

CLIMATE BRIEFING PAPER

CLIMATE RISK GUIDE VIETNAM

COMMISSIONED BY:

BREAD FOR THE WORLD REGIONAL OFFICE FOR VIETNAM & LAO PDR

(Final draft, January 31, 2022)



CLIMATE & DEVELOPMENT ADVICE

IMPRINT

Authors

Thomas Hirsch, Jaume Marquès Colom & Antonella Kania, Climate & Development Advice

www.climate-development-advice.de

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Proof reading

Paula McDiarmid

75 Westwood Park, London, SE23 3QQ, UK

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Abbreviations

B 1	North West climatic zone (of Vietnam)
B 2	North East climatic zone (of Vietnam)
B 3	North Delta climatic zone (of Vietnam)
B 4	North Central climatic zone (of Vietnam)
CO ₂	Carbon dioxide
CO ₂ eq	CO ₂ -equivalent emissions, usually measured in metric tonnes (tCO ₂ eq)
GHG	Greenhouse gases
IPCC	Intergovernmental Panel on Climate Change
MONRE	Ministry of Natural Resources and Environment (Vietnam)
NAP	National Adaptation Plan
NDC	Nationally Determined Contribution (the climate pledge of states)
N 1	South Central climatic zone (of Vietnam)
N 2	Central Highlands climatic zone (of Vietnam)
N 3	South of Vietnam climatic zone (of Vietnam)
UNFCCC	United Nations Framework Convention on Climate Change

Introduction

The climate is no longer a relatively stable system. It is changing more and more rapidly due to rising emissions of greenhouse gases by us humans. Yet many of these changes are dynamic. This means that climate observations from the past only help us to a limited extent to predict the effects of climate change in the future. This means that traditional coping capacities are increasingly reaching their limits. In addition, some of the potential damages of climate change are so severe, or are about to become so severe, that they exceed the limits of adaptive capacity and therefore need to be covered separately, for example through climate risk insurance.

For these reasons, climate change cannot be ignored when planning projects and programmes. Understanding the climatic conditions in a project region and developing an idea of

- how they might change in the near future,
- what the potential hazards are,
- how vulnerable the project is to them,
- and what the resulting risks are for the achievement of the project objectives, but also for the target groups and the region as a whole

are indispensable foundations of good project and programme planning.

Bread for the World therefore makes climate proofing of projects in the concept note development phase a mandatory part of the application process. If it turns out that projects are particularly climate-sensitive, further steps such as conducting a climate risk analysis are required.

This publication is intended to help with these steps. It complements a climate proofing guide and a guide to climate risk assessments that are still in the making. It is aimed primarily at the staff of Bread for the World and our partner organisations, but also at other interested parties.

In this publication we present the key characteristics of the two main climatic zones and the seven sub-zones of Vietnam, respectively, according to the official subdivision made by the government.

We briefly show the trends for the most important climatic parameters for the coming decades for all seven subzones, taking into account different scenarios in combating climate change. Based on this, we develop a climate risk profile for each of the seven zones with hazard potentials, vulnerabilities and resulting specific risks.

This is supplemented by a brief introduction to the most important climatological terms and the elementary principles of climate change, as well as a concluding brief overview of the basics of climate adaptation and a further reading list.

The study of this publication is not a substitute for a deeper examination of the specific climate-related issues in the course of project planning, but it can provide an introduction or a general overview of the challenges of climate change for the different provinces of Vietnam.

We intend to follow up this Climate Briefing Paper with further papers at loose intervals in order to gradually provide interested parties with a complete set of tools to plan and implement programmes and projects in a way that minimises the impact on their success, even under the conditions of climate change.

We hope you enjoy reading this report and would appreciate your feedback to further improve its quality.

A Short Guide to Climate and Climate Change

Climate

The **climate** is a long-term pattern of average weather (at least 30 years) in a particular area. Therefore, the climate does not describe the current weather but an average calculation. The climate consists of several variables, such as temperature, precipitation and wind.¹

The **mean temperature** is defined as the average of minimum and maximum temperature of a year.

Precipitation is expressed in millimetres. One millimetre of precipitation means 1 litre of precipitation on one square meter.

Both precipitation and temperature are shown in a **climate diagram**. The months from January to December are shown on the horizontal axis. The respective temperature at a specific time of the year can be read on the left vertical axis. The red graph shows the maximum temperature, i.e. the maximum temperature in May was 31.18 degrees Celsius. The orange graph shows the average temperature. The minimum temperature is shown in yellow. On the right horizontal axis the precipitation can be read. The precipitation is shown in the diagram as a light blue bar.

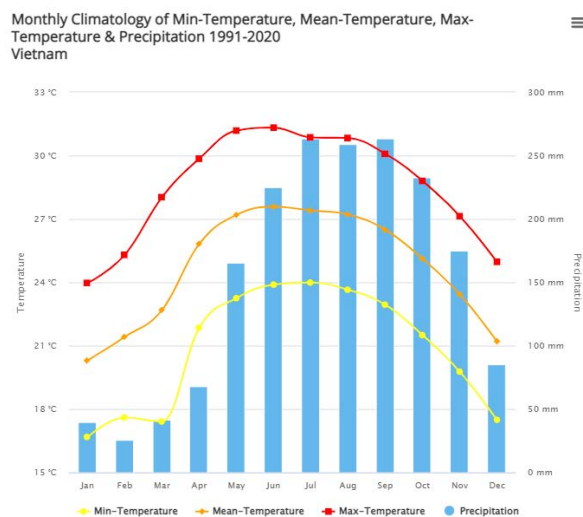


Figure 1: Climate diagram from Vietnam. Source: <https://climateknowledgeportal.worldbank.org/country/vietnam/climate-data-historical>

The **global climate system** is an interactive complex system consisting of five main components. The atmosphere, the oceans, the cryosphere, the land surface and the biosphere. The primary energy source for the climate system is the sun. The way how these components interact at a specific location determines its climate. This is why the climate varies from region to region. The world can be divided in different **climate zones**.

The climate zoning of the world according to the **Koepfen-Geiger climate classification** is based on temperature and precipitation and divides climates in five main climate groups: A tropical, B dry, C temperate, D continental, E polar climate. To further differentiate the 5 main climates, there are further classification options, which describe for example whether the region is a rainforest or a tundra region. Lastly, there is the possibility to further differentiate according to the temperatures in winter and summer. In total, there are 31 possibilities for the assignment of a climate zone for a region.

¹Intergovernmental Panel on Climate Change (IPCC). Link: <https://www.ipcc.ch/sr15/chapter/glossary/>.

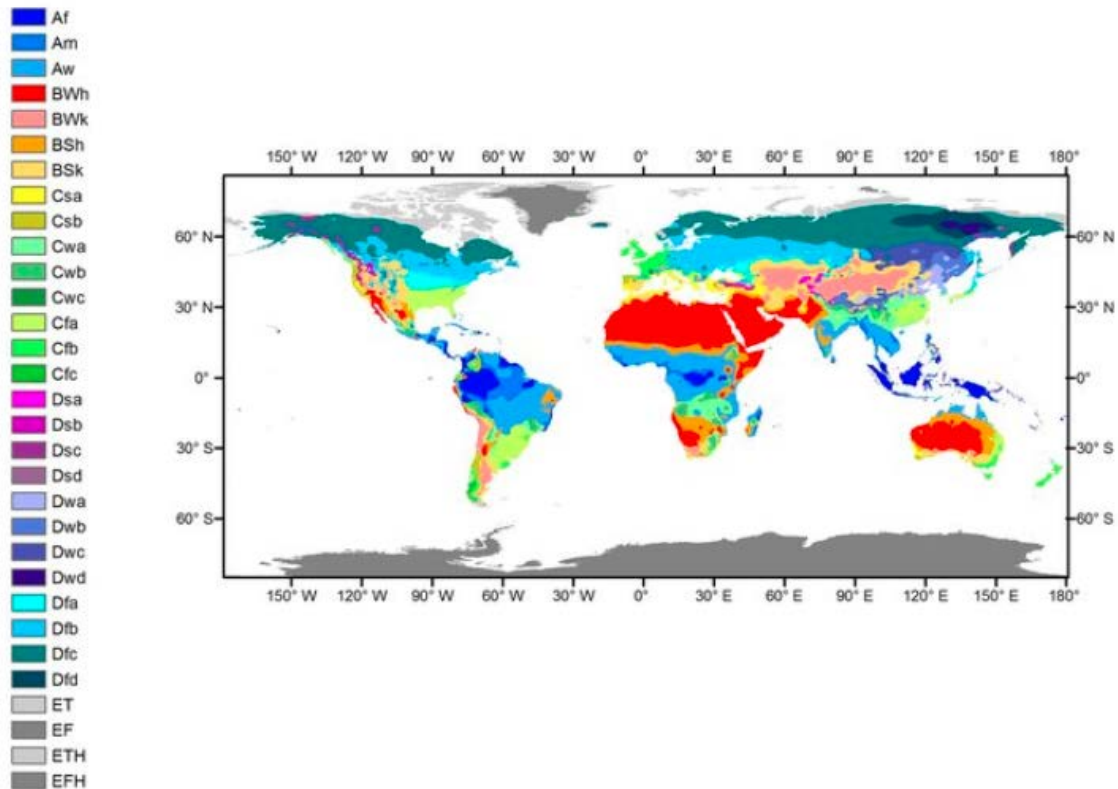


Figure 2: The Koeppen-Geiger climate classification global map. Source: <https://doi.org/10.5194/hess-11-1633-2007>

The **atmosphere** is the most important component of the climate system. Figure 3 shows the **earth's energy budget** and the influence of the atmosphere on radiation, serving as a filter, or protection shield: Incoming solar radiation is partly reflected by the atmosphere, partly absorbed by it, partly absorbed by the earth surface, and partly reflected by earth. Carbon dioxide and other greenhouse gases, that are part of the atmosphere, play a crucial role for energy budget. Their increase due to man-made emissions in terms of atmospheric concentration causes global warming.

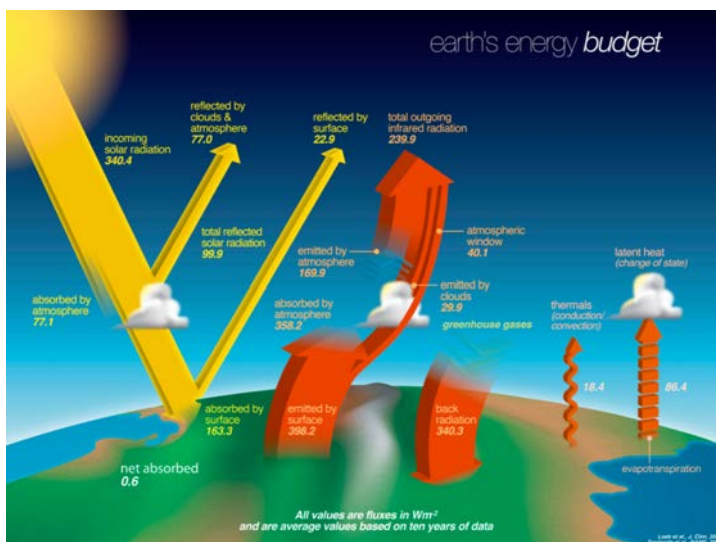


Figure 3: The energy budget of the earth. Source: NASA Link: <https://www.nasa.gov/sites/default/files/thumbnails/image/ceres-poster-011-v2.jpg>

The **hydrosphere** includes all liquid surfaces, i.e. fresh water, such as in rivers or lakes, and salt water in seas. Energy, or heat, is not only moved in the atmosphere from places with an energy surplus to places with an energy deficit, but also in oceans, in form of currents. These balancing movements follow the first law of thermodynamics. Furthermore, oceans are important carbon sinks, i.e. they store large amounts of carbon dioxide, and thus, help to mitigate climate change.

The **cryosphere** contains water in solid form, including ice sheets in Greenland and Antarctica, glaciers, permafrost (permanently frozen soils) and snow-covered areas. Important for the climate is the high reflective capacity (albedo) of snow- and ice-covered surfaces. With less ice-coverage, global warming would accelerate significantly.

The **land surface**, especially soils and vegetation, plays an important role in evaporation. In areas such as the tropics, evaporation plays a major role due to high temperatures and the availability of water. Thus, tropical landscapes, especially forests, can produce their own rainfall. The topography, especially the relief, is an important shaping the climate, too. Mountains can serve as effective barriers between different climate zones. Topography is also important for wind systems. The more fissured the surface of the earth is, the more the climate differs, even on a small scale.

The **biosphere**, both terrestrial and marine, has a significant impact on the greenhouse effect. Marine and terrestrial plants, especially forests, can store a large amount of carbon dioxide.

Climate change

The **United Nations Framework Convention on Climate Change** (UNFCCC), in its Article 1, defines climate change as: “a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods” (IPCC).²

CO₂ released from burning fossil fuels to generate electricity, heat and air conditioning is the main source of **GHG (greenhouse gas) emissions**, followed by CO₂, nitrous oxide and methane emissions originating from agriculture, deforestation and other land-use changes. Industries, transportation, construction and the waste sector are the other economic sectors that cause global warming. What are the most emission-intense sectors vary from country to country. In developing countries, agriculture and land-use changes tend to cause most of the national emissions, while the energy sector tends to be the most emission-intense in emerging economies and developed nations. The common goal for all is to achieve GHG neutrality by 2050 – and even 5-10 years earlier in rich nations. Decarbonisation pathways will be as different as current emission profiles. Achieving carbon neutrality requires huge investments, a system change to a circular economy, and international collaboration.

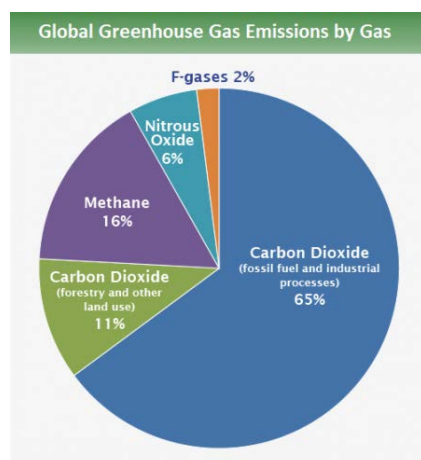


Figure 4: Global greenhouse gas emissions by gas source: <https://www.epa.gov/ghgemissions/global-greenhouse-gas-emissions-data>

² <https://www.ipcc.ch/sr15/chapter/glossary/>

Greenhouse gas effect: Greenhouse gases effectively trap the sun's warmth in the lower atmosphere, where they allow shortwave solar radiation to enter the atmosphere but block the long-wave radiation reflected from earth. Since the beginning of the industrial revolution, the concentration of carbon dioxide in the atmosphere has risen by almost 50%, first slowly and then increasingly faster since the 1990s, from 280 parts per million (ppm) in 1880 to 418 ppm in May 2021. In 2019, annual manmade GHG emissions totalled 43 billion tons.

Climate change impacts: Rising temperatures melt the ice, including glaciers, Arctic sea ice and ice sheets in Greenland and Antarctica. The melting of this ice causes the sea level to rise. Coastlines can therefore change as a result of **sea level rise**. Due to climate change, **extreme weather events** are intensified by the consequences of climate change, for instance more frequent and more extreme storms; mid-latitude and tropical extreme rainfalls and flooding, particularly in Asia; and severe drought and crop failure. These impacts have a huge potential to undo development successes.

Since 1980, losses caused by climate extremes have quadrupled. Most at risk are vulnerable, predominantly rural populations whose livelihoods depend on intact ecosystems, as in agriculture, forestry and fisheries sectors. How threatening the risk is can be seen in the warning of the insurer Swiss Re Group that 50% of global GDP is in peril, as climate change puts 20% of the world's countries at the risk of ecosystem collapse.

A better world is still possible, if strong and effective climate action is taken now. The IPCC Special Report on Global Warming of 1.5°C (2018)³ analysed the change needed to avoid a climate catastrophe: halve global carbon dioxide (CO₂) emissions by 2030; immediately switch investments from fossil to renewable energies, achieving 100% renewable energy supply within 15-20 years; turn soils, agrarian land and forests from greenhouse gas emission sources to sinks; and, finally, achieve carbon neutrality, i.e. global net zero emissions by 2050.

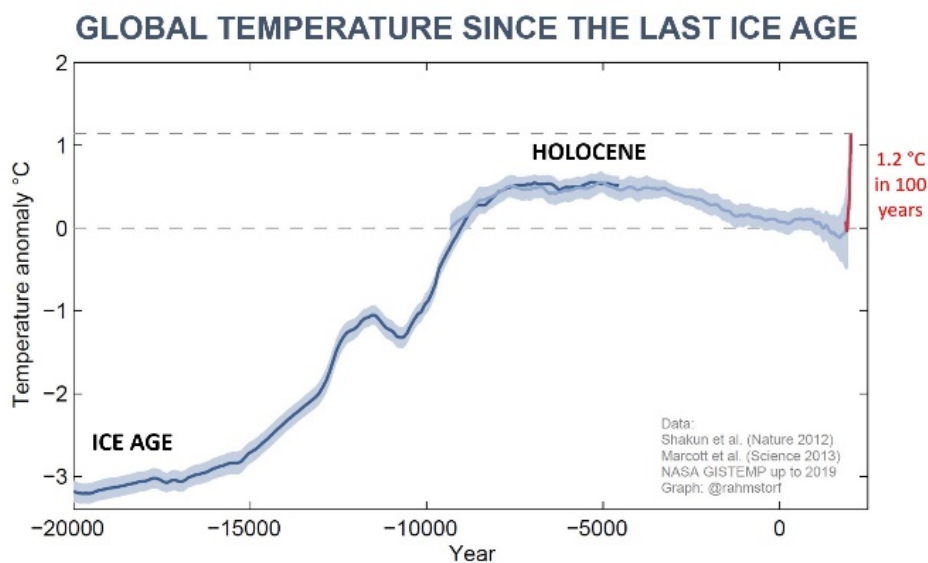


Figure 5: Global temperature rise

The future we get is defined by **climate action** in the 2020s. Only through limiting global warming to 1.5°C global temperature rise can we prevent massive burdens falling on current and future generations. It is incumbent to take ambitious and structured climate actions in all aspects of work. As a first step, a program could calculate its current GHG emissions. A carbon footprint calculator can be found at: <https://www.carbonfootprint.com/calculator.aspx>

³ <https://www.ipcc.ch/sr15/>

The Climate of Vietnam

In this publication we present the key characteristics of the two main climatic zones and the seven sub-zones of Vietnam, respectively, according to the official subdivision made by the government (see also the map on the following page):

Climatic zones	Climatic sub-zones	Provinces
North Vietnam	North West(B1)	Lai Chau, Son La, Dien Bien
	North East (B2)	Lao Cai, Yen Bai, Hoa Binh, Ha Giang, Tuyen Quang, Phu Tho, Cao Bang, Lang Son, Bac Kan, Thai Nguyen, Quang Ninh
	North Delta (B3)	Phu Tho, Vinh Phuc, Bac Giang, Bac Ninh, Ha Noi, Hai Phong, Hai Duong, Hung Yen, Ha Nam, Nam Dinh, Thai Binh, Ninh Bin
	North Central (B4)	Thanh Hoa, Nghe An, Ha Tinh, Quang Binh, Quang Tri, Thua Thien–Hue
South Vietnam	South Central (N1)	Da Nang city, Quang Nam, Quang Ngai, Binh Dinh, Phu Yen, Khanh Hoa, Ninh Thuan, Binh Thuan
	Central Highlands (N2)	Kon Tum, Gia Lai, Dak Lak, Dak Nong, Lam Dong
	South of Vietnam (N3)	Binh Phuoc, Dong Nai, Ba Ria-Vung Tau, Binh Duong, Tay Vinh, Long An, Ca Mau, Kien Giang, Tien Giang, Ben Tre, Tra Vinh, Vinh Long, Dong Thap, Soc Trang, Hau Giang, An Giang, Bac Lieu, Ho Chi Minh City, Can Tho city

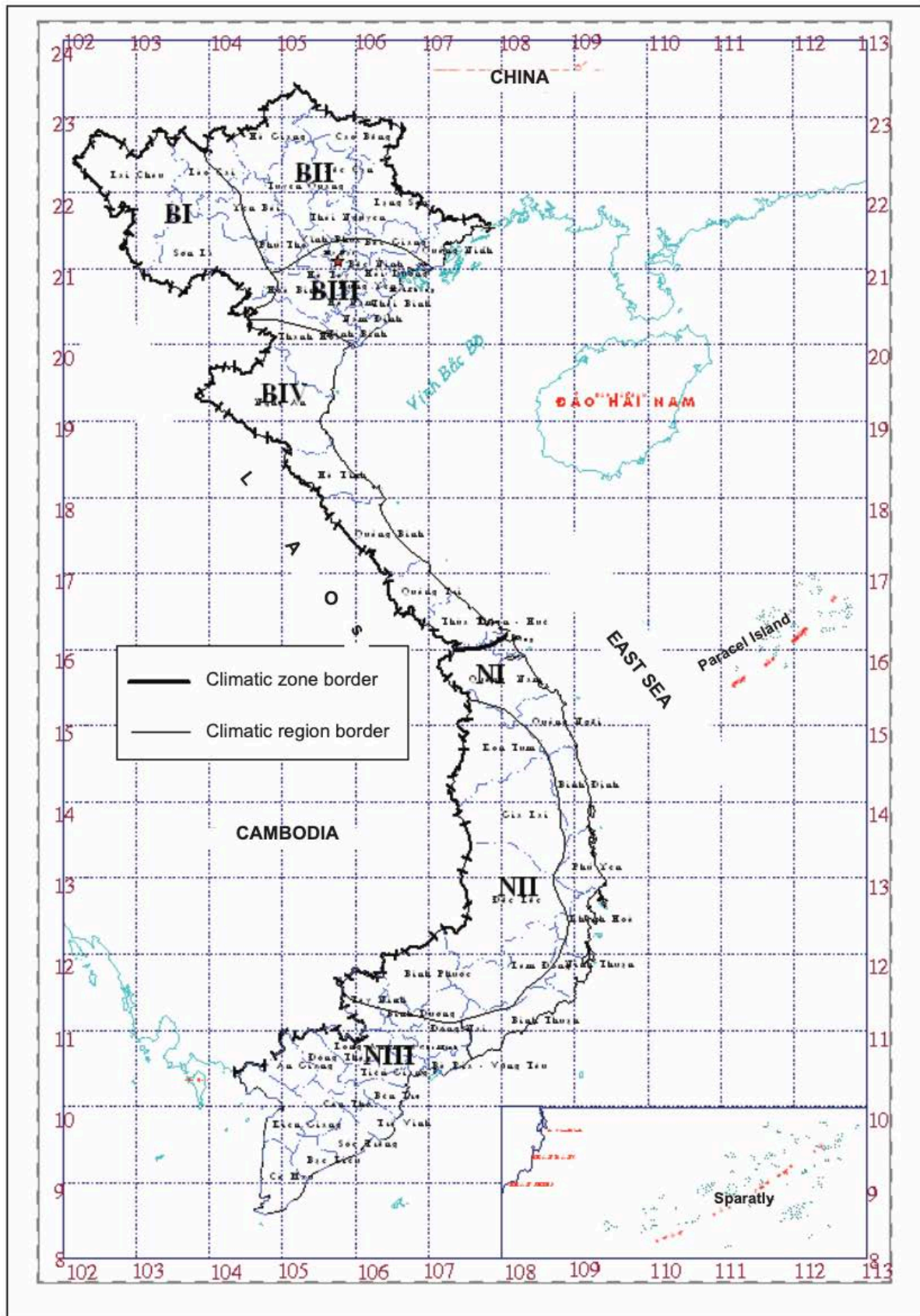
Table 1: Vietnam’s climatic zones and the corresponding provinces. Source: ISPONRE 2009

Our climate projections show the climate anomalies as compared to the reference period 1995 – 2014. The climate projections are based on climate model data from the Coupled Model Inter-comparison Project 6 (CMIP6), overseen by the World Climate Research Program and building the data foundation of the IPCC 6th Assessment Report (IPCC 2021). This set of climate model data is used to project the future climate in different scenarios of future emission development, as a combined result of different mitigation efforts and pathways of socio-economic development. These scenarios are called Shared Socioeconomic Pathways (SSPs). So far, five of them have been developed:⁴

- SSP 1, the sustainability pathway, allowing to limit global warming well below 1.5°C; 2 sub-scenarios
- SSP2, a middle-of-the-road scenario of decisive but delayed climate action, leading to around 2.5°C temperature increase;
- SSP3, a scenario of delayed action, characterized by regional rivalry, leading to around 3.5°C temperature increase;
- SSP4, another scenario of delayed climate action, characterized by increasing inequality, leading to around 3°C temperature increase
- SSP5, the worst-case scenario of far-delayed phase-out of fossil fuels, leading to 4.5°C temperature increase.

How these scenarios 1-3 translate into different climate futures in Vietnam’s climatic sub-zones is shown in the following chapters.

⁴ <https://doi.org/10.5194/gmd-13-3571-2020>



Source: *Climatology and Climatic Resources in Viet Nam*

Figure 6: Climatic division of Vietnam in two main and seven sub-zones: North Vietnam (B1 – B4) and South Vietnam (N1 – N3). Source: ISPNRE, 2009

The climate of North Vietnam

The four climate zones of North Vietnam

The Vietnam Assessment Report on Climate Change (VARCC)⁵ divides North Vietnam in four climatic zones: North West (B1), North East (B2), North Delta (B3) and North Central (B4). The three first zones are monsoon-influenced humid tropical climate, whereas the North Central (B4) is majorly tropical monsoon climate according to the Koeppen-Geiger Climate Classification.⁶ The North of Vietnam is characterized by abundant rainfall. In the climate zones of the North of Vietnam, mean temperature ranges from 22°C to 27.5°C in summer and 10°C to 15°C in winter.

The **North West (B1)** climatic zone comprises the Lai Chau, Son La, and Dien Bien provinces. The altitude of this zone ranges between 100m and more than 3000m. Its climatic characteristics include a relatively cold and dry winter with abundant sunlight and little drizzly rain. Summers are hot with frequent winds from the West, abundant rainfall, low influence of storms, and tropical low pressures.

According to the VARCC, the rainy season starts in April and ends in October, with the highest rainfall between June and August. The average annual temperature is 22-23°C (26-27°C in the hottest and 15-17°C in the coldest months) as shown in Figure 7. Average rainfall ranges from 1200-1700mm. During the dry season, the precipitation rate between November and March is less than 50 mm per month.

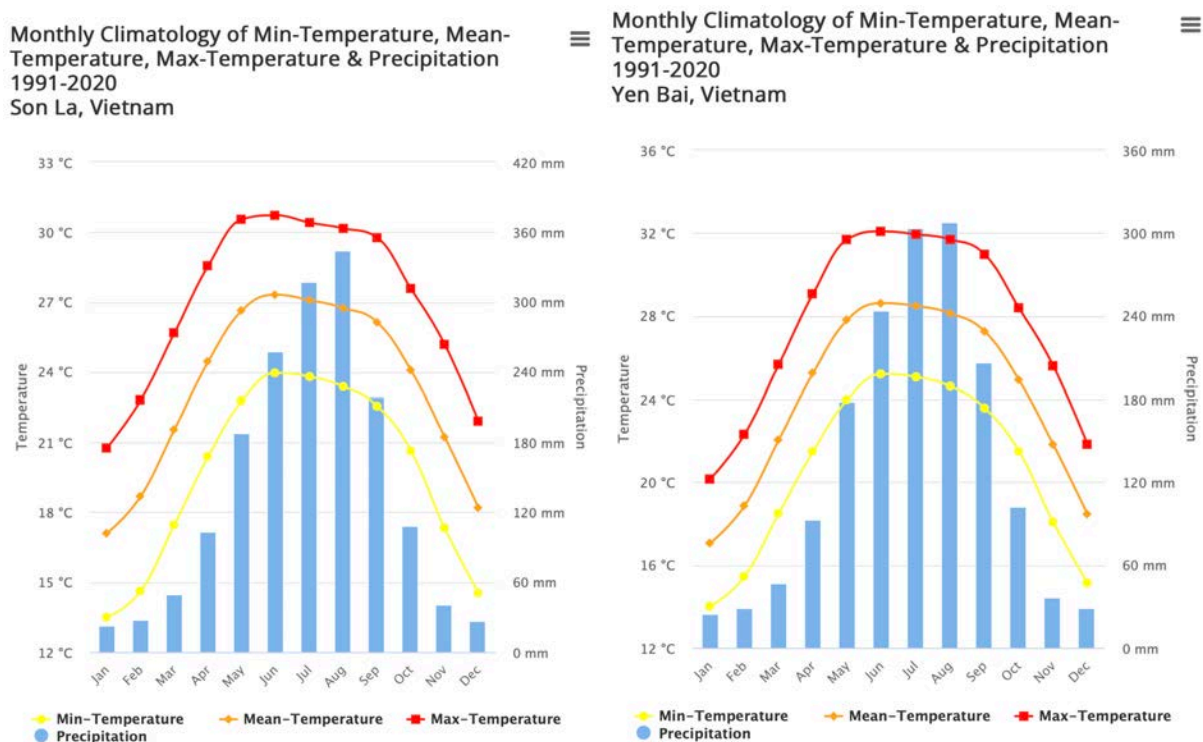


Figure 7 Climate diagrams of Son Lau (B1) and Yen Bai (B2), Vietnam. Source: <https://climateknowledgeportal.worldbank.org/country/vietnam/climate-data-historical>

The **North East (B2)** climatic zone includes the provinces of Lao Cai, Yen Bai, Hoa Binh, Ha Giang, Tuyen Quang, Phu Tho, Cao Bang, Lang Son, Bac Kan, Thai Nguyen, and Quang Ninh. The altitudes range from 50m to more than 3000m. The B2 region has a relatively cold and dry winter with scarce light, drizzly rain and sometimes hoarfrost. Summers are hot, rainy and with prevailing hot West winds.

⁵ Vietnam Assessment Report on Climate Change (IPONRE,2009). Accessible at: https://wedocs.unep.org/bitstream/handle/20.500.11822/7940/VTN_ASS_REP_CC.pdf?sequence=3&isAllowed=y

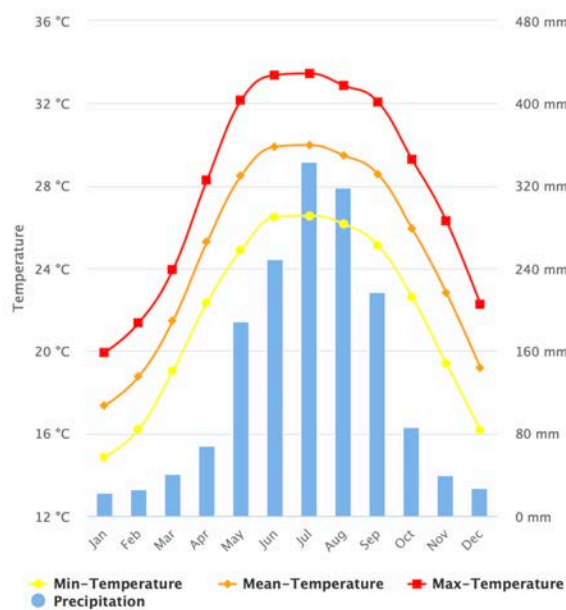
⁶ The climate classification for South Vietnam according to Köppen-Geiger: <https://climateknowledgeportal.worldbank.org/country/vietnam>

In the climatic zone B2, the rainy season goes from April to October with most rainfall falling between June and August. The mid-northern provinces have a smoother transition between rainy and dry seasons than the easternmost provinces – such as Quang Ninh. Between November and March, rainfall remains below 60mm per month. The annual rainfall ranges from 1200 to 1900mm. In B2, the average temperature ranges between 21-24°C (27-29°C in the hottest and 14-16°C in the coldest months). The region has a monsoon-influenced humid tropical climate.

The **North Delta (B3)** climatic zone includes the provinces of Phu Tho, Vinh Phuc, Bac Giang, Bac Ninh, Ha Noi, Ha Tay, Hai Phong, Hai Duong, Hung Yen, Ha Nam, Nam Dinh, Thai Binh, and Ninh Bin. This climatic zone is low lying (below 50 m above sea level) in the Red River delta. Winters are cool, with ample drizzly rain, and summers humid and hot, with abundant rainfall during monsoon.

The North Delta climatic zone is affected by tropical storms and abundant rainfall. Annual rainfall ranges from 1200 to 2100mm. The rainy season is between May and September/October, with a peak in July and August, with almost half of the annual rainfall in these two months. Between November and April, the dry season, monthly rainfall is below 80 mm. Average temperature is between 23°C and 30°C in the hottest and between 16°C and 17.5°C in the coldest months.

Monthly Climatology of Min-Temperature, Mean-Temperature, Max-Temperature & Precipitation 1991-2020
Ha Noi City, Vietnam



Monthly Climatology of Min-Temperature, Mean-Temperature, Max-Temperature & Precipitation 1991-2020
Ha Tinh, Vietnam

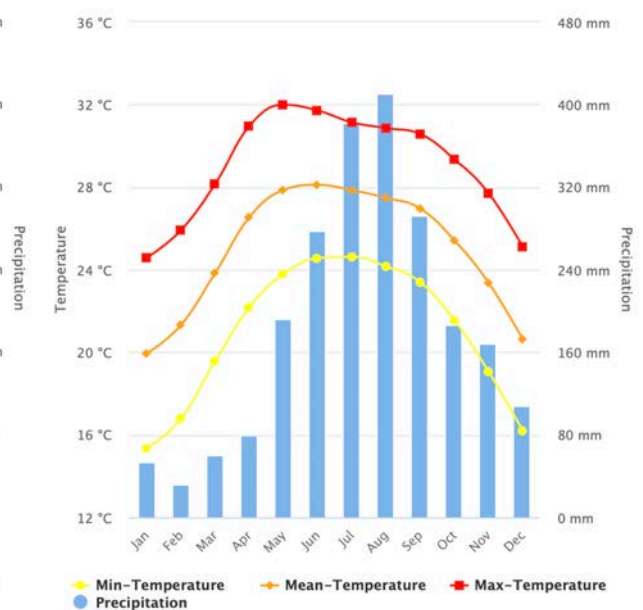


Figure 8 Climate diagrams of Ha Noi City (B3) and Ha Tinh (B4), Vietnam. Source: <https://climateknowledgeportal.worldbank.org/country/vietnam/climate-data-historical>

The **North Central (B4)** climatic region includes the provinces of Thanh Hoa, Nghe An, Ha Tinh, Quang Binh, Quang Tri, and Thua Thien–Hue. The zone ranges from the Western mountains (up to 2000m altitude) over the hills and plains in the midlands to the eastern coastline. Winters are cold (mountains) to mild (coast), dry, with reduced sunlight, drizzly rain and a low incidence of hoarfrost inland. Summers are hot, with a high frequency of hot western winds, peak temperatures in May and June and peak rainfall in July to September, and a high risk to be affected by tropical storms.

In the North Central region, annual rainfall ranges between 1700 and 2000mm in northern provinces and between 2000 and 2800mm in the southern part. The rainy season lasts in average five months but rainfall patterns are not homogenous: In the northern part, the rainy season starts earlier, peaks earlier and is less intense. In the southern part with its purely tropical monsoon regime, the rainy season starts a little bit later, the peak is longer, and total precipitation is significantly higher. In the southern part of the North Central climatic zone, the dry period starts later, is shorter and more humid as in

the northern part of B4. The average annual temperature is between 24°C and 28°C in the hottest and 18°C and 20°C in the coldest months. The B4 region is the warmest of the four northern climate regions.

Key trends of observed climate change in the North of Vietnam

Temperatures in the North of Vietnam have increased in the past thirty years: Since the 1970s, the mean annual temperature has increased by 0.66°C in Hanoi, 1.08°C in Son La, and 1.04°C in Ha Tinh provinces. Between 1971 and 2020, average temperature increased at a rate of 0.26 per decade, with a steepening rise between 2010 and 2020. Extreme events rise in magnitude and frequency. Cold days have become less frequent while hot days are steeply increasing in terms of both, number of hot days and maximum temperatures reached. Precipitation so far shows no statistically significant changes at zonal level, but there are deviations at local level, i.e. tentatively less rainfall in many locations of B1, no clear trend in B2 and B3, and more rainfall in many locations of B4.

Climate projections for North West climatic zone (B1)

In the provinces of Son La, Dien Bien, and Lai Chau mean temperatures is projected to increase by 0.5°C by 2030 and by 2040 in a range from 0.8°C to 1.3°C by 2040 (best- and worst-case scenarios). By 2060, further temperature increase would be quite limited in the best-case scenario. By 2100, the mean temperatures in the B1 region in this scenario would be 0.8-0.9°C higher than in 2013. In the SSP2-4.5 scenario – or ‘middle-of-the-road’ scenario – mean temperature would increase by 1.81°C in Son La. In the worst-case scenario, temperature would even increase by 4.65°C. Annual mean minimum and maximum temperatures are also projected to increase. Highest temperature levels would be reached in the month of May.

Projected hot days, i.e. maximum temperature above 35°C, are expected to vary in the three provinces between 23 and 86 days annually by 2050 and between 38 and 158 days annually by 2100 – according to the most optimistic to the most pessimistic scenarios. In the middle-of-the-road scenario there will be an average of 78.24 annual hot days by 2100. Thus, growing heat will have severe impact on health and livelihoods in future.

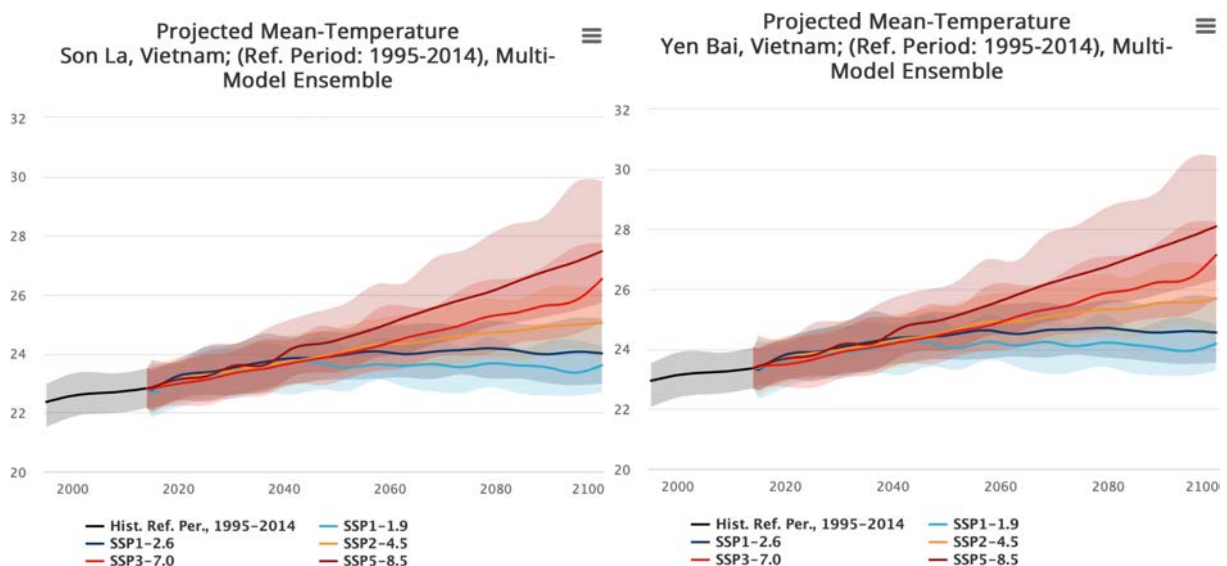


Figure 9: Projected mean temperatures in Son La (B1) and Yen Bai (B2) in 2020 – 2100 in different emission pathway scenarios. Source: <https://climateknowledgeportal.worldbank.org/country/vietnam/climate-data-projections>

All scenarios show trends for a delay in the months of rainy season and anomalies in the projected precipitation seem to increase even in the middle-of-the road scenario SSP2-4.4 for the B1 region. In the B1 climatic zone, the number of projected of annual consecutive dry days– with a daily accumu-

lated precipitation under 1mm – are expected to be between 40.88 and 47.29 days in 2050 and between 34.63 and 43.51 days by 2100 for the SSP2-4.5 and SSP3-7.0 scenarios, respectively. According to the scenario SSP3-7.0, B1 would become the climatic zone of Vietnam with the longest dry periods. That is especially important for Dien Bien province with the highest projected number of consecutive dry days in Vietnam.

Climate projections for the North East (B2)

In the provinces of Lao Cai, Yen Bai, Hoa Binh, Ha Giang, Tuyen Quang, Phu Tho, Cao Bang, Lang Son, Bac Kan, Thai Nguyen, and Quang Ninh the mean temperatures will increase between 0.98°C and 1.02°C by 2040.⁷ By 2050, the scenario of the sustainability pathway projects an increase of mean temperatures in the North East climatic zone by 0.99°C. In the case of unabated global warming, temperatures would increase between 1.42°C and 1.94°C by 2050, as compared to 2013. By 2100, mean temperature in Yen Bai is projected to increase the best-case scenario by 0,85°C compared to 2013. In a middle-of-the-road scenario, the increase would already be at 3,35°C and in the worst-case-scenario even 5,76°C. Steepest temperature increases would happen in the dry season, especially in February to May.

Projected annual very hot days (>35°C) in Yen Bai are projected to increase from an average of 22,47 days in 2013 to 32,74 – 40,47 days in 2040, depending on the scenario. By 2060, the number of hot days would remain stable in the scenario aligned with the 1.5°C temperature goal while it would further rise to 49 days in the middle-of-the-road scenario and even to 60 days in the worst-case scenario of unabated global warming. By 2100, the number of very hot days would reach 39 in the best-case scenario, which is almost double the number of hot days in 2013. In the middle-of-the road-scenario, the number would increase by a factor of two and a half (59) and in the worst-case scenario even fivefold (117).

Most provinces in the North East climatic zone are projected to become somewhat wetter across all scenarios: By the end of the century, precipitation may be up to 15% higher as compared to 2013, depending on the scenario.

Climate projections for North Delta (B3)

In the provinces of Phu Tho, Vinh Phuc, Bac Giang, Bac Ninh, Ha Noi, Hai Phong, Hai Duong, Hung Yen, Ha Nam, Nam Dinh, Thai Binh, and Ninh Bin the mean temperatures will increase in average by 0.73°C by 2040, as compared to 2013.⁸ In the most climate ambitious scenario, temperature in Ha Noi City would increase by 2060 by 0.89°C and then stabilize at this level by 2100. In the middle-of-the road scenario, temperature increase by 2060 would be of about 1.71°C, increasing further to 2.41°C by the end of the century. In the worst-case scenario, Ha Noi City would turn into a 'hot house', with 2,34°C higher temperatures in 2060, and 4.81°C higher mean annual temperature. A similar increase in annual mean minimum and maximum temperatures is expected. As in other northerner regions as B2, there are projected peak temperature increases up to 8.5°C in the month of May.

Projected average largest 1-day precipitation increases, i.e. heavy rainfall events, remain relatively stable in the climate ambitious scenarios, while these events, which may lead to flash floods, are projected to increase in both, the middle-of-the-road scenario and scenarios of unabated climate change. Bac Giang is projected to be among the provinces of Vietnam with the highest relative increase of seasonal precipitation (42% by 2100 in the middle-of-the-road scenario). The increase in the number of projected consecutive dry days is particularly significant in Bac Ninh and Bac Giang provinces with 36.5-37 quarterly consecutive dry days in 2050, rising to 41-42 days in 2100 in the scenario SSP3-7.0.

⁷ All the following trends taken from <https://climateknowledgeportal.worldbank.org/country/vietnam/climate-data-projections>

⁸ Ibid

In Ha Noi City, the number of very hot days (>35°C) is projected to increase from 29 days (2013) to 39.5 days (2060) and further to 41.5 days in the most climate-ambitious scenario. The numbers are significantly higher in a middle-of-the road scenario with already 60 days in 2060 and 71 days in 2100. In the case of unabated climate change, temperatures would be higher than 35°C on 72 days in 2060 and 128 days in 2100. In terms of precipitation, Ha Noi City is projected to become slightly wetter in annual average. Looking at the distribution of annual rainfall, October may become notably wetter, while rainfall may decrease slightly during the summer, and in other months, too.

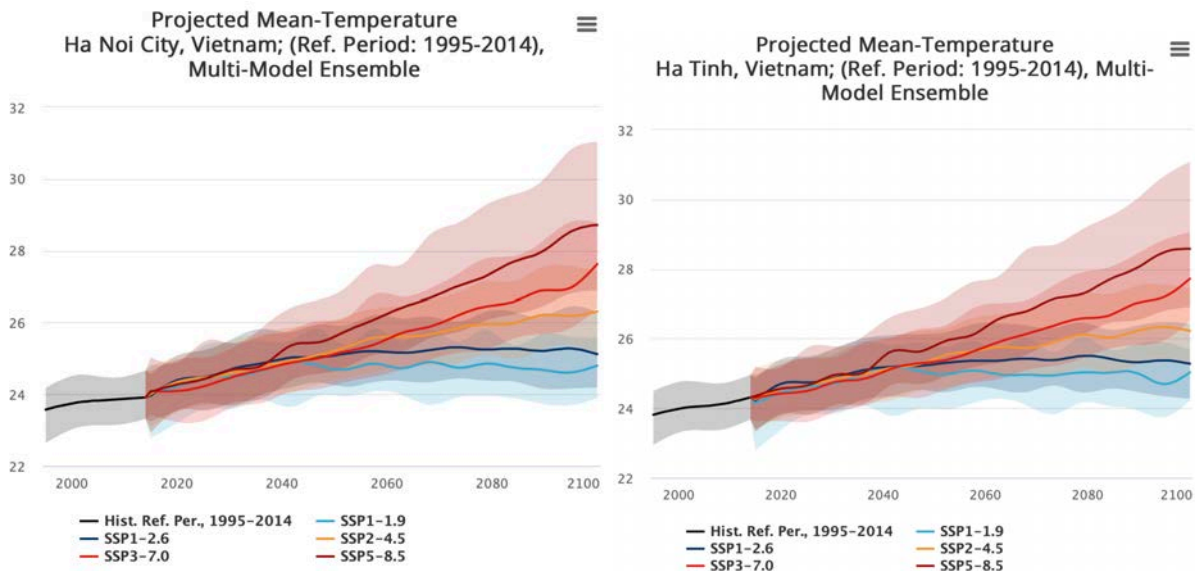


Figure 10: Projected mean temperatures in Ha Noi City (B3) and Ha Tinh (B4) in 2020 – 2100 in different emission pathway scenarios. Source: <https://climateknowledgeportal.worldbank.org/country/vietnam/climate-data-projections>

Climate projections for North Central (B4)

The provinces of Thanh Hoa, Nghe An, Ha Tinh, Quang Binh, Quang Tri, and Thua Thien – Hue present a tropical monsoon climate, as well as the climatic zones further south: This means that they have less pronounced dry seasons and higher rainfall than in the B1, B2, and B3 regions. In the North Central climatic zone, mean temperature will increase within a range of 0.51°C and 0.70°C by 2030, and from 0.87°C to 1.23°C by 2040 as compared to 2013 – if the best and worst case scenarios are considered. According to the middle-of-the-road scenario SSP2-4.5, the temperature will further increase in Ha Tinh by 1.43°C by 2060 and by 1.95°C by 2100 as compared to 2013, while this increase would amount to 2,06°C (2060) and 4,01°C (2100) in the worst-case scenario. Annual minimum and maximum temperatures are projected to vary the most in the month of May, but they show similar trends as the mean temperature.

The number of extremely hot days (> 35°C) is projected to steeply increase. not only will increase with time but there is not a similar distribution throughout the region B4. In the course of the year, the increase is strongest during the rainy season in most provinces of B4. The province of Thua Thien-Hue is an exception, where the increase is projected to be highest in the month of May. In Ha Tinh, with 33 hot days in 2013, the number is projected to increase in the best case scenario of limiting global warming to 1.5°C to 42 days in 2040 and 2060, and then slightly fall to 38 days. In the middle-of-the-road scenario, the number of hot days would increase to 43 (2040), 61 (2060), and 72 days (2100); in the worst-case scenario of unabated climate change, 58 hot days are projected for 2040, 77 for 2060 and 140 for 2100.

The direction of future changes in annual mean precipitation is less clear, and the scale of projected changes statistically little or not significant. During the year, late winter and spring is likely to become a bit drier, while the rainy season and especially the month of October could become significantly

wetter.⁹ However, rainfall may fluctuate more, including with higher peaks of daily precipitation but also more days without rain.¹⁰

Climate hazards, vulnerabilities and risks in the North West climatic zone (B1)

The highlands of the North West climate zone (100 - >3000m), which includes the provinces Lai Chau, Son La, and Dien Bien, are susceptible to the climate hazards of drought, wildfires, typhoon, and precipitation-triggered landslides. Rapid onset extreme events such as drought and wildfires also trigger slow onset events like desertification, the loss of biodiversity, and land and forest degradation.

The entire region is susceptible to **drought**, which is expected to steeply increase by 10 percent annually. Droughts and dry spells will occur more frequent and they will last longer.¹¹ Climate projections for the B1 region show a delay in the rainy season. No other climate zone in Vietnam will have longer dry periods. The province of Dien Bien is likely to be affected the hardest with the highest number of consecutive dry days in Vietnam (in average 51 consecutive dry days every three months). This region also bears the highest risk of **wildfire**, with an estimated average between 25 and 50 wildfire events per year. **Heatwaves** are likely to occur more often and more extreme between May and September.¹²

According to climate projections, future scenarios include a trend to less frequent but more intense **typhoons**¹³ in the B1 region. **Precipitation-triggered landslides** occur especially in the provinces of Lai Chau and Dien Bien, especially for the bordering area between them.¹⁴

In terms of **vulnerabilities**, the lack of precipitation, higher temperatures and evaporation will most likely lead to insufficient water sources in the dry season.¹⁵ Water scarcity would negatively affect agriculture and the population. Climate adaptation strategies in terms of timely crop planting, sustainable water resource management, and acquisition of resilient crops is much needed to reduce **climate risks** in the B1 region. Higher temperatures are the new climate normal that needs to be considered in agriculture. Less predictable rainfall needs to be factored-in, too. Agriculture is the economic sector most exposed to climate risks, followed by hydropower generation and tourism.^{16,17}

Climate hazards, vulnerabilities and risks in the North East (B2)

The highlands of the North East climate zone B2 (50 - >3000 m) encompass the provinces of Lao Cai, Yen Bai, Hoa Binh, Ha Giang, Tuyen Quang, Phu Tho, Cao Bang, Lang Son, Bac Kan, Thai Nguyen, and Quang Ninh with altitudes raging from 50 to 500 m. The main climate hazard are riverine flooding and drought events, typhoon foothills, and, in northern and north-eastern areas, precipitation-triggered landslides.

Riverine flooding is the main climate hazard in this region due to all the riverine land of the Red River's tributaries, which are subject to high flooding risks. In this region, the risk of flooding is higher than in the B1 region, but it is still lower than in the B3 region.

The provinces of Lao Cai and Yen Bai, due to their geographical location in a highland area, are more prone to suffer from **precipitation-triggered landslide risks**. The rest of the B2 region, with the exception of Quang Ninh, has relatively low risks to precipitation-triggered landslide risks.

⁹ <https://climateknowledgeportal.worldbank.org/country/vietnam/climate-data-projections>

¹⁰ WBKP Vulnerability

¹¹ ADB, WB

¹² <https://climateknowledgeportal.worldbank.org/country/vietnam/climate-data-projections>

¹³ <https://climateknowledgeportal.worldbank.org/country/vietnam/vulnerability>

¹⁴ <https://climateknowledgeportal.worldbank.org/country/vietnam/vulnerability>

¹⁵ ISPONRE, 2009

¹⁶ Global Data Risk Platform (<https://preview.grid.unep.ch/index.php?preview=map&lang=eng>); ISPONRE, 2009

Typhoons can have an impact in the entirety of the B2 region, but particularly for the northernmost and eastern areas of the B2 region including the provinces of Ha Giang, Cao Bang, Tuyen Quang, Bac Kan, Lang Son, or Quang Ninh. Tropical typhoons from the East Sea will increase in intensity.

The number and intensity of **cold fronts** crossing from the northern coast will decrease in the north-western and northeastern areas of the B2 zone. The increase in temperature will continue to reach new high records, similarly to the B4 region.

Drought will occur more frequently and for longer periods as both, the number of consecutive dry spells and number of hot days will increase, especially for the westernmost areas of the B2 region.

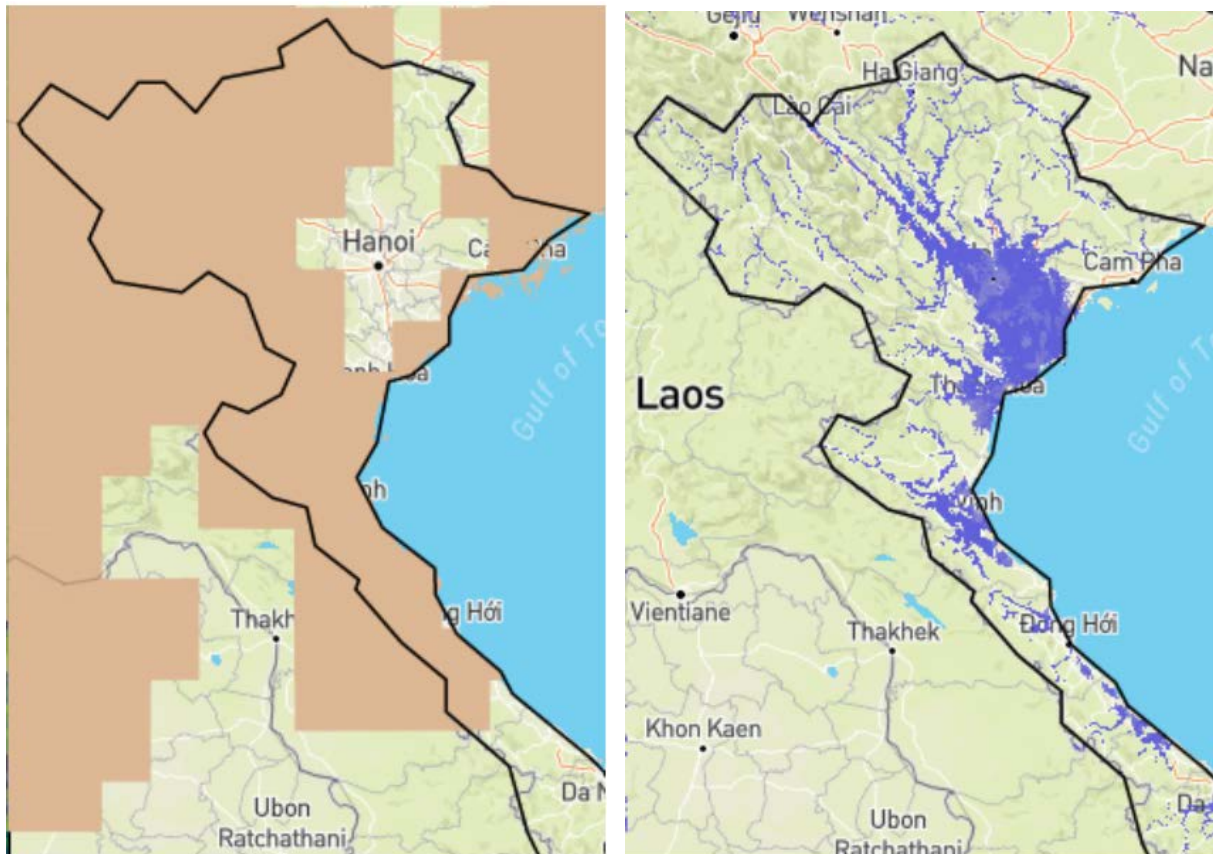


Figure 11: Maps showing drought risks (marked in brown) and flood risks (blue) in the northern climatic sub-zones of Vietnam. Source: <https://climateknowledgeportal.worldbank.org/country/vietnam/vulnerability>

Quang Ninh is by far the province with **the highest susceptibility to climate hazards** in the B2 climatic zone. It is exposed to rapid onset events such as storm surges, precipitation-caused landslides, typhoons, tsunamis, and slow onset events as sea level rise and saline intrusion. Saline intrusion happens when saltwater enters low freshwater levels in coastal and river delta regions.¹⁸ Furthermore, the province is also likely to suffer drought during the dry season, a similar situation to other northwestern provinces.

The water, agricultural and health sectors are most **vulnerable**. The increase in temperature will affect the surface evaporation rate, leading to a potential reduction in the rivers' flowrate and water source scarcity. Furthermore, subtropical crops will lose capacity and winter crops will become less important in the regions' agricultural sector. At a later future, the agricultural sector will likely require a shift in crop structure and plantation activity to adapt to higher temperatures. Costs of production will increase due to more frequent irrigation and the higher demand for water. Changing conditions may lead to the emergence of infectious and other diseases, particularly during the months of summer.¹⁹

¹⁸ Rentschler, J. et al. 2020

¹⁹ ISPNRE, 2009

Resulting climate risks: The combination of slow and rapid onset events represents a risk to riverine settlements and infrastructures in the B2 climatic zone. The increase of both drought and riverine flooding also puts at risk the agricultural sector and economic activities related to forestry, particularly for those areas prone to precipitation-related landslides. In the B2 region, heat and drought may endanger the remaining walnut and pine trees.²⁰ The province of Quang Minh requires particular attention, due to its especially high risk exposure.

Climate hazards, vulnerabilities and risks in the North Delta (B3)

The North Delta climatic zone, or B3, is a lowland and includes the provinces of Phu Tho, Vinh Phuc, Bac Giang, Bac Ninh, Ha Noi, Hai Phong, Hai Duong, Hung Yen, Ha Nam, Nam Dinh, Thai Binh, and Ninh Bin. Being less than 50 m above sea level and crossed by the Red River, this climatic zone is highly susceptible to the hazards of flooding, storm surge, and typhoons, as well as threatened by sea-level rise and salinization. Furthermore, some of the western provinces and coastal lines in B3 are affected by drought.²¹

The very high risk of **riverine and coastal flooding** represents the biggest climate hazard in B3 with its Red River Delta, as shown in Figure 11. The most exposed are the provinces of Ha Noi City, Ninh Binh, Nam Binh, Thai Binh, Hai Phong City, Ha Nam, and Hung Yen. Similar to the Mekong Delta in the south, this area of the Red River Delta will suffer from **rising sea levels** in combination with coastal sinkage due to, among others, dense urbanization and exhaustion of groundwater. **Salinity intrusion** in groundwater and soil will affect the B3 coastal provinces, especially the Thai Binh and Nam Binh provinces. In the Northern Delta, sea level rises at 0.5-0.6 cm annually. Furthermore, **coastal erosion** is likely to pressure infrastructure, trade, and industrial operations in these areas.²²

Typhoons are likely to hit the Northern coast with a higher intensity. Heavy rainfall originated from typhoons will create greater losses in the areas along the Red River.²³

Vulnerabilities: Especially **vulnerable** to high temperatures and heatwaves are those urban areas with low ventilation and low heat release. Together with Ho Chi Minh City, Hanoi is one of the urban areas with the highest threat of deadly heat globally. Especially vulnerable to drought are the western provinces of Than Hoa and Hoa Binh as well as the coastal provinces of Hai Phong City, Thai Binh, and Nam Binh. Especially vulnerable to flooding is the Red River Delta as a whole. Without additional coastal protection measures, the loss and damage caused by a once-in-a-century storm surge in the Red River by 2050 can incur costs totaling to 9 percent of Vietnam's GDP.²⁴ Apart from that, the agricultural sector will face higher production costs to the more frequent need of resilient and effective irrigation methods. The rise of sea level will increase the vulnerability of the coastal mangrove forests and threaten current coastal infrastructure and industries of the B3 climatic zone.²⁵ Mangrove forests in the Red River Delta, including the Quang Ninh province (B2), have more than halved since the 1940s, making the coast more vulnerable.²⁶

Resulting climate risks: The combination of the described multiple hazards and vulnerabilities puts almost the entire climate zone B3 at a high climate risk, that is projected to further grow in future. The mortality risk due multiple hazards in the B3 region are significantly rising.²⁷ The risk of asset and productivity loss is rising, too. Most at risk are the lowest lying riverine settlements, the most vulnerable population groups, paddy cultivation and the water sector. Hazard-exposed infrastructure is at high risk of premature value loss and material damages, too, including in urban areas.

²⁰ Mui, Nguyen Thi, 2003

²¹ <https://climateknowledgeportal.worldbank.org/country/vietnam/vulnerability> and IPONRE, 2009

²² ISPONRE, 2009

²³ WB-ADB Report + <https://climateknowledgeportal.worldbank.org/country/vietnam/vulnerability>

²⁴ ADB-WB Report

²⁵ ISPONRE, 2009

²⁶ Munárriz, M. 2016

²⁷ <https://preview.grid.unep.ch/index.php?preview=map&lang=eng>

Climate hazards, vulnerabilities and risks in the North Central (B4)

In terms of climate hazards, the North Central climatic zone B4 with the provinces Thanh Hoa, Nghe An, Ha Tinh, Quang Binh, Quang Tri, and Thua Thien–Hue with an average altitude up to 100m is mainly affected by drought, typhoon, flood, and, in certain areas, precipitation-triggered landslides. The North Central region is also affected by the impacts of sea level rise.

With a projected increase in temperature and hot days, **drought** will become a major hazard in most parts of the B4 climatic zone (Figure 11), with dry spells projected to further increase in terms of frequency and duration. **Riverine and flash floods** will occur more often and more frequently due to increasing changes in precipitation and the very high risk to tropical typhoons. **Typhoon foothills** can potentially affect the entire climatic zone, but especially the provinces of between Thanh Hoa and Quang Binh (Figure 12).

Geographically most exposed to flooding are the provinces of Thanh Hoa, Nghe An, and Ha Tinh. Exposure to **precipitation-triggered landslide** is highest in the province of Quang Binh. In terms of **sectoral vulnerability**, agriculture and coastal infrastructure suffer the highest economic losses from typhoons. Agriculture is also very vulnerable to riverine and flash floods, particularly during summer floods.²⁸ Long periods of heavy rain lead to floods in downstream areas such as Thua Thien-Hue, 30 percent of which occur during May and June and are short, normally lasting one to three days.²⁹

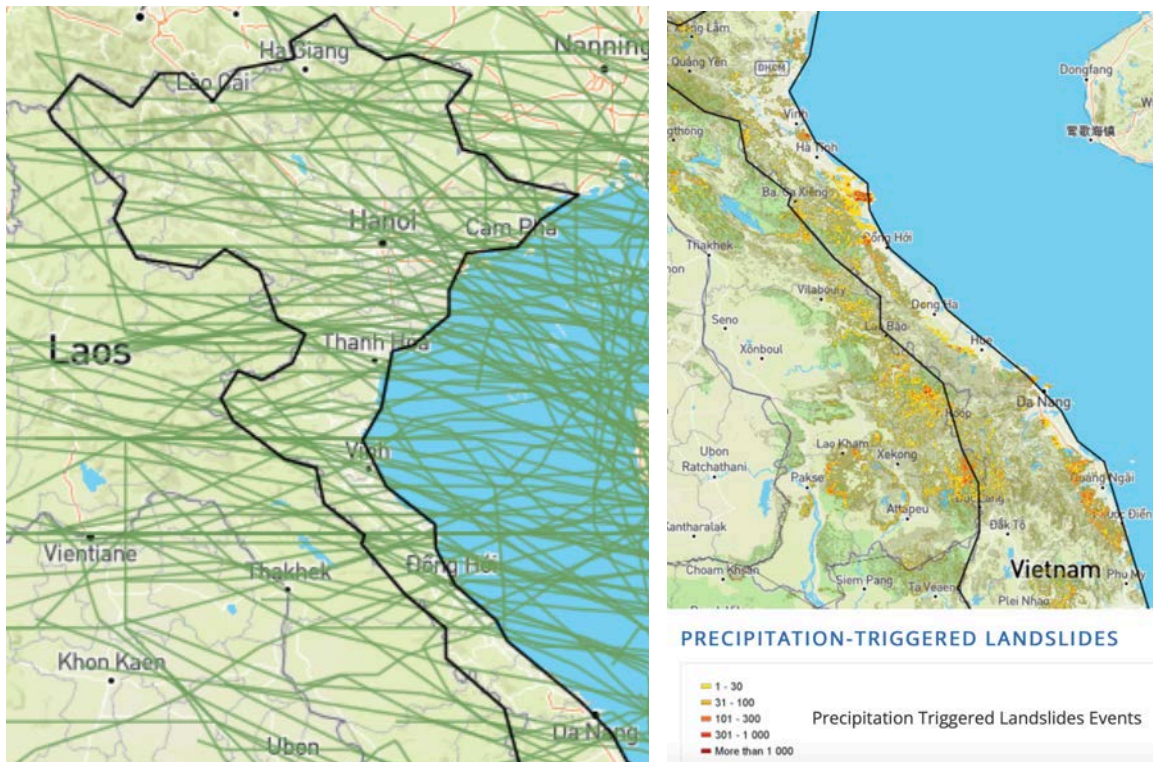


Figure 12: Typhoon tracks (1969-2009) and precipitation-triggered landslides in the northern regions of Vietnam. Source: <https://climateknowledgeportal.worldbank.org/country/vietnam/vulnerability>

Resulting climate risks: Drought and flood events, typhoons and precipitation-triggered landslides put the population in B4 at risk to suffer from climate-induced loss and damage. The agricultural sector and coastal settlements and infrastructure are at the highest risk. Northern wet forests and coastal bamboo and mangrove forests are at risk, too, due to increasing temperatures, salinity, and sea-level rise (Mui, 2003)³⁰. With regard to heatwaves, elderly people, others with pre-existing vulnerabilities, and outdoor workers are most at risk.

²⁸ Shaw, 2006

²⁹ Ibid

³⁰ Mui, Nguyen Thi, 2003

The Climate of South Vietnam

The three climatic zones of South Vietnam

According to the Vietnam Assessment Report on Climate Change (ISPONRE 2009), South Vietnam is divided in three climatic zones: South Central (N1), Central Highlands (N2) and South of Vietnam (N3). All three climate zones are characterized by a humid tropical monsoon climate but with certain variations regarding temperature, the length of the rainy season and the months with the highest rainfall.

The **South Central climatic zone (N1)** includes Da Nang city and Quang Nam, Quang Ngai, Binh Dinh, Phu Yen, Khanh Hoa, Ninh Thuan and Binh Thuan provinces. The zone lies in the lowlands (maximum 100 m altitude). The winter is warm and sunny while the summer is hot and relatively dry, especially in Da Nang city with dry west winds and a Mediterranean climate, according to the Koeppen-Geiger Climate Classification.³¹ The rainy season is between August and December, with highest rainfall between September and November. The average annual temperature is 25-27°C (28.5-30°C in the hottest and 20-24°C in the coldest month). Average annual rainfall amounts to 1200-2000mm. 2-4 months have precipitation rates below 50mm.

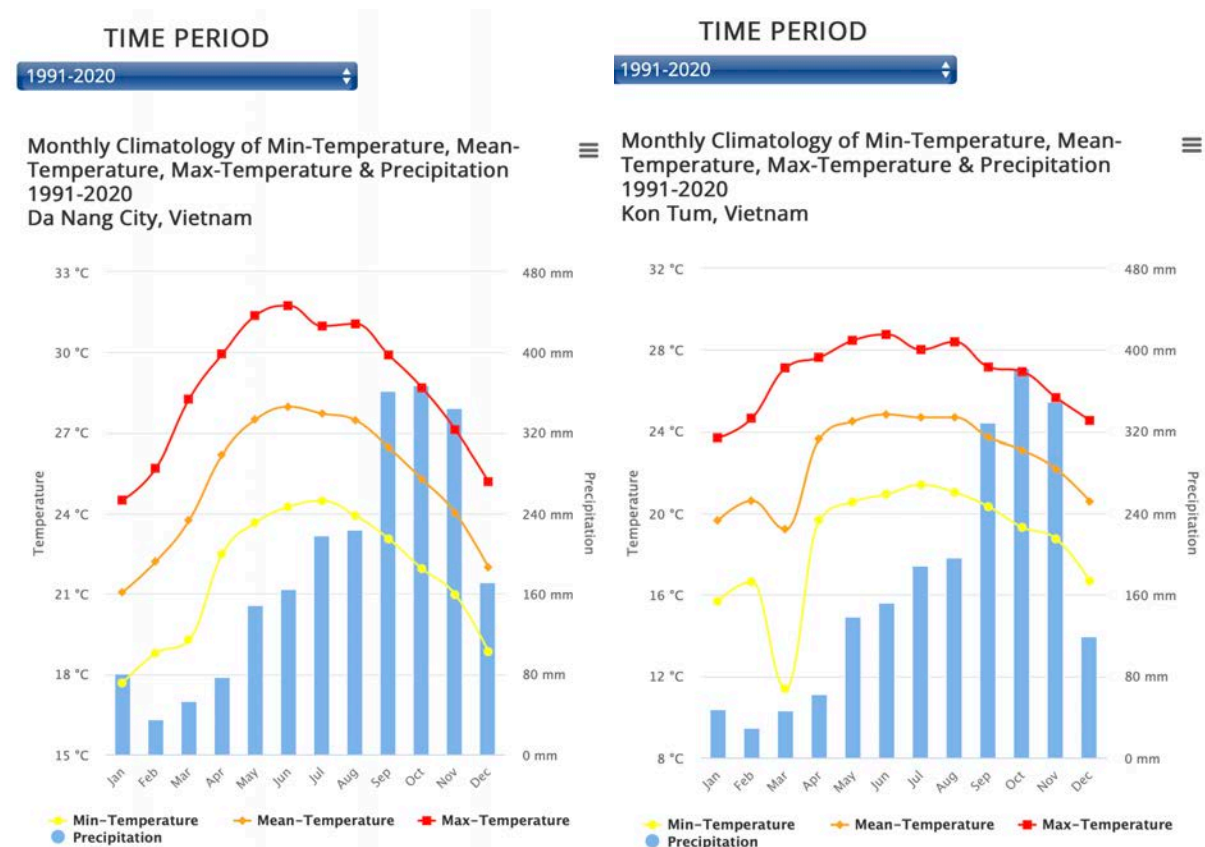


Figure 13: Climate diagrams of Da Nang City (N1) and Kon Tum (N2). Source: <https://climateknowledgeportal.worldbank.org/country/vietnam/climate-data-historical>.

The **climatic zone of the Central Highlands (N2)** includes Kon Tum, Gia Lai, Dak Lak, Dak Nong and Lam Dong province (100 – 800 m average altitude, mountains up to 2600m). The winter is quite dry and relatively cold as compared to N1 and N3 because of the altitude, while the summer is very rainy. The driest 3-5 months with rainfall below 50mm are in late winter and spring. The rainy seasons goes from May to October, with July to September as the wettest months. Annual average rainfall varies from

³¹ The climate classification for South Vietnam according to Köppen-Geiger you find here: <https://climateknowledgeportal.worldbank.org/country/vietnam>

1400 – 2000mm. Annual average temperature is of about 21-24°C (24-28°C in the hottest and 19-21°C in the coldest month, with absolute minimum temperatures of about 3-9°C).

The **climatic zone South of Vietnam (N3)** (less than 50 m above sea level) is formed by Binh Phuoc, Dong Nai, Ba Ria-Vung Tau, Binh Duong, Tay Vinh, Long An, Ca Mau, Kien Giang, Tien Giang, Ben Tre, Tra Vinh, Vinh Long, Dong Thap, Soc Trang, Hau Giang, An Giang and Bac Lieu provinces, Ho Chi Minh City and Can Tho city.

The South of Vietnam is characterized by high temperatures throughout all the year, most sunlight hours of all the country, a relatively long dry period from middle winter to early summer, and a quite rainy summer (May – October), with most rainfall in August – October. Mean annual temperature is 26.5 – 27.5°C (28 – 29°C in the hottest and 24 – 26°C in the coldest month) Absolute minimum temperatures are with 14-18°C the by far highest of Vietnam, while the absolute maximum temperatures are with 38-40°C slightly below those of the North Central and South Central climatic zones. Average annual rainfall is very high, too: 1600-2000mm.

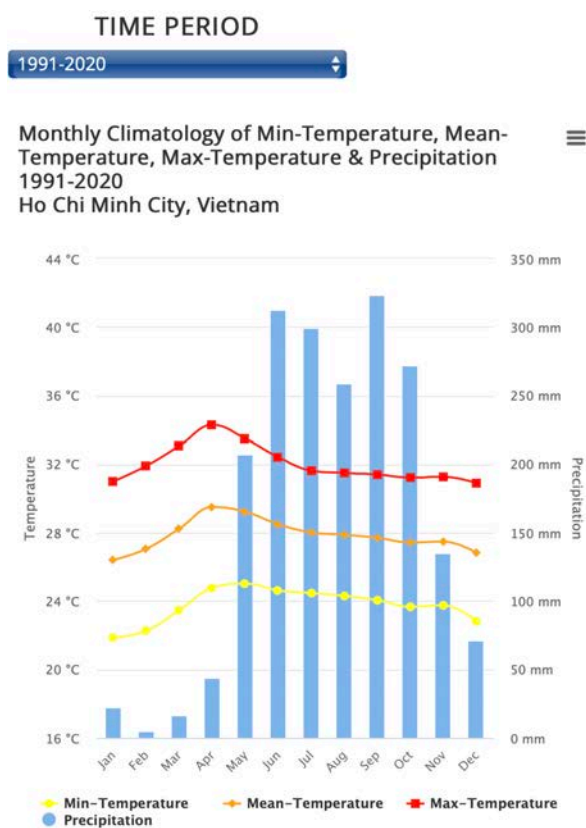


Figure 14: Climate diagram of HCMC (N3). Source: <https://climateknowledgeportal.worldbank.org/country/vietnam/climate-data-historical>

Key trends of observed climate change

Between 1960 and 2020, mean annual temperature has increased by 0.97°C in Da Nang City, 0.95°C in Kon Tum, and 0.88°C in HCMC.³² Warming has significantly increased since the 1980es, with approximately 0.26°C per decade, which is almost twice the rate of global warming.³³ Temperature increase in winter is higher as in summer and maximum as well as minimum temperatures increase faster as

³² <https://climateknowledgeportal.worldbank.org/country/vietnam/climate-data-historical>

³³ Nguyen, D. Q., Renwick, J., & McGregor, J. (2014). Variations of surface temperature and rainfall in Vietnam from 1971 to 2010. *International Journal of Climatology*: 34: 249–264.

mean temperature, leading to significantly more hot days and less cold days. Changes in mean annual rainfall are less significant, with slight decrease in N3 and slight increase in N1 and N2 (ibid).

Climate projections for the South Central climatic zone (N1)

In Da Nang City, mean temperature increase as compared to 2014 would increase by 2030 by around 0.5°C and by 2040 in a range between 0.62 – 0.98°C (best- and worst-case scenarios). By 2060, the temperature increase would remain almost the same in case of a sustainability pathway, with net zero emissions by 2050 globally, while temperature increase as compared to 2013 would already be at 1.7°C in the worst-case scenario. In this scenario, in 2100, average temperature in Da Nang City would be 3.7°C higher as in 2013. In the middle-or-the-road scenario, temperature would still be 1,71°C higher as in 2013, while the increase in the best-case scenario would be limited to 0.7°C.

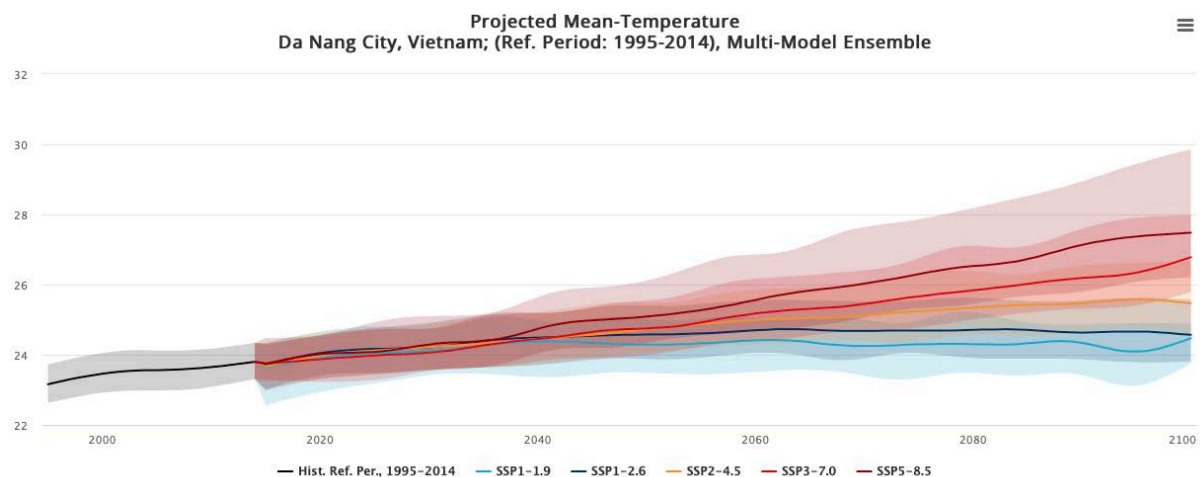


Figure 15: Projected mean temperature in Da Nang City in 2020 – 2100 in different emission pathway scenarios. Source: <https://climateknowledgeportal.worldbank.org/country/vietnam/climate-data-projections>

Annual mean minimum and maximum temperatures are projected to increase in a quite similar order as the average temperature. Particularly notable is the projected steep increase of the number of very hot days, i.e. maximum temperature above 35°C from 2,5 days in 2013 to 14 days in 2040 and 76 days in 2100 in the worst-case scenario, while this increase could be limited to 5 days in a scenario with immediate and massive emission reduction and at least halved to 21 days in a middle-of-the-road scenario (ibid). Changes in precipitation are much more difficult to model. Annual precipitation changes forecasted are statistically not significant in none of the scenarios (ibid) but there seems to be an on-going trend of drier late winter to early summer and a wetter November.

Climate projections for the Central Highlands (N2)

In Kon Tum province, mean temperature increase as compared to 2014 would increase by 2030 by around 0.4°C and by 2040 in a range between 0.58 – 0.98°C (best- and worst-case scenarios). By 2060, the temperature increase would remain almost the same in case of a sustainability pathway, with net zero emissions by 2050 globally, while temperature increase as compared to 2013 would already be at 1.87°C in the worst-case scenario. In this scenario, in 2100, average temperature in Kon Tum province would be 3.88°C higher as in 2013. In the middle-or-the-road scenario, temperature would still be 1,82°C higher as in 2013, while the increase in the best-case scenario would be limited to 0.6°C.

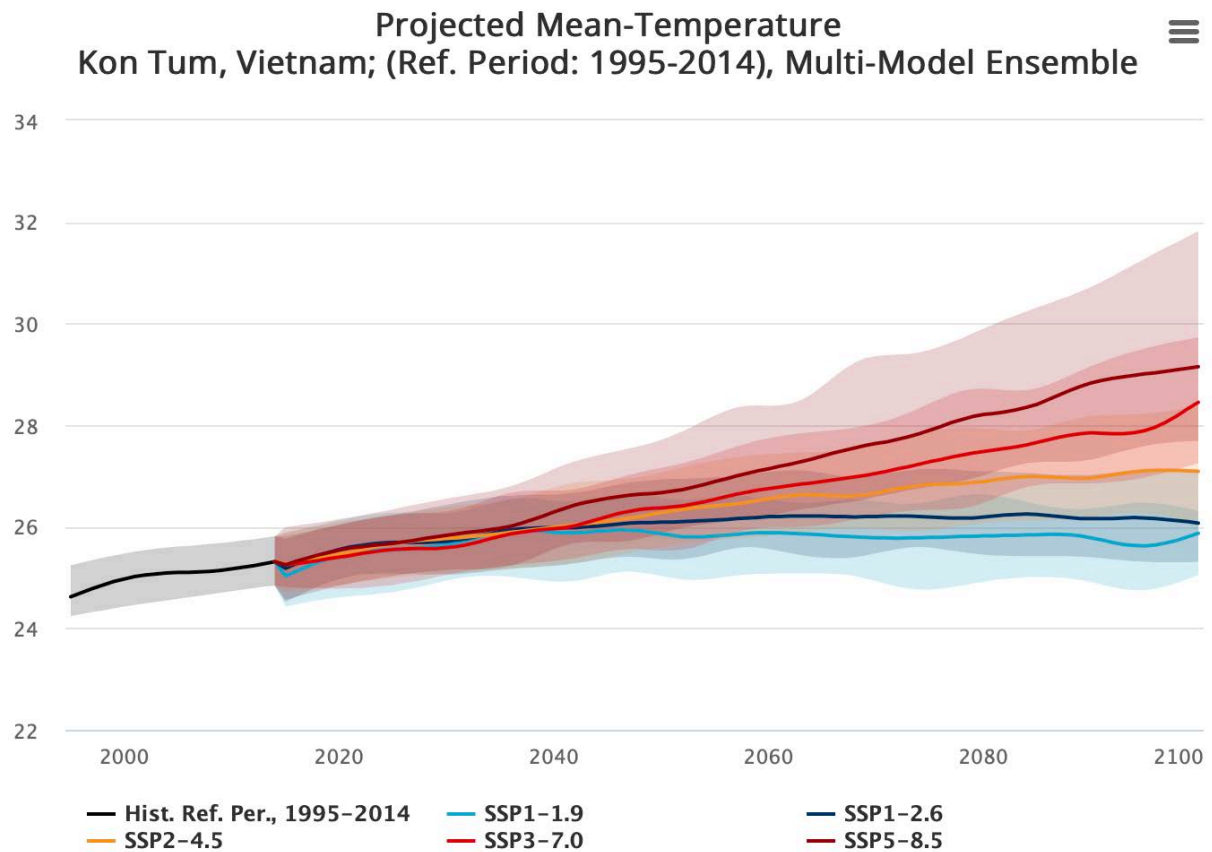


Figure 16: Projected mean temperature in Kon Tum province in 2020 – 2100 in different emission pathway scenarios. Source: <https://climateknowledgeportal.worldbank.org/country/vietnam/climate-data-projections>

Annual mean minimum and maximum temperatures are projected to increase in a quite similar order as the average temperature. Particularly notable is the projected steep increase of the number of very hot days, i.e. maximum temperature above 35°C from 27.7 days in 2013 to 44.3 days in 2040 and 118.6 days in 2100 in the worst-case scenario, while this increase could be limited to 27.5 days in a scenario with immediate and massive emission reduction and at least more than halved to 55.8 days in a middle-of-the-road scenario (Ibid). Changes in precipitation are much more difficult to model. Annual precipitation changes forecasted are statistically not significant in none of the scenarios (Ibid) but there seems to be an ongoing trend of drier late winter to early summer and a slightly wetter July.

Climate projections for South of Vietnam (N3)

In HCMC, mean temperature increase as compared to 2014 would increase by 2030 by around 0.4°C and by 2040 in a range between 0.48 – 0.89°C (best- and worst-case scenarios). By 2060, the temperature increase would remain almost the same in case of a sustainability pathway, with net zero emissions by 2050 globally, while temperature increase as compared to 2013 would already be at 1.71°C in the worst-case scenario. In this scenario, in 2100, average temperature in Ho Chi Minh City would be 3.57°C higher as in 2013. In the middle-or-the-road scenario, temperature would still be 1.72°C higher as in 2013, while the increase in the best-case scenario would be limited to 0.51°C

Projected Mean-Temperature Ho Chi Minh City, Vietnam; (Ref. Period: 1995-2014), Multi-Model Ensemble

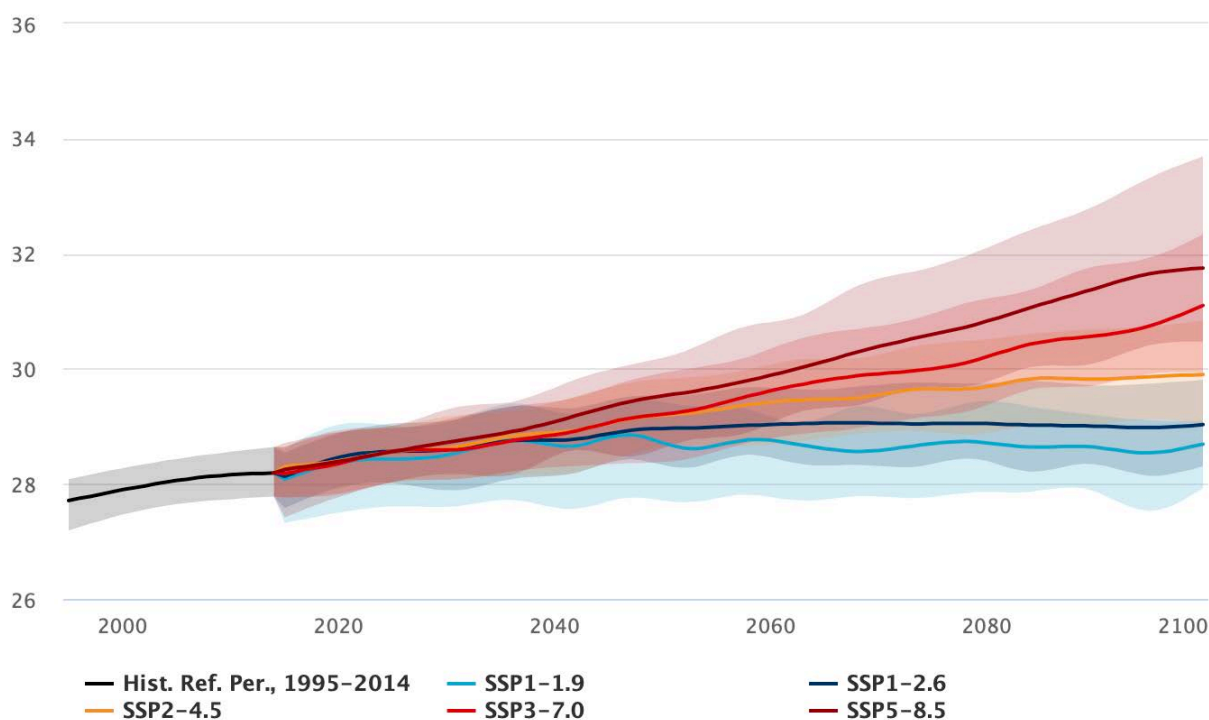


Figure 16: Projected mean temperature in Ho Chi Minh City in 2020 – 2100 in different emission pathway scenarios. Source: <https://climateknowledgeportal.worldbank.org/country/vietnam/climate-data-projections>

Annual mean minimum and maximum temperatures are projected to increase in a quite similar order as the average temperature. Particularly notable is the projected steep increase of the number of very hot days, i.e. maximum temperature above 35°C from 25.4 days in 2013 to 55.2 days in 2040 and 199.2 days in 2100 in the worst-case scenario, while this increase could be limited to 48.5 days in a scenario with immediate and massive emission reduction and at least more than halved to 87.2 days in a middle-of-the-road scenario (Ibid). Changes in precipitation are much more difficult to model. Annual precipitation changes forecasted are statistically not significant in none of the scenarios (Ibid) but there seems to be an ongoing trend of slightly drier early summer (March and April) and a slightly wetter summer (June until August).

Climate hazards, vulnerabilities and risks in the South Central climatic zone (N1)

The main climate hazards in the lowland (<100m) South Central climate zone, composed by the coastal provinces Da Nang city, Quang Nam, Quang Ngai, Binh Dinh, Phu Yen, Khanh Hoa, Ninh Thuan and Binh Thuan provinces, are typhoon, flood, heat wave and precipitation-triggered landslides. Apart from these sudden onset extreme events, sea level rise and salinity intrusion are the most important slow onset climate hazards.

Almost the entire zone, but especially the northern and central parts are susceptible to **typhoons**.³⁴ According to climate projections, it is likely that in future more severe typhoons will occur in this region, while the total number of typhoons may even go down. Thus, the typhoon hazard is expected to increase in magnitude, not in frequency.³⁵ A stronger fluctuation of the stormy season is also likely.³⁶

³⁴ <https://climateknowledgeportal.worldbank.org/country/vietnam/vulnerability>

³⁵ ADB/World Bank, 2020

³⁶ ISPONRE, 2009

The risk of **coastal and particularly riverine flooding** along the along the main rivers and their tributaries is another severe hazard and it is projected to increase with rising temperatures: In this case, the ENSO³⁷ is likely to leading to more extreme rainfall events to N1. The most flood-prone areas and river and river systems are the coastal region between Da Nang and Quang Ngai, Binh Dinh province, Son Ky Lu river and all rivers in Khanh Hoa and Ninh Thuan province. Da Nang is also exposed to storm surges.³⁸ **Precipitation-triggered landslides** occur especially on steep slopes between Da Nang and Quang Ngai, and may increase in frequency if more extreme rainfall events occur.³⁹

Heat waves are likely to increase in terms of both, magnitude and frequency, especially in the northern part of N1, between Da Nang city and Binh Dinh province. Hottest month are April to June.⁴⁰

Sea level rise of 0.5m would especially affect Phan Rang Thúp Chàm and the coastline between Nha Trang and Binh Thuan. In the second part of the century, with higher sea levels, increasingly more parts of the coastline of the South Central climate zone will be affected.⁴¹

In terms of **vulnerabilities**, higher temperatures in combination with higher evaporation and potentially scarcer water sources in the dry season will negatively affect agriculture, which needs to adapt to these changing conditions in terms of crop varieties and planting seasons. Costs of production are likely to increase, because of the need of more irrigation. Mangrove forests come under pressure with rising sea levels, leading to higher coastal erosion and increased pressure on sea life, which in turn leads to adaptation needs of coastal fisherfolk and other people depending on mangrove forests. Rising sea levels also shrink availability of land, put at risk coastal infrastructure and settlements, and lead to the need of investments in coastal protection and defence. Stronger typhoons also enhance vulnerability of coastal population settlements, infrastructure and livelihoods. Higher temperatures, less available water, and more heatwaves enhances stress to life, leads to more vector-borne diseases and pests, and puts at risk elderly people and other people with pre-existing vulnerabilities, leading to more cardiovascular or respiratory diseases, lower work productivity (especially for outdoor activities), and more diarrhoeal diseases, among others.⁴²

Resulting climate risks: The combination of hazards makes coastal settlements and settlements and infrastructures along flood-prone rivers particularly vulnerable in N1. Most at risk population groups are elderly people and other people with pre-existing vulnerabilities. Most at risk economic sectors are agriculture and fisheries.

Climate hazards, vulnerabilities and risks in the Central Highlands (N2)

The climate zone N2, the Central Highlands, cover the provinces Kon Tum, Gia Lai, Dak Lak, Dak Nong and Lam Dong in an altitude of 100 to 800m. The main climate hazard is riverine flooding, followed by heat waves, typhoon foothills, dry spells and, in certain areas, precipitation-triggered landslides. Altogether, the Central Highlands are significantly less climate hazard-prone as to the South Central climate zone, not to mention the South of Vietnam.⁴³

Riverine flooding can occur along all river systems. They are slightly stronger in the central and the southern part of N2, compared to its northern part. **Flash floods** can occur locally, too, especially during the monsoon. According to projections, this risk may increase slightly in future. **Precipitation-triggered landslide risks** are highest between Kong Tum and Kong Chro, but apparently only low to

³⁷ El Niño-Southern Oscillation (ENSO) is a recurring climate pattern involving changes in the temperature of waters in the Pacific Ocean and leading to more extreme rainfall events and more drought events.

³⁸ <https://climateknowledgeportal.worldbank.org/country/vietnam/vulnerability>

³⁹ Ibid.

⁴⁰ <https://climateknowledgeportal.worldbank.org/country/vietnam/climate-data-projections>

⁴¹ https://ss2.climatecentral.org/#9/12.3856/109.0517?show=satellite&projections=0-K14_RCP85-SLR&level=0.5&unit=meters&pois=hide

⁴² ISPONRE, 2009

⁴³ <https://climateknowledgeportal.worldbank.org/country/vietnam/vulnerability> and ISPONRE, 2009

moderate in most other parts of the Central Highlands. **Typhoon foothills** can affect the entire zone, but especially its central part. If the severity of typhoons increases, typhoons may become much more damaging in the Central Highlands. **Heatwaves** are a serious climate hazard today, and their appearance is projected to strongly increase, exposing the zone to a significant hit risk. Droughts do not occur, but prolonged **dry spells** do, and they are likely to increase, especially between winter and early summer. This is an effect of higher evaporation and more volatile rainfall. Being far away from the sea, sea level rise will not affect the Central Highlands, not even indirectly.⁴⁴

In terms of **vulnerabilities**, the described changes will become stressors for agriculture in particular. Water availability could become a limiting factor outside the rainy season, while during the rainy season, too much water could become a problem, especially in middle stream and downstream areas of the river basins. This is likely to result in lower yields and/or higher adaptation costs in agriculture. A considerable part of the tropical forests in Central Highlands is predicted to come under severe heat stress, leading to a loss of pine, pomu wood and cold-favouring plants. These forests may come under stress to be replaced by tropical cash crops, which will find more favourable temperatures as today. Higher temperatures will also lead to more vector-borne diseases and pests, affecting humans, livestock and crops. In this regard, adaptation is required, too. The even steeper increase of heat waves with its particular risks for elderly and sick people, but also outdoor workers, needs to be taken seriously into account, as already explained for the previous zones.⁴⁵

Resulting climate risks: The combination of hazards makes settlements and infrastructures along flood-prone rivers particularly vulnerable in N2. Most at risk population groups are elderly people and other people with pre-existing vulnerabilities. Most at risk economic sectors are agriculture and forestry, but also the building sector, due to heat.

Climate hazards, vulnerabilities and risks in the South of Vietnam (N3)

The deltaic South of Vietnam (N3) is less than 50 m above sea level and dominated by the Mekong river. N3 covers the provinces Binh Phuoc, Dong Nai, Ba Ria-Vung Tau, Binh Duong, Tay Vinh, Long An, Ca Mau, Kien Giang, Tien Giang, Ben Tre, Tra Vinh, Vinh Long, Dong Thap, Soc Trang, Hau Giang, An Giang and Bac Lieu, as well as Ho Chi Minh City and Can Tho city. Floods, sea level rise, salinity intrusion, heat waves and storm surge are the main climate hazards in the South of Vietnam, the climate zone of Vietnam with the highest and broadest hazard exposure.⁴⁶

⁴⁴ Ibid

⁴⁵ ISPONRE, 2009

⁴⁶ <https://climateknowledgeportal.worldbank.org/country/vietnam/vulnerability> and ISPONRE, 2009

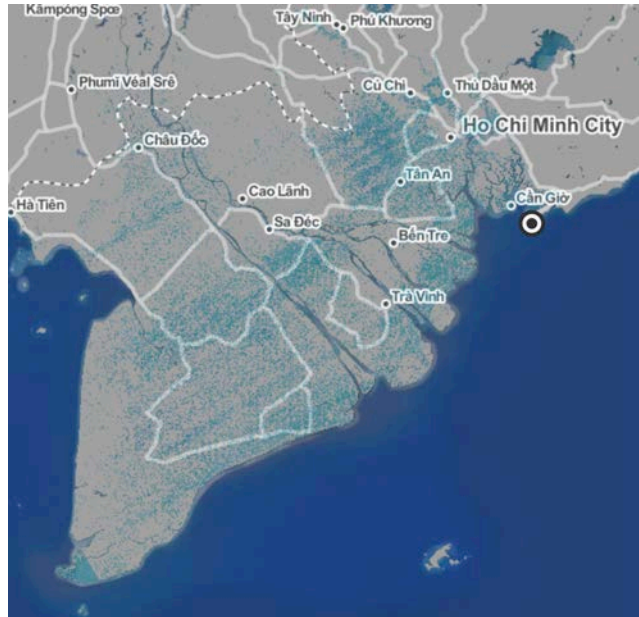


Figure 17 on the left: Flood risk map of the three southern climatic sub-zones of Vietnam. Source: <https://climateknowledgeportal.worldbank.org/country/vietnam/vulnerability>

Figure 18 on the right: Simulation of flooded areas in the South of Vietnam at 1m of sea level rise (upper end of the worst case projection for the year 2100. Source: https://ss2.climatecentral.org/#8/9.571/105.672?show=satellite&projections=0-K14_RCP85-SLR&level=1&unit=meters&pois=hide

As shown in the figure at the left, **riverine and coastal flooding**, but also **flash floods**, are a major risk in almost the entire Mekong delta. With highly fluctuating river levels because of more extreme rainfall events in combination with drought in the upstream Mekong river basin, but also due to hydro-engineering measures further upstream on the Mekong, rising sea levels (see figure on the right), in combination with sinking coastal land caused by groundwater depletion, river erosion, sand mining, soil sealing and the high pressure on the soil in densely built-up urban areas, these problems are projected to become more and more hazardous in decades to come. **Salinity intrusion** in groundwater and soils is another related hazard in the Mekong delta, going hand in hand with the aforementioned hazards. Storm surges are another hazard for parts of the delta, i.e. HCMC and the arms of the Mekong from its mouth upwards to My Tho, Vinh Long and Can Tho.⁴⁷

High temperatures during most of the year and a large number of hot days and **heatwaves** is already today a strong climate hazard, especially in cities with little shadow, low ventilation and a dense building development that stores heat. Temperatures and heat waves will further increase. Ho Chi Minh City is among the urban areas most threatened by deadly heat globally.⁴⁸

In terms of **vulnerabilities**, coastal settlements and cities, including HCMC, settlements along the rivers, and agriculture are most vulnerable to the climate hazards because of their high exposure to climate hazards, be it physically, geographically, or socio-economically. Agriculture, in particular rice cultivation, but also shrimp cultivation and fisheries are highly exposed to the aforementioned climate hazards. Sweetwater availability will become increasingly vulnerable, too. to these hazards, too. Without high investments in coastal protection (e.g. embankments, sluices, pumping stations, mangrove forests, etc.), infrastructure and building may face severe asset loss and damages. Power stations and hydropower may become vulnerable to changing climate conditions with more climate extremes, too.

⁴⁷ Ibid.

⁴⁸ Mathews et al, 2017

As explained earlier, higher temperatures will also lead to more vector-borne diseases and pests, affecting humans, livestock and crops. Cities like HCMC need specific adaptation measures to reduce heat stress, which is particularly high in cities if they become urban heat islands, due to a lack of cooling parks, waterbodies, wind breaks etc. In highly industrialised urban areas like HCMC, the negative effects of heat stress on productivity could become quite significant, apart from additional health risks for elderly and sick people.⁴⁹

Resulting climate risks: The combination of the described multiple hazards and vulnerabilities puts almost the entire climate zone N3 at a high climate risk, that is projected to further grow in future. Particularly at risk are coastal settlements and cities, especially HCMC. Settlements along the Mekong are also at high risk exposure, as well as other very low lying areas (less than 2 m above sea level). The agriculture, aquaculture and the water sector are the most risk-prone economic sectors. Most at risk population groups are elderly people and other people with pre-existing vulnerabilities.

Building Climate Resilience – Basic Terms and Adaptation Options for Vietnam

Climate change adaptation is an adjustment in natural or human systems in response to current or expected climate stimuli or their effects.

Climate disaster risk management is a systematic process of implementing policies, strategies and measures to reduce the impacts of natural hazards and related environmental and technological disasters. This includes, among other things, disaster risk reduction, preparedness, response, recovery and rehabilitation.

Climate proofing is an approach to identify, address and minimise project-related climate risks.

Climate resilience is defined as the capacity of a socio-ecological system (1) to absorb stresses and maintain function in the face of external stresses imposed upon climate change, and (2) adapt, re-organise and evolve into more desirable configurations that improve the sustainability of the system, leaving it better prepared for future climate change impacts.

Climate risk assessment is a methodology to determine the nature and extent of risk by both analysing hazards and their potential likelihood and intensity and estimating impacts through the evaluation of conditions of vulnerability and the identification of exposed people, property, infrastructure, services, livelihoods and their environment.

Disaster risk refers to the potential disaster losses of sudden or slow-onset events in lives, health, livelihoods, assets and services which could be incurred by a particular community or a society over some specified future time period. Disaster risk is a function of hazard, exposure, vulnerability and capacity.

Disaster risk reduction: The concept and practice of reducing disaster risks through systematic efforts to analyse and manage the causal factors of disasters, including through reduced exposure to hazards, lessened vulnerability of people and property, wise management of land and the environment, and improved preparedness for adverse events.

Gender sensitivity and gender responsiveness: A gender-sensitive programme considers gendered norms, roles and inequalities and has an awareness of these issues. However, in gender-sensitive programmes, appropriate solutions or actions might not be taken. This is the case for gender-responsive programmes that actively work to address and change inequalities.

⁴⁹ ISPONRE, 2009. ADP/World Bank, 2017.

Hazard: A dangerous phenomenon, substance, human activity or condition that may cause loss of life, injury or other health impacts, property damage, loss of livelihoods and services, social and economic disruption, or environmental damage.

The **National Adaptation Plan (NAP)** process was established under the UNFCCC helping countries conduct medium- and long-term climate adaptation planning. It is a flexible programme that builds on each country’s existing adaptation programmes and actions, and helps to align adaptation with other national policies.

Nationally Determined Contributions (NDCs) are the pledges of climate action (adaptation and mitigation) of State Parties to the UNFCCC under the Paris Agreement.

Vulnerability: The characteristics and circumstances of a community, system or asset that make it susceptible to the damaging effects of a hazard and, hence, disaster. There are many aspects of vulnerability, arising from physical, social, economic and environmental factors.

If a project or program is categorized in the climate proofing process as being exposed to climate risks, a climate risk assessment should be done, to fully understand the risks. Based on the results of this diagnosis, a risk reduction and adaptation plan should be developed to avert or minimize the risk. Adaptation plans typically show how the climate impact chain leading to negative impacts on the project can be modified in such a way by taking adaptation measures that risks are minimized.

The following list shows a sample of possible adaptation options for sectors that are at risk:

Sector	Adaptation options	Sources for practical information
Agriculture	Drought-/heat tolerant varieties (Drip water) irrigation (Drought) Vertical gardening (salinity) Floating gardens (flood) Erosion control (landslides) Changing cropping patterns Agroecological pest control	https://climateportal.cdbbd.org/solution-navigator/ https://www.adaptationcommunity.net/agroecology/
Forestry	Afforestation/reforestation Resilient plant & tree species Sustainable forest management /Agroforestry	https://worldagroforestry.org
Coastal zones	Build typhoon shelters Mangrove reforestation Resilient aquaculture Early warning systems	https://www.adaptation-undp.org/undp-helps-vietnam’s-coastal-communities-adapt-climate-change https://www.giz.de/en/worldwide/18661.html
Settlements	Flood-/storm-proof houses Stormwater management Natural shade & ventilation	https://www.unep.org/news-and-stories/story/5-ways-make-buildings-climate-change-resilient http://bengaluru.urbanwaters.in/about-the-million-wells-campaign/
Energy	Climate resilient infrastructure Decentralized energy systems	https://climateportal.cdbbd.org/solution-navigator/

Vietnam’s key adaptation policies and reports can be found here: <https://climateknowledgeportal.worldbank.org/country/vietnam/adaptation> .

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Climate data for Vietnam:

[Data on Average Monthly Temperature and Rainfall in Vietnam \(1901-2015\)](#)

[Tutiempo.net](#): Climate information of provinces’ climate since 1950: Temperature, precipitation, wind speed, and annual days with rain, storm, snow, hail, tornado, and fog.

[PSMSL – Permanent Service for Mean Sea Level](#): Access to global sea level monitoring stations. Free and accessible data from 1960 until 2015.

[Climate Change Knowledge Portal](#) of the World Bank: Observed and predicted temperature and precipitation for years 1930-2020 and 2020-2099 respectively. Downloadable and free databases.

[National Centre for Hydro-Meteorological Forecasting](#): Division of eight areas affected by storms in the territory of Vietnam. Good figures on storm impacts on Vietnam with data between 1961-2014

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