such as typical constructive typologies for infrastructures or the crop seasonality for the agricultural production. For flood, vulnerability is a function of the water depth. The only exception is represented by agricultural production, for which it is a function of the season in which the flood is occurring. In the case of agricultural drought, the 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, when the loss of hydropower production is evaluated.

## EXPOSURE

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

The losses caused by floods and droughts are evaluated on population, GDP and a series of critical sectors (education, health, transport, housing, and productive and agricultural sectors). The critical 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.


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

# COUNTRY CLIMATE OUTLOOK

## OVERVIEW

The Kingdom of Eswatini has summer rainfall season, with about 75% of the precipitation falls during the months of October to March, usually in the form of thunderstorms and frontal rains. The country is divided into four ecological zones, based on elevation, landforms, geology, soils and vegetation. The Highveld, Middleveld and Lowveld occupy about one-third of the country each, while the Lubombo Plateau occupies less than one-tenth of the country. The climatic conditions range from subhumid and temperate in the Highveld to semi-arid in the Lowveld. Moreover, the climate is strongly influenced by the country's position on the eastern side of southern Africa, which exposes it to moist maritime tropical air coming off the Indian Ocean for much of the year. These interactions between the atmosphere and the ocean can produce considerable variations in climate[1].

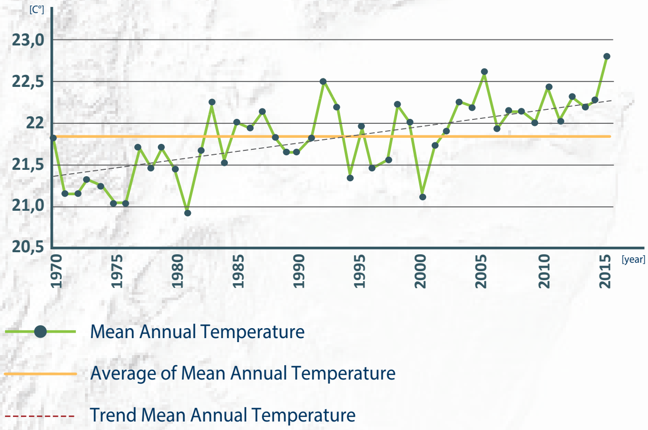
## CLIMATE TRENDS

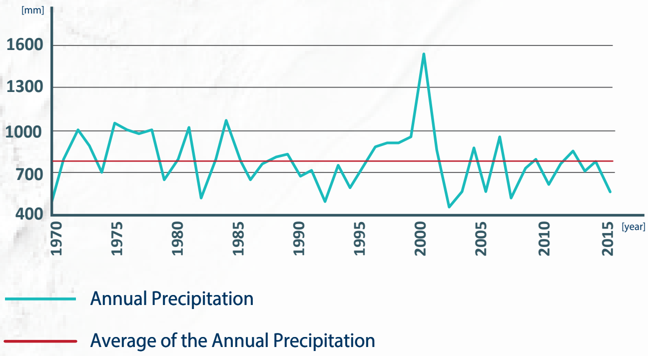
Similarly to other Southern Africa countries, temperature observations indicate that the Kingdom of Eswatini has experienced a considerable increase in temperature over recent years. An analysis of climate data from 1970 to 2015 [2] shows an average rise of temperature of around 1˚C.

Trends for precipitation are not as clear as those for air temperatures, and are variable in time and space. The trend indicates a slight decrease in annual values from the 1990s.

Average annual precipitation for the Kingdom of Eswatini is approximately 780 mm, while the mean number of wet days is around 85.

## TEMPERATURE AND PRECIPITATION TRENDS IN CURRENT CLIMATE




## RIVERS OF ESWATINI

*The Kingdom of Eswatini is abundantly watered, with four large rivers flowing eastward across it into the Indian Ocean. There are four main river systems in the country:*

*• The Komati and Lomati systems, in the north of the country, both originate in South Africa and flow out of the Kingdom of Eswatini back into South Africa, before entering Mozambique;*

*•The Mbuluzi River rises in the Kingdom of Eswatini and flows into Mozambique; there are two sources of the river, one in the Highveld north of Mbabane forming the Black Mbuluzi and one in the Middleveld near Manzini forming the White Mbuluzi or imbuluzane;*

*•The Great Usutu River is the largest river in the Kingdom of Eswatini, with a basin area of 2,682 km$^2$. Together with a number of major tributaries, it originates in South Africa and flows out into Mozambique, forming the border between Mozambique and South Africa;*

*•The Ngwavuma, in the south of the country, rises in the Kingdom of Eswatini and flows into South Africa before entering Mozambique.[3]*

*Photo Credits: World Vision/Geoffrey K. Denye - The Great Usutu River*

## CLIMATE PROJECTIONS FOR  ESWATINI

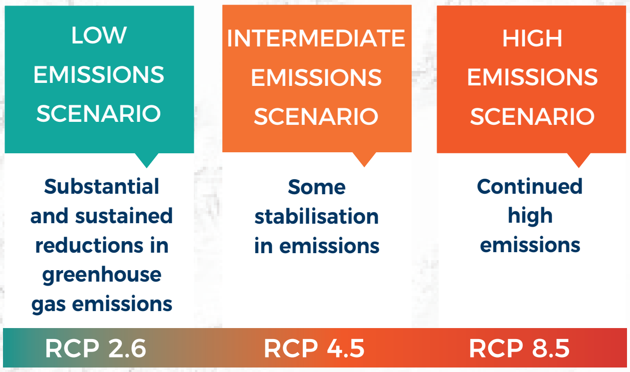
There is a wealth of climate projection studies over multiple time spans and on multiple scales. Climate models are tools used by the scientific community to assess weather condition trends over long periods. In a recent study [4], temperature and precipitation change from global climate models of the Coupled Model Intercomparison Project Phase 5 (CMIP5) were reported. For different greenhouse emission scenarios (see IPPC's Emissions Scenarios), three future periods (2025-2049, 2050-2074 and 2071-2095) were compared against the reference period 1980-2004.

In all periods, models show sharper rises in temperature across low to high emissions scenarios. This is more evident in long-term period projections.

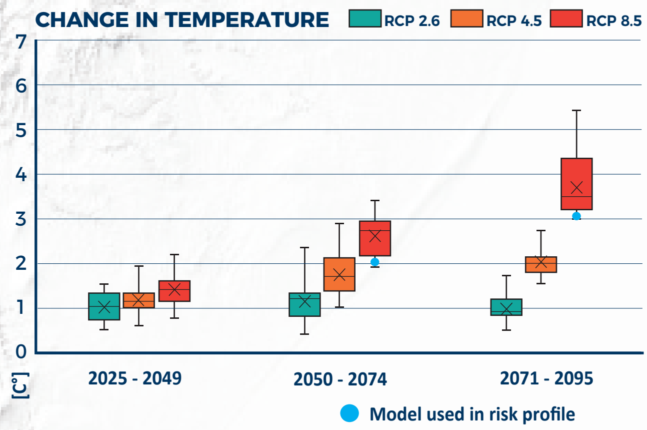
In high emission scenarios (RCP8.5), model projections show an increase of between 2˚C and 3.5˚C for the mid-term period (2050-2074), and an increase of between 3˚C and 5.5˚C for the long-term period (2071-2095).

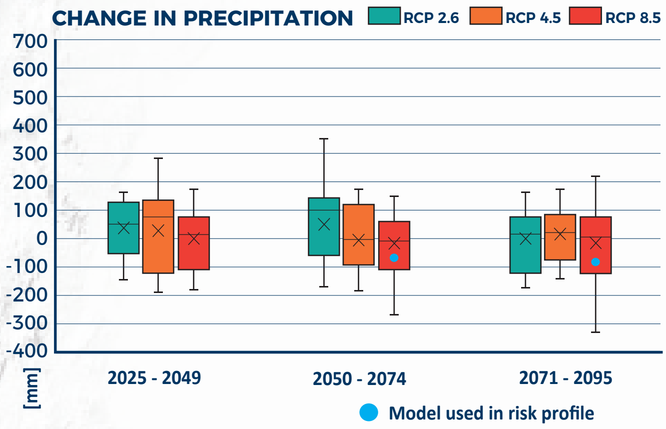
Future change in precipitation seems to be less predictable, for all three periods, where variability is high for all considered emission scenarios (containing both negative and positive changes).

| Time Frame | Climate Projections (RCP 8.5 - High emission scenario ) |
|---|---|
| Mid-term Future (2050-2074) | Increase in temperature from 2˚C to 3.5˚C<br>divergent change in precipitation (from -30% to +20% ) |
| Far Future (2071-2095) | Increase in temperature from 3˚C to 5.5˚C<br>highly uncertain change in precipitation (from -40% to +25%) |




IPCC's Emissions scenarios for Climate Projections




## CLIMATE PROJECTIONS USED IN THIS RISK PROFILE

The results of the Risk Profile referring 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).[5, 6, 7]

In this study, it was decided to use a high-resolution model, accurately calibrated on the African domain, to better capture climate variability, important for assessing extremes. Regional model projections were checked for consistency against the full ensemble of available global models in the area. The model forecasted changes in temperature and annual precipitation by the end of the century, in line with the range of variability of the global models analyzed in the study by Alder and Hostetler [4].

The high emission scenario was maintained as representative of the worst climate change scenario, enabling the analysis of a full range of possible changes. However, in this case, the regional model (blue dot in the above plots) predicts a more moderate increase in temperature (3.1˚C in the long term future), with respect to the global ensemble. For precipitation, a decrease in annual value (less than 10%) is simulated, while the ensemble average is close to zero. This behaviour is frequently observed in high-resolution models with respect to global ones.[8]

# COUNTRY SOCIO-ECONOMIC OUTLOOK

## OVERVIEW

The Kingdom of Eswatini is a landlocked country in Southern Africa bordering South Africa and Mozambique [9]. About 20.5% of its population inhabits urban areas. With a GDP per capita of about $3.000, the Kingdom of Eswatini is classified as a lower middle-income country. Its income distribution is highly skewed, with an estimated 20% of the population controlling 80% of the nation's wealth [9].

The Kingdom of Eswatini is very closely linked to South Africa on which it depends for approximately 85% of its imports and about 60% of exports.

Growth slowed down to 0.4% in 2015, with a slight increase to 1.4 % in 2016 and 1.9% in 2017, and forecasts for 2018 and 2019 are 1.3% and 2% respectively. This slowdown is also due to continued drought [9].

Approximately 70% of the population depends on subsistence agriculture. The manufacturing sector has grown little over the last decade. Sugar and soft drink concentrates are the biggest foreign exchange earners. The importance of mining has dwindled in recent years. Coal, gold, diamond, and quarry stone mines are small-scale, and the only iron ore mine closed in 2014 [10].

## PROJECTIONS

Recently, climate scientists and economists have built 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 [11,12]. The scenarios range from relatively optimistic trends for human development, with "substantial investments in education and health, rapid economic growth and well-functioning institutions" [13], to more pessimistic economic and social development, with little investment in education or health in poorer countries, coupled with a fast-growing population and increasing inequalities.

## SOCIO-ECONOMIC PROJECTIONS USED IN THE RISK PROFILE

The "middle of the road" scenario envisages that historic development patterns will persist throughout the 21st century. The results shown in this report refer to this scenario. According to these conditions, the population of the Kingdom of Eswatini in 2050 will increase by 15% compared to 2016 (World Bank Data), whereas GDP is expected to increase more than three-fold.

| POPULATION | GDP |
|---|---|
| 2016 Projection | 2016 Projection |
| 1.343 | 3.721 |
| [Million People] | [Billion$] |
| 1.546 | 17.711 |
| 2050 Projection | 2050 Projection |

## ESWATINI

AREA : 17.200 km²

POPULATION DENSITY : 81 people/km²

MEDIAN AGE : 20.5 years

HUMAN DEVELOPMENT INDEX : 0.54

LIFE EXPECTANCY AT BIRTH : 48.9 years

MEAN YEARS OF SCHOOLING : 6.8 years

EMPLOYMENT TO POP. RATIO (AGES > 15) : 38.6%

EMPLOYMENT IN AGRICULTURE : 68.4%

EMPLOYMENT IN SERVICES : 18.5%

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

# A “SENDAI DRIVEN” PRESENTATION

The Sendai Framework guides the organisation of the risk profile results.

The **first page** of results refers to Sendai Framework Target B: “*Substantially reduce the number of affected people globally by 2030*” and specifically to Sendai indicator B1: “*Number of directly affected people attributed to disasters*“.

The **second page** presents indicators that contribute to increasing knowledge of the country on Sendai Framework Target C: “*Reduce direct disaster economic loss in relation to global gross domestic product (GDP) by 2030*”.
The indicator C1 “*Direct economic loss attributed to disasters*” is computed as a compound index of several indicators computed in a fully probabilistic manner in this study that can be reconciled to the Sendai indicators.

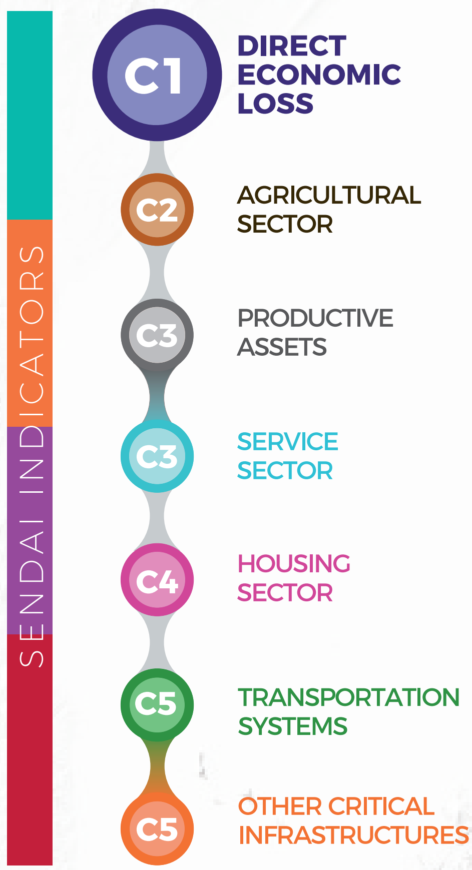
**In the case of floods**, the indicators used are:
·**C2** Direct agricultural loss attributed to disasters (based on the main crops).
·**C3** Direct economic loss to all other damaged or destroyed productive assets attributed to disasters. In this risk profile, C3 is split into two components: productive assets (industrial buildings and energy facilities) and service sector (governmental and service buildings).
·**C4** Direct economic loss in the housing sector attributed to disasters.
·**C5** Direct economic loss resulting from damaged or destroyed critical infrastructure attributed to disasters. In this risk profile C5 is split into two components: transportation systems (roads and railways) and other critical infrastructures (health and education facilities).

Sendai Framework **Target D**: “*Substantially reduce disaster damage to critical infrastructure and disruption of basic services, among them health and educational facilities, including through developing their resilience by 2030*” is also addressed. The count of affected critical infrastructures (e.g. health and education facilities and kilometres of transportation network) is provided.

**In the case of droughts**, the indicators computed are:
·**C2** Direct agricultural loss attributed to disasters (based on the main crops).
·**C3** Direct economic loss to all other damaged or destroyed productive assets attributed to disasters. In these calculations, only hydropower losses are assessed in the context of drought.

In the **third page** of results for floods, the most relevant sectors for the country are selected and their AAL distribution is presented in present and future climate conditions in relation to the exposure distribution considered in the study. In the case of droughts, the spatial distribution of the main hazard indexes is presented as they represent the main driver for risk computations. An explanation box for each drought hazard index is given in the page to help their interpretation.

For floods, the results are broken down on the **fourth and final page** according to different return periods and presented in terms of PML curve of the total damage across all sectors. The contribution of the different sectors is highlighted in each range of return periods of the total damage.
In the case of droughts, the result derived in economic terms for income losses due to lack of agricultural production and loss of hydropower production are broken down according to different return periods.



# RESULTS | FLOODS

## KEY MESSAGES

- Floods are relevant natural hazards in the Kingdom of Eswatini, affecting on average about 2,900 people every year, almost 0.22% of the country's total population.

- Affected populations are geographically concentrated in the Hhohho and Manzini regions.

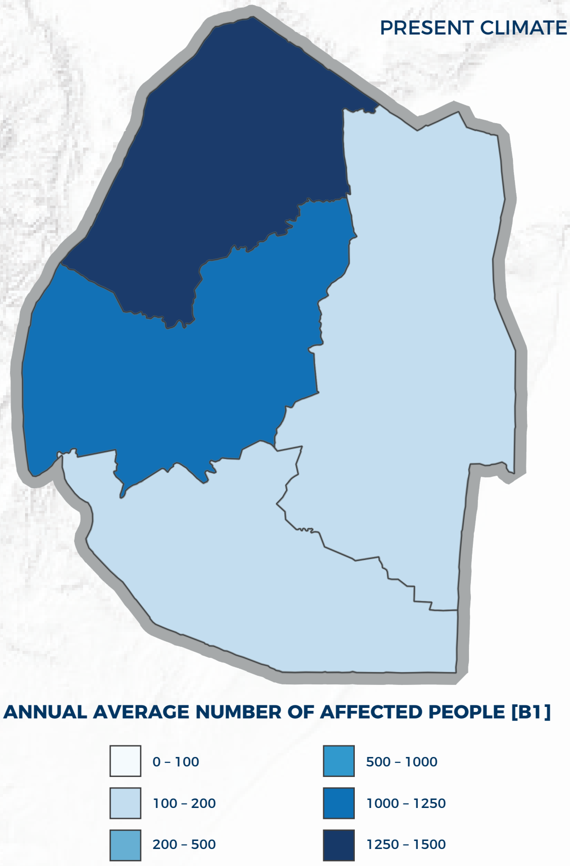
- Future climatic conditions paired with projections of future population show a decrease in affected population with respect to present conditions.

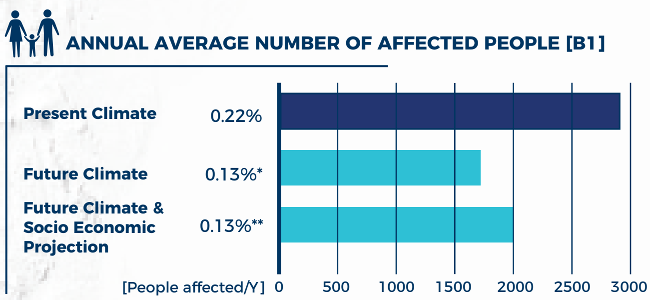
- The affected GDP in flooded areas amounts to almost 0.8% of total national GDP.

- The affected GDP is expected to double by 2100 if future climatic conditions are paired with projections of future GDP growth.

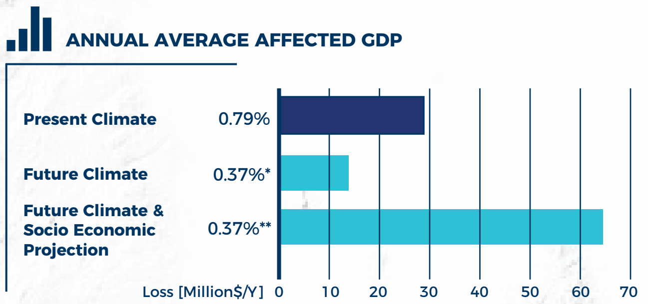
- Future climatic conditions alone, due to a greater probability of a decrease rather than an increase in precipitation, would bring an overall risk decrease, if present population and GDP are accounted for. However, as shown in the climate section, some global climate models predict an opposite trend in the future, with an increase in precipitation and, possibly, flood risk too.

- Taking into consideration the above-mentioned circumstances, risk-informed decision-making for sustainable development is crucial.

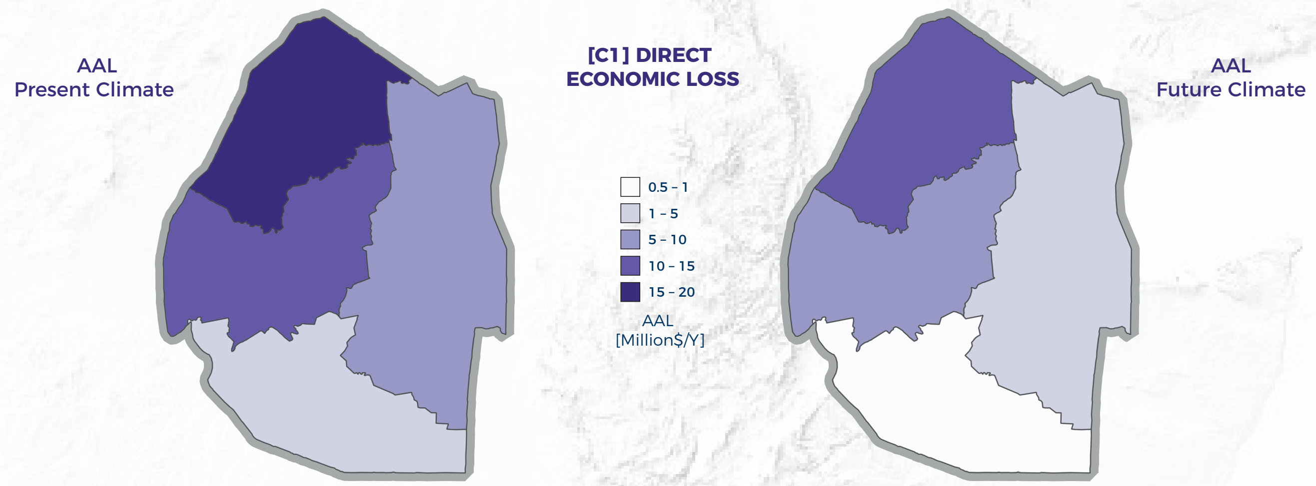



* % computed with reference to the total 2016 Population / GDP
** % computed with reference to the total 2050 Population / GDP



# RESULTS | FLOODS



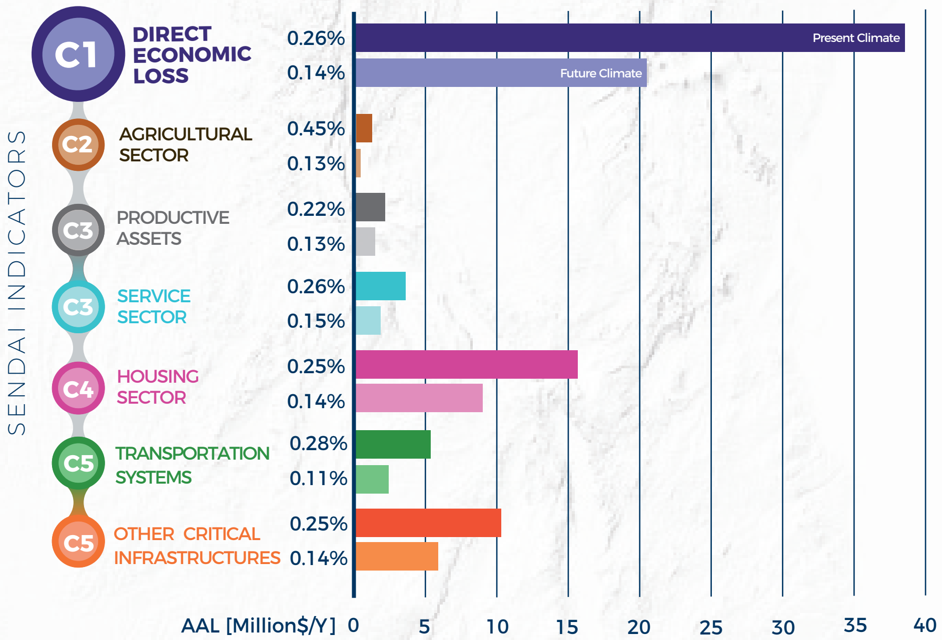

## KEY MESSAGES

- The direct economic loss in the Kingdom of Eswatini is geographically distributed in line with exposure concentration, with the highest values in the Hhohho and Manzini regions. The pattern prevails in future climate, albeit with a certain decrease in absolute values.

- The value of direct economic losses in terms of AAL amounts to $US 38 million, almost 0.26% of the total exposure value in the current climate. The largest portion of losses is due to housing and critical infrastructures (i.e. health and education), accounting for almost 70% of total loss.

- The proportion of different sectors in overall loss does not significantly change in future climate conditions.

- Considering the present exposed assets, average annual losses tend to decrease in future climate conditions, for all sectors. However, as already discussed for GDP and population, risk figures may change when considering future exposure evolution.



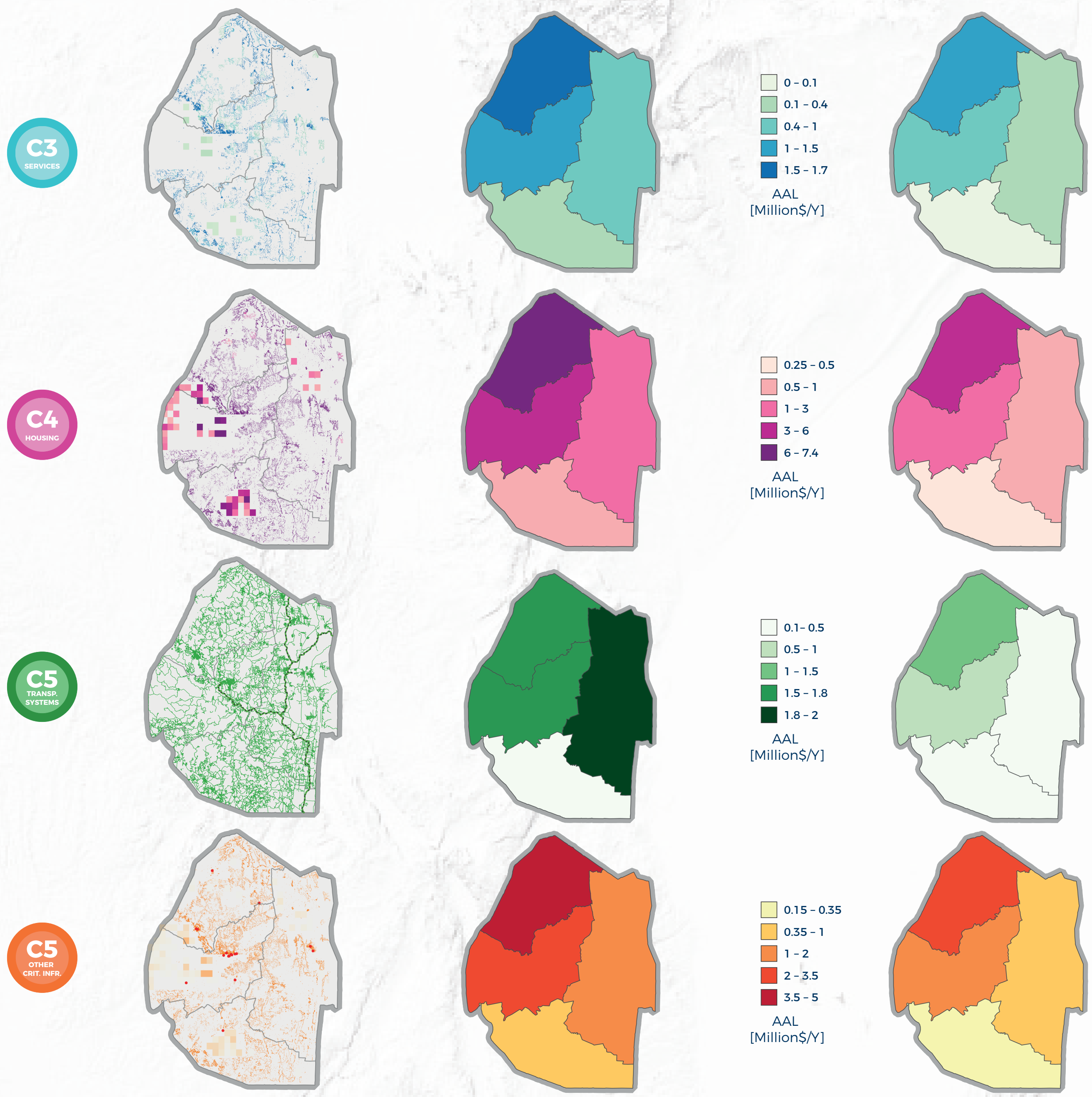

**AFFECTED INFRASTRUCTURES [D]**

# RESULTS | FLOODS

## KEY MESSAGES

- Comparison between present and future climate AALs shows a consistent pattern across all regions and sectors (except for transportation), with Hhohho and Manzini as the two most affected regions.
- In current climate conditions, roads and railway networks are most affected in Lubombo, whereas in future climate conditions, Hhohho and Manzini would be the two most affected regions.

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



# RESULTS | FLOODS

## KEY MESSAGES

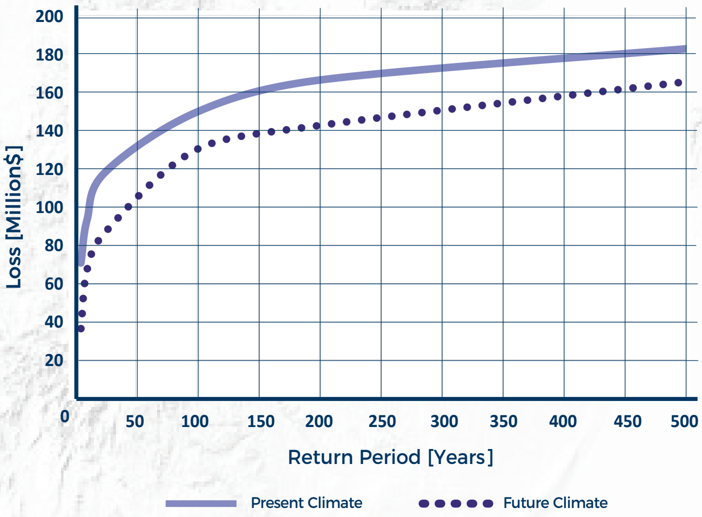
- In both present and future climate, the PML curves rise steeply up to the 10-year loss, meaning that considerable losses may be experienced relatively frequently. Another change of slope is observed for a 100-year loss, and after that it tends to even out.

- Both high (rare) and low (frequent) losses may be experienced less frequently in future climate conditions. However, given the high level of uncertainty in future climate prediction, worse scenarios may still be possible (compare climate section at p.8).

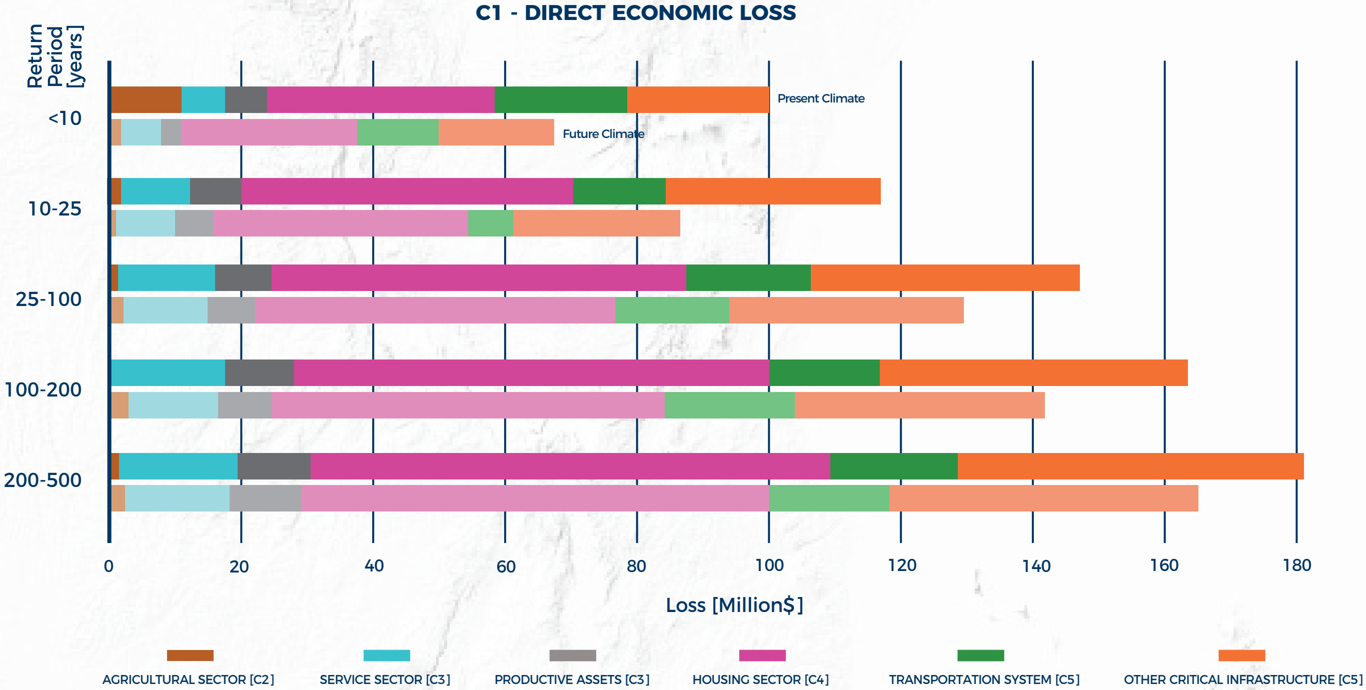
- The share of losses across sectors and for the different return periods does not change under future conditions (except for transportation).

- As regards rare events (25 to 500 return period), the transportation system would maintain the present level of losses also in future climate conditions.

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




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



# RESULTS | DROUGHTS

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.

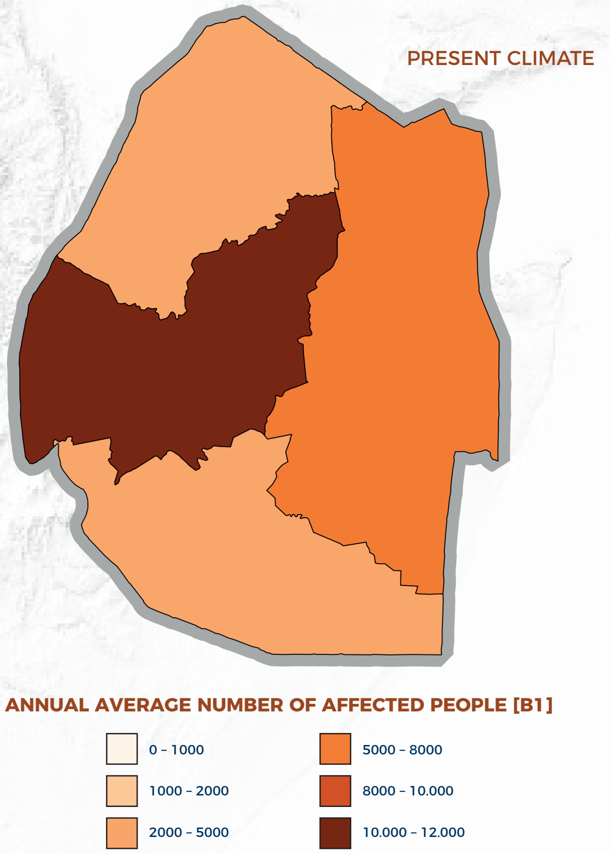
## KEY MESSAGES

- With respect to present conditions (1951-2000 climate), annual precipitation is expected to decrease while a strong increase in temperature is foreseen in future conditions (2050-2100 climate), causing an increase in the frequency of droughts.

- GDP affected by droughts is expected to increase by a factor 2. Currently, an average of 2.9% of GDP is affected by droughts annually, however this is expected to rise to 5.6%.

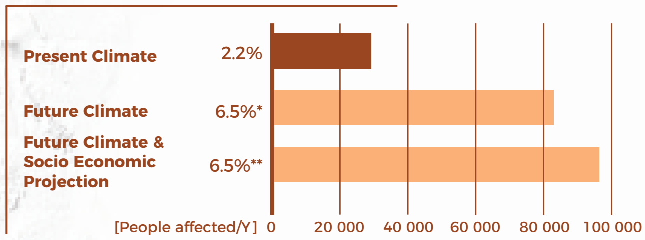
- Under future climate conditions, double the amount of livestock is expected to be affected by droughts on an annual basis. Currently, an average of 2.8% of livestock are annually affected by drought conditions. Under future conditions, this is expected to increase to 5.8%.

- Currently, an average of almost 2,2% of the population (30,000 people) per year are affected by droughts. Under future conditions, this number is expected to increase to 6.5% (almost 100,000 people if population growth is accounted for).



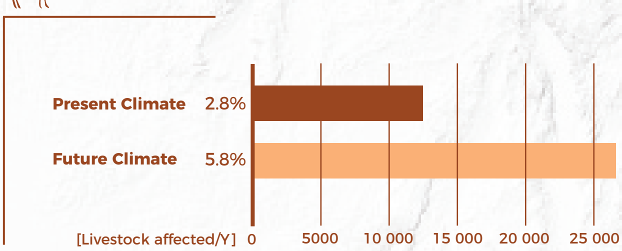

This map shows the average annually affected people by drought conditions. Drought conditions are calculated using the Standardized Precipitation-Evapotranspiration Index. Drought conditions are defined as at least three months of dry conditions (see glossary).

### ANNUAL AVERAGE NUMBER OF AFFECTED PEOPLE [B1]

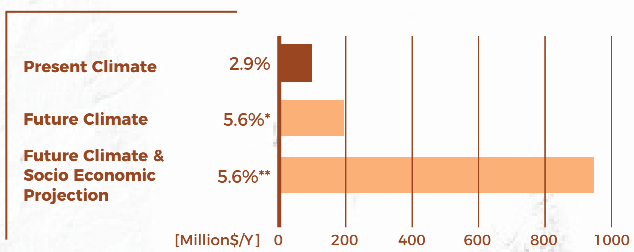



* % computed with reference to the total 2016 Population / GDP
** % computed with reference to the total 2050 Population / GDP

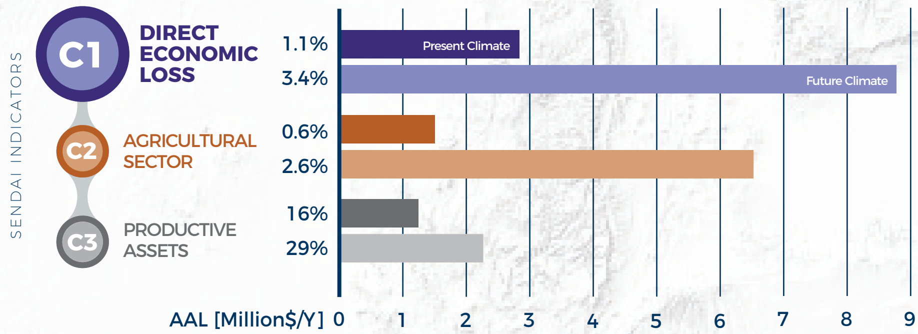
### ANNUAL AVERAGE NUMBER OF AFFECTED LIVESTOCK




### ANNUAL AVERAGE AFFECTED GDP



# RESULTS | DROUGHTS




C2 is computed considering only the direct loss suffered because of a loss of agricultural (crop) production with respect to a reference production in the present climate. The crops considered in the analysis are the ones that contribute at country level to at least 85% of the total gross crop production value. It might therefore happen that crops that have an important role in the local agriculture (commercial or for subsistence) might be neglected in the overall analysis. C3 is computed considering only the loss in hydropower production as compared to a nominal production in present climate.

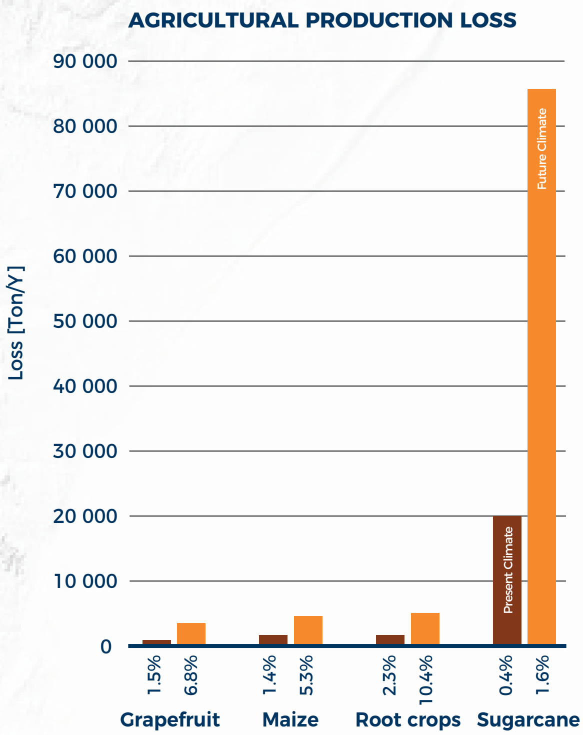
## KEY MESSAGES

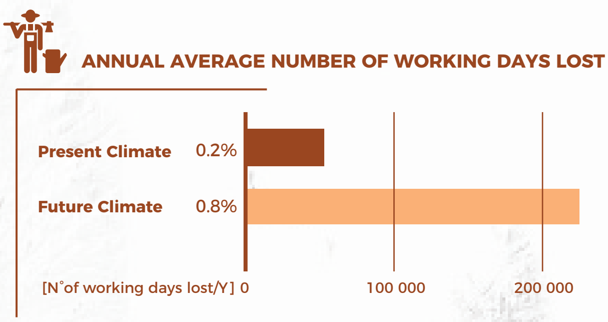
- Losses in agricultural production (C2) are projected to increase substantially (about 4 times), but are still low compared to total income from crops (<3%). Losses in hydropower generation (C3) due to drought are set to double under future climate conditions, compared to present conditions (for Lubholho and Maguga dams).

- Total direct economic losses (C1) due to drought is for the most part attributable to the agricultural sector (C2), and to a lesser extent due to the loss of hydropower (C3).

- Agricultural losses in absolute terms are mainly due to sugarcane. In relative terms, root crops can be heavily affected, particularly under future conditions when approximately 10% of production may be affected by droughts.

- Approximately a 4-fold increase in lost working days is expected under future climate conditions. The loss of working days is estimated at less than 1% for both present and future conditions. However, the number of working days lost, expressed as a percentage of the average amount of days required for harvesting, is approximately 3 times higher.



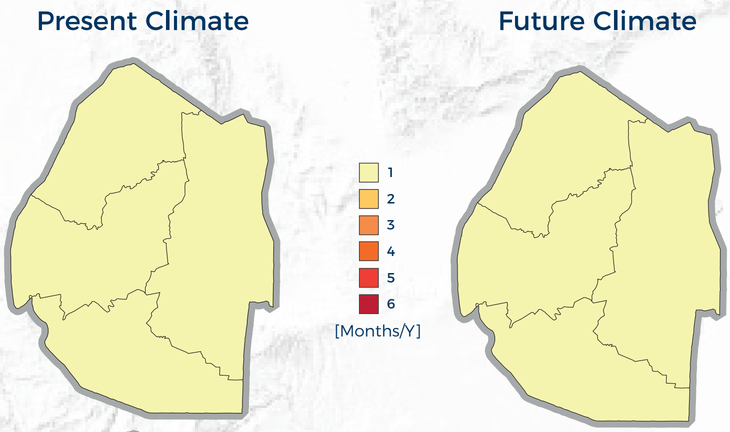



# RESULTS | DROUGHTS

## SPEI

**Standardised Precipitation-Evapotranspiration Index**

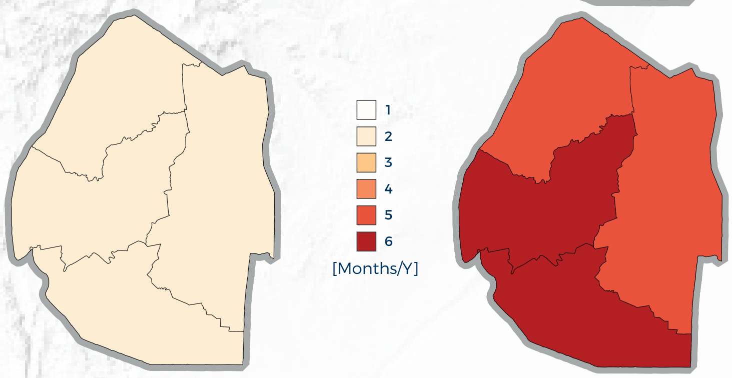
This map denotes the average amount of dry months in a year for a return period of 1 in 10 years. Dry months are defined using the Standardized Precipitation minus Evapotranspiration Index (SPEI; see 'Drought' in Glossary). This is particularly important for areas dependent on rainfall for their water resources. A 1-in-10 years drought does not have a large effect in the Kingdom of Eswatini, with less than 3 dry months per year in all areas, under both present and future climate conditions.




## SSMI

**Standardized Soil Moisture Index**

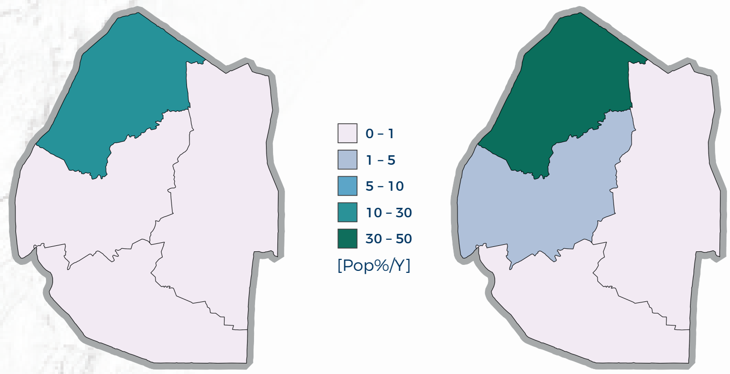
This map denotes the average amount of months per year with low soil moisture conditions for a return period of 1 in 10 years. Soil moisture is calculated using the Standardized Soil Moisture Index (SSMI) using the same threshold as SPEI (see 'Drought' in Glossary). In future climate, soil moisture condition will drastically aggravate, as the whole country will experience longer dry periods. Manzini and Shiselweni will be the most affected regions.




## WCI

**Water Crowding Index**

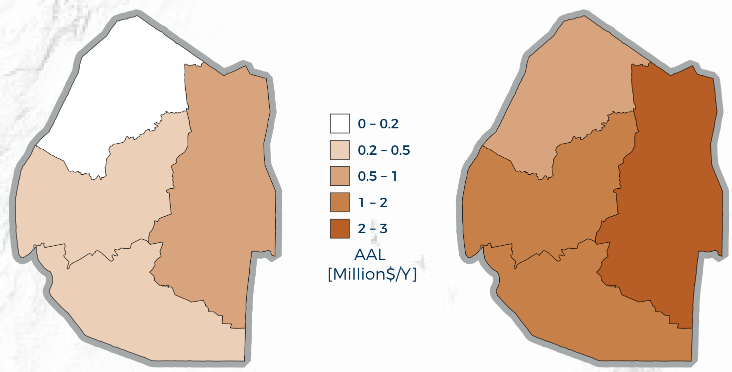
These maps show the percentage of the population per province experiencing water scarcity, based on the water available per person per year (<1000 m³/person/year). Water scarcity basically indicates that a population is dependent on water resources from outside their immediate region (~85 km²). Specifically, areas with high concentrations of people are dependent on outside water resources (primarily Hhohho). Under future climate conditions, also a small portion of the population in Manzini may become more dependent on water from elsewhere as water availability per person drops just below the threshold in a few parts.




## C2

**Agricultural Sector**

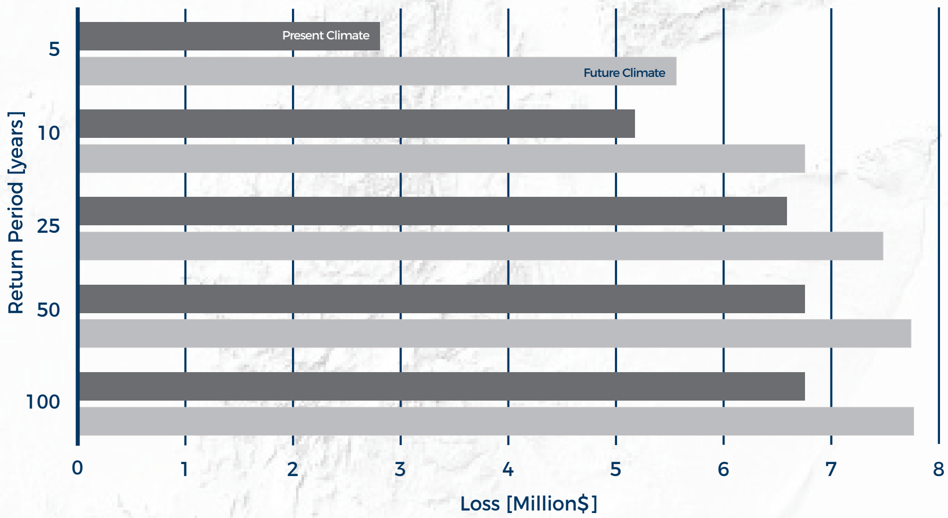
The distribution of agricultural (crop) losses shows a concentration of losses in the eastern and southern parts of the country, in line with exposure distribution. Under future climate conditions, the same spatial pattern is maintained, although an increase in losses is estimated throughout the entire country.



## KEY MESSAGES

● For hydropower losses (defined as the production below production with average reservoir conditions under the present climate), losses do not increase much with higher return periods under present climate conditions. Significant increases in losses under future climate conditions are expected for frequent events: in relative terms the largest losses for low return periods (+100% and +30% for 5 and 10 years return period respectively), whereas for high return periods, the relative increase is much smaller (around 14%).

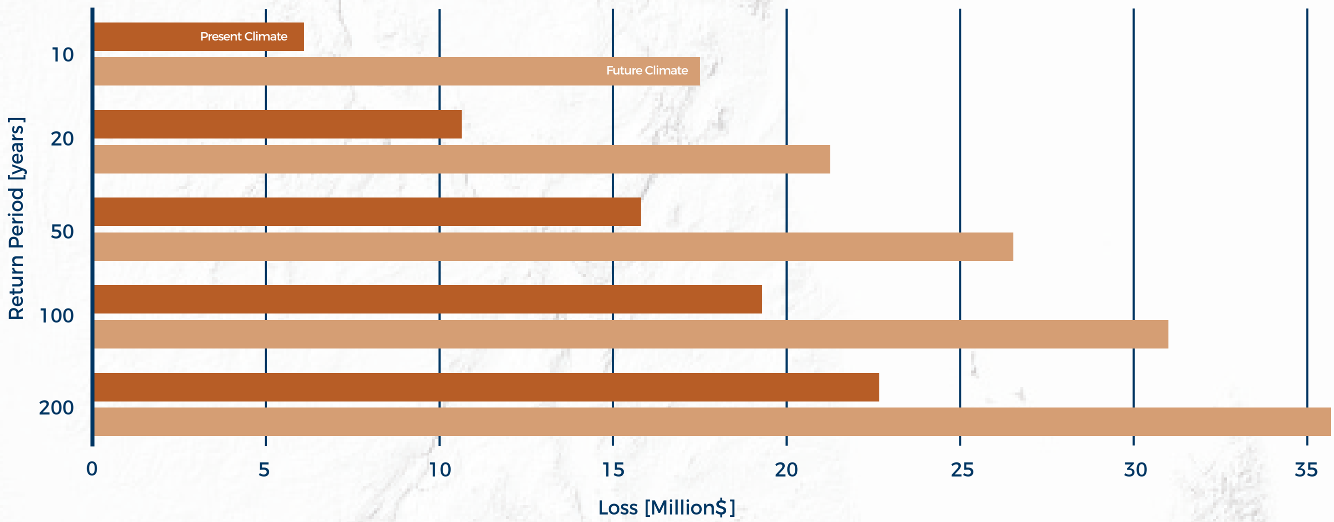
**PROBABLE MAXIMUM LOSS (PML)**
**C3 - PRODUCTIVE ASSETS (HYDROPOWER LOSS)**




*There are four main hydropower plants in the Kingdom of Eswatini: Maguga, Ezulwini, Edwaleni and Maguduza; they generate approximately 60 MW, satisfying approximately 15% of the country's total electricity demand [9]. The three power stations Ezulwini, Edwaleni and Maguduza are cascaded, with the Luphohlo Dam as the key water supply. The Dam is built on and powered by the Lusushwana River. Water supplied by the dam to the Ezulwini Hydropower station is used downstream by the Edwaleni Hydropower Station, and lastly by the Maguduza Hydropower Station. The Maguga Hydropower Station is powered by the Maguga dam, built on and powered by the Komati River [14].*

● In the case of agricultural income losses (see Glossary), current climate conditions present a gradual increase in expected losses when return periods go up from 10 to 200 years. It is worth noting that these results might be affected by a high level of uncertainty as we move into the very rare losses domain.
Under future climate conditions, agricultural income losses increase significantly in absolute units, compared to present climate conditions, where relative increases are highest for the lowest return periods of 10 and 20 years.

**PROBABLE MAXIMUM LOSS (PML)**
**C2 - AGRICULTURAL LOSS**



# 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, from improving building codes and designing risk reduction measures, to carrying out macro-level assessments of the risks to prioritise investments. Risk metrics can help discern the contributions of different external factors (such as demographic growth, climate change, urbanization expansion, etc.) and provide a net measure of progress of disaster risk reduction policies implementation.

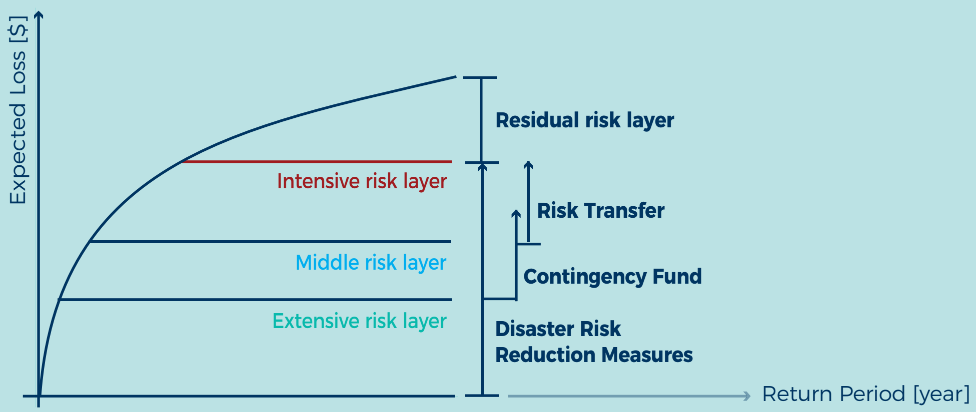
AAL can be interpreted as an opportunity cost, given that resources set aside to cover disaster losses could be used for development. Monitoring AAL in relation to other country economic indicators, such as GDP, capital stock, capital investment, reserves, and social expenditure, would provide indications of country 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 layers. Extensive Risk Layer: this layer is typically the one associated with risk reduction measures (e.g. flood defences, local vulnerability reduction interventions). Immediately after this extensive layer is the Mid Risk Layer, which builds up cumulative losses from higher impact events. The losses of this layer are normally mitigated using financial funds, like a contingency fund, that are normally put in place and managed by the country itself.**

**The losses that compose the Intensive Risk Layer (severe, infrequent hazard events) are difficult to finance on the country level, and a mechanism of risk transfer has to be put in place (e.g. insurance and reinsurance measures). The remaining layer of the curve determines the Residual Risk (catastrophic events), which is the risk that is considered acceptable/tolerable due to the extreme rarity of the events able to determine such loss levels. Due to this rarity, there are no concrete actions to reduce risk beyond preparedness actions that tend to ease the conditions determined by the event (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**
Drought refers to dryer than normal conditions of a specific area (i.e. variability). Not to be confused with aridity, which refers to a lack of water resources in absolute terms. In this profile, drought hazard is denoted by various indicators, covering a range of the drought types. Both hydrological and agricultural droughts are explicitly addressed, both in terms of hazard, exposed population and GDP, and corresponding losses related to crop production and hydropower generation. Drought hazard and risk are modelled based on distributed rainfall and a hydrological model solving the water balance (same one as used for the flood risk assessment). Dry conditions are defined as months with standardised SPEI values below -1.5, which correspond with the driest 6% of months as found in the period 1951-2000 (assessed for January, February, March, etc. separately).

**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*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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

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