Climate Risk Profile: Philippines*

Summary

This profile provides **an overview of projected climate parameters and related impacts** on different sectors in the Philippines until 2080 **under different climate change scenarios** (so-called Representative Concentration Pathways, RCPs). RCP2.6 represents a low emissions scenario that aims to keep global warming likely below 2 °C above pre-industrial temperatures. RCP6.0 represents a medium to high emissions scenario. **Model projections do not account for effects of future socio-economic developments unless indicated otherwise.**

Crop yields are projected to be **heterogeneously affected**. While for both rice and sugar cane, atmospheric changes resulting from the higher emissions scenario suggest partially beneficial impacts, maize yields are projected to decline by more than 5 % by 2080 under RCP6.0. Extreme events including **tropical cyclones** and **heavy precipitation events** may have adverse effects on agricultural production. Projected exposure to **extreme droughts** is subject to substantial modelling uncertainty.

Agriculture, 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 of the country.

While overall water availability is projected to increase, **water availability adjusted for population growth** is projected to decline by almost half by 2080 under both emissions scenarios.

Depending on the emissions scenario, **mean temperature** in the Philippines is projected to **rise by between 1.7 °C and 2.5 °C** until 2080, relative to pre-industrial levels. The number of **very hot days** with maximum temperature exceeding 35 °C is projected to increase by up to **24 days by 2080**, particularly in South Luzon, Visayas and Northern Mindanao, where major cities are located.

The projected climatic changes are likely to affect human health in various ways. The **population share exposed to at least one heatwave** per year is **expected to increase** under both emissions scenarios. Unmitigated exposure to heat is projected to increase the number of **heat-related deaths** from less than 1 in the year 2000 to almost **3 deaths per 100 000** people in 2080 under RCP6.0.

Precipitation is projected to increase by more than **200 mm per year** until 2080 under both emissions scenarios. **Heavy precipitation events** are projected to increase in both frequency and intensity. Average **tropical cyclone intensity** and **tropical cyclone precipitation rates** are also projected to increase.

Sea levels are projected to **rise between 37 cm (RCP2.6) and 43 cm (RCP6.0)** by 2080 relative to the year 2000. Higher sea levels may contribute to an **increased risk of storm surges** associated with tropical cyclones and an increasing frequency of tidal flooding.

Tropical cyclones will **impact infrastructure,** as they are projected to become less frequent, but **more severe. The exposure of major roads to floods** is also likely to increase between 1 % and 1.5 % by 2080, depending on the emissions scenario.

* 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

The Republic of the Philippines is **located in Southeast Asia**. With a population of **108 million** and an annual demographic growth rate of 1.3 %, the country ranks 13th among the world's most populous countries [1]. The Philippines is classified as a **lower-middle income country**, ranking 107th out of 189 countries in the Human Development Index (HDI). The economy has recorded stable growth of more than 6 % in recent years until 2019 [1], [2]. However, economic performance saw a record contraction in 2020 due to the impacts of the COVID-19 pandemic which resulted in a -9.6 % full-year GDP growth rate [3].

Quality of life indicators [1], [2], [4]

Human Development Index (HDI) 2019 [2]	ND-GAIN Country Index 2019 [4]	GINI Coefficient[1] 2018 [1]	Real GDP per capita 2019 [1]	Poverty headcount ratio 2019 [1]		Prevalence of undernourishment 2017–2019 [5]
0.718 **107 out of 189** (0 = low, 1 = high)	**43.5** **117 out of 182** (0 = low, 100 = high)	**42.3** (0 – 100; 100 = perfect inequality)	**3337.68 USD** (constant 2010 USD)	**6.0 %** (at 1.9 USD per day, 2015 PPP)[2]	**54.9 %** (at 5.5 USD per day, 2015 PPP)	**14.5 %** (of total population)

Regional development

There are large **regional differences in development** in the Philippines. Figure 1 shows the geographical disparities in the **Subnational Human Development Index** (SHDI) and for each of its three subdimensions health, education and income. **Highly urbanised parts of the country score significantly better than rural areas**. Parts of Luzon (National Capital Region, Calabarzon, Cordillera, Central Luzon and Ilocos) are the regions with the highest level of development, while the Autonomous Region in Muslim Mindanao (ARMM) shows lower levels of human development, compared to other regions in the Philippines.

The three subdimensions of the SHDI exhibit similar spatial patterns, with the National Capital Region consistently showing the highest levels for health, income and education. The status of living, approximated by real gross national income per capita, is highest in the National Capital Region and the neighbouring areas. Health, approximated by life expectancy at birth, positively affects the SHDI across all regions. On the other hand, the education dimension, measured by mean years of schooling of adults and expected years of schooling of children aged 6, reduces the overall SHDI.

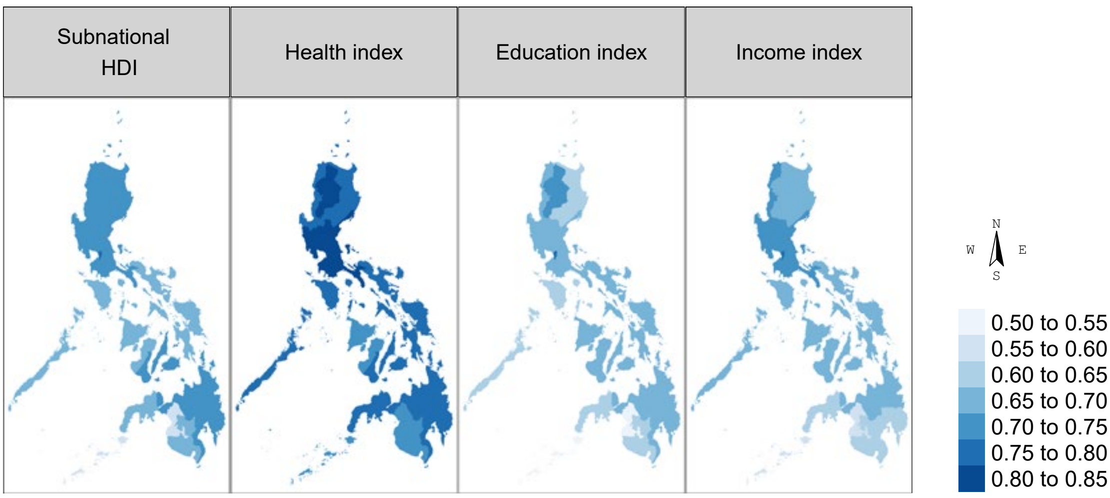

Figure 1: Subnational indices for human development (data for 2019). Source: Global Data Lab (2021). Subnational Human Development Index [6].

[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

The Philippines is an **archipelagic country** consisting of 7 641 islands located in the Western Pacific Ocean [7]. It is subdivided into **three island groups** from north to south: Luzon, Visayas and Mindanao. Given the volcanic origin, the topography is predominantly mountainous. With 2 954 m, Mount Apo on Mindanao is the highest peak in the Philippines [8]. The larger islands, particularly Luzon and Mindanao, have a more varied topography dominated by complex terrain with long mountain ranges. Visayas consists of smaller islands mostly characterised by high mountains.

Due to its geographical location along the typhoon belt in the Pacific and the Circum-Pacific Belt, the world's most active seismic zone, also referred to as the "Ring of Fire", it is **highly exposed to multiple hazards** including typhoons, volcanic eruptions and earthquakes [9], [10]. The Philippines ranks **4th in the Global Climate Risk Index 2021**, which covers an average period of 20 years [11].

The climate in the Philippines is **maritime and tropical** with relatively high temperatures and humidity. It can be divided into two major seasons: a dry season (December-May) and a rainy season (June-November) [12]. Climate variability is largely **influenced by the El Niño-Southern Oscillation** (ENSO). El Niño events are associated with a reduction in precipitation in the Philippines relative to years when ENSO is neutral. In contrast, **La Niña** events are associated with colder conditions and heavy precipitation events [13]. In addition, El Niño is also associated with less frequent but more intense tropical cyclones (TCs), which can cause severe flooding and landslides, even in the absence of La Niña conditions [13], [14].

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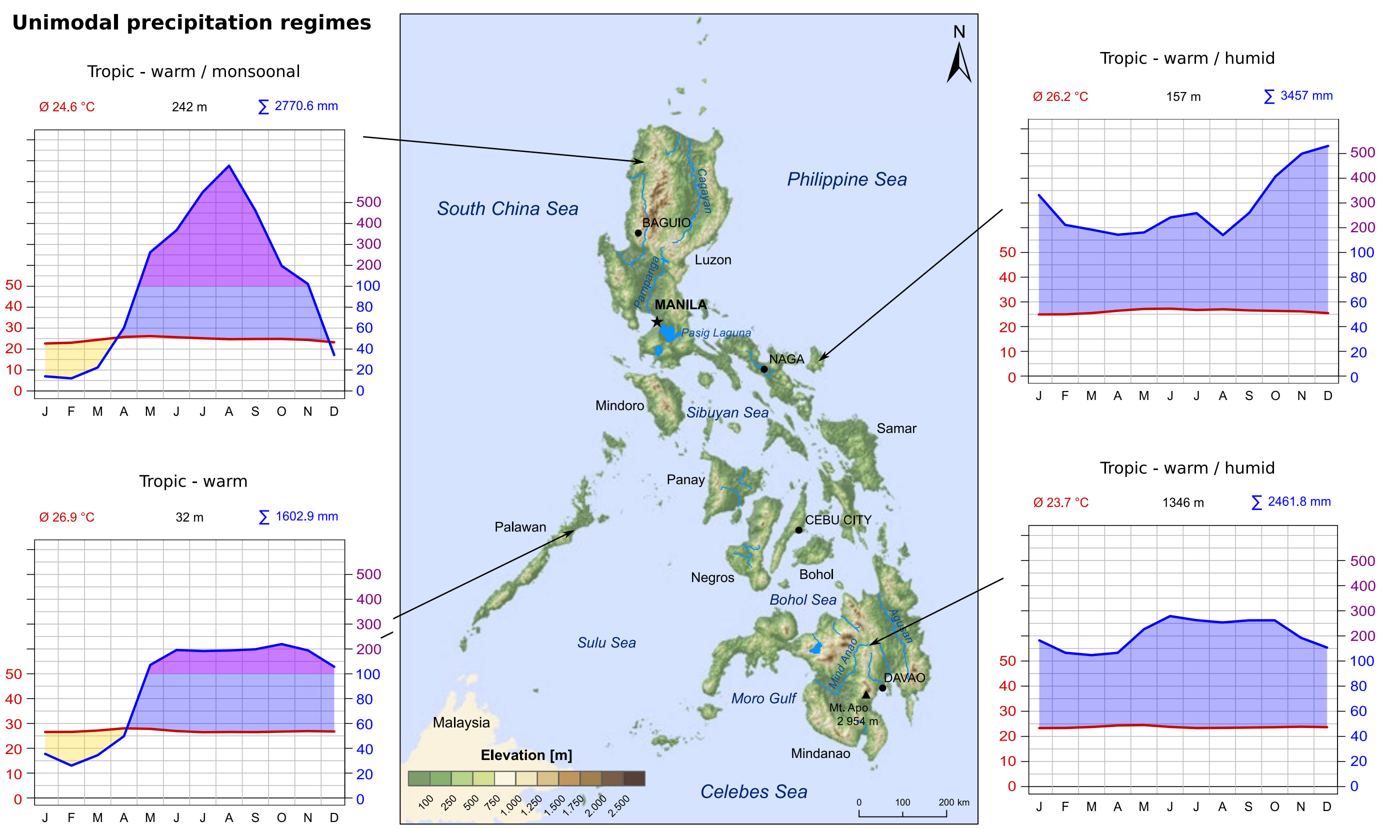

Figure 2: Topographical map of the Philippines with existing precipitation regimes.[3]

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

Present climate and related extremes

Excluding areas of high altitude[4], **temperatures in the Philippines are generally high** with a mean annual value of approximately 26.6 °C. Temperatures are on average coolest in January and hottest in May with mean values of 25.5 °C and 28.3 °C, respectively [12]. A **rising trend has been observed** from the latter part of the 20th century to the present: Between 1958 and 2014, average mean temperature has increased by 0.62 °C [15].

Precipitation patterns in the Philippines vary substantially by location, depending on moisture-bearing wind directions and the location of mountain ranges. Mean annual precipitation sums range from 965 to 4 064 mm with the larger share occurring in the second half of the year [12]. It is determined by the southwest monsoons in the summer months and by the northeast monsoon and tropical cyclones in winter [15]. In the **last three decades**, both **the amount and the intensity of precipitation have increased** [15].

The Philippines is regularly exposed to various **extreme weather events**. Given its location in the northwestern Pacific basin, the most active tropical cyclone (TC) basin in the world, it is one of the countries most exposed to tropical storms globally [16]. Every year, an average of 20 TCs enter the Philippine Area of Responsibility[5], with an **average of about 8–9 TCs** making landfall [17]. The northern provinces are most frequently affected (Figure 3). TCs are associated with strong windspeeds, storm surges and heavy precipitation, often causing severe flooding and landslides [18].

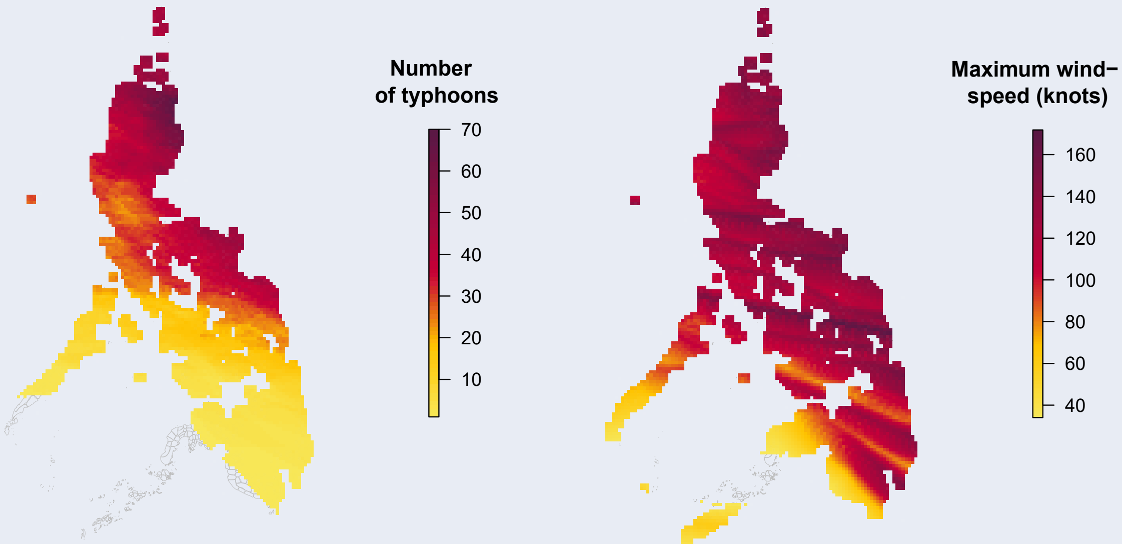

Figure 3: Total number of typhoons (> 64 knots) passing through each grid cell of the Philippines from 1950-2015 (left) and maximum windspeed at each grid cell from 1950-2015 (right). Own depiction using data from Geiger, T., Frieler, K., & Bresch, D. N. (2018) [19].

El Niño is the most important climate factor influencing the **annual variability in frequency and intensity of TCs** [16], [20]. During El Niño periods, TCs are of greater average intensity but tend to hit the Philippines less frequently [13], [14]. Some studies indicate that over the past decades, TCs in the northwestern Pacific have become less frequent [21], [22]. Past trends in TC intensity remain uncertain [23], [24].

While **heavy precipitation and flooding events** are often associated with tropical cyclones, particularly in the northern regions, heavy precipitation may also occur as part of the monsoon season as well as in the months of low cyclonic activity, often associated with cold surges [18], [25], [26]. **Over the past two decades,** the country has experienced a total of **175 flood disasters** including 77 tropical cyclone-associated floods [27].

Interannual variations in extreme precipitation are also influenced by El Niño [28]. Severe flooding, increased runoff and soil erosion are particularly common during La Niña [29], whereas **droughts** often occur in conjunction with El Niño events [13]. The reduction of water inflow and runoff into reservoirs during droughts regularly leads to water scarcity, with severe consequences for agricultural production, human health and the energy sector [30].

[4] Baguio has an elevation of 1 500 m above sea level and has a mean annual temperature of 18.3 °C.

[5] The Philippine Area of Responsibility is an area in the northwestern Pacific where PAGASA, the Philippines' national meteorological agency monitors weather occurrences.

Projected climate changes

How to ...

... read the line plots

(black line)	historical	(grey line)	best estimate
(blue line)	RCP2.6	(grey shade)	likely range
(red line)	RCP6.0	(light shade)	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’ scenario[6]. 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 events[7]. 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) [32], which developed the underlying format of the climate risk profiles (see also ‘Acknowledgements’ at the end of this climate risk profile).

[6] 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.

[7] 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 [31]).

Temperature change and heat risk indicators

Temperature

Under the low emissions scenario (RCP2.6), **mean annual temperature is projected to increase by 1.7 °C by 2050** relative to the year 1876 and stabilise at this level subsequently (Figure 4). The projected warming develops similarly for the medium to high emissions scenario (RCP6.0) until 2050 but diverges thereafter. By 2080, the projected change in air temperature reaches 2.5 °C under RCP6.0.

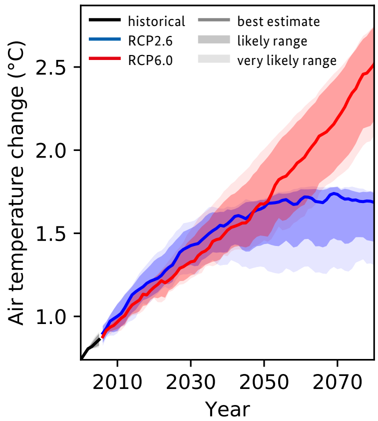

Figure 4: Projected changes in air temperature relative to 1876 for the Philippines for different GHG emissions scenarios.

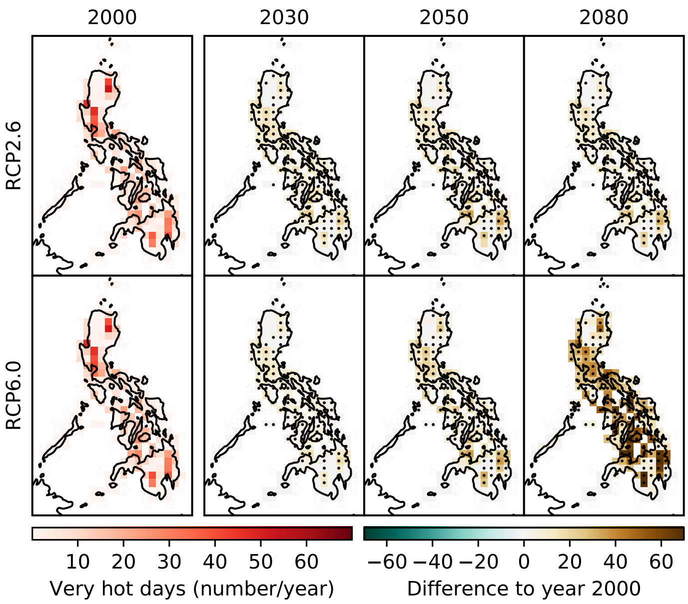

Figure 5: Projections of the number of very hot days (days with a maximum temperature >35 °C) per year for the Philippines. The left-most column displays historical values for the year 2000, the other columns display projections for the years 2030, 2050 and 2080. The upper row shows projections under 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. **These days are projected to increase substantially in South Luzon, Visayas and Northern Mindanao** where major cities are located. Under the low emissions scenario (RCP2.6), very hot days are projected to increase by 5 to 7 days in 2030, 2050 and 2080 compared to the year 2000. Under the medium to high emissions scenario (RCP6.0), very hot days could increase by 4, 8 and 24 days in 2030, 2050 and 2080, respectively (Figure 5).

Tropical cyclones

There is considerable uncertainty in tropical cyclone projections under future global warming. On the one hand, the **overall frequency of tropical cyclones in the northwestern Pacific basin is projected to decrease** [33]–[36]. Also, an identified poleward shift of TCs in this basin may lead to a reduced number of tropical cyclones making landfall in the Philippines [22], [37], [38].

On the other hand, **climate change contributes to more severe typhoons** as the proportion of tropical cyclones of category 4–5 (Saffir-Simpson scale) and the average tropical cyclone intensity are projected to increase due to higher sea surface temperatures. Also, **tropical cyclone precipitation rates are projected to increase** due to the higher water holding capacity of a warmer atmosphere [32], [38], [39]. In combination with projected sea level rise, the risk of storm surges will likely increase substantially [23], [36].

Precipitation, flood and drought risk indicators

Precipitation

Precipitation is projected to increase under both emissions scenarios (Figure 6). Compared to the year 2000, annual precipitation is projected to increase by 64 mm, 77 mm and 229 mm per year by 2030, 2050 and 2080, respectively, under the low emissions scenario. Under a medium to high emissions scenario, an increase of 85 mm, 123 mm and 260 mm per year is projected for the same time periods.

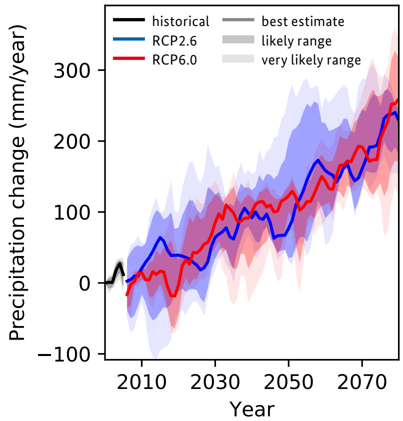

Figure 6: Projected changes in precipitation for the Philippines in mm per year relative to the year 2000 for different GHG emissions scenarios.

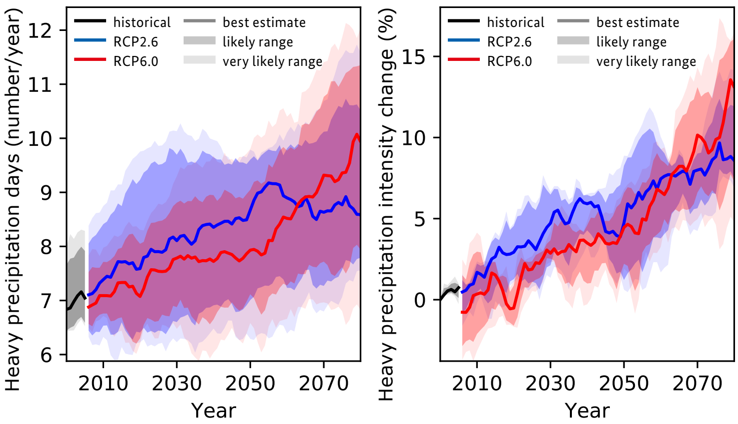

Figure 7: Projections of the number of days with heavy precipitation (left) and the change in heavy precipitation intensity (right) over the Philippines under different GHG emissions scenarios.

Heavy precipitation events

Heavy precipitation events[8] are expected to increase in frequency and intensity. Projections for the Philippines show an average increase in frequency from 7 days in the year 2000 to about 8 and 9 days in 2030 and 2050, respectively, under RCP2.6 (Figure 7). The intensity of heavy precipitation events is expected to increase by 5 % in 2030 and 2050 under RCP2.6. The change in intensity develops similarly under RCP6.0, with a 3 % and 4 % change in 2030 and 2050, respectively. In 2080, both frequency and intensity under RCP6.0 (10 heavy precipitation days, intensity increase of 13.1 %) exceed RCP2.6 (9 heavy precipitation days, intensity increase of 8.6 %). The **projected changes pose a significant challenge** to future infrastructure needs and flood risk management.

Surface runoff

In line with the increase in annual precipitation, **surface runoff**, defined as the amount of water discharged through surface and subsurface streams, **is projected to increase** by 14 % by 2080, compared to the year 2000, under both the low and the medium to high emissions scenario. Projections show significant increases in runoff in Southern Luzon, Visayas and Western and Southern Mindanao in particular.

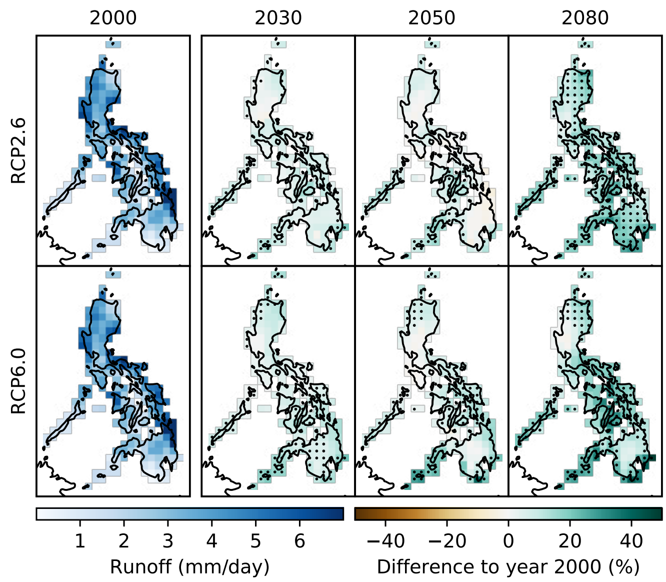

Figure 8: Projections of runoff (water availability from precipitation) for the Philippines as percent difference to values in the year 2000 in mm per day. The left-most column displays historical values for the year 2000, the other columns display projections for the years 2030, 2050 and 2080. The upper 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.

[8] 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" [32].

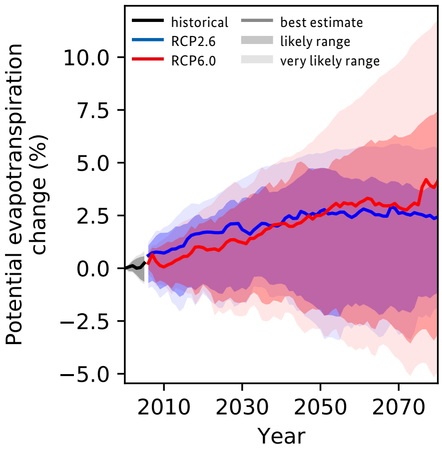

Figure 9: Projected changes in potential evapotranspiration for the Philippines for different GHG emissions scenarios, relative to the year 2000.

Potential evapotranspiration

Potential evapotranspiration, the total amount of water that would be evaporated or transpired if enough water was available at and below the land surface, is **projected to increase with climate change** driven by higher air temperatures and rising air movements. Both RCP2.6 and RCP6.0 suggest that potential evapotranspiration increases steadily over the upcoming decades (Figure 8). In the low emissions scenario, the potential evapotranspiration is expected to increase by about 2.5 % by 2050 compared to the year 2000 and approximately remain on this level subsequently. The medium to high emissions scenario projects potential evapotransporation to constantly increase over time increasing by more than 4 % by 2080 compared to the year 2000.

Soil moisture

Soil moisture, an important indicator of drought conditions, refers to the amount of water stored in the soil and is a function of temperature, precipitation and soil characteristics. Under both emissions scenarios, **soil moisture is projected to remain approximately at year 2000 levels until 2050**, and increase by nearly 2 % by 2080 compared to the year 2000 (Figure 9). This increase is likely driven by rising average precipitation sums.

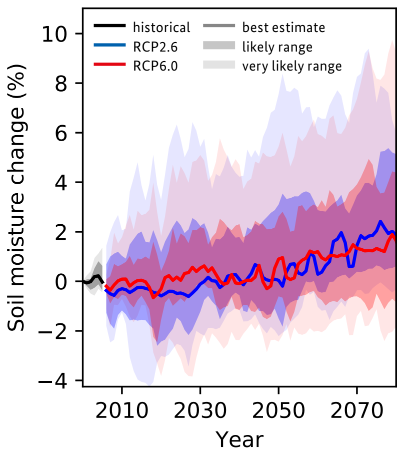

Figure 10: Projected changes in soil moisture for the Philippines for different GHG emissions scenarios, relative to the year 2000.

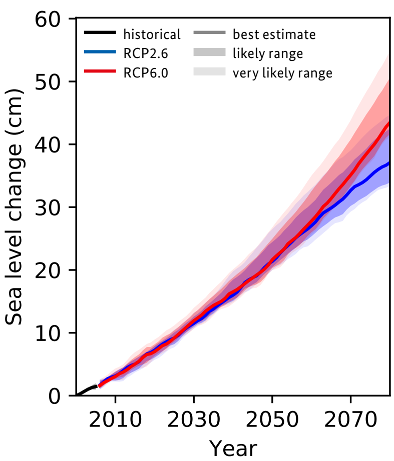

Figure 11: Projected changes in sea level off the coast of the Philippines for different GHG emissions scenarios, relative to the year 2000.

Sea level rise

Compared to the year 2000, **sea levels are projected to rise by 12 cm, 21 cm and 37 cm by 2030, 2050 and 2080**, respectively, already under the low emissions scenario. Under the medium to high emissions scenario, sea level rise is estimated to develop similarly until 2060 but accelerate afterwards, reaching a rise of 43 cm in 2080 compared to the year 2000. Numerous low-lying coastal areas, including the country's capital Manila, are highly vulnerable to rising sea levels, which will likely increase the risk of storm surges and the frequency of tidal flooding. Besides that, coastal erosion and the salinisation of aquifers can have severe impacts for communities and ecosystems.

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 and year. It is computed by summing up runoff over the entire country and dividing the result by 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 a future under climate change. Thresholds for water stress and water scarcity are defined at 1 700 and 1 000 m³ per person and year, respectively [41].

Assuming a stable population, water availability per capita increases in the Philippines for both emissions scenarios. Under RCP2.6 (RCP6.0), water availability increases from 8 600 m³ per person and year in 2000 to 9 800 (9 500) m³ per person and year in 2080. However, **factoring in the projected population growth, water availability is projected to decrease** to mere 4 600 m³ per person and year in 2080 under RCP2.6 and 4 500 m³ per person and year under RCP6.0, respectively. While this is still well above the water stress threshold, the adequacy of water available per capita is also largely determined by diets, of which plant-based products generally have lower water footprints (or the amount of water needed to produce products) than animal-based products [42]. Meat is however an important part of the Philippine diet representing on average 17 % of household food consumption [43].

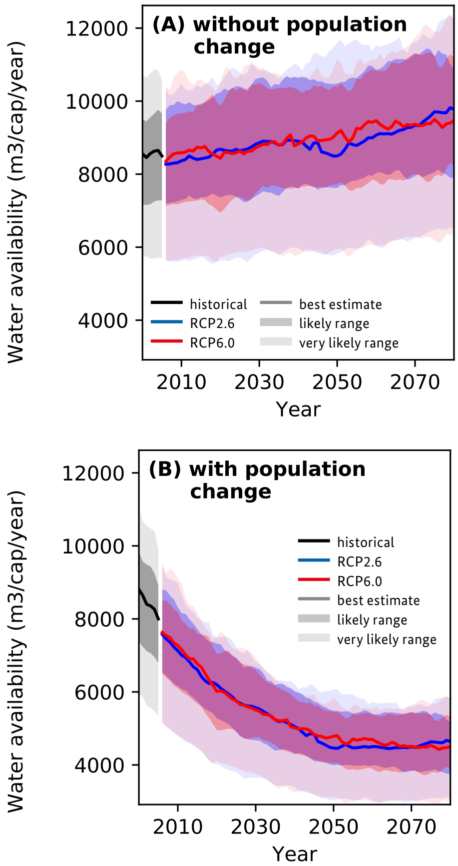

Figure 12: Projections of water availability for the Philippines, measured in m³ of freshwater available per inhabitant per year. Panel A shows projections assuming a constant population, Panel B takes expected population changes into account. 1 000–1 700 m³ per capita year indicates water stress, 500–1 000 m³ per capita/year indicates water scarcity, and <500 m³ per capita/year indicates absolute water scarcity [41].

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b. Agriculture

The agricultural sector in the Philippines employs 9.72 million people (22.9 % of national employment) while contributing 9.2 % to the gross domestic product [44]. Due to the **high share of subsistence farming**, the overall productivity of the agricultural sector is still comparatively low. **Rice, maize, coconut and sugarcane** are the top agricultural products of the Philippines in terms of volume (Figure 13). In 2018, 117 kg per capita of rice, 73 kg per capita of maize, 138 kg per capita of coconut and 232 kg per capita of sugarcane were produced [45]. **Rice, the country's most important staple crop,** is grown on almost one third of the total crop land. About a quarter of the total agricultural area is dedicated to the cultivation of coconuts, which are an important export commodity.

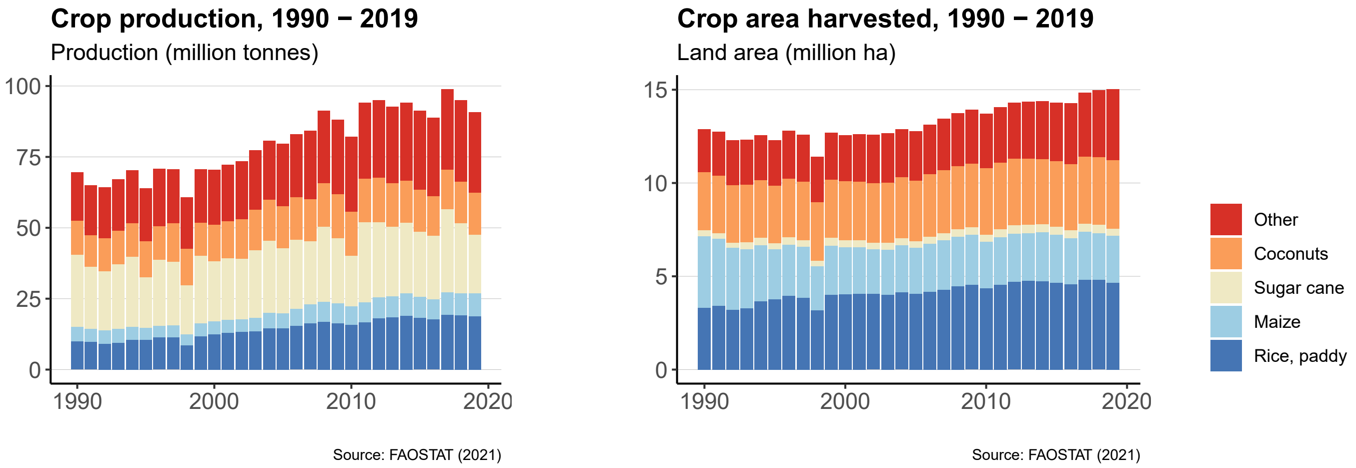

Figure 13: Historical development of selected crops in the Philippines from 1990 to 2019.
Crop production in million tonnes (left) and crop area harvested in million ha (right). Source: FAOSTAT (2021) [46].

Exposure of total land area and crop land area to droughts

The **share of land area exposed to extreme droughts is subject to high modelling uncertainty** under both emissions scenarios.[9] It is projected at 0.3 % in 2030 and 0.1 % in 2050 for both RCP2.6 and RCP6.0. Given their relevance for agricultural production and the use of crop land, it is particularly important to assess periods of drought. The **share of crop land area exposed to droughts is estimated to remain approximately at today's level of 0.25 %** under both emissions scenarios until 2080. While only extreme droughts are covered here, the population and the economy may already be affected by less extreme droughts, potentially requiring resilience strategies to mitigate drought impacts.

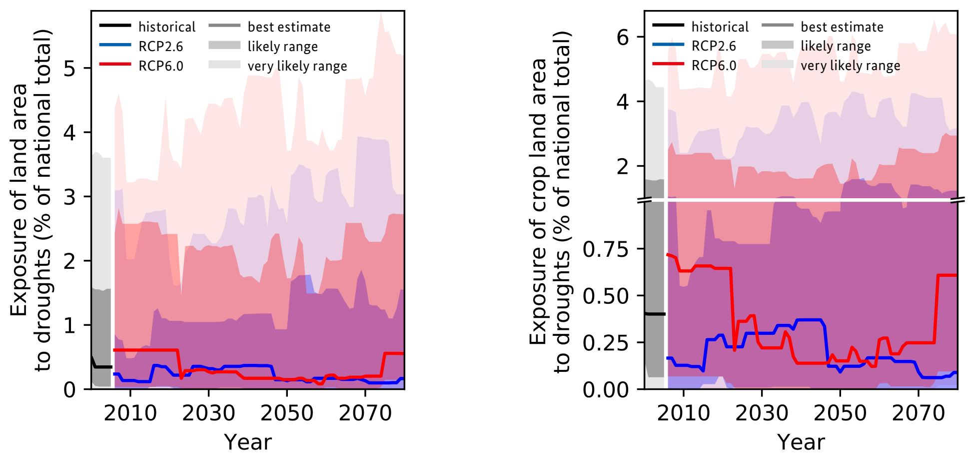

Figure 14: Projections of the annual percentage of total land area (left) and crop land area (right) exposed to droughts for the Philippines for different GHG emissions scenarios.

[9] The underlying drought indicator focuses on extreme drought events which were considered as very rare events in pre-industrial times. Non-extreme droughts are not captured in this indicator but may still be highly relevant.

Crop yield changes

Rice and sugar cane productions are projected to partially benefit from changing atmospheric conditions (Figure 15). Rice yields are projected to increase in the medium term (2050) compared to the year 2000, under both emissions scenarios, while long term outcomes are subject to high uncertainty. Sugar cane yields are projected to decline in 2030 and 2050, but are expected to increase towards 2080, compared to the year 2000.

In contrast, **maize yields are projected to decline** by 2.1 % in 2030, 2.8 % in 2050 and 3.4 % in 2080 under RCP2.6. The decline is slower but more severe in the long term under RCP6.0 with yield reductions of 0.7 % in 2030, 2.1 % in 2050 and 5.5 % in 2080.

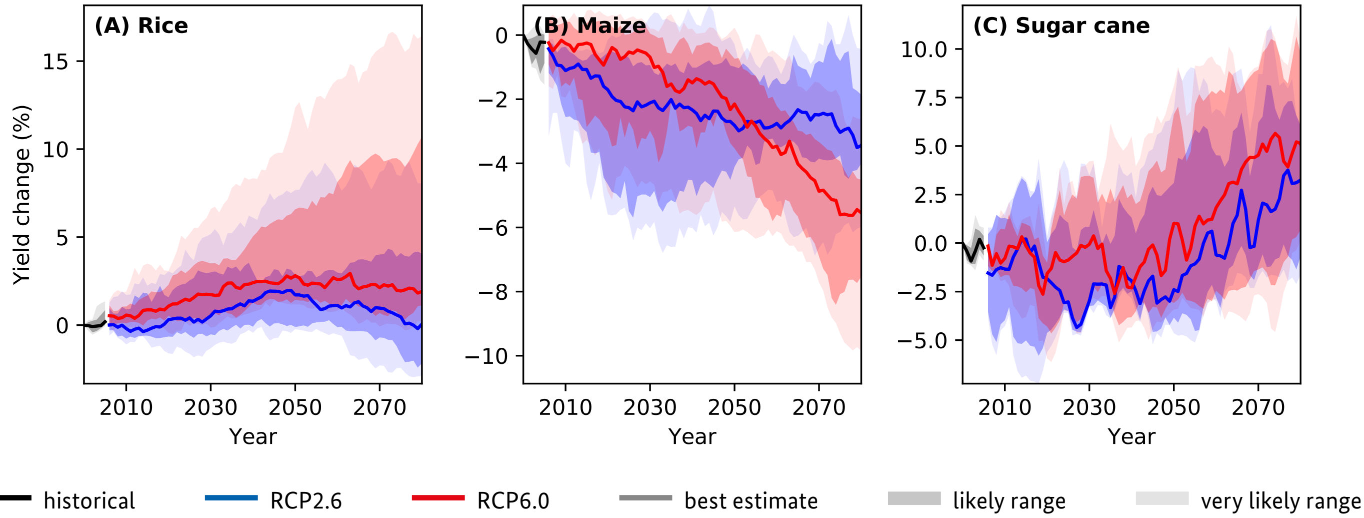

Figure 15: Projected changes in yields for selected crops in the Philippines for different GHG emissions scenarios, assuming constant land use and agricultural management, relative to the year 2000.

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c. Infrastructure

The Philippines face the challenge of an **ageing and often insufficient public infrastructure**, which is to a large extent of poorer quality than that of its regional neighbours [47]. Additionally, climate change is expected to significantly affect infrastructure predominantly through more intense extreme weather events.

Tropical cyclones are considered the most destructive hydrometeorological hazard in the Philippines due to the strong, moisture-bearing winds, as well as torrential precipitation and storm surges that lead to coastal and inland flooding and landslides [18]. They regularly cause heavy casualties, severe damage to agriculture and infrastructure and contamination of clean water supplies [29]. The most devastating typhoon in the last two decades, known as Super Typhoon Haiyan (Yolanda), which hit the Philippines in the 2013 Pacific typhoon season, caused damages of more than 2.1 billion USD [48]. In 2020, Super Typhoon Goni led to damages of more than 56 million USD in the energy sector alone [49].

While the overall frequency of tropical cyclones is projected to decrease in the future, the **projected higher average intensity** may lead to increasingly devastating effects for critical infrastructure including transportation networks, electricity generation, water supply and public health infrastructure. Rapid population growth and associated buildout of infrastructure, particularly in coastal areas, are likely to exacerbate the damages from tropical cyclones.

Floods and landslides, which are often associated with tropical cyclones, especially in the northern regions, have particularly devastating impacts on infrastructure and human welfare. These include flood-related causalities, direct and indirect health impacts, reduced food security and the destruction of livelihoods and properties. With a projected increase in tropical cyclone precipitation rates as well as in the overall frequency and intensity of heavy precipitation events, damages from flooding and landslides may also become more severe in the absence of effective flood risk management strategies.

Flood exposure of major roads, land area and population[10]

Infrastructure exposure to at least one riverine flood per year, illustrated with the example of major roads, is **projected to increase** under both emissions scenarios (Figure 16)**.** From 0.6 % of major roads exposed to floods in the year 2000, the share increases to 1.0 % in 2030 and 2050 for RCP2.6, and 0.8 % for the same time periods in RCP6.0; and 1 % and 1.5 % in 2080 for RCP2.6 and RCP6.0, respectively. Impassable roads and bridges may cause significant disruption and related social and economic impacts, including disruption to travel and business and impediments to access to health services, food and water supplies.

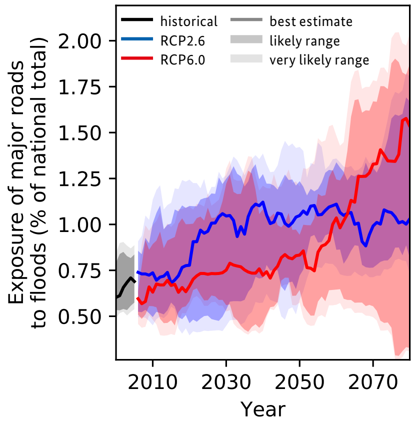

Figure 16: Projected exposure of major roads to river floods at least once per year for the Philippines for different GHG emissions scenarios.

In total, more than 1.3 million hectares of land are susceptible to flooding nationwide [50]. The **share of total land area exposed to riverine floods increases** by 0.06 % in 2050 and by 0.08 % in 2080 under RCP2.6. RCP6.0 follows a similar trend until 2050, increasing to 0.13 % by the year 2080 (Figure 17).

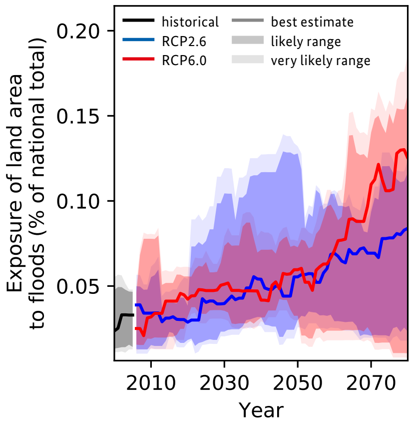

Figure 17: Projected exposure of total land area to river floods at least once per year for the Philippines for different GHG emissions scenarios.

The **share of total population exposed to floods increases** from 0.1 % in 2000 to 0.2 % in 2080 under RCP2.6, and to 0.5 % under RCP6.0 (Figure 18). The development of residential areas in low-lying areas can exacerbate the risk of flooding for households. Given the growing population, rapid urbanisation and structural economic inequality, poor urban communities located in flood prone areas are disproportionately more vulnerable.

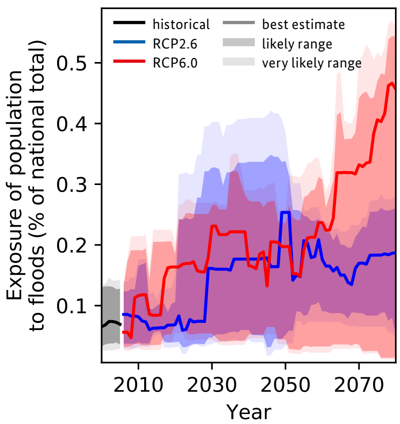

Figure 18: Projected exposure of population to river floods at least once per year for the Philippines for different GHG emissions scenarios.

[10] This section only considers riverine floods.

d. Human health

Despite significant improvements in providing healthcare in recent years, the Philippine health sector still faces large challenges in providing adequate health services with marginalised communities often facing additional obstacles [51]. Besides that, **climate change threatens human health in the Philippines in various ways: Extreme temperatures** have a direct impact on human wellbeing, with urban populations being particularly affected as they experience higher temperatures than outlying areas [52]. Heat stress can trigger a variety of adverse health outcomes ranging from a general decline in well-being to deadly heat strokes.

In addition, warmer and wetter conditions are likely to lead to an increase particularly in vector-borne and water-borne diseases. Increased exposure to **extreme weather events** including flooding and more intense tropical cyclones may directly increase the rates of cardiovascular, infectious and respiratory diseases, while at the same time indirect effects may occur through reduced food security and damaged health infrastructure [53]–[55].

Population exposed to humid heatwaves

The proportion of the population exposed to humid heatwaves[11] is **expected to increase under both emissions scenarios**. Already under the low emissions scenario, the share of population exposed to at least one humid heatwave per year is projected to increase from below 4 % in 2000 to 14 % by 2030 and 18 % by 2050. Under the medium to high emissions scenario, the increase is projected to rise even further to almost 30 % by 2080 (Figure 19). Unmitigated exposure to extreme temperatures could lead to serious illnesses, premature deaths and economic damages.

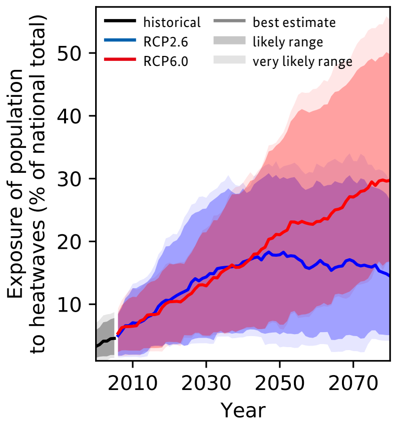

Figure 19: Projected share of the population exposed to humid heatwaves at least once per year for the Philippines under different GHG emissions scenarios.

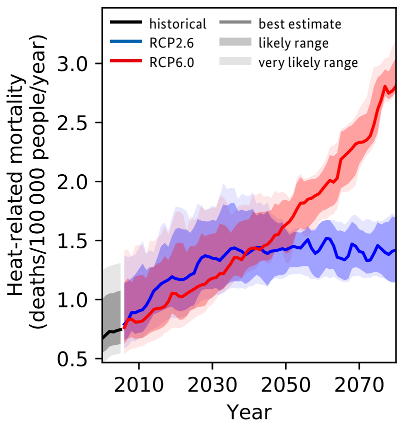

Figure 20: Projections of heat-related mortality for the Philippines for different GHG emissions scenarios, assuming no adaptation to increased heat.

Heat-related mortality

Heat-related mortality is projected to double from 0.7 deaths per 100 000 people and year to 1.4 deaths per 100 000 people by 2030 already under RCP2.6. Under RCP6.0, heat-related mortality is projected to increase up to 2.8 deaths per 100 000 inhabitants and year by 2080 (Figure 20).

[11] Humid heatwaves are characterised 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 climate 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 [32].

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