



Climate Risk Profile: Nigeria*

Summary

	<p>This profile provides an overview of projected climate parameters and related impacts on different sectors in Nigeria until 2080 under different climate change scenarios (called Representative Concentration Pathways, RCPs). RCP2.6 represents the low emissions scenario in line with the Paris Agreement; RCP6.0 represents a medium to high emissions scenario. Model projections do not account for effects of future socio-economic impacts.</p>		<p>The crop land area exposed to droughts is projected to be stable for both emissions scenarios, however, involving high uncertainty towards potential drought events, with some models projecting a sevenfold increase. Crop yields are projected to be heterogeneously affected. Yields of cassava, sugar cane or groundnuts are benefiting from climate change, whereas yields of maize, millet and wheat are projected to decline. The impact of droughts is projected to be less severe in Nigeria, while heavy precipitation events and very hot days will have a stronger impact.</p>
	<p>Agriculture, health, infrastructure and water are highly vulnerable to climate change. The need for adaptation in these sectors has been stressed in Nigeria's NDC targets and should be represented in the German development cooperation portfolio of the country.</p>		<p>Water availability, adjusted to population growth, is projected to decline by more than 75 % – from 3 300 m³ per capita and year in 2000 to about 800 m³ per capita in 2080 – and thus fall below the UN threshold for water scarcity.</p>
	<p>Depending on the scenario, mean temperature in Nigeria is projected to rise by between 1.8 and 3.9 °C until 2080 compared to pre-industrial levels. Potential evapotranspiration is projected to increase by almost 7 %.</p>		<p>The population share exposed to heatwaves is projected to almost quadruple to more than 20 %. The number of very hot days is set to increase by about 90 days in most regions of Nigeria. Heat-related mortality is projected to increase from about 2 to almost 10 deaths per 100 000 people per year by 2080.</p>
	<p>Precipitation is projected to increase by about 40 mm per year until 2080. Nigeria has suffered from several major flood events in the past, the frequency and severity of which have been increasing over time. This trend is expected to continue, given projections of 1 to 1.5 more days of heavy precipitation in 2080. Flood-exposed regions are projected to double in size. It is very likely, however, that they will be even bigger. Surface runoff is expected to increase in the north and decrease in the central regions.</p>		
	<p>The sea level is projected to rise between 31 cm (RCP2.6) and 39 cm (RCP6.0) until 2080 which may contribute to flooding and cause saline intrusion in coastal waterways and groundwater reservoirs.</p>		
	<p>The exposure of Nigeria's infrastructure to extreme floods is expected to double until 2080. GDP exposure to heatwaves is closely linked to the population exposure to heatwaves, with about 20 % of the GDP affected by heatwaves until 2080.</p>		

* This Climate Risk Profile was implemented by Climate Analytics and ifo Institute as part of a collaboration with the Potsdam Institute for Climate Impact Research (PIK) and is based on the Climate Risk Profiles developed within the AGRICA project. The Climate Risk Profile is up to date as of October 2021.

Context

Nigeria is an emerging economy in **sub-Saharan West Africa**. With a population of **201 million**, of which almost half are under 15 years old, it is the most populous country on the continent. With a GDP of 477.2 billion USD (2010), its economy is the largest in Africa and the GDP per capita of 2 374 USD (2010) is above average for the region [1]. However, as **population growth (2.6 %)** exceeds GDP growth (2.2 %), Nigerians' income is declining on a per capita basis. Furthermore, welfare distribution is relatively unequal (Gini: 35.1) and particularly concentrated in the **petroleum industry**. Other important economic sectors are the

agricultural and industrial sectors which account for 21.9 % and 27.4 % of GDP, respectively [1]. About 35.0 % of the population are employed in the agricultural sector, the majority of whom are subsistence farmers.

In 2020, Nigeria experienced its **deepest recession in decades due to the COVID-19 pandemic**, with an estimated GDP contraction of -4 % [2]. Effects on the job market are expected to be felt for years to come, regarding both poverty rates as well as general economic and social development.

Quality of life indicators [1], [3], [4], [5]

Human Development Index (HDI) 2019 [3]	ND-GAIN Country Index 2019 [4]	GINI Coefficient ¹ 2018 [1]	Real GDP per capita 2019 [1]	Poverty headcount ratio 2018 [1]	Prevalence of under-nourishment 2017–2019 [5]	
0.539 161 out of 189 (0 = low, 1 = high)	36.8 161 out of 182 (0 = low, 100 = high)	35.1 (0–100; 100 = perfect inequality)	2,374 USD (constant 2010 USD)	39.1 % (at 1.9 USD per day, 2011 PPP) ²	92.0 % (at 5.5 USD per day, 2011 PPP)	12.6 % (of total population)

Regional differences

Figure 1 shows the **Subnational Human Development Index (SHDI)** across Nigeria's different regions, both aggregated and for each of the three dimensions health, education and income [5]. The degree of the aggregated SHDI is **highest in the southern coastal region and continuously decreases towards the north-east**. Exceptions are the capital city Abuja in the centre of the country as well as Borno state in the northwest. The **three dimensions of the SHDI exhibit similar regional patterns**, pointing to a structural imbalance of development. The health status, measured by life expectancy at birth, is relatively high nationwide, positively affecting the SHDI. The same can be said about the standard of living, proxied by income. The negative effect mainly stems from the education dimension, measured by mean (expected) years of schooling. The northern half of the country shows deficits, while the coastal regions score higher in terms of education.

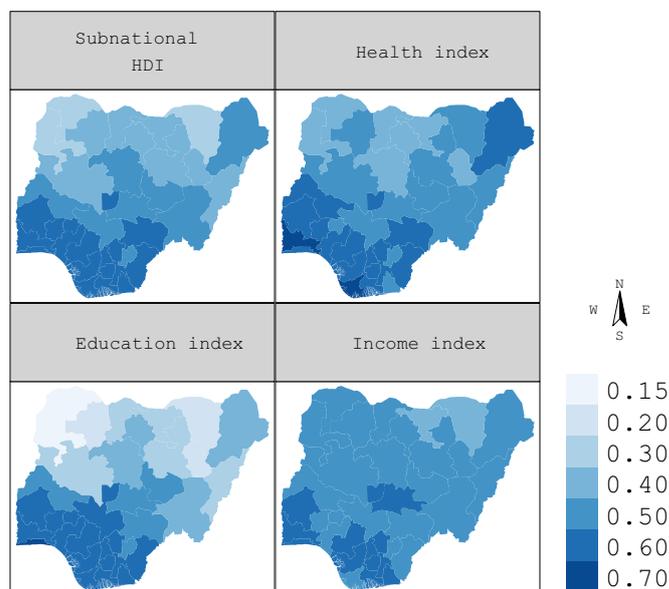


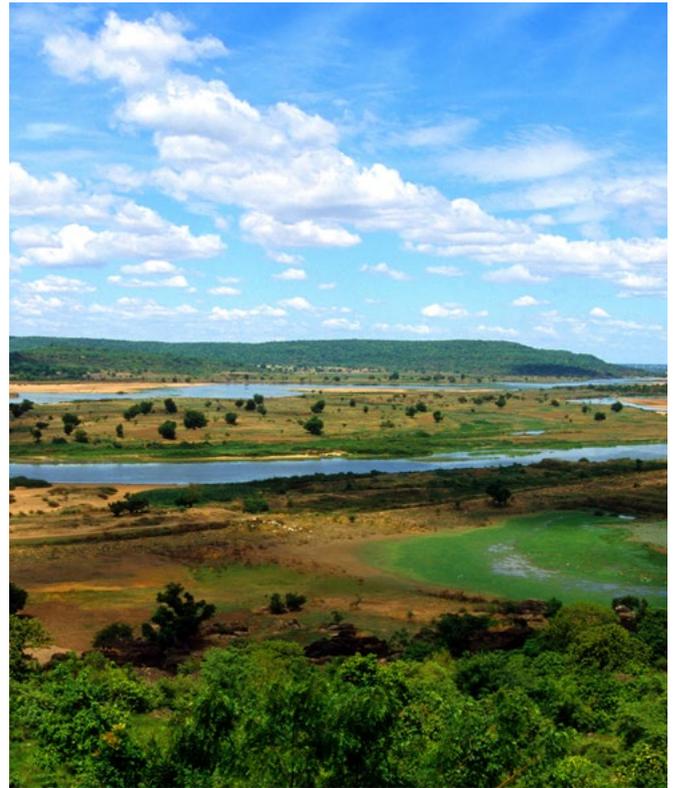
Figure 1: Subnational indices for human development (data for 2019). Source: Global Data Lab (2021). Subnational Human Development Index [6].

¹ The Gini coefficient measures the extent to which the distribution of income within an economy deviates from a perfectly equal distribution. A Gini index of 0 represents perfect equality, while an index of 100 represents perfect inequality.

² Poverty headcount ratio for the year 2018 adjusted to 2011 levels of Purchasing Power Parity (PPP). PPP is used to compare different currencies by taking national differences in cost of living and inflation into account.

Topography and environment

Nigeria has a land area of 923 769 km² [7]. Located in sub-Saharan West Africa, the southern coast of the country is marked by the Gulf of Guinea in the Atlantic Ocean. The 850 km long coastline is dominated by the Niger River Delta. The **Niger**, together with its main tributary **Benue**, is the country's largest river and flows through the southern plains. While there are plateaus and hills in the centre, the north is again characterised by river plains. Nigeria has a tropical climate with alternating rainy and dry seasons [7]. The length of the **rainy seasons decreases from south to north**, with constant hot and humid weather at the coast and a mostly savannah / (semi-)arid climate closer to the Sahara (Figure 2). Vegetation across these zones differs accordingly. The humid south is dominated by flat swampland near the coast and rain forest further inland. Towards the dryer north, forests are first replaced by grassland and open savannah and ultimately by a (semi-)arid landscape. **Staple crops differ depending on climatic conditions**, with root crops being grown in the south and grains and legumes in the north [7]. Nigeria can be divided into **six major agro-ecological zones (AEZ)**³: Arid/Sahel, Semi-arid/Sudan Savannah, Northern Guinea Savannah, Southern Guinea Savannah, Derived Savannah and Humid Forest [8].



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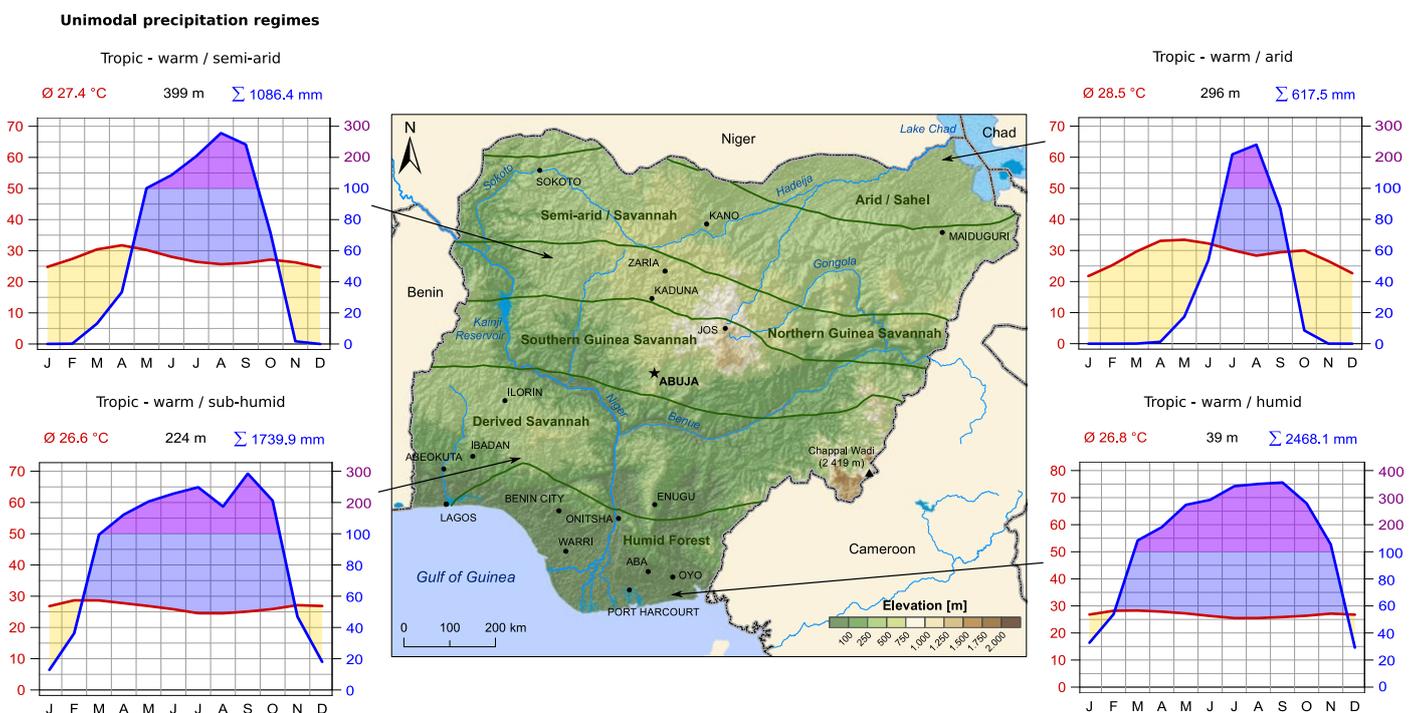


Figure 2: Topographical map of Nigeria with agro-ecological zones and existing precipitation regimes.⁴

³ It should be noted that there are different classifications of AEZs in Nigeria.

⁴ The climate graphs display temperature and precipitation values which are averaged over an area of approximately 50 km × 50 km. Especially in areas with larger differences in elevation, the climate within this grid might vary.

Present climate and related extremes

Temperatures vary depending on the seasons, with the **lowest temperatures in December and January and two peaks in April and October**. The period from July to September experiences more moderate temperatures due to the rainy season. At the country level, temperatures vary between 25 °C and 30 °C (Figure 5). **Harmattan wind** from the Sahara Desert influences the northern regions of Nigeria from November to March, bringing particularly hot and dry air. Since the 1960s, southern Nigeria has seen a larger increase in temperatures than the north [9].

Precipitation patterns follow the different climatic zones and are reflected in a shorter rainy season in the north (April to October) and a longer rainy season (February to November) in the south (Figure 2). Annual precipitation sums range from below 1 000 mm in the north to over 3 000 mm in the coastal south. Since the 1960s, **annual precipitation sums have decreased** by around 3.5 mm per month per decade, mostly driven by changes in the (semi-)arid climate of the northern regions [9]. Furthermore, the **annual precipitation peak has shifted** from August to July for the north and from July to September for the southern regions. This high variability in precipitation throughout the year is becoming more prominent [9].

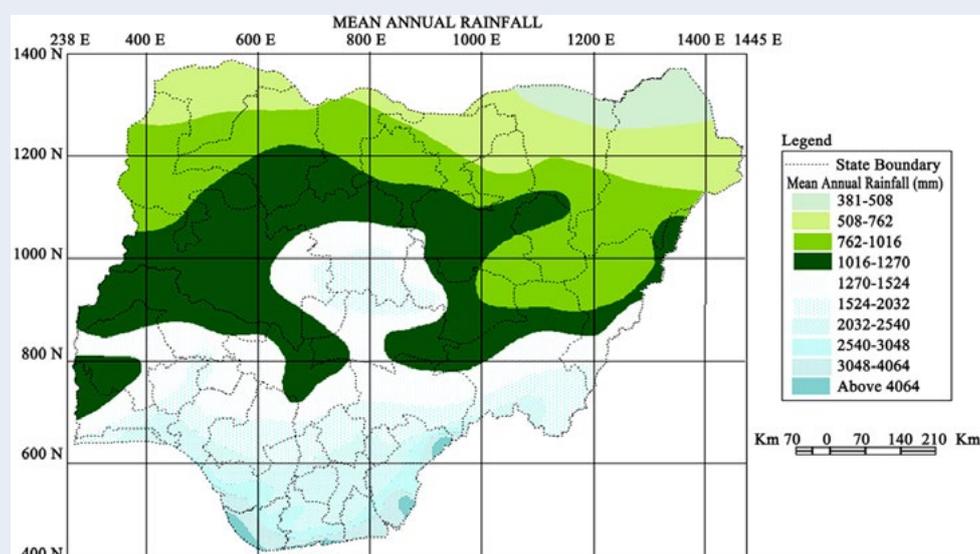


Figure 3: Map of Nigeria showing mean annual precipitation patterns from Ishaku et al. (2010) [10].

Floods have become more prevalent in Nigeria in recent years, both in frequency and severity. Most of the **51 flood events since 1985** were riverine floods attributed to heavy precipitation, which primarily affect the river plains in the north and south [10]. The nationwide floods in 2012 affected more than seven million people, resulting in unprecedented damages, losses and deaths [10]. Heavy flooding destroys or blocks infrastructure, decreases soil quality and has adverse effects on agricultural production, which increases economic hardship, as a large share of Nigerians depend on agriculture as their main source of income and economic livelihood.

Droughts have a historic significance in Nigeria, particularly for the northern regions of the Sahel [11]. Recent insights from scientific literature suggest an **expansion of the Sahara Desert** by about 3 600 km² a year, including a **drying up of Lake Chad** due to precipitation shifting south [11], [12]. However, **individual drought events** which destroy crop yields on a larger scale **happened less frequently** in recent years. The trend has been going towards a generally dryer climate which makes it more difficult to sustain agricultural production [11].

Heatwaves⁵ can have a strong impact on health, mortality and GDP in a short amount of time. Nigeria experiences heatwaves **regularly from March to May**, which is right before the start of the rainy season [9]. Hot days⁶ have increased by 73 days from 1960 to 2003 with the highest occurrence between September and November [9].

⁵ A heatwave refers to a period of unusually hot weather over a region during the warm period of the year persisting for at least three consecutive days based on local climatological conditions [13].

⁶ Here, hot days are defined as days on which the temperature exceeds the 90th percentile of days in the current local climate of the region and season; 'cold' days are defined as the mirror image below the 10th percentile of days in the current local climate. Note that this definition differs from that of very hot days used for the projections in this climate risk profile (cf. Figure 5).

Projected climate changes

How to ...

... read the line plots

 historical	 best estimate
 RCP2.6	 likely range
 RCP6.0	 very likely range

Lines and shaded areas show multi-model percentiles of 31-year running mean values under two different climate change scenarios called Representative Concentration Pathways (RCPs). RCP2.6 (blue) represents a low emissions scenario which would be a 'likely below 2°C' scenario⁷. RCP6.0 (red) shows a medium to high emissions scenario. Lines represent the best estimate (multi-model median) and shaded areas the likely range (central 66 %) and the very likely range (central 90 %) of all model projections. Projections do not account for effects of future socio-economic changes (e.g. population growth). Note that the presented indicators apply thresholds for defining extreme events that in pre-industrial time would have been considered very rare events⁸. When interpreting these projections, it should be considered that climate-related events that remain below these thresholds can also have devastating impacts which may not be reflected by these indicators.

... read the map plots for projections

Colours show multi-model medians of 31-year mean values under the low emissions scenario RCP2.6 (top row) and medium to high emissions scenario RCP6.0 (bottom row) for different 31-year periods (the central year is indicated above each column). Colours in the leftmost column represent values for a baseline period (colour bar on the left). Colours in the other columns show differences relative to this baseline period (colour bar on the right). The presence of a dot in the other columns indicates that at least 75 % of all models agree on the sign of the difference, absence of a dot mean less than 75 % agreement.

... learn more on the sources, methodology and interpretation

For further guidance and background information about the database, models and methods underlying the figures and analyses in this profile, kindly refer to the supplemental information provided by the Potsdam Institute for Climate Impact Research (PIK) [13], which developed the underlying format of the climate risk profiles (see also 'Acknowledgements' at the end of this climate risk profile).

⁷ Note that RCP2.6 is, however, not consistent with the more ambitious goal of the Paris Agreement to limit global warming to 1.5 °C above pre-industrial levels.

⁸ A flood event occurs when daily discharge exceeds pre-industrial 100-year return levels, while a drought event is defined by a monthly soil moisture which drops below the 2.5th percentile of the pre-industrial baseline for at least seven months in a row (see Table 1 of the underlying publication describing the indicators [14]).

Temperature change and heat risk indicators

Temperature

The **increasing trend of the mean temperature** which was observed in the past is set to continue in the coming decades (Figure 4).

Under RCP2.6, the **mean temperature is projected to increase until 2040 by approximately 2.2 °C**, relative to the year 1876, and stay almost constant afterwards. The likely (very likely) range includes values below 1.8 °C (1.9 °C).

Under RCP6.0 the mean temperature is projected to continue along the initial growth path with a temperature increase of 3.2 °C in 2080 and the likely range between 2.7 °C and 3.9 °C.

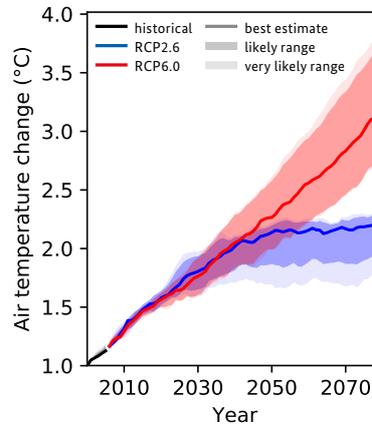


Figure 4: Projected change in air temperature relative to 1876 for Nigeria for different GHG emissions scenarios.

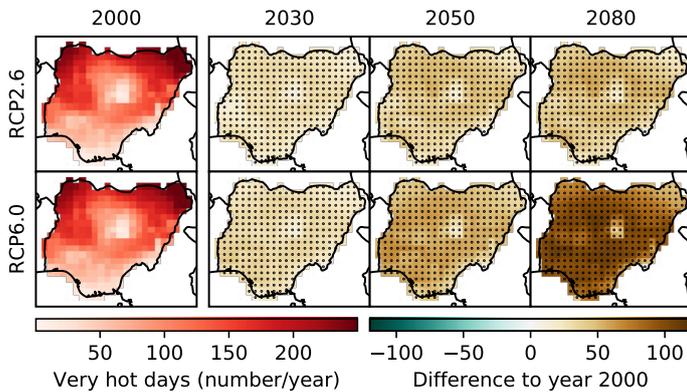


Figure 5: Projections of the number of very hot days (days with a maximum temperature >35 °C) per year for Nigeria. The left-most column displays historical values for the year 2000, the other columns display projections for the years 2030, 2050 and 2080. The upper row shows projections under RCP2.6, the lower row those under RCP6.0. A dot in a grid cell indicates high agreement between the models and thus low uncertainty regarding the direction of change.

Very hot days

Very hot days are defined as days on which the maximum temperature exceeds 35 °C. Values for the year 2000 illustrate the climatic range across Nigeria with a moderate number of very hot days in the coastal regions of the south and more frequent hot days in the drier north. One notable exception is the central Jos mountain plateau visible on the map.

The projections until 2080 indicate an **increase in the number of very hot days for all regions of Nigeria** (Figure 5). Under RCP6.0, projections show a massive increase in line with a much higher exposure to heatwaves. The dots visible on the maps signal a high model agreement of more than 75 %. Under RCP2.6, 45 more very hot days in 2080 compared to 2000 on national average are projected, while under RCP6.0, the increase amounts to almost 90 days. The very likely range is **31 to 47 days more for RCP2.6, while it is 72 to 101 days more for RCP6.0.**

Precipitation, flood and drought risk indicators

Precipitation

Contrary to the historical development, **annual precipitation shows a tendency to increase** in the future for the best estimate (Figure 6). However, this involves considerable uncertainty with an extension of the very likely ranges of around 150 mm in 2080 for the RCP6.0 scenario. This magnitude roughly corresponds to the mean monthly precipitation amounts for the country.

Both RCP scenarios exhibit similar trends with increases by about 40 mm per year projected for 2080 compared to the year 2000 for the best estimate. However, the uncertainty of the projections is higher under RCP6.0 with a (very) likely range of the projected change of -33 to 114 mm (-35 to 118 mm), compared to -10 to 68 mm (-24 to 82 mm) for RCP2.6.

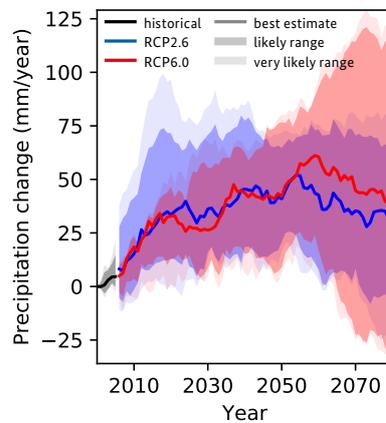


Figure 6: Projected change in precipitation for Nigeria in mm per year relative to the year 2000 for different GHG emissions scenarios.

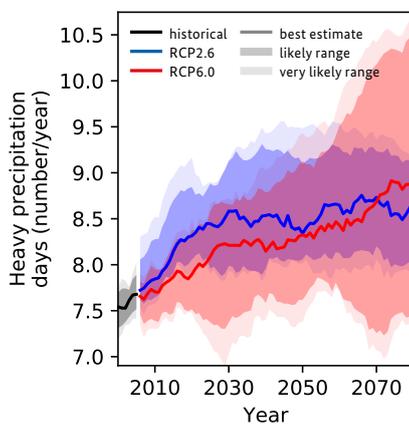


Figure 7: Projections of the number of days with heavy precipitation over Nigeria under different GHG emissions scenarios.

Heavy precipitation events

Heavy precipitation⁹ events are projected to increase in the next decades in Nigeria, as a warmer atmosphere can hold more evaporated water to rain down, increasing the risk of flash floods. Heavy precipitation days refer to days with precipitation in the top two percent of all days with precipitation on record.

While in 2000, about 7.5 days of heavy precipitation occurred on average per year, this number is projected to increase to almost 9 days in 2080 for both RCP scenarios (Figure 7). Both the likely and the very likely projection ranges allow for an even higher frequency between 8 and 9 for RCP2.6 and between 7.5 and 10.5 for RCP6.0. With flash floods due to excessive precipitation being one of the most devastating climate extremes in Nigeria, even small increases may have a major impact. However, less extreme heavy precipitation events are not reflected in this indicator.

Surface runoff

The benchmark year 2000 shows a particularly high rate of surface runoff¹⁰ for the southern regions. This is due to precipitation rates being generally higher in the south, oversaturating the soil so that newly occurring precipitation cannot be absorbed and stored in the ground. High rates of runoff point towards both surface as well as subsurface flows.

Climate change is projected to **increase runoff by 10 % in northern Nigeria, decrease runoff by 10 % in central Nigeria and not change runoff in the south** (Figure 8). It is expected that higher temperatures and more frequent dry spells will dry up the soil (Figure 10) and make it less penetrable for short and heavy precipitation events.

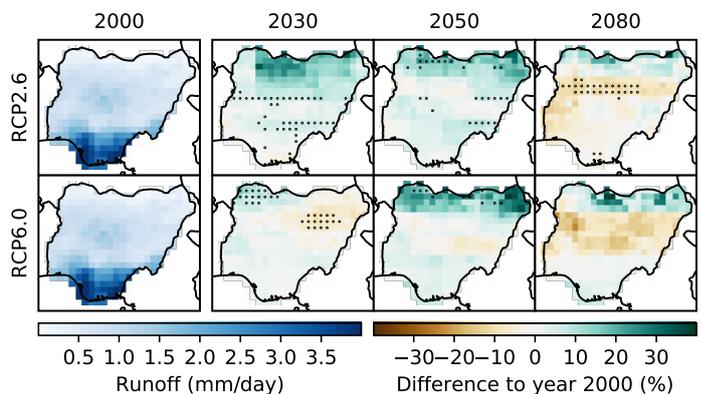


Figure 8: Projections of runoff (water availability from precipitation) for Nigeria as percent difference to values in the year 2000 in mm per day. The left-most column displays historical values for the year 2000, the other columns display projections for the years 2030, 2050 and 2080. The upper row shows projections under RCP2.6, the lower row those obtained under RCP6.0. A dot in a grid cell indicates high agreement between the models and thus low uncertainty.

⁹ Heavy precipitation events are defined as days "on which the precipitation sum exceeds the 98th percentile of the daily precipitation sums of all wet days from 1861 to 1983, where a wet day is a day with a precipitation sum of at least 0.1 mm" [13, supplementary material].

¹⁰ Runoff is defined as the amount of water discharged through surface and subsurface streams, including all precipitation, snow melt and irrigation water that is neither absorbed by the soil nor evaporated.

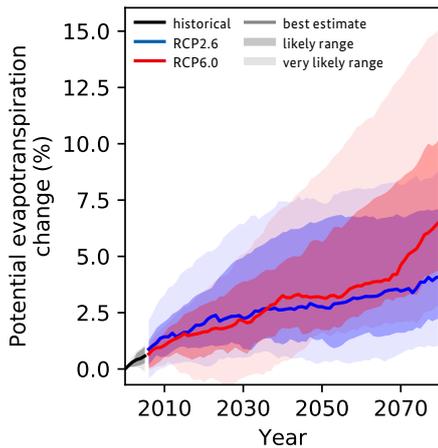


Figure 9: Projected change in potential evapotranspiration for Nigeria for different GHG emissions scenarios, relative to the year 2000.

Potential evapotranspiration

Evapotranspiration is the combination of evaporation of water from land and other surfaces and transpiration from plants into the atmosphere due to a higher air temperature and rising air movements. More specifically, potential evapotranspiration refers to the total amount of water that would be evaporated or transpired if enough water was available at or below the land surface.

In line with the projected rise in temperature (Figure 4), the **best estimate of potential evapotranspiration change is an increase by 4.1 % (RCP2.6) to 6.6 % (RCP6.0)** relative to the baseline year 2000. The very likely range has a lower bound of 2.2 %/4.4 % (RCP2.6/6.0) and an upper bound of 7.1 %/10.3 % (RCP2.6/6.0) (Figure 9).

Higher evapotranspiration rates dry up the soil, increasing drought risk, decreasing agricultural productivity and making the sealed soils more vulnerable to flash flooding in case of strong precipitation events.

Soil moisture

Soil moisture, as an important indicator for drought conditions, is signalling the actual amount of moisture present in the soil as a function of temperature, precipitation and soil characteristics.

It is **projected to stay mostly constant over the course of the century**, only slightly decreasing by 1.1 % towards 2080 (Figure 10). This is presumably due to the combined effect of an increase in potential evapotranspiration (Figure 9) and an increase in precipitation (Figure 6). The uncertainty displayed by the likely range varies between -5 and +3 % (RCP2.6) and between -9 and +4 % (RCP6.0).

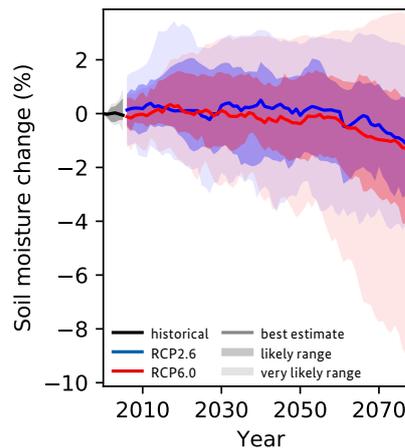


Figure 10: Projected change in soil moisture for Nigeria for different GHG emissions scenarios, relative to the year 2000.

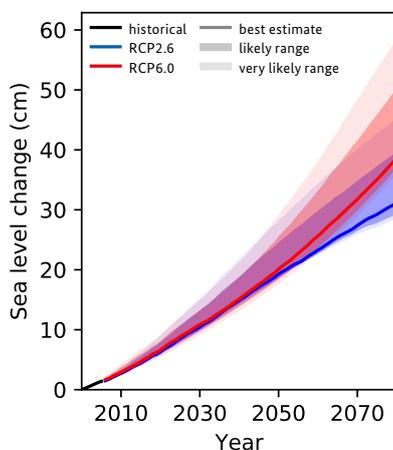


Figure 11: Projected change in sea level off the coast of Nigeria for different GHG emissions scenarios, relative to the year 2000.

Sea level rise

The **sea level is projected to rise by 31 cm (RCP2.6) up to 39 cm (RCP6.0)** from 2000 to 2080 (Figure 11). The uncertainty of the projections is moderate, with a very likely range of 29 to 40 cm for RCP2.6 and 37 to 50 cm for RCP6.0. This may cause saltwater intrusion into groundwater reservoirs.

Even small elevations of the sea level can already have major effects and change coast lines permanently. For coastal ecosystems and communities, there is an additional threat of flooding due to sea level rise. This rise mostly stems from oceanic thermal expansion and melting of Antarctic ice, resulting in salinization, flooding and erosion [9].

Sector-specific climate change risk assessment

a. Water resources

Water availability at the national level is projected using the Falkenmark Water Stress Indicator that provides a measurement of water availability per capita per year. It is computed by summing up runoff over the entire country divided by the national population. Due to increased variability in precipitation patterns, and the increased intensity and frequency of extreme events, **water stress plays a critical role** in determining food security in the future. Thresholds for water stress and water scarcity are defined at 1 700 and 1 000 m³ per person per year, respectively.

Assuming a stable population, total water availability in Nigeria is projected to remain relatively stable at about 3 300 m³ per capita per year over the next decades, with an almost constant very likely range of approximately ± 700 m³ per capita per year (Figure 12).

However, factoring in the expected strong population growth under SSP2, **water availability per capita is projected to drop considerably to about 800 m³ per capita per year in 2080**, i.e. below the UN water scarcity threshold. This finding is supported by a narrow level of uncertainty of ± 200 m³ per capita per year in 2080. The population in 2080 is expected to be more than three times as large as it is today, making it increasingly difficult to provide enough water to the entire population.

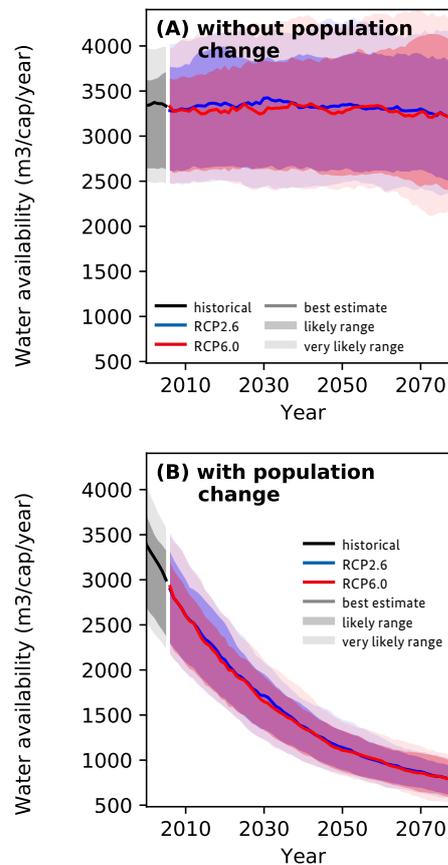


Figure 12: Projections of water availability for Nigeria, measured in m³ of freshwater available per inhabitant per year. Panel A shows projections assuming a constant population, Panel B takes expected population changes into account. 1 000–1 700 m³ per capita year indicates water stress, 500–1 000 m³ per capita/year indicates water scarcity, and <500 m³ per capita/year indicates absolute water scarcity [15].



b. Agriculture

Crop land areas exposed to droughts

Figure 13 shows the projected share of land area that is exposed to droughts per year. This **exposure of crop land area to droughts is projected to be relatively stable** in the future with a corridor for the best estimate between 1–2 % of the national total. However, the graph also shows high uncertainty for these developments with lower bounds just above 0.2 % and upper bounds of the likely range around 29 % (RCP2.6) and 32 % (RCP6.0). It is, therefore, **difficult to make a reliable statement** about the future development. Note that this drought indicator focuses on extreme drought events that would have been considered very rare events in pre-industrial times.¹¹ However, already more moderate drought events – which may not be captured here but may happen more frequently – can have severe socio-economic impacts.

In the absence of an increase in individual pronounced drought events, the focus is **on adapting to an overall dryer climate** and switching to more suitable cultivars. This is of particular importance given the high reliance on agriculture of many households and the large share of the agricultural sector in the economy.

Crop yield changes

The vulnerability analysis demonstrates that **regions in northern Nigeria**, which are subject to desertification and droughts, **experience higher degrees of vulnerability to climate change than those in the south**, which are rather affected by floods and erosion [11]. Desertification reduces farmlands, lowers productivity and damages crop yields for rainfed crops. Crops that need a dryer climate such as roots or nuts, on the other hand, can benefit from the expected developments.

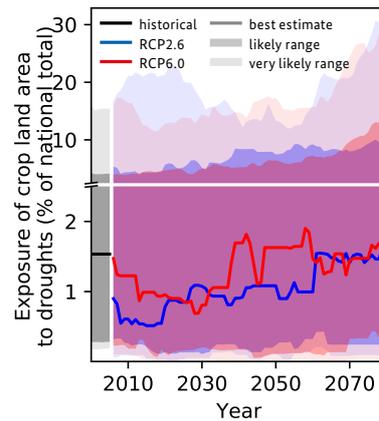
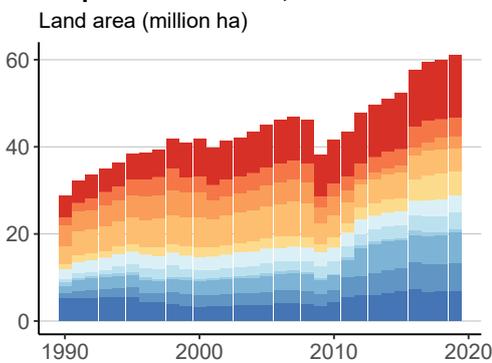


Figure 13: Projections of the annual percentage of crop land area exposed to droughts for Nigeria for different GHG emissions scenarios.

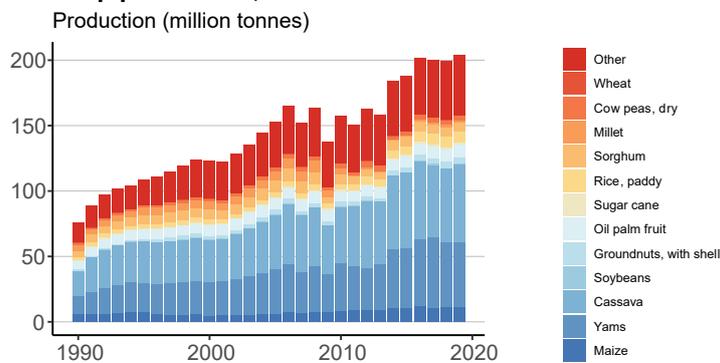
Crop yield projections under RCP2.6/6.0 show decreases for maize (–5/–10 %), millet/sorghum (–6/–8 %) and wheat (–10/–20 %) referring to the respective best estimate (Figure 15). One factor for this could be that maize, sorghum and millet are plants whose metabolic pathway does not benefit from the increase in CO₂ concentrations. However, it needs to be taken into account that the projections do not consider possible adaptation measures such as changes in agricultural management [14]. **Other crops may benefit substantially**, particularly under RCP6.0 (Figure 15). Cassava shows the highest increase in crop yields under RCP6.0. This could be a result of the combination of the CO₂ fertilisation effect and the relatively good tolerance of the crop to both precipitation and temperature extremes [14]. These crops are also the ones driving the increase in production observed in the past decades [15]. Their production was continually expanded due to their robustness against dry spells and better adaptability to a changing climate. The size of crop land area increased relatively less than production from about 30 to 50 million ha over the same time period, highlighting an increased effectiveness of production [15].

Crop area harvested, 1990 – 2019



Source: FAOSTAT (2021)

Crop production, 1990 – 2019



Source: FAOSTAT(2021)

Figure 14: Historical development of selected crops in Nigeria from 1990 to 2019. Crop production in million tonnes (left) and crop area harvested in million ha (right). Source: FAOSTAT (2021) [15].

¹¹ Climate Risk Profiles: Supplemental Information" [13].

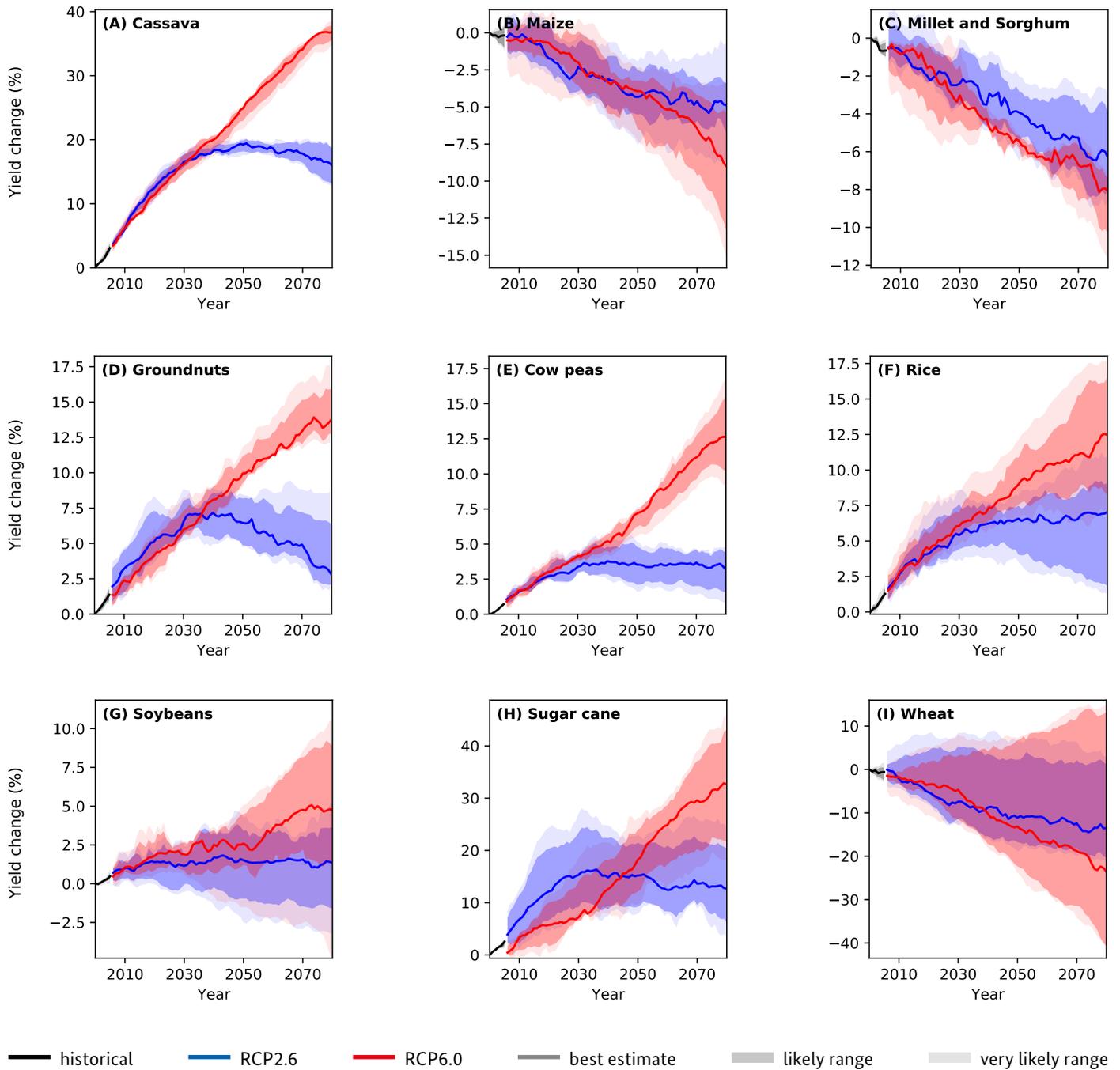


Figure 15: Projected change in yields for selected crops in Nigeria for different GHG emissions scenarios, assuming constant land use and agricultural management, relative to the year 2000.

c. Infrastructure

Flood exposure of urban land area

The exposure of urban land areas to riverine floods is projected to double from 0.08 % in 2000 to about 0.16 % in 2080 for both emissions scenarios (Figure 16). However, this projection involves large uncertainty, especially under RCP6.0, with the very likely range varying between 0.06 % and 0.79 % in 2080. RCP2.6 has a very likely range between 0.06 % and 0.29 % in 2080.

This potential increase is particularly important as the urbanisation rate in Nigeria is steadily increasing (2019: 51.2 %) [2]. Therefore, **flooding in urban areas can be especially devastating**, affecting a disproportionately large share of the population and economic value. With more people affected, it would also be more challenging to mitigate these negative effects by providing governmental support.

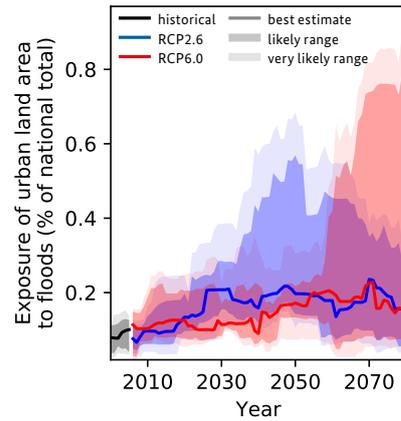


Figure 16: Projected exposure of urban land area to river floods at least once per year for Nigeria for different GHG emissions scenarios.

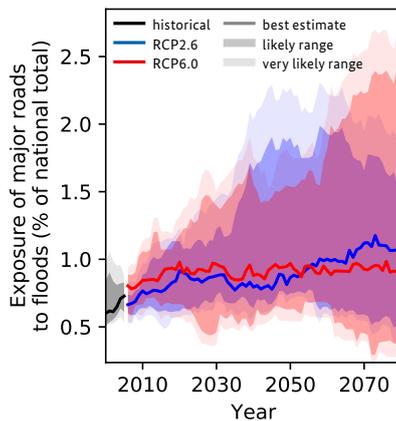


Figure 17: Projected exposure of major roads to river floods at least once per year for Nigeria for different GHG emissions scenarios.

Flood exposure of infrastructure

Infrastructure exposure to river floods, illustrated with the example of major roads in Figure 17, is **projected to almost double**, given the best estimate, relative to the year 2000 from 0.6 % to 1.1 % of the national total until 2080. The uncertainty of this measure is displayed in the span of the very likely range of 0.5 % to 1.6 % for RCP2.6 and 0.4 % to 2.4 % for RCP6.0 in 2080. This covers primarily extreme flooding events.¹² Trends for smaller, yet still devastating floods are not necessarily captured by this indicator.

This finding is relevant to assess indirect costs that occur due to flooding. For instance, regarding the exposure of farmers who need to transport their produce to the market, employees who have to reach their workplace or children who must commute to school.

Exposure of GDP to heatwaves

The exposure of GDP to humid heatwaves is closely related to the exposure of the population to heatwaves (Figure 19). The **projection shows strong increases for the past and next decade** before reaching a plateau at about 16/21 % (RCP2.6/6.0) after 2030. The very likely range of exposure in 2080 is 9/13 % and 26/32 % (RCP2.6/6.0). The projection includes mostly extreme events, leaving the possibility for additional smaller periods of heat.

The close link between GDP and population demonstrates that the main channel of GDP exposure is through the workforce. Especially in the more precarious subsistence farming, adverse effects to household or farm members cannot be absorbed easily by insurance or income from other sources.

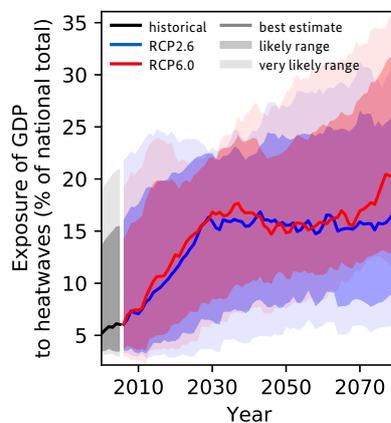


Figure 18: Projected share of the GDP exposed to humid heatwaves in Nigeria for different GHG emissions scenarios.

¹² See explanatory footnote 4 on the definition of extreme event indicators.

d. Human health

Population exposed to heatwaves

The **exposure to humid heatwaves**¹³, which are characterised by the co-occurrence of high temperatures and high relative humidity, **is projected to increase**. Humid heatwaves pose a bigger threat to human health than dry heatwaves.

Both emissions scenarios exhibit similar development trajectories for the projected exposure of Nigerians to humid heatwaves. The **percentage of the population annually exposed to such events is projected to almost quadruple to 19/22 % (RCP2.6/6.0) until 2080 compared to 6 % in 2000 (Figure 19)**. The very likely range follows this trend with a lower bound around 10/14 % and an upper bound around 27/34 % (RCP2.6/6.0). Given the expected strong population growth in Nigeria, this would affect even more people in absolute numbers.

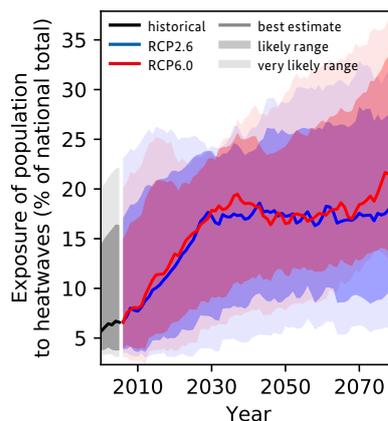


Figure 19: Projected share of the population exposed to humid heatwaves at least once per year for Nigeria under different GHG emissions scenarios.

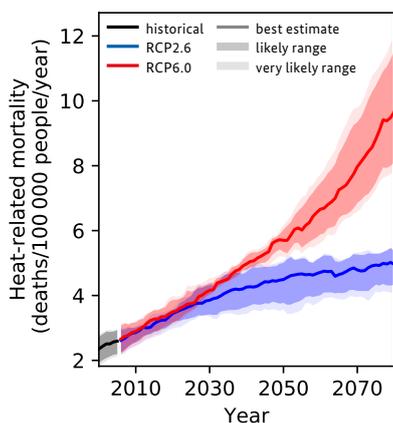


Figure 20: Projections of heat-related mortality for Nigeria for different GHG emissions scenarios, assuming no adaptation to increased heat.

Heat-related mortality

Along with the population's exposure to heatwaves (Figure 20), **heat-related mortality is projected to increase during the next decades**. Under RCP2.6, excess mortality due to heat is **expected to approximately double from 2.5 to 5 deaths per 100 000 people per year until 2080**. Under RCP6.0, mortality rates are projected to almost quadruple to almost 10 deaths per 100 000 people per year until 2080.



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¹³ Humid heatwaves are characterized by the co-occurrence of high temperatures and high relative humidity. Humid heatwaves pose a bigger threat to human health than dry heatwaves. A heatwave (as defined for the projections used in this risk profile) takes both relative humidity as well as mean and maximum air temperature into account. In particular, a grid cell is classified to be exposed to at least one heatwave per year if the Heat Wave Maximum Index daily (HWMId) of that year is in the top 2.5% of the HWMId distribution under pre-industrial climate conditions and the humidity exceeds 45 on all days of the respective heatwave [13].

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