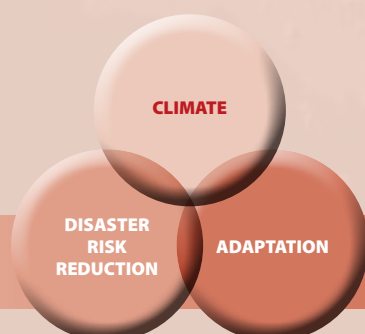


Vulnerability, Risk Reduction, and Adaptation to Climate Change

VIETNAM



GFDRR
Global Facility for Disaster Reduction and Recovery



COUNTRY OVERVIEW

Vietnam, located in Southeast Asia, has been ranked as one of the best-performing economies in the world over the past decade. Its economy has proven resilient to economic and other shocks; real GDP grew by an average of 7.3% per year over 1995-2005; the share of industry rose from 29% to 41% of GDP over the same period; and per capita income rose from US\$ 260 in 1995 to US\$ 835 in 2007.¹ Vietnam has made rapid progress in achieving several of the targets of the Millennium Development Goals, although poverty reduction is progressing at a slower pace for the country's ethnic minorities.² The relative contribution of agriculture, forestry, and fishing has declined in recent years due to the rapid growth of the industry and service sectors; however, they still contribute 21% of GDP³ and employ over 47% of the country's labor force.⁴ Rice production has a particularly vital role for the country in terms of food security, rural employment and foreign exchange, employing two-thirds of the rural labor force and positioning Vietnam as the world's second-largest rice exporter.⁵ The two most important rice-growing areas are the deltas of the Mekong and Red River.

Vietnam's long coastline, geographic location, and diverse topography and climates contribute to its being one of the most hazard-prone countries of the Asia-Pacific region, with storms and flooding, in particular, responsible for economic and human losses. Given that a high proportion of the country's population and economic assets (including irrigated agriculture) are located in coastal lowlands and deltas, Vietnam has been ranked among the five countries likely to be most affected by climate change.⁶

PRIORITY ADAPTATION MEASURES

Key Sectors⁷

Water resources

Coastal zones and aquaculture

Agriculture

Energy and transportation

Forestry

Human health

Vietnam ratified the United Nations Framework Convention on Climate Change (UNFCCC) in 1994, and the Kyoto Protocol in 2002. In 2010, it submitted to the UNFCCC its Second National Communication on Climate Change, which identifies the following vulnerable sectors and approaches that are needed to cope with the impacts of climate change:

➔ **Water resources:** Plan for the sustainable development of water resources in river basins; prioritize the review of existing and new reservoirs, dams, and dykes for incorporation of climate change concerns.

➔ **Coastal zones:** Apply a three-pronged approach that involves coastal protection measures (e.g., construction of dykes and pumping stations, protection and restoration of mangroves and urban wetlands), non-structural adaptation (e.g., building the resilience of poor communities in flood-prone areas), and, in cases where the former two approaches are not feasible, withdrawal.

¹Vietnam Country Overview, World Bank:

<http://siteresources.worldbank.org/INTVIETNAM/Resources/VietnamCountryOverview.pdf>

² Vietnam Development report 2007, World Bank Report No. 38064-VN.

³ FAO Vietnam Country Profile: <http://www.fao.org/countries/55528/en/vnm/>

⁴ Vietnam Employment Trends 2010, ILO (2011).

⁵ Impacts of Climate Change on Agriculture and Policy Options for Adaptation: The Case of Vietnam, IFPRI Discussion Paper 01015 (2010).

⁶ GFDRR Country Profile for Vietnam.

⁷ Vietnam's Second National Communication to the UNFCCC. Socialist Republic of Vietnam (2010).

- ➔ **Agriculture:** Short-term measures include erosion control, construction of reservoirs, crop selection, and farming methods that are better suited to the changing climate. Long-term measures include switching cropping patterns, crossbreeding, and modernizing cultivation techniques. Management and planning solutions are also needed for the development of new crop-livestock systems, designing new agricultural incentive systems, and setting up insurance policies.
- ➔ **Forestry:** Measures identified include the sustainable management of forests, research and expanded coverage of drought and pest-resistant species, and measures to control and reduce forest fires.
- ➔ **Aquaculture:** Improved planning is needed for various eco-regions; species tolerant to higher water temperatures need to be cultivated, and improved capacity needs to be developed in aqua-farm management.
- ➔ **Energy and transportation:** Climate change needs to be mainstreamed into planning strategies on energy and transport, energy efficiency and conservation need to be enhanced, and improvements and reinforcements need to be made to energy and transportation infrastructure in vulnerable regions.
- ➔ **Human health:** Improved pollution standards and regulations are needed, the capacity of local health-care institutions needs to be built, timely weather and hazard forecasts and disease outbreak warnings are needed, and information on climate change and epidemics needs to be widely disseminated.

CLIMATE BASELINE AND CLIMATE FUTURE

CLIMATE BASELINE

Spanning 15 degrees of latitude, Vietnam hosts diverse climates across its land, with southern parts that are near the equator experiencing a tropical climate, and northern parts in the humid subtropics seeing greater seasonal variation.⁸ The country's topography is also varied, ranging from hills and mountains (100-1000 m) that cover three fourths of the terrain, to sedimentary deltas – heavily cultivated and populated fertile plains⁹ – of which the most important are the Bac Bo in the north, and the Nam Bo in the south, which correspond to the courses of the Red River and the Mekong River, respectively.¹⁰ In northern regions, average temperatures range from 22-27.5°C in summer to 15-20°C in winter, while southern areas have a narrower range of 28-29°C in summer to 26-27°C in winter.¹¹ Annual rainfall ranges from 700-5,000 mm, with northern areas generally receiving more than the south, and mountains playing an important local role in determining rainfall distribution.¹² The number of rainy days per year is highly variable, ranging from 60 to 200.¹³ Vietnam's 3,260 km coastline, located along

⁸ UNEP and IPONRE (2009) define 7 different climatic zones for the country, based on varying geographic conditions.

⁹ Vietnam's Second National Communication to the UNFCCC. Socialist Republic of Vietnam (2010).

¹⁰ FAO Aquastat Country Profile for Vietnam: http://www.fao.org/nr/water/aquastat/countries/viet_nam/index.stm

¹¹ UNDP Climate Change Country Profile – Vietnam:

http://country-profiles.geog.ox.ac.uk/UNDP_reports/Vietnam/Vietnam.hires.report.pdf

¹² Vietnam Assessment Report on Climate Change, UNEP and IPONRE (2009).

¹³ Vietnam's Second National Communication to the UNFCCC. Socialist Republic of Vietnam (2010).

the northwest Pacific Ocean typhoon route, exposes the country to an average of 7 typhoons per year, particularly the northern and central parts of the country.¹⁴

Flooding is the subject of monsoon dynamics, which bring heavy rainfall in the north and south from May-October, and in central regions from September-January. Given the country's high inter-annual variability of rainfall and rainy days, however, some regions that experience floods during rainy seasons can also experience drought during dry seasons. Vietnam's south central coast region frequently suffers from prolonged droughts. Inter-annual variations tend to be associated with the El-Nino Southern Oscillation, which is believed to influence monsoon behavior, resulting in drier and warmer than average conditions in Southeast Asia during El-Nino years.¹⁵

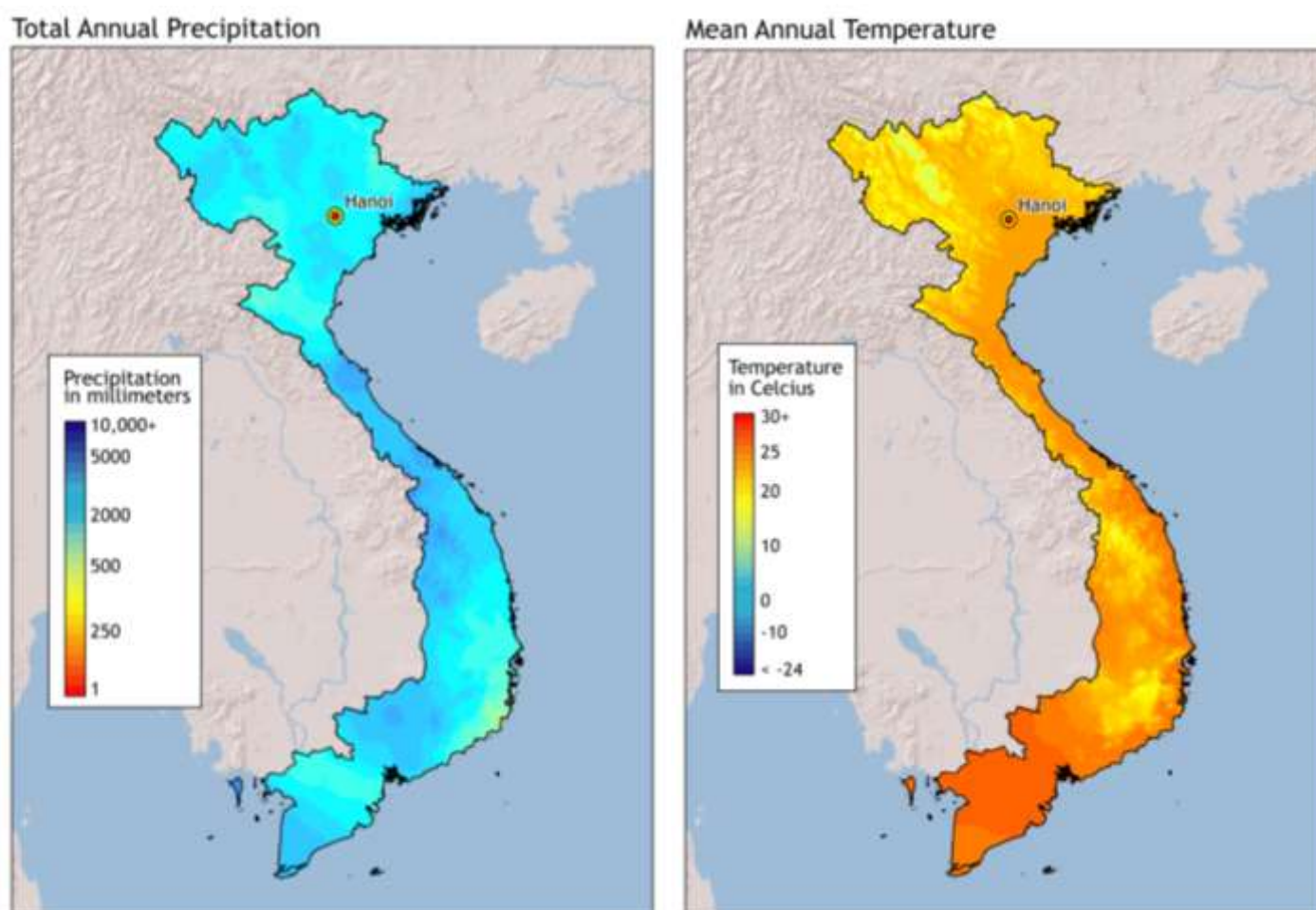


Figure 1: Mean annual precipitation and temperature in Vietnam¹⁶

¹⁴ *Climate Change and Human Development in Vietnam*, UNDP Human Development report 2007/2008.

¹⁵ *UNDP Climate Change Country Profile: Vietnam*.

¹⁶ WorldClim 1960-1990 averages. Robert J. Hijmans, Susan Cameron, and Juan Parra, at the Museum of Vertebrate Zoology, University of California, Berkeley, in collaboration with Peter Jones and Andrew Jarvis (CIAT), and with Karen Richardson (Rainforest CRC).
www.worldclim.org/current

Major Climate Processes¹⁷

South Asian monsoon
Northeast Asian monsoon
El Niño
Pacific tropical cyclones

Impacts on Climate

- Summer rainfall in north and south
- Winter rainfall in central region
- Warmer and drier than average conditions
- Rainfall from June to November

RECENT CLIMATE TRENDS

Over the past four decades, there have been noticeable changes in Vietnam's climate particularly regarding rise in temperatures and sea level:¹⁸

- ➔ Mean annual temperature has increased by 0.40°C since 1960, with the rate of increase more rapid in the dry seasons (November, December, January and February, March, April) and more intense in the southern parts of the country.
- ➔ The frequency of 'hot' days and nights has increased significantly since 1960 in every season, with an especially high rate of 'hot' day increase between September and November, and 'hot' night increases in June to August.
- ➔ The annual frequency of 'cold' days and nights has decreased significantly,¹⁹ with the rate of decrease being strongest in December, January and February in each case.
- ➔ Rainfall in Vietnam is characterized by high variability on both annual and inter-decadal time scales, which make trends since 1960 difficult to categorize. Mean rainfall over Vietnam does not show any statistically significant change since 1960, and neither does the proportion of rainfall falling in heavy events, nor the maximum amount falling in 1-day or 5-day events.
- ➔ The number of cold fronts affecting Vietnam has decreased since the 1970s.²⁰
- ➔ The trajectory of typhoons affecting Vietnam appears to have moved southward in recent years, and the peak month for landfall has shifted from August in the 1950s to November in the 1990s.²¹
- ➔ The frequency of tropical cyclones operating in the East Sea has been observed to have decreased over the past several decades, although the frequency of tropical cyclones that affect Vietnam has increased by 0.43 event per decade in the past 50 years.²² Higher-intensity typhoons are noted to be occurring more frequently.²³
- ➔ Regarding sea level change along the coast, observations show that average sea level has decreased by 0.20 cm per year (1965-2006) at Hon Dau station, by 0.260 cm per year (1978-2006) at Son Tra station, and has increased by 0.398 cm per year (1981-2006) at Vung Tau station.²⁴

¹⁷ UNDP Climate Change Country Profile for Vietnam and UNEP & IPONRE (2009).

¹⁸ All information has been taken from *UNDP Climate Change Country Profile for Vietnam*, unless otherwise specified.

¹⁹ Hot' day or 'hot' night is defined by the temperature exceeded on 10% of days or nights in current climate of that region and season. 'Cold' days or 'cold' nights are defined as the temperature below which 10% of days or nights are recorded in current climate of that region or season.

²⁰ UNEP & IPONRE (2009) and Vietnam 2nd National Communication to the UNFCCC (2010).

²¹ Climate Change and Human Development: Vietnam, UNDP Human Development Report 2007/2008.

²² UNEP & IPONRE (2009). Note that elsewhere this study contradicts itself by suggesting that there has been a decreasing trend in the number of cyclones that affect Vietnam per decade since the 1970s.







²³ Vietnam 2nd National Communication to the UNFCCC (2010).

²⁴ UNEP & IPONRE (2009).

CLIMATE FUTURE

CLIMATE FUTURE AT A GLANCE

At a Glance²⁵

Temperature	Mean annual temperature will increase, with some suggesting greater increases in the southern zones		1 °C to 2.0°C by 2050
Rainfall	Annual average rainfall will increase		
	Relatively large increase in winter rainfall expected		
	Proportion of rainfall falling in heavy events, particularly in northern regions		+2-14% by 2090
Extremes	Heat waves		+100-180%
	Cold waves		-20-40%
	Run-off		+7% by 2050
	Sea level		+28-33cm

The climate science community sources a suite of models to inform decision makers on future climate. Among the most widely used are GCMs (Global Climate Models), RCMs (Regional Climate Models), and downscaling techniques (both empirical and statistical) and several comprehensive reviews are available on the subject. Global Climate Models (GCMs) are our primary source of information about future climate. GCMs comprise simplified but systematically rigorous interacting mathematical descriptions of important physical and chemical processes governing climate, including the role of the atmosphere, land, oceans, and biological processes. The bullet points below offer insights into a changing climate are thusly derived for Vietnam from a suite of GCMs used by the Intergovernmental Panel on Climate Change²⁶. It is important to note, however, that Vietnam has 7 distinct climate regions that differ in terms of temperature, rainfall, and extreme event regimes. The magnitude of climate change is thus likely to vary at regional levels.

- ➡ Mean annual temperatures are projected to increase by 1oC by 2050, with similar projected rates of warming for all seasons. Some studies indicate that similar warming is likely to occur across all regions, while others²⁷ suggest that the country's southern climatic zone will experience smaller warming than the northern and north central zones.
- ➡ A temperature rise of 1oC is projected to increase the number of heatwaves by 100 to 180 percent, while the number of cold surges would decrease by 20 to 40 percent²⁸.
- ➡ Substantial increases are expected in the frequency of days and nights that are considered 'hot' under current climate, coupled with projected decreases in the number of days and nights considered 'cold' under current climate²⁹.
- ➡ Winter rainfall is expected to increase by 8 percent and summer rainfall by 1 percent by 2050. Autumn rainfall is projected to decline by 4 percent by 2050, while no change is projected for spring rainfall.
- ➡ Runoff is projected to increase by 7 percent by 2050.

²⁶ Unless otherwise noted, projections have been taken from the World Bank Climate Change Knowledge Portal:

<http://sdwebx.worldbank.org/climateportal/>

²⁷ E.g., Vietnam 2nd National Communication to the UNFCCC (2010).

²⁸ United Nations Vietnam Climate Change Factsheet: *The Effects of Climate Change in Vietnam and the UN's Response*, UN (2011).

²⁹ UNDP Country Climate Change Profile for Vietnam.

- ➡ As yet it is not possible to get a clear picture for precipitation change for Vietnam under a future climate. This is due to large model uncertainties, with multi-model analyses of the Sahel suggesting a drying trend, and some individual models suggesting a more humid future. What is clear, however, is that the future will increase climate variability and extreme events.
- ➡ The proportion of total rainfall that falls in heavy events is projected to increase by 2-14 percent by the 2090s³⁰, and the probability of extreme rainfall and flooding will increase³¹, particularly in northern regions and cities such as Hanoi, with increased risk of landslides in mountainous areas.
- ➡ Sea level is projected to rise by between 28 cm (low-emission scenario) to 33 cm (high emission scenario) by 2050³².
- ➡ Tropical cyclones are poorly simulated by General Circulation Models and it is therefore difficult to project future changes in typhoon frequency, intensity or pathway for Vietnam. While there is evidence that tropical cyclones may become more intense as sea surface temperatures rise, regional uncertainties remain.
- ➡ El Nino is known to affect monsoon rainfall in Southeast Asia, yet this relationship is poorly understood, rendering it difficult to model.

CLIMATE CHANGE IMPACTS ON NATURAL HAZARD VULNERABILITY

AT A GLANCE

Located in Southeast Asia's tropical monsoon belt, Vietnam is ranked among the region's most hazard-prone areas³³ and commonly experiences floods, droughts and typhoons, as well as occasional forest fires, landslides, and earthquakes. Figure 3 gives an indication of the economic damage associated with major hazards in the country. Given its high exposure to floods and storms, and the fact that two of its most important economic sectors – industry and agriculture – are located in coastal lowlands and deltas – Vietnam has been listed by the World Bank³⁴ as one of the five countries that will be worst-affected by climate change.

- ➡ **Tropical cyclones** – Much of Vietnam's coastline of 3,260 km is exposed to typhoons, which strike the country an average of 6-8 times per year. The storms bring strong winds, heavy rain and flooding, and result in human, economic and agricultural damage in coastal areas that can be exacerbated by high tides and storm surges. As shown in Figure 3, storms resulted in nearly US\$ 4.5 billion in damage in Vietnam over the past century, and, due to population growth in exposed areas, as well as a rise in infrastructure assets, the damage potential from typhoons is increasing.³⁵ Although rising sea surface temperatures are expected to increase tropical cyclone intensity in the Atlantic, uncertainties remain with regard to projections of the impact of climate change on typhoon frequency and intensity in the Pacific Ocean. A southward shift has been

³⁰ UNDP Country Climate Change Profile for Vietnam.

³¹ United Nations Vietnam Climate Change Factsheet: *The Effects of Climate Change in Vietnam and the UN's Response*, UN (2011).

³² UNEP & IPONRE (2009).

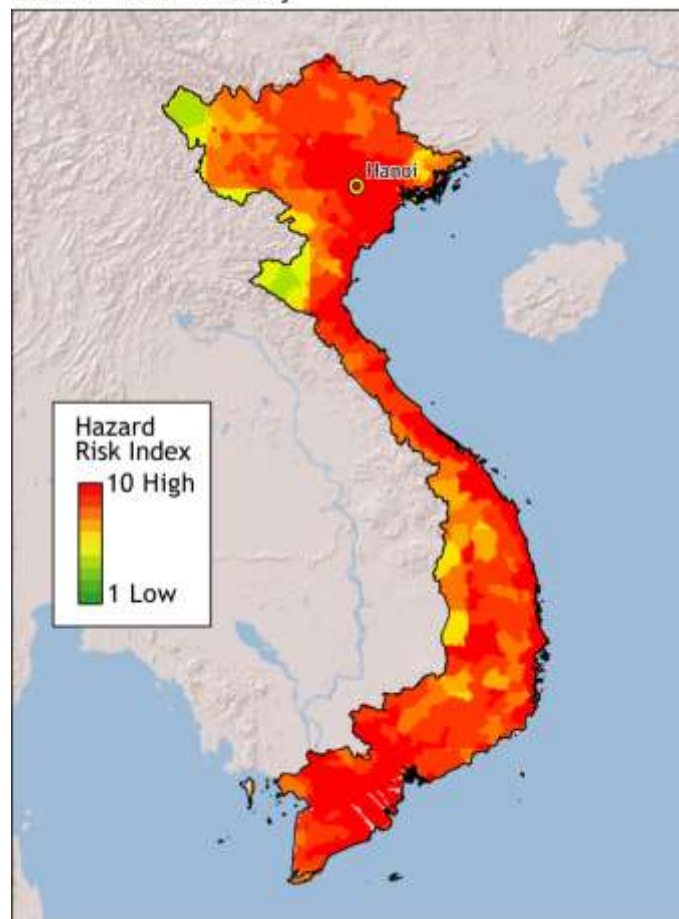
³³ GFDRR Country Profile for Vietnam.

³⁴ 2007 Assessment, in GFDRR Country Profile for Vietnam.

³⁵ UN Climate Change Factsheet: *The Effects of Climate Change in Vietnam and the UN's Response* (2011).

observed for the country in typhoon trajectory in the past five decades; if this continues, Ho Chi Minh City, a major contributor to national GDP (23%) and FDI (20%), would be at greater risk of being directly hit.³⁶

Risk of Flood Mortality



Risk of Drought Mortality

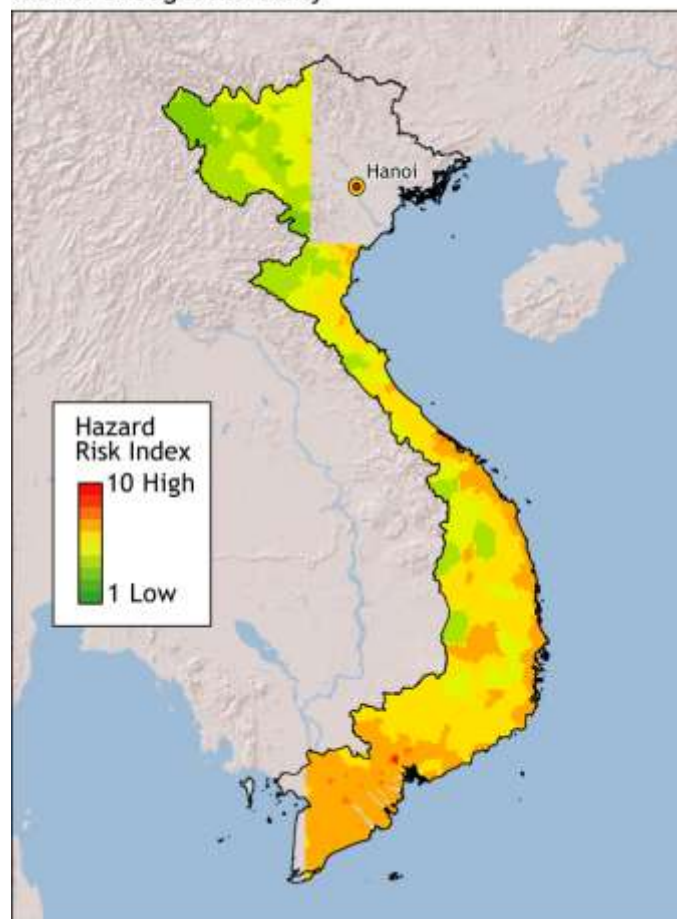


Figure 2: Exposure to climate-related hazards across Vietnam³⁷

➡ **Floods** – Vietnam experiences several types of flooding. Intense rainfall associated with typhoons frequently causes immense destruction in heavily populated coastal areas as well as in the Red River and Mekong deltas, the country's major rice-growing areas. These deltas are also vulnerable to flooding caused by heavy monsoon rainfall. Rainfall that is less immediately damaging but results in prolonged inundation can also cause severe economic and social damage; long-standing waters damage crops and property, and can adversely impact health by allowing disease vectors to spread.³⁸ Flash flooding and landslides are a risk³⁹ in hilly terrain, which covers three fourths of the country. With wet seasons projected to get wetter with

³⁶ Ho Chi Minh City Adaptation to Climate Change: Summary Report, ADB (2010).

³⁷ Columbia University Center for Hazards and Risk Research (CHRR) and Columbia University Center for International Earth Science Information Network (CIESIN).

³⁸ Flooding in Mekong River Delta, Vietnam, UNDP Human Development Report Occasional Paper: (2007).

³⁹ National Strategy for Natural Disaster Prevention, Response and Mitigation to 2020, Socialist Republic of Vietnam (2007).

climate change, rainfall is expected to be concentrated even more in the rainy seasons, leading to an increase in the intensity, frequency, and duration of floods.⁴⁰ Climate change is also expected to exacerbate flood risk by raising sea level and thus storm surge. Without major actions such as dyke reinforcement and improved drainage, nearly 5 percent of Vietnam's area is at risk of inundation by 2100 due to the added threat of sea level rise caused by climate change.⁴¹

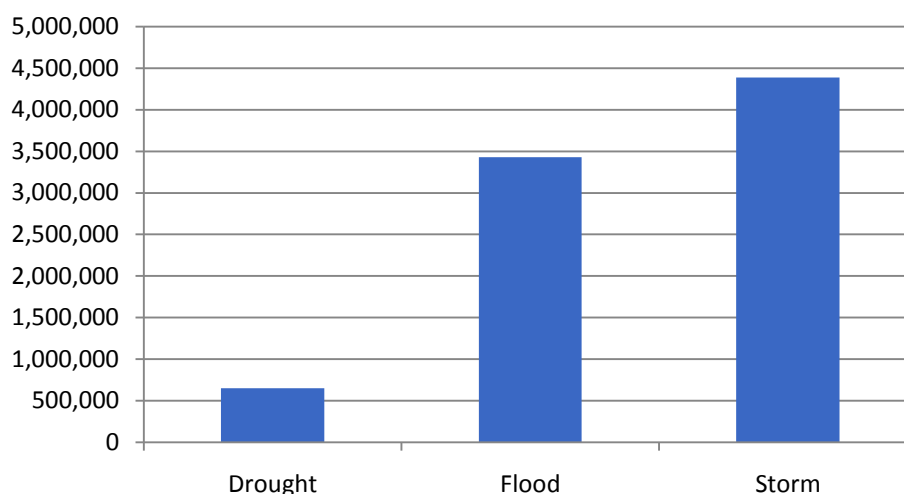


Figure 3: Total damages from select disaster types in Vietnam 1900-2011 (in US \$)⁴²

➔ **Droughts:** High year-to-year variation in rainfall across some regions of the country means that some areas that experience floods in rainy seasons can also experience drought in dry seasons.⁴³ For example, rainfall in Ninh Thuan province has actually been increasing over time, but greater variability has also increased drought incidence, so that the province received only 50% of its normal rainfall in 2004, with drought continuing into the following two years.⁴⁴ An estimated 1-1.3 million people are estimated to be drought-affected in 9 provinces of the Mekong region of Vietnam, representing 13-17% of the total population. Forestry, agriculture and livestock, industry, fisheries, and aquaculture are all affected, and forest fires can also be a serious consequence. As climate change is expected to increase rainfall variability as well as raise temperatures and lead to more heatwaves, drought is likely to remain a serious – if not growing – concern over the coming decades.

Implications for Disaster Risk Management (DRM)

- ➔ Not enough is known about the impacts of climate change on the intensity and frequency of typhoons that affect Vietnam. However, recent decades have seen a southward shift in trajectory, which, if continued into the future, could endanger Ho Chi Minh City, a major economic hub of the country.
- ➔ Sea level rise will exacerbate coastal flooding and could result in larger storm surges associated with typhoons. Coastal flooding and salt-water intrusion will become an increasing threat.

⁴⁰ *Economics of Adaptation to Climate Change: Vietnam*, World Bank (2010).

⁴¹ *United Nations Vietnam Fact Sheet: Cities and Climate Change*.

⁴² EM-DAT: The OFDA/CRED International Disaster Database; www.em-dat.net - Université Catholique de Louvain, Brussels, Belgium.

⁴³ Vietnam's Second National Communication to the UNFCCC (2010).

⁴⁴ *Drought Management Considerations for Climate Change Adaptation: Focus on the Mekong Region (Vietnam Report)*, Oxfam-Vietnam.

- ➔ Projected increases in summer and winter rainfall, runoff, rainfall variability, and the proportion of rain falling in heavy events will have profound implications for flooding, both in coastal and deltaic areas as well as in hilly terrain, where flash floods and mudslides are a major risk.
- ➔ High inter-annual rainfall variability poses drought risk in many provinces at present. Projected increasing variability is likely to exacerbate drought risk.

SECTORAL CLIMATE RISK REDUCTION RECOMMENDATIONS

WATER RESOURCES AND AGRICULTURE

Vietnam has over two thousand rivers, eight basins with a catchment area larger than 10,000 km², abundant surface water resources in terms of total run-off, and abundant renewable groundwater resources.⁴⁵ The Mekong and Red River basins—major rice growing regions— together span 45% of the country.⁴⁶ Despite these abundant provisions, however, the distribution of water resources in the country can be highly variable. Due to irregularities in monsoon rainfall, severe floods can occur in some seasons and insufficient flows in others, leading to drought conditions.

Agriculture continues to play an important role in poverty alleviation and food security in Vietnam, and remains an important sector of Vietnam's economy, contributing about 21% of GDP.⁴⁷ Rice, the most important crop, is grown by nearly 80% of Vietnamese farmers, on roughly 45% of the country's agricultural land⁴⁸ and, in addition to meeting domestic demand, constitutes a major export item. Other important crops include maize, coffee, rubber, and tubers.

Climate change is expected to exacerbate rainfall variability so that floods and droughts occur more frequently,⁴⁹ with rice crops particularly vulnerable to damage caused by long periods of inundation. Another major risk is posed by sea level rise, with the Mekong Delta projected to see a loss of 590,000 ha due to inundation and saline intrusion, an area which accounts for 13% of today's rice production.⁵⁰ A 30 cm rise in sea level is expected to increase the salinity of the main tributaries of the Mekong River as far as 10 km inland.⁵¹ The future effects of increased temperature on water demand, crop growth rates and pest incidence could also be significant.⁵² Overall, studies indicate that climate change could reduce annual rice production by 2.7⁵³ to 9.1 million tons (see table below) by 2050. In the absence of adaptation measures, climate change could also reduce production of other major crops as shown in Table 1.

Near-term adaptation options in agriculture include measures such as changes in sowing and cultivation practices, erosion control, and changes in cropping patterns. Looking further ahead, it will become increasingly important to select crops that are better suited to a changing climate and give more attention to land and water management. Agricultural incentives, insurance measures to

⁴⁵ FAO Aquastat Vietnam Page: http://www.fao.org/nr/water/aquastat/countries/viet_nam/index.stm

⁴⁶ Ibid.

⁴⁷ FAO Vietnam Profile: <http://www.fao.org/countries/55528/en/vnm/>

⁴⁸ Potential Climate Change Mitigation Opportunities in the Agriculture and Forestry Sector in Vietnam, Background Paper submitted to World Bank Carbon Finance Assist (2010).

⁴⁹ Vietnam Assessment report on Climate Change, UNEP and IPONRE (2009).

⁵⁰ Economics of Adaptation to Climate Change: Vietnam Case Study, World Bank (2010).

⁵¹ Climate Change and Human Development in Vietnam, UNDP Human Development Report Occasional Paper, 2007.

⁵² Vietnam's 2nd National Communication to the UNFCCC, 2010.

⁵³ Impacts of Climate Change on Agriculture and Policy Options for Adaptation, IFPRI Discussion Paper (2010).

mitigate risk, disaster and pest warning systems, and research in agricultural technology will also be needed to reduce vulnerability in the long term in this sector.⁵⁴

Table 1: Changes in crop production in 2050 due to climate change with no adaptation (million metric tons)⁵⁵

Climate scenario impact	Paddy rice			Maize Yields	Cassava Yields	Sugar cane Yields	Coffee Yields	Vegetables Yields
	Yields	Sea level	Total					
Dry	-6.7	-2.4	-9.1	-1.1	-1.9	-3.7	-0.4	-1.7
Wet	-5.8	-2.5	-8.4	-1.0	-2.6	-2.9	-0.4	-3.1
MoNRE	-3.4	-2.4	-5.8	-0.3	-0.6	-1.4	-0.1	-0.9

COASTAL ECOSYSTEMS AND AQUACULTURE⁵⁶

Aquaculture and fisheries contribute 3% of Vietnam's GDP and account for 12% of total exports – about US\$ 2.5 billion – while providing a source of livelihood to about 4 million people. These resources are under increasing pressure, however, from the impacts of overfishing and unregulated fishing, spurred in turn by production-based policies and coastal planning that greatly favor the promotion of economic growth (such as through coastal tourism, which has been largely unregulated). This situation is resulting in conflicting coastal zone use and giving rise to a host of environmental problems. Sediment loading and pollution, among other factors, have severely damaged coral reefs, sea grasses, and mangroves; surveys of coral reefs off the coasts of Hai Phong and Quang Ninh show major deterioration in coverage, with few surviving reefs. As coral reefs are highly sensitive to ocean water temperature, future temperature rise could cause further deterioration. Coastal degradation is also increasing vulnerability to extreme climatic events such as storms, heavy rainfall, and flooding, resulting in damage to boats, housing, coastal vegetation, and aquaculture facilities. Vulnerability to sea level rise, which has been observed off of several coastal stations in Vietnam and is projected to increase over the coming decades, is growing. Among other impacts, the resulting salt-water intrusion may necessitate relocation of aquaculture farms.

A variety of adaptation measures are being investigated, such as the development of aquaculture plans for the country's various coastal ecosystems on the basis of climate change assessments. There are plans of introducing heat-tolerant varieties in aquafarming, and improving management capacities, particularly for aspects for coastal and marine planning that are impacted by climatic disasters. There are also plans to construct additional storm shelters for fishing ships, improve communication facilities on ships so that hazard warnings can be disseminated, and to offer better weather forecast bulletins to fishermen.

⁵⁴ Vietnam's 2nd National Communication to the UNFCCC (2010).

⁵⁵ *Economics of Adaptation to Climate Change: Vietnam Case Study*, World Bank (2010). The study uses 3 scenarios: (i) Vietnam's official scenario for climate change, published by the Ministry of Natural Resources and Environment (MoNRE) in 2009, a middle range scenario; (ii) a Dry scenario; and (iii) a Wet scenario. The Dry and Wet scenarios represent the extremes of the distribution by climate moisture indices.

⁵⁶ Summarized from Vietnam's 2nd National Communication to the UNFCCC (2010); *Vietnam Development Report 2011: Natural Resources Management*, Joint Development Partner Report (2010); *Vietnam Fisheries and Aquaculture Marketing Study*, Prepared for the World Bank in collaboration with FAO (2005), and *Climate Change and Human Development in Vietnam*, UNDP Human Development Report (2007).

FORESTRY⁵⁷

Forestry contributes about 1% of GDP in Vietnam (or 5% if outputs from wood-based products are included). The furniture and paper product manufacture sub-sectors have had the highest turnover since 2002, but the wood processing industry has also been rising rapidly, and contributed about US\$ 2.8 billion in exports in 2008. About 13 million hectares of the country's land are forested, of which 3 million hectares are plantations.

Of the 25 million people living in or near forests in Vietnam, the poor are particularly dependent on forest products for meeting basic needs. Despite remarkable achievements in poverty reduction in the country in recent decades, poverty continues to be relatively high among communities living in forested lands, particularly in remote uplands. As community-forest management projects are still being piloted and have yet to become mainstreamed, most forest is still under state control.

Deforestation has been high in recent decades and remains so; mangroves declined from 400,000 ha in 1943 to less than 60,000 ha in 2008. Major causes for this include conversion to agriculture, infrastructure development, illegal logging, overexploitation, and forest fires. As a result, flash flooding and mudslides are posing increasingly serious risks. Given that climate change is projected to increase rainfall variability as well as rainfall intensity in Vietnam, and to change temperature and humidity profiles, the risk of drought and forest fire may increase, as may the risk of pest and disease outbreaks that endanger the country's forests. Studies indicate that by 2100, all the country's natural forest ecosystems will shrink, with tropical moist semi-deciduous forests being the most vulnerable to climate change.⁵⁸

Improved sustainable forest management is needed, as is research to identify resilient plant and tree species. Forest fire management and control programs and warning systems are also increasingly necessary. On the economic and production side, timber use efficiency needs to be improved, as do timber and non-timber processing technologies. Afforestation and reforestation can provide tremendous benefits: in coastal zones of the country, mangrove planting has been shown to greatly reduce the cost of dyke maintenance⁵⁹ as well as improve coastal resilience and livelihoods. These programs need to be supported with appropriate policy and enforcement measures that strictly prohibit further deforestation of mangroves. Particular attention needs to be paid to the poverty reduction needs of communities living in upland forest areas.

ENERGY AND TRANSPORTATION⁶⁰

Changing temperature trends will affect the demand for a variety of energy-related services, such as air conditioning, industrial cooling processes, and agricultural drainage pumps. For example, a 1°C rise in summer temperature is expected to raise energy demand by 1 percent across residential, commercial and institutional sectors in Vietnam. Therefore, it is important to identify and implement measures in energy use efficiency and conservation in order to mitigate the impacts of increased future demand. The energy sector is itself vulnerable to the impacts of climate variability and change as severe storms, often experienced in coastal areas, can damage electricity transmission and distribution infrastructure, as can rising sea levels. Also, projected increases in

⁵⁷ Unless otherwise noted, this information is taken from *Vietnam Development Report 2011: Natural Resources Management*, Joint Development Partner Report (2010).

⁵⁸ Vietnam's 2nd National Communication to the UNFCCC (2010).

⁵⁹ UNEP Regional Seas Information Series, *Using Ecosystems to Address Climate Change: Ecosystem-Based Adaptation*

⁶⁰ Ibid note 58.

rainfall variability and intensity will affect streamflow, with implications for hydropower generation, reservoir design, and flood control measures. Studies will need to be conducted to project future energy demand for various provinces, and the planning and design of energy infrastructure needs to be geared to handle potential changes in climatic and hydrological variables.

The transportation sector is also vulnerable to the impacts of extreme climatic events; between 2001 and 2005, severe weather events caused damages of over US\$ 160 million in the country, and studies indicate that a rise of 100 cm in sea level would submerge 11,000 km of roads. As heavy rainfall and flooding may become more frequent with climate change, it will be increasingly important to focus on resilient structure design for energy and transportation infrastructure so that it is able to better withstand storm and flood risk. In upland areas that are susceptible to landslides and mudslides, railway network infrastructure also needs to be strengthened.

ADAPTATION

Ongoing Efforts- At a Glance

Adaptation

- Climate-Resilient Infrastructure Planning and Coastal Zone Development (ADB/GEF)
- Climate Change Impacts in Huong River Basin and Adaptation in its Coastal District Phu Vang (NCAP)
- Strengthening Sustainable Development and Climate Planning (UNDP)
- Strengthening National Capacities to Respond to Climate Change in Vietnam (UNDP)
- Climate Change Impact and Adaptation Study in the Mekong Delta (ADB)
- Mekong River Commission Climate Change Adaptation Initiative (AusAID)

Vulnerability Reduction

- Vietnam Urban Upgrading Project (World Bank)
- Ho Chi Minh City Environmental Sanitation Project (World Bank)
- Coastal Cities Environmental Sanitation Project (World Bank)
- Strengthening Water Management and Irrigation Systems Rehabilitation Project (ADB)
- Phuoc Hoa Multipurpose Water Resources Project (ADB)
- Capacity Building for River Basin Water Resources Planning (ADB)

GFDRR Interventions

- Vietnam Disaster Risk Management Capacity Building Program
- Global Handbook for Urban Flood Risk Management – Vietnam
- Asia Leadership Development in Disaster Risk Management
- Building Resilience in East Asia - Vietnam
- Gender and Disaster Risk Management in South East Asia

EXISTING ADAPTATION FRAMEWORK/STRATEGY/POLICY AND INSTITUTIONAL SET-UP

The Government of Vietnam adopted its National Target Program to Respond to Climate Change (NTP-RCC) in 2008, thus setting goals that involve a range of inter-sectoral institutional measures and reflect the cross-cutting nature of the impacts of climate change. These include vulnerability assessments across sectoral, regional, and community levels; enhancing the role of science and technology for adaptation solutions; increasing public awareness and participation; and integrating climate change into development strategies, plans, and programs in all sectors.⁶¹

The country has an unevenly distributed network of 174 meteorological surface stations and 248 hydrological stations, as well as 29 agro-meteorological stations.⁶² Forecasting services are at national, regional, and provincial levels. With a view to strengthening hydro-meteorological capacity, the Government of Vietnam approved the *Master Plan of the National Natural Resources and Environmental Observation Network until 2020*. Also, as part of the NTP-RCC, Vietnam is developing a *Scientific and Technological Program on Climate Change*, with the aim of establishing a scientific foundation to support policies, strategies, and action plans. Awareness raising among the public on climate change falls within the domain of the Ministry of Information and Communication. Civil society institutions are also involved; in 2008, the Vietnam NGO Climate Change Working Group was established to foster discussion and information sharing.

INSTITUTIONAL AND POLICY GAPS

➡ *Disaster reduction and climate resilience*

- Disaster response needs to shift from being passive and damage-driven to proactive, with a focus on ex-ante measures.
- Forecasts and warning systems need to be improved for hazards such as flash floods and landslides;
- Improved coordination is needed for emergency relief, damage recovery, and rehabilitation of hazard-struck areas.
- Improved vehicle management is needed on rivers and at sea to reduce damage to pelagic fishing boats.
- Construction planning needs to include better safety measures, particularly in industrial zones, tourist zones, the urban areas of coastal regions, and upland areas.
- Increased spending on maintenance and extension of coastal and flood defenses is necessary, particularly for the Mekong River and Red River deltas, and their specifications should be adjusted to cope most cost-effectively with expected sea level rise. Ensuring mangrove health will result in lower costs.

➡ *Awareness*

- Efforts in community awareness raising and training on risk from climate hazards need to be frequent and systematic, and relevant modules should be included in school curricula.

⁶¹ *Climate-resilient Development in Vietnam: Strategic Directions for the World Bank*. World Bank (2011).

⁶² Vietnam's 2nd National Communication to the UNFCCC (2010).

- Outreach and extension services are needed to better inform farmers of climate risk in the agriculture sector, and similar efforts are needed for the aquaculture sector.

➡ *Planning, legislation, and policy*

- There is lack of synchronized planning and coordination among ministries and sectors, and insufficient attention is given to the integration of natural hazard and climate risk issues within local and sectoral socio-economic development programs.
- Institutional mandates are not clearly defined; overlaps need to be reduced.
- Stringent regulations are needed to discourage construction in zones that are at-risk of inundation, flash floods, storms, sea surges, and landslides.
- Penalties need to be enforced for actions in contravention of existing environmental policies that could increase vulnerability, e.g., destruction of mangrove forests.
- Incentives need to be provided to households and the private sector for purchasing disaster-related insurance.

RESEARCH, DATA, AND INFORMATION GAPS

Vietnam has made remarkable progress in economic and social development terms in recent years. However, it is one of Southeast Asia's most disaster-prone countries and is considered highly vulnerable to climate change due to expected future increases in flood and drought occurrence and/or severity, as well as damage caused by sea level rise and consequent saline intrusion to coastal urban and agricultural areas. Despite its rapid development and ongoing efforts to address climate risk, additional capacity is needed in order to address the range of data, research, and institutional gaps that still exist.

➡ *Assessment and research*

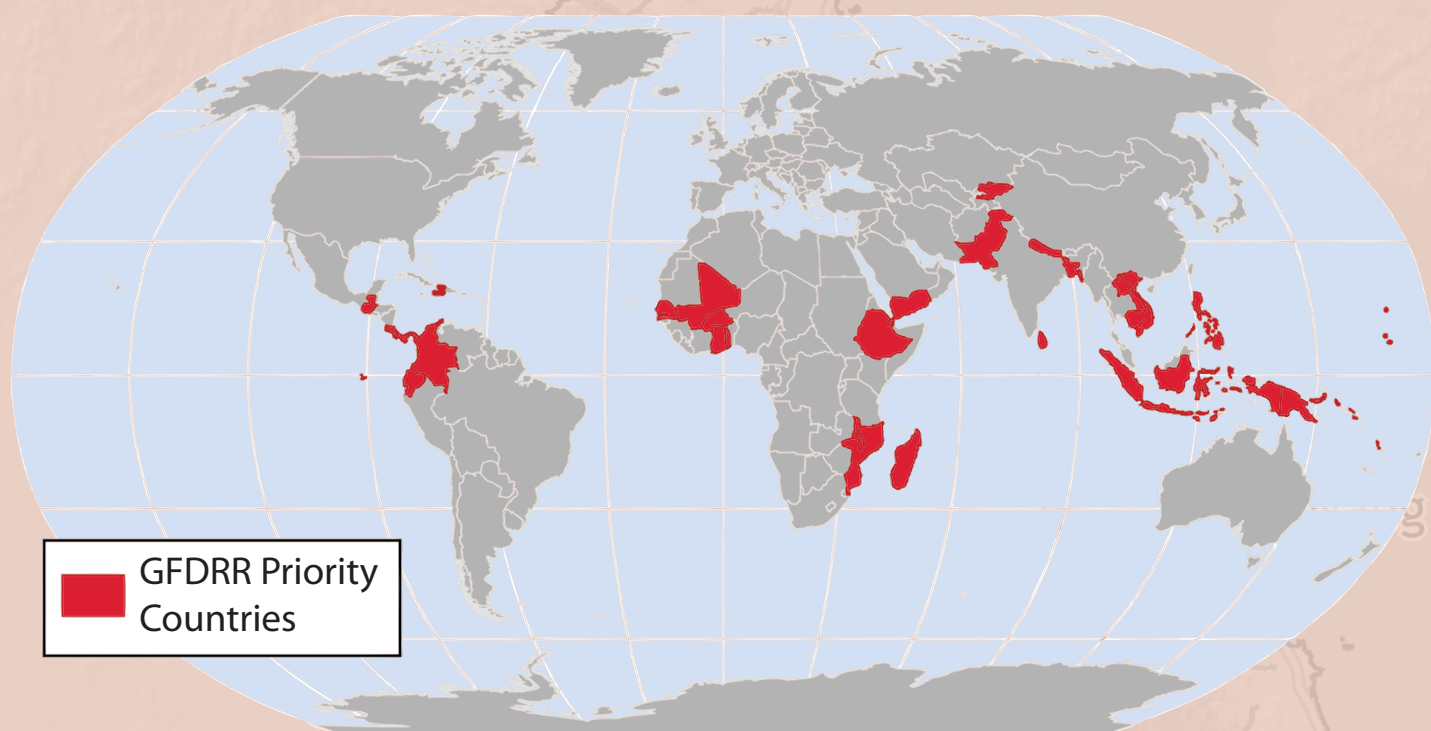
- Improved local information is needed on impacts of climate change for key sectors.
- Adaptation assessments, models, and tools do not provide sufficient information, particularly for cross-sectoral or inter-regional assessments.
- There is insufficient capacity to assess the country's technological needs for adaptation.
- Research (and dissemination to farmers) is needed on flood- and drought-tolerant crop species and improved production methods.
- Research groups should have better access to real-time data, in order to refine predictions.
- Zoning maps are needed to depict areas that are at risk from various natural hazards.

➡ *Monitoring*

- Geographic coverage of hydrometeorological observation infrastructure needs to be more uniform; it is currently absent in some areas that are important from an early warning perspective;
- Multi-sector pilot projects should be implemented in key vulnerable areas in order to contribute to observations of environmental and climate change, their impact, and local coping responses.

Climate Risk and Adaptation Country Profile

This Country Profile (<http://countryadaptationprofiles.gfdr.org>) is part of a series of 31 priority country briefs developed by the Global Facility for Disaster Reduction and Recovery (GFDRR) as part of its Disaster Risk Management Plans. The profile synthesizes most relevant data and information for Disaster Risk Reduction and Adaptation to Climate Change and is designed as a quick reference source for development practitioners to better integrate climate resilience in development planning and operations. Sources on climate and climate-related information are linked through the country profile's online dashboard, which is periodically updated to reflect the most recent publicly available climate analysis.



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