Federal Ministry
for Economic Cooperation
and Development

Climate Risk Profile: Niger*

Summary

This profile provides an **overview of projected climate parameters and related impacts** on different sectors in Niger 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 socioeconomic impacts.**

Agriculture, biodiversity, health, infrastructure and water are highly vulnerable to climate change. The **need for adaptation in these sectors should be represented in the German development cooperation portfolio** in Niger.

Depending on the scenario, **temperature** in Niger is projected to **rise by between 2.0 and 4.6 °C by 2080**, compared to pre-industrial levels, with higher temperatures and more temperature extremes projected for the south-west of Niger.

Precipitation trends are **highly uncertain** with projections ranging from a slight decrease to a stronger increase in annual precipitation sums. Future dry and wet periods are likely to become **more extreme**.

Climate change is likely to cause **severe damage to the infrastructure sector** in Niger including roads and bridges. As roads are the backbone of Niger's transportation network, investments will need to be made into building climate-resilient roads and other infrastructure.

The models project a possibility of an **increase in crop land exposure to drought**. Yields of heat- and drought-sensitive crops are projected to decline, while yields of less sensitive crops such as cow peas and groundnuts are projected to benefit from CO_2 fertilisation. Farmers will need to adapt to these changing conditions.

Agro-ecological zones might **shift, affecting ecosystems, biodiversity** and **crop production**. Models project regionally varying changes in species richness and tree cover in response to climate change.

Per capita water availability will decline by 2080 mostly due to population growth. Model projections indicate that **water saving measures are expected to become more important all over Niger**.

The **population affected** by at least one **heatwave** per year is projected to **rise** from 1.7 % in 2000 to 12 % in 2080. This is related to 50 more very hot days per year over this period. As a consequence, **heat-related mortality** is estimated to **increase by a factor of three** by 2080.

* Further in-depth information on climate impacts and selected adaptation strategies in the agricultural sector can be found in a complimentary climate risk analysis for Niger, which will be finalised in spring 2021.

Context

Niger is a **landlocked country** in Western Africa, **belonging to the Sahel region**. Currently home to a **population of 22 million**, it is one of the fastest growing countries worldwide with **an annual growth rate of 3.8 %** [1]. The majority of the inhabitants live in the southern cities, most importantly in Niamey, followed by Maradi, Zinder and Tahoua. With a real GDP per capita of 404 USD, Niger is one of the poorest countries in the world, **counting as a least developed country (LDC)** [1]. Its economy is dominated by the agricultural sector, contributing 39.2 % to the country's GDP in 2018, followed by the services sector with 38.1 % and the industrial sector with 15.5 % [2]. **Staple crop production is dominated by cereals such as millet and sorghum** [3]. Onions and cow peas are the major cash crops, with Niger being the second largest producer of cow peas in West Africa (after Nigeria) [4]. Other cash crops include groundnuts, sesame and tiger nuts [4], [5]. Oilseeds accounted for 88 % of Niger's agricultural exports in 2017, while rice was the main agricultural import at 5.8 % of total imports [6]. **Over 80 % of Niger's population is employed in the agricultural sector,** heavily relying on agriculture for food security and livelihoods [7]. Therefore, concerns are rising over the effects of climate change including rising temperatures, reduced water availability and the occurrence of floods and other extreme weather events. **Agricultural production in Niger is primarily subsistence-based and rainfed**. Currently, less than 1 % of the national crop land is irrigated [8]. Hence, especially smallholder farmers are directly affected by the impacts of climate variability, which can reduce their food supply and increase the risk of hunger and poverty. **Limited adaptive capacity in the agricultural sector underlines the country's vulnerability to climate change.**

Quality of life indicators [1], [9]–[11]

Human Development Index (HDI) 2018	ND-GAIN Vulnerability Index 2017	GINI Coefficient 2014	Real GDP per capita 2018	Poverty headcount ratio 2014	Prevalence of undernourishment 2016–2018
0.377 **189 out of 189** (0 = low, 1 = high)	**31.0** **175 out of 181** (0 = low, 100 = high)	**34.3** (0–100; 100 = perfect inequality)	**404 USD** (constant 2010 USD)	**44.5 %** (at 1.9 USD per day, 2011 PPP) [1]	**16.5 %** (of total population)

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[1] Poverty headcount ratio for the year 2014 adjusted to 2011 levels of Purchasing Power Parity (PPP). PPP is used to compare different currencies by taking into account national differences in cost of living and inflation.

Topography and environment

Niger is **part of the Saharan desert** and mainly located on a plateau with an average altitude of 500 m. The **highest peak is Mount Idoukal-n-Taghès at 2 022 m**, located in the central part of the country [7]. Niger is characterised by **three climatic zones**: the desert zone, which extends from the north to the centre, a narrow strip called the intermediate zone, which is mostly inhabited by pastoralists, and, similar in size, a semi-arid zone in the south [12]. Having its peak in August, **the rainy season occurs between May and October**, with a shorter period in the north. The country can be divided into **three major agro-ecological zones (AEZ)**, each of which is characterised by specific temperature and moisture regimes and, consequently, specific crops grown within its boundaries (Figure 1) [13][2]. In terms of surface water, Niger's major source is the **Niger River in the west**. Upstream development of hydropower dams as well as uncontrolled abstractions for agricultural use are raising concerns about **critical reductions of essential water resources** from the river [14]. Lake Chad in the eastern part of the country is another important source of water. However, due to climate impacts and unsustainable water management, the open lake surface has shrunk from approximately 25 000 km² in the 1960s to a minimum of 1 800 km² in 2010, affecting the food and water supply of approximately 50 million people in Niger and its bordering countries [15]. Other environmental challenges include **human-induced pressures as a result of poor agricultural practices, land degradation, desertification, poaching and pollution** [16]. Heavier precipitation and drier conditions are expected to intensify in the context of climate change, highlighting the **need for adaptation measures to protect biodiversity and maintain fragile ecosystems and their services**.

Present climate [17]

Niger is characterised by a mostly arid climate as large parts of the country are located in the Sahel and the Sahara region. Mean annual temperatures range from 23 °C to 30 °C with higher values in the south of Niger.

Annual precipitation sums range from as little as 10 mm in the desert areas of the north to 800 mm in the south, which has a semi-arid climate characterised by savannah.

The country has a single rainy season (unimodal precipitation regime) lasting from May to October with its peak in August.

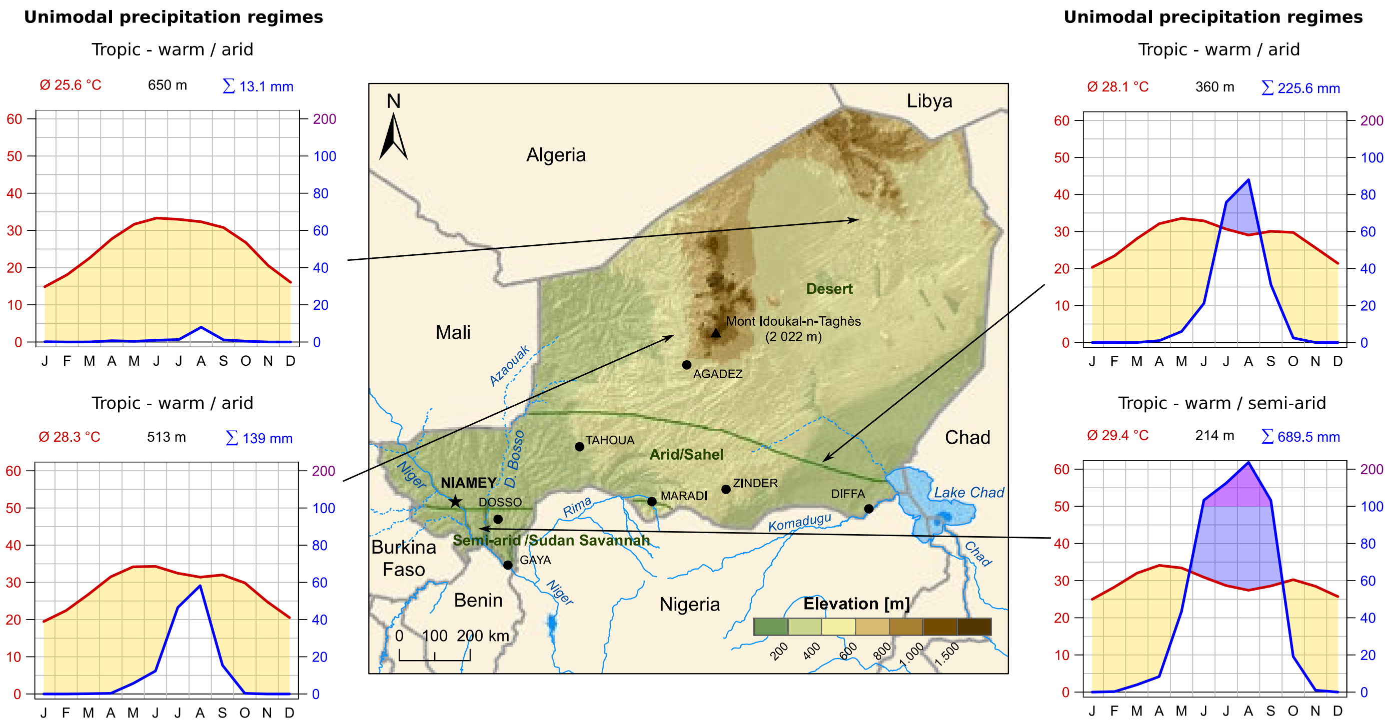

Figure 1: Topographical map of Niger with agro-ecological zones and existing precipitation regimes.[3]

[2] It should be noted that there are different classifications of AEZs in Niger.

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

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 RCP2.6 (blue) and RCP6.0 (red). In particular, 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.

How to read the map plots

Colours show multi-model medians of 31-year mean values under RCP2.6 (top row) and RCP6.0 (bottom row) for different 31-year periods (central year indicated above each column). Colours in the leftmost column show these 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 (absence) of a dot in the other columns indicates that at least (less than) 75 % of all models agree on the sign of the difference.
For further guidance and background information about the figures and analyses presented in this profile kindly refer to the supplemental information on how to read the climate risk profile.

Temperature

In response to increasing greenhouse gas (GHG) concentrations, **air temperature over Niger is projected to rise by 2.0 to 4.6 °C (very likely range) by 2080** relative to the year 1876, depending on the future GHG emissions scenario (Figure 2). Compared to pre-industrial levels, median climate model temperature increases over Niger amount to approximately 2.1 °C in 2030, 2.5 °C in 2050 and 2.6 °C in 2080 under the low emissions scenario RCP2.6. Under the medium/high emissions scenario RCP6.0, median climate model temperature increases amount to 2.1 °C in 2030, 2.7 °C in 2050 and 3.7 °C in 2080.

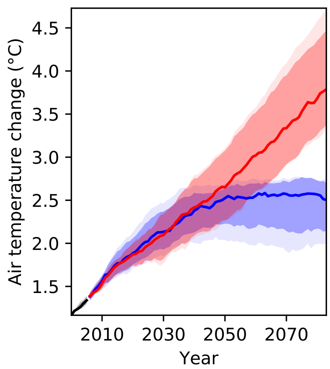

Figure 2: Air temperature projections for Niger for different GHG emissions scenarios.[4]

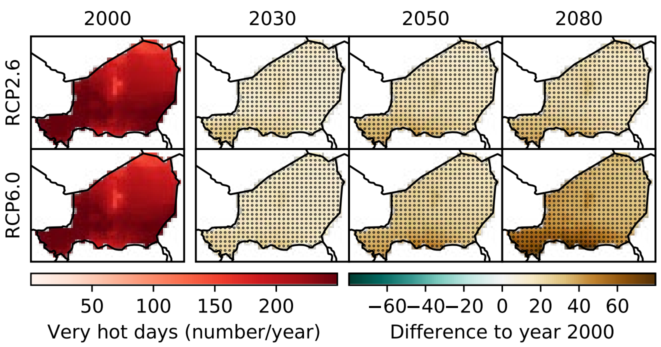

Figure 3: Projections of the annual number of very hot days (daily maximum temperature above 35 °C) for Niger for different GHG emissions scenarios.

Very hot days

In line with rising mean annual temperatures, the annual number of very hot days (days with daily **maximum temperature above 35 °C**) is projected to rise substantially and with high certainty, in particular over south-western Niger (Figure 3). Under the medium/high emissions scenario RCP6.0, the multi-model median, averaged over the whole country, projects **16 more very hot days per year in 2030 than in 2000**, **27 more in 2050 and 40 more in 2080**. In some parts, especially in south-western Niger, this amounts to about 300 days per year by 2080.

[4] Changes are expressed relative to year 1876 temperature levels using the multi-model median temperature change from 1876 to 2000 as a proxy for the observed historical warming over that time period.

Precipitation

Future projections of precipitation are less certain than projections of temperature change due to high natural year-to-year variability (Figure 4). Out of the four climate models underlying this analysis, one model projects almost no change in mean annual precipitation over Niger, one projects a decline and the other two models project an increase. Under RCP2.6, median model projections show **a precipitation increase of 29 mm per year by 2080**, while median model projections for RCP6.0 show a lower annual **increase of 19 mm by 2080** compared to year 2000. The projected absolute changes in mean annual precipitation show high regional variations.

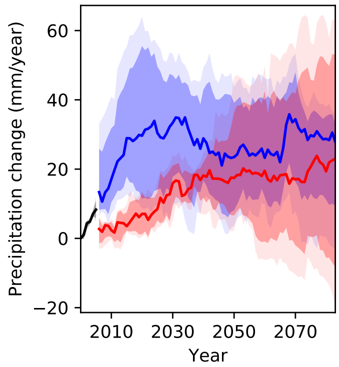

Figure 4: Annual mean precipitation projections for Niger for different GHG emissions scenarios, relative to the year 2000.

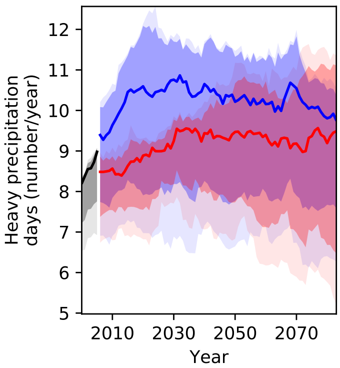

Figure 5: Projections of the number of days with heavy precipitation over Niger for different GHG emissions scenarios, relative to the year 2000.

Heavy precipitation events

In response to global warming, **heavy precipitation events are expected to become more intense** in many parts of the world due to the increased water vapour holding capacity of a warmer atmosphere. At the same time, the number of days with heavy precipitation events is expected to increase. This tendency is also found in climate projections for Niger (Figure 5), with climate models projecting **an increase in the number of days with heavy precipitation events**, from 8 days per year in 2000 to 10 and 9 days per year in 2080 under RCP2.6 and RCP6.0, respectively.

Soil moisture

Soil moisture is an important indicator for drought conditions. In addition to soil parameters, it depends on both precipitation and evapotranspiration and therefore also on temperature, as higher temperatures translate to higher potential evapotranspiration. **Annual mean top 1-m soil moisture projections for Niger show almost no change under either RCP by 2080** compared to the year 2000 (Figure 6). However, looking at the different models underlying this analysis, there is large year-to-year variability and modelling uncertainty, with some models projecting an increase and others projecting a decrease in soil moisture. Hence, a clear trend cannot be identified.

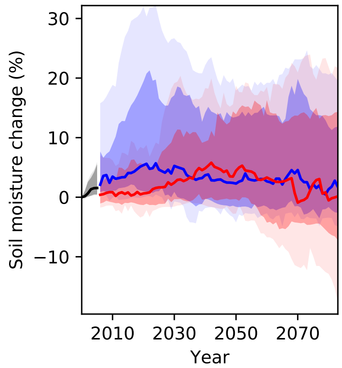

Figure 6: Soil moisture projections for Niger for different GHG emissions scenarios, relative to the year 2000.

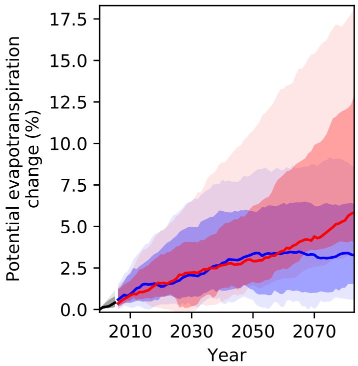

Figure 7: Potential evapotranspiration projections for Niger for different GHG emissions scenarios, relative to the year 2000.

Potential evapotranspiration

Potential evapotranspiration is the amount of water that would be evaporated and transpired if sufficient water was available at and below land surface. Since warmer air can hold more water vapour, **it is expected that global warming will increase potential evapotranspiration in most regions of the world.** In line with this expectation, hydrological projections for Niger indicate a stronger and more continuous rise of potential evapotranspiration under RCP6.0 than under RCP2.6 (Figure 7). Under RCP6.0, **potential evapotranspiration is projected to increase by 2.2 % in 2030, 2.9 % in 2050 and 5.4 % in 2080** compared to year 2000 levels.

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Sector-specific climate change risk assessment

a. Water resources

Current projections of water availability in Niger display high uncertainty under both GHG emissions scenarios. Assuming a constant population level, multi-model median projections suggest almost no change in per capita water availability over Niger by the end of the century under either RCP (Figure 8A). Yet, when accounting for population growth according to SSP2 projections[5], **per capita water availability for Niger is projected to decline by 85 % by 2080** relative to the year 2000 under both scenarios (Figure 8B). While this decline is primarily driven by population growth rather than climate change, it highlights the urgency to invest in water saving measures and technologies for future water consumption.

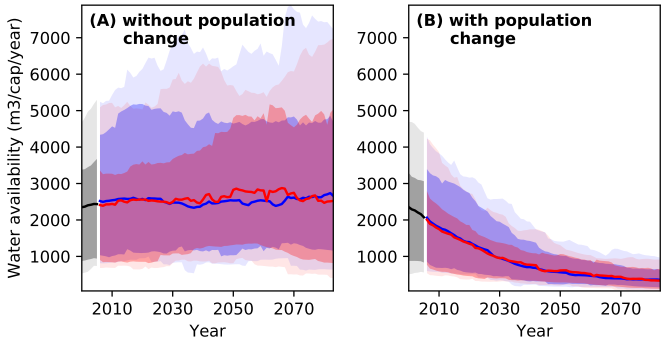

Figure 8: Projections of water availability from precipitation per capita and year with (A) national population held constant at year 2000 level and (B) changing population in line with SSP2 projections for different GHG emissions scenarios, relative to the year 2000.

Projections of future water availability from precipitation vary depending on the region and scenario (Figure 9). In line with precipitation projections, **water availability is projected to increase in most parts of the country** under both RCPs. However, in most cases, model agreement on these increases is low towards the end of the century.

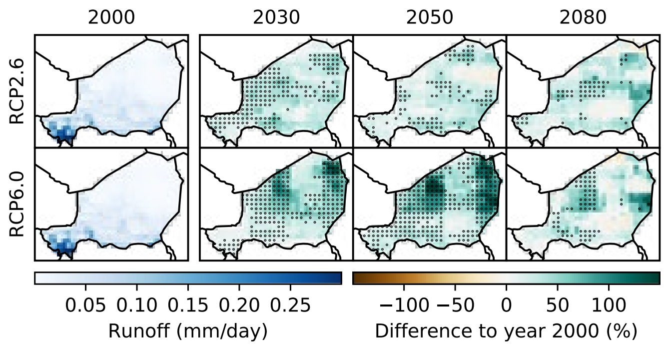

Figure 9: Water availability from precipitation (runoff) projections for Niger for different GHG emissions scenarios.

Over the last decades, Niger has experienced strong seasonal and annual variation in precipitation as well as recurring droughts, all of which present major constraints to agricultural production. The country was hit by **recurring droughts between 1950 and 1980** as precipitation amounts decreased during that time [18]. Although annual precipitation sums recovered afterwards, they remain below the national average of the past century [18]. Further droughts were registered in 2005, 2008, 2010 and 2012 [19]. The **2012 drought affected a total of 5.4 million people** in Niger, 1.3 million of whom faced serious food insecurity and depended on humanitarian aid [20]. Extreme droughts tend to have a cascading effect: First, lack of water reduces crop yields, which increases the risk of food insecurity for people and their livestock and in turn limits their capacity to cope with future droughts [21]. Transhumance used to be an effective way to deal with variations in precipitation amounts and droughts in Niger, but people's reliance on this type of pastoralism has been challenged by increasingly unpredictable precipitation patterns and, consequently, a lack of good pastures and water [22]. Additional stressors include **increasing competition for natural resources (partly due to population growth), depletion of livestock, and intercommunal and cross-border conflicts**, making this mode of living less profitable and sometimes even dangerous [22].

[5] Shared Socio-economic Pathways (SSPs) outline a narrative of potential global futures, including estimates of broad characteristics such as country level population, GDP or rate of urbanisation. Five different SSPs outline future realities according to a combination of high and low future socio-economic challenges for mitigation and adaptation. SSP2 represents the "middle of the road"-pathway.

b. Agriculture

Smallholder farmers in Niger are increasingly challenged by the uncertainty and variability of weather that climate change causes [23]. Since **crops are predominantly rainfed**, yields highly depend on water availability from precipitation and are prone to drought. However, the length and intensity of the rainy season is becoming increasingly unpredictable and the **use of irrigation facilities remains limited**: In 2010, less than 33 % of the estimated irrigation potential of 270 000 ha (0.6 % of total national crop land) were irrigated [8]. Irrigated crops include onions, sesame and cow peas [24]. Large parts of Niger's **soils are severely degraded** due to unsustainable farming techniques and grazing practices, limiting opportunities for crop production [25].

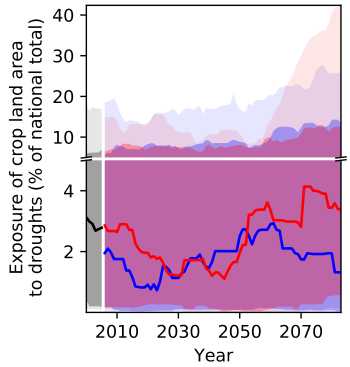

Figure 10: Projections of crop land area exposed to drought at least once a year for Niger for different GHG emissions scenarios.

Currently, the high uncertainty of projections regarding water availability (Figure 9) translates into high uncertainty of drought projections (Figure 10). According to the median over all models employed for this analysis, **the national crop land area exposed to at least one drought per year will hardly change in response to global warming. However, there are models that project an increase in drought exposure.** Under RCP6.0, the likely range of drought exposure of the national crop land area per year widens from 0.4-6.0 % in 2000 to 0.5–12.1 % in 2080. The very likely range widens from 0.1-18.0 % in 2000 to 0.1–40.6 % in 2080. This means that **some models project a doubling of drought exposure over this time period, while others project no change.**

In terms of yield projections, model results indicate a **negative yield trend for maize** under either RCP (Figure 11)[6]. Compared to the year 2000, maize yields are projected to decline by 5.3 % under RCP2.6 and by 2.7 % under RCP6.0 by 2080. **However, yields of millet and sorghum, cow peas and groundnuts are projected to gain from climate change**. Under RCP6.0, crop yields are projected to increase by 3.8 % for millet and sorghum, 54 % for cow peas and 52 % for groundnuts by 2080 relative to the year 2000. A possible explanation for the positive results under RCP6.0 is that cow peas and groundnuts are so-called C3 plants, which follow a different metabolic pathway than maize, millet and sorghum (C4 plants), and benefit more from the CO_2 fertilisation effect under higher concentration pathways. Although yield changes of maize, millet and sorghum appear to be small at the national level, they will likely increase more strongly in some areas and, conversely, decrease more strongly in other areas as a result of climate change impacts.

Overall, adaptation strategies such as switching to improved varieties in climate change sensitive crops need to be considered, yet should be carefully weighed against adverse outcomes, such as a resulting decline of agro-biodiversity and loss of local crop types.

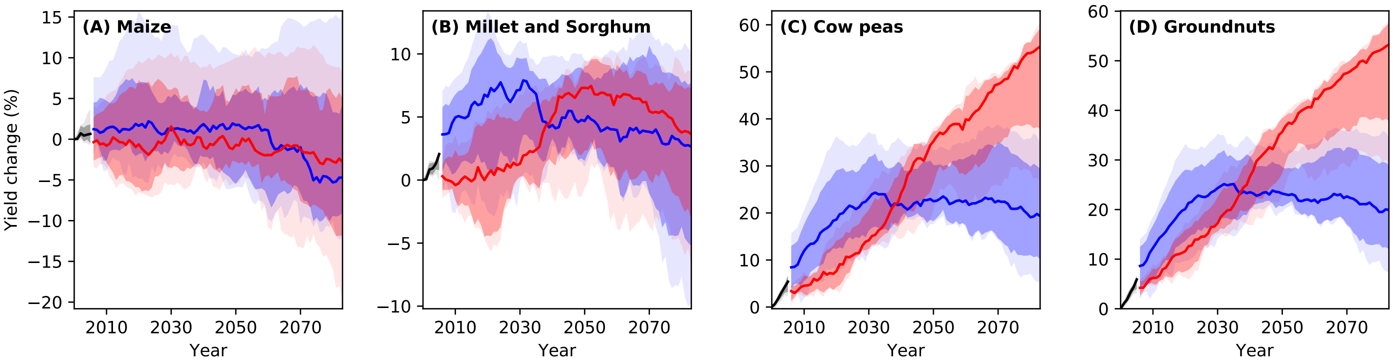

Figure 11: Projections of crop yield changes for major staple crops in Niger for different GHG emissions scenarios assuming constant land use and agricultural management, relative to the year 2000.

[6] Modelling data is available for a selected number of crops only. Hence, the crops listed on page 2 may differ. Maize, millet and sorghum are modelled for all countries, except for Madagascar.

c. Infrastructure

Climate change is expected to significantly affect infrastructure in Niger through extreme weather events. High precipitation amounts can lead to the **flooding of roads**, while high temperatures can cause **roads, bridges and protective structures to develop cracks and degrade more quickly**. This will require earlier replacement and lead to **higher maintenance and replacement costs**. Roads serve communities to trade goods and access healthcare, education, credit and other services. The **absence of railways, low navigability of the Niger River** and a limited number of airport facilities increase Niger's reliance on road transportation [26]. Overall, **Niger has one of the lowest road densities** in Africa with 13 km/1 000 km² [27]. Investments will have to be made to build climate-resilient road networks.

Extreme weather events will also have **devastating effects on human settlements and economic production sites**, especially in urban areas with high population densities like Niamey, Zinder or Maradi. **Informal settlements are particularly vulnerable to extreme weather events**: Makeshift homes are often built in unstable geographical locations including steep slopes or river banks, where flooding can lead to loss of housing, contamination of water, injury or death. Dwellers usually have a low adaptive capacity to respond to such events due to high levels of poverty and lack of risk-reducing infrastructures. For example, **heavy rains during the 2019 rainy season** caused flooding in several localities across Niger, **affecting 256 000 people** (67 % in the regions of Maradi, Zinder and Agadez) and leaving **22 000 houses destroyed** [28]. In the 1998-2014 period, a total of **1.6 million people were affected by flooding** in Niger [29]. Flooding and droughts will also affect hydropower generation: Niger is currently investing in hydropower projects including the construction of the Kandadji Dam on the Niger River. However, variability in precipitation and **climatic conditions could severely disrupt hydropower generation**.

Projections of river flood events are subject to substantial modelling uncertainty, largely due to the uncertainty of future projections of precipitation amounts and their spatial distribution, affecting flood occurrence (see also Figure 4). While the absolute value of 0.14 % is small to begin with, median projections still indicate more than a doubling of national road exposure to floods by mid-century (Figure 12). Although median projections decline again towards the end of the century, they are subject to high modelling uncertainty with the very likely range indicating that **road exposure to floods can settle anywhere between a threefold increase and a twofold decrease** by 2080 (from 0.07–0.4 % in 2000 to 0.03–1.3 % in 2080). Similarly, median projections of urban land area exposed to floods at least once a year show almost no change (Figure 13), with a very likely range of 0.0–0.3 % by 2080 under RCP6.0. However, it should be noted that projections show the exposure of roads to river floods and exclude, for instance, exposure to floods from excessive precipitation, which is a common phenomenon in Niger, mostly due to its dry, impermeable soils and lack of vegetation [29].

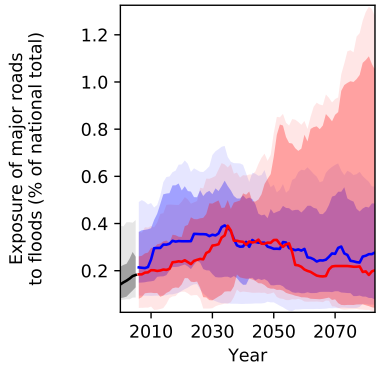

Figure 12: Projections of major roads exposed to river floods at least once a year for Niger for different GHG emissions scenarios.

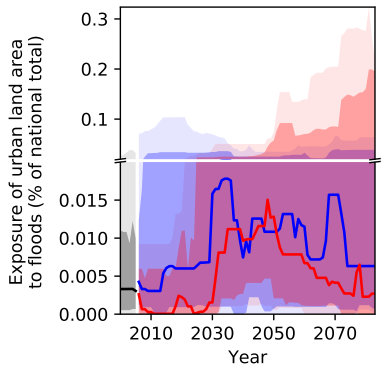

Figure 13: Projections of urban land area exposed to river floods at least once a year for Niger for different GHG emissions scenarios.

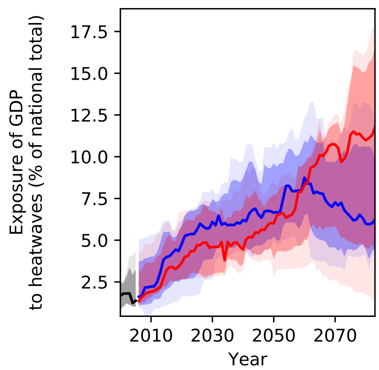

Figure 14: Exposure of GDP in Niger to heatwaves for different GHG emissions scenarios.

With the **exposure of the GDP to heatwaves projected to increase** from around 1.7 % in 2000 to 6 % (RCP2.6) or 11 % (RCP6.0) by 2080 (Figure 14), policy planners are strongly advised to start identifying heat-sensitive economic production sites and activities, and integrating climate adaptation strategies such as improved solar-powered cooling systems, "cool roof" isolation materials or switching the operating hours from day to night [30].

d. Ecosystems

Climate change is expected to have a significant influence on the ecology and distribution of tropical ecosystems, though the magnitude, rate and direction of these changes are uncertain [31]. With rising temperatures and increased frequency and intensity of droughts, **wetlands and riverine systems are increasingly at risk of being converted to other ecosystems,** with plant populations being succeeded and animals losing habitats. Increased temperatures and droughts can also impact succession in forest systems while concurrently increasing the risk of invasive species, all of which affect ecosystems. In addition to these climate drivers, low agricultural productivity and population growth might motivate further agricultural expansion, resulting in increased deforestation, land degradation and forest fires, all of which will impact animal and plant biodiversity.

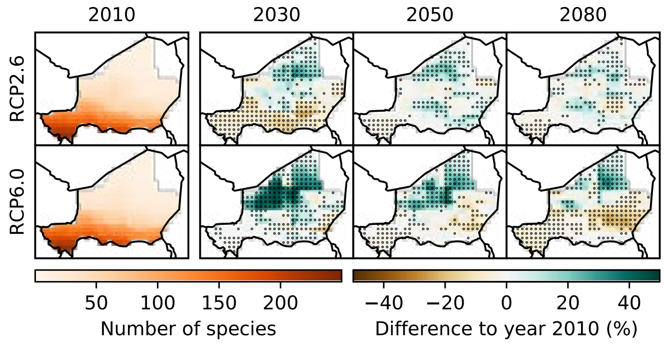

Figure 15: Projections of the aggregate number of amphibian, bird and mammal species for Niger for different GHG emissions scenarios.

Model projections of species richness (including amphibians, birds and mammals) and tree cover for Niger are shown in Figure 15 and 16, respectively. The models applied for this analysis show particularly strong agreement on the development of species richness under RCP6.0: **Northern Niger is expected to gain up to 20 % of animal species due to climate change, while southern Niger is expected to lose around 20 %** (Figure 15). With regard to tree cover, model results are far less certain and of low magnitude. For RCP2.6, there is model agreement in very few areas showing no change in tree cover. Under RCP6.0, **tree cover is projected to increase by only 0.5 % in central Niger by 2080** (Figure 16).

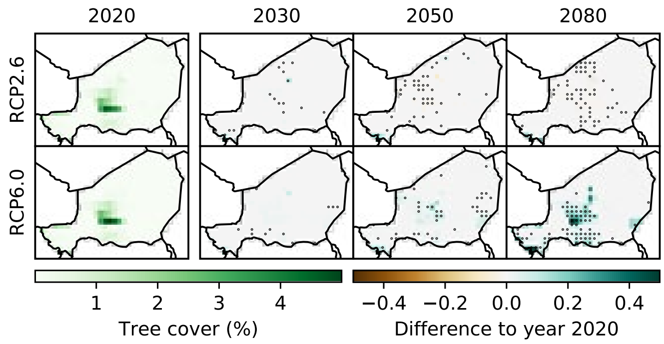

Figure 16: Tree cover projections for Niger for different GHG emissions scenarios.

It is important to keep in mind that the **model projections exclude any impacts on biodiversity loss from human activities such as land use**, which have been responsible for significant losses of global biodiversity in the past, and are expected to remain its main driver in the future [32]. In recent years, Niger's vegetation has experienced profound disturbances due to population pressure and increasing demand for farmland and firewood, leaving large parts of Niger's soils severely degraded [25]. According to an ICRISAT report, around **80 000 to 120 000 ha of land are annually degraded** in Niger [33].

e. Human health

Climate change threatens the health and sanitation sector through more frequent incidences of heatwaves, floods, droughts and storms. Among the key health challenges in Niger are morbidity and mortality through vector-borne diseases such as malaria, waterborne diseases related to extreme weather events (e.g. flooding) such as diarrhoea and cholera, respiratory diseases, meningitis, measles, injury and mortality through extreme weather events as well as **climate impacts on food and water supply, which can increase the risk of malnutrition and hunger** [34]. Many of these challenges are expected to become more severe under climate change. According to the World Health Organization (WHO), Niger recorded around 8 million cases of malaria in 2018 [35]. **Climate change is likely to have an impact on malaria transmission periods and the geographic range of vector-borne diseases:** In Niger, the general malaria risk is projected to fall due to rising temperatures, however, some regions are likely to become more vulnerable to malaria, for instance, due to more frequent incidences of flooding [36], [37]. A study found that **temperature increases and low humidity due to climate change have the potential to** prepone the seasonal onset of meningitis and **significantly increase the number of meningitis cases** [38], [39]. Niger is part of the so-called Meningitis Belt, which largely coincides with the Sahel region and which is where the majority of meningitis epidemics occur. In 2015, the country suffered from a major meningitis epidemic with 8 500 reported cases and 573 deaths [40]. Climate change also poses a threat to food security since households in Niger depend on agricultural production for up to 40 % of their food consumption [5].

Rising temperatures will result in **more frequent heatwaves** in Niger, leading to **increased heat-related mortality.** Under RCP6.0, the population affected by at least one heatwave per year is projected to increase from 1.7 % in 2000 to 12 % in 2080 (Figure 17). Furthermore, under RCP6.0, **heat-related mortality will likely increase from about 3 to about 10 deaths per 100 000 people per year**, which translates to an increase by a factor of more than three towards the end of the century compared to year 2000 levels, provided that no adaptation to hotter conditions will take place (Figure 18). Under RCP2.6, heat-related mortality is projected to increase to about 6 deaths per 100 000 people per year in 2080.

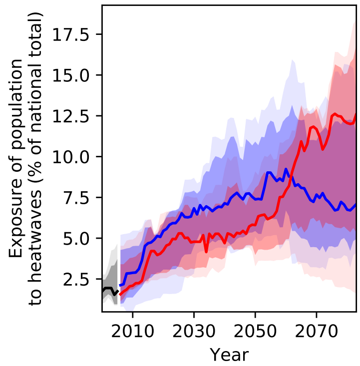

Figure 17: Projections of population exposure to heatwaves at least once a year for Niger for different GHG emissions scenarios.

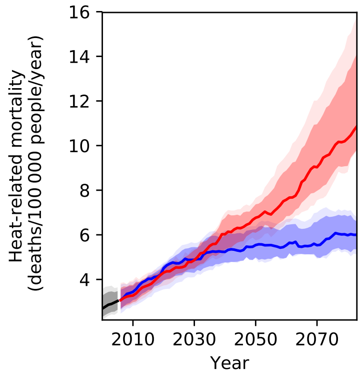

Figure 18: Projections of heat-related mortality for Niger for different GHG emissions scenarios assuming no adaptation to increased heat.

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