



# CLIMATE CHANGE AND GREENHOUSE GAS EMISSIONS: Causes, Impacts, and Solutions for Vietnam

Climate change and the resulting increase in greenhouse gas (GHG) emissions are among the most pressing global challenges. These issues have profound implications for all countries, and Vietnam, with its vulnerable geography and reliance on agriculture, faces a particularly urgent need to address them. Greenhouse gas (GHG) emissions are the release of heat-trapping gases into Earth's atmosphere. These gases form a natural blanket around the planet, allowing sunlight to pass through but trapping some of the heat that radiates back from the surface. This process, known as the greenhouse effect, is essential for life, keeping the planet warm enough to support ecosystems. However, human activities have dramatically increased the concentration of these gases, intensifying this effect and leading to global warming and climate change.

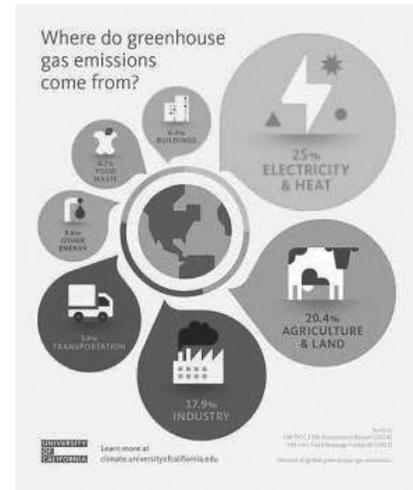
## 1. CAUSES AND IMPACTS OF GREENHOUSE GAS EMISSIONS

Greenhouse gas emissions are a phenomenon where gases in the atmosphere absorb the infrared radiation and heat from Earth. Then, they will radiate them in many directions. In fact, this natural phenomenon is beneficial for our planet because it can maintain a warm temperature. However, with the utilization of non-renewable energy and other human activities, the production of gases in the atmosphere is getting out of control. As a result, greenhouse gas emissions hold too much heat and infrared in the atmosphere, making the Earth scorching. This causes climate change and global warming.

In general, the gases in the atmosphere are called greenhouse gases. They act like the glass in a greenhouse, retaining heat to keep the temperature warm. Some examples of greenhouse gases are methane, nitrous oxide, fluorinated gases, and carbon dioxide. Those gases create an insulating layer that prevents the Earth's heat from escaping into space. However, impulsive human activity produces more gases in the atmosphere, trapping more of the Earth's heat, making the temperature hotter, and leading to global warming.

Greenhouse gas emissions come from various sources, either naturally or due to human activity. Here are some greenhouse gas emission causes you should know:

Agricultural activity, particularly livestock farming and rice cultivation, are major sources of methane and nitrous oxide. Methane is produced by livestock digestion and the decomposition of organic matter in flooded rice paddies. Nitrous oxide is released from the use of nitrogen-based fertilizers.



**Fossil combustion activity:** Fossil combustion is one of the main causes of greenhouse gas emissions. Fossil energy, such as coal and natural gas, is the source for power plants, industry, and transportation. The process of fossil combustion can emit carbon dioxide into the atmosphere. Moreover, other gases, like nitrogen dioxide and sulfur dioxide, also cause air pollution. The combustion process occurs not only in the industrial sector but also in transportation, where vehicles powered by gasoline also produce carbon dioxide and other pollutants. In addition, cultivated rice fields also produce methane, especially if the rice fields are flooded, allowing anaerobic processes to occur and release more methane into the atmosphere.

**Deforestation:** Deforestation contributes to greenhouse gas emissions because carbon dioxide-absorbing trees are cut down. This results in the loss of carbon sinks as well as the production of carbon through land burning. Forests act as vital carbon sinks, absorbing CO<sub>2</sub> from the atmosphere. When forests are cleared, not only is this carbon-absorbing capacity lost, but the stored carbon is also released back into the atmosphere.

**Industrial processes:** Many industrial activities, such as cement and chemical production, release GHGs as a byproduct.

**Waste management:** Landfills and waste treatment facilities produce methane as organic waste decomposes.

Greenhouse gas emissions have existed for hundreds of years and play a crucial role in



maintaining Earth's warm temperature. However, with the uncontrolled emissions recently, we might see these impacts:

**Global warming:** Greenhouse gas emissions are the main cause of global warming, as gases in the atmosphere hold more heat and radiate it back to the Earth. As a result, temperatures continue to rise and cause extreme weather changes, such as droughts, storms, and heat waves.

**Environmental damage:** This emission affects the environment significantly, as it can increase sea warming and ocean acidification. Additionally, coral reef life is also under threat, even though coral reefs serve as a habitat for various types of marine life.

**Economic impact:** Excessive greenhouse gas emissions affect the environment and the economy. This phenomenon damages the agricultural field and infrastructure, halting the economic cycle.

The main causes of greenhouse gas (GHG) emissions are human activities, primarily the burning of fossil fuels for electricity, heat, and transportation, followed by agriculture, deforestation, industrial processes, and waste management. These activities release significant amounts of gases like carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>), and nitrous oxide (N<sub>2</sub>O) into the atmosphere, trapping heat and increasing global temperatures.

## 2. IMPACTS OF CLIMATE CHANGE TO SECTORS

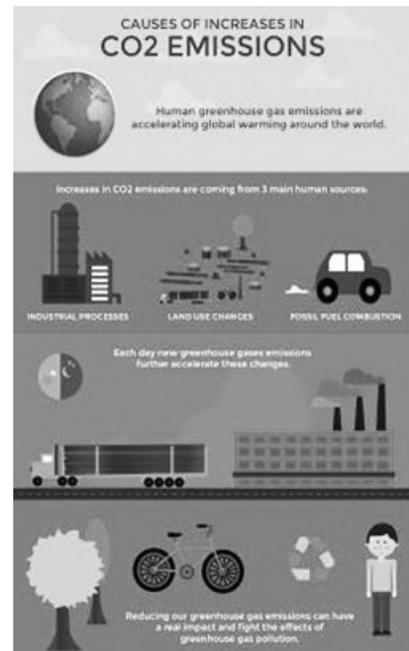
### *Natural resources and environment*

**Water resources:** In recent years, water flows of main river basins have been lower than the average for many years. Water flows in the dry season decrease, the water levels reach historic lows in many places, droughts and water shortages happen more frequently, and saline intrusion extends further into the mainland. Under climate change scenarios, in most river basins, flows during the flood season tend to increase; high and extreme floods occur with higher frequency and severity.

**Land resources:** Prolonged heat and droughts increase the risk of arid soil, reducing soil quality. Increased droughts during the dry season and increased rainfall during the rainy season cause a rise in erosion and landslides in riverside and upland areas. Flooding due to sea level rise is one of the major threats to land resources of the delta and coastal areas.

**Forest resources:** Increased heat will increase the risk of forest fires. Rising temperature, high humidity, heavy rain, strong wind, degraded land, and other factors create favorable conditions for pests and insects to grow and spread, severely affecting the conservation and development of forest ecosystems. Reduced area due to forest fires, pests and diseases, as well as changes in the growth and development of forest ecosystems will affect the output and value of forest products.

**Sea and island resources:** Rising sea temperature changes the growing season, increasing the outbreak of phytoplankton, which is detrimental to the growth of seagrasses. Climate change increases ocean acidification; strong storms destroy coral reefs, grasslands, give rise to species modification, and decrease marine fish resources. The islands and island groups will bear the brunt of climate change impact.



**Mineral resources:** Rising sea level may cause soil, rock and ore to be inundated, contaminated with salt and alum, increasing mining and processing costs. Climate change may also facilitate the formation of new ore bodies. Some types of heavy minerals found in solid rocks (gemstones, gold, titanium, etc.) can easily accumulate over time and form placer deposits and weathered mines.

**Biodiversity:** Climate change and sea level rise can change the structure and distribution of species and biodiversity of ecosystems. Rising temperature will change the distribution and structure of biomes. Sea level rise and increased storm intensity change the composition of sediments, salinity, and pollute water, degrade and threaten mangroves and species.

### *Agriculture and rural development*

**Cultivation:** Vietnam's rice and corn yields could decline by 8.8% and 18.7% in 2030, and 15.1% and 32.9% in 2050 respectively. If the sea level rises by 100cm, 32.2% of agricultural land is at risk of flooding. Under the climate change scenario, if rice yield and cultivation area remain unchanged with no adaptation measures, Vietnam will run the risk of losing 21.4% of rice production by 2100.

**Husbandry:** Impacts of climate change on husbandry include changes in the production and quality of animal feed, and



increase in disease outbreaks. Pig farming is expected to decrease by about 8.2% in terms of headcount.

**Forestry:** Climate change and extreme weather events will increase the risk of forest fires, especially in the Northwest, North Central and Central Highlands; affect the distribution of biodiversity in sensitive forests such as dipterocarp forests, mangroves, evergreen broadleaf forests; increase the risk of developing forest pests and diseases; affect the productivity and suitability of planted forests; change the distribution and risk of biodiversity loss, especially for species with narrow ecological distribution.

**Aquaculture:** Saline intrusion will significantly reduce areas of freshwater aquaculture, affecting the ecological environment, and changing biodiversity.

#### **Transportation infrastructure**

Storms and heavy rains cause flooding and erosion, damaging traffic works and equipment in ports and wharves; sea level rise and spring tide may cause flooding of roads, coastal stations, port and wharves infrastructure; storms, fog and heavy rain affect aviation activities; saline intrusion causes structural corrosion and damage equipment. The roadways sector is heavily affected by climate change, followed by railways and inland waterways. The maritime and aviation sectors are insignificantly affected. Mountainous areas in the North, Central Coast and Central Highlands are at risk of erosion and landslides. The Red River Delta and the Mekong River Delta regions are at risk of flooding due to sea level rise. Central coastal provinces face risks of inundation and erosion caused by rain and floods. All of these risks have an impact on transport infrastructure.

#### **Urban development and housing**

Sea level rise may cause the inundation of metropolises such as Ho Chi Minh City as well as cities in the Mekong River Delta and along the Central Coastal regions. Municipalities in the Northern mountainous, hilly region and the Central regions are often affected by extreme rain and post-storm circulation, causing floods, flash floods and landslides. Climate change also affects water resources and water supply systems.

#### **Tourism**

Climate change has direct impacts on tourism resources, infrastructure and travel activities. Tourism service facilities, accommodations and entertainment facilities are damaged or degraded under the impact of typhoons and floods. Climate change also indirectly affects tourism activities through its effects on other sectors, such as transport, energy, water management, and land-use, etc.

#### **Public health**

Climate change will adversely affect human health, especially that of the elderly, women, children, and people with chronic illnesses. According to statistics, an average temperature increase of 1°C results in a 3.8% increase of hospitalisation rate for children aged under 5 due to respiratory infections. Climate change facilitates the development of vector-borne diseases, increasing the likelihood of outbreaks and spread of diseases, such as influenza A, diarrhea, cholera, dysentery, malaria, dengue fever, yellow fever, typhoid, viral encephalitis, severe acute respiratory syndrome, plague, and zika.

#### **Industry and trade**

**Industry:** Rising temperatures lead to increases in energy consumption in industries as well as costs of ventilation and cooling for mines and reduce the efficiency and output of power plants. Rain, storms and sea level rise will affect the operating process, increasing the cost of maintenance and repair works; affect the supply and consumption of energy; increase the risk of inundation in industrial zones. If the sea level rises by about 100 cm, most coastal industrial zones will suffer from flooding of between 10% and 67% of their total areas.

**Energy:** Increased temperatures increase the energy demand due to the use of cooling equipment. Unusual rainfall and water flows affect the supply capacity and production plan of hydroelectricity, damage the electricity supply infrastructure, increase the cost of new investment, renovation, repair and upgrading of equipment and electricity distribution network. Sea level rise has negative impacts on power plants, power transmission systems, substations, fuel systems, mines, coal yards and other energy-related facilities in coastal areas.

**Trade:** Climate change can affect commercial infrastructure through local flooding, impacting the storage and circulation of goods. Sea level rise will affect seaports, river ports as well as trade and logistics centres in coastal areas. Different climate change responses in different countries could also affect global, regional and domestic trade.

#### **Impacts of climate change to delta, coastal and mountainous areas**

- **Delta areas:** The delta areas will face risks of inundation due to sea level rise. Increased saline intrusion and droughts bear serious impacts on freshwater supply, reducing water quality; rice yield may decrease between 8% and 15% by 2030, and possibly 30% by 2050. Other threats are also on the rise, such as lack of water for domestic use, negative



effects on the aquaculture and fishing environments, increased crop diseases, degradation of soil, and the loss of biodiversity and rare genetic resources.

- *Coastal areas:* Coastal areas of Vietnam are severely affected by sea level rise and such climate-related hazards as typhoons and tropical depressions, floods, and landslides. Sea level rise will increase the risk of inundation in coastal areas. Climate change accelerates soil degradation processes, increases saline intrusion area, reduces rice production and creates many other environmental consequences; degrades biodiversity in coastal areas, changes the ecosystems of lowland areas; shrinks the area of forests and natural vegetation.

- *Mountainous areas:* Rising temperatures will affect agriculture, biodiversity, energy production and consumption, and public health. Floods will affect agriculture, water resources, transportation, people's health and lives. The heavily affected groups are mainly people in mountainous areas, especially ethnic minorities and the elderly, women and children. Under the impact of heavy rains caused climate change, the intensity of flash floods tends to increase, causing greater impacts on people's lives.

### 3. EFFORTS IN CLIMATE CHANGE ADAPTATION

Vietnam has implemented many programs and projects to adapt to climate change.

*Climate monitoring, early warning of natural disasters*

The monitoring system for climate change and sea level rise has been developed and operated. Developing hydrometeorological forecasting technology; enhancing the accuracy in typhoon and tropical depression forecasts. Establishing the earthquake and tsunami warning system, warning of geological hazards and natural environmental disasters; establishing a set of zoning maps to provide warnings for different natural disasters.

*Natural disaster response, flood prevention for major cities, reinforcement of river dikes, sea dikes, and the safety of reservoirs*

- Consolidating irrigation infrastructure; developing and expanding clean water supply systems in rural areas; supporting residents in areas that are prone to floods and landslides; formulating plans to relocate and resettle residents in areas frequently hit by floods, typhoons, flash floods and landslides; adjusting production plans and infrastructure to adapt to and limit the negative impacts of climate change;

- Proactively undertaking natural disaster prevention, focusing on areas vulnerable to natural disasters; improving the capacity of search, rescue and

disease prevention; implementing flood prevention planning in the Day and Red - Thai Binh River systems; protecting flood drainage spaces in the river basins like the Red - Thai Binh River, Mekong, Cau, Nhue - Day, Dong Nai, and Saigon Rivers and other major rivers; constructing drainage works;

- Repairing and improving dam safety in the North, Central Coastal regions and Central Highlands; building new large reservoirs in the Central Northern, Central Southern Coastal regions and Central Highlands; building new small reservoirs and spillway clusters in the Northern mountainous regions; repairing and upgrading irrigation systems in the Red River Delta; completing and finalizing the irrigation systems, expanding flood drainage canals and regulating sewers in the Mekong River Delta; continuing the investment program to reinforce, protect and upgrade sea dikes from Quang Ninh to Quang Nam and from Quang Ngai to Kien Giang provinces;

- Promoting measures to prevent and mitigate impacts of high tides, inundation, and saline intrusion; developing flood risk maps based on sea level rise scenarios at the commune level; implementing flood prevention schemes for Ho Chi Minh City, Can Tho, Ca Mau and other coastal cities, especially those in the Mekong River Delta;

*Ensuring food security*

Transforming crop structure, developing large-scale agricultural production; researching, selecting, creating and applying new plant and animal species adaptable to climate change; constructing irrigation works for production restructuring; restructuring public investment, significantly directing investment capital into irrigation to serve multiple purposes; prioritizing capital for implementation of irrigation for upland crops, high-value industrial plants and for aquaculture; facilitating and ensuring the interests of the parties involved in agricultural insurance and risk-sharing.

*Ensuring water security*

Formulating and implementing the national master plan on water resources and the consolidated master plan for river basins, integrated with climate change; implementing solutions to ensure water security in the context of climate change; determining the minimum flow on rivers, streams and downstream of reservoirs and dams; promulgating legal documents on incentives for thrifty use of water and restriction of underground water exploitation; developing criteria for products, equipment and technologies for economical use of water.

*Building climate-resilient communities*

Enhancing community capability and participation in climate change response; focusing on local response



experiences and the role of governments at all levels and community organisations; developing sustainable livelihood; improving public health and access to basic healthcare and education services; promoting the use of local knowledge in responding to climate change

*Protecting and sustainably developing forests and preservation of biodiversities*

Conserving and improving forest carbon stocks; protecting and restoring forests, planting mangroves and coastal protection forests; protection of ecosystems and conservation of biodiversity achieved a number of important results.

#### 4. SOLUTIONS AND LESSONS FOR VIETNAM

Many climate change solutions can deliver economic benefits while improving our lives and protecting the environment. We also have global frameworks and agreements to guide progress, such as the Sustainable Development Goals, the UN Framework Convention on Climate Change and the Paris Agreement. Three broad categories of action are: cutting emissions, adapting to climate impacts and financing required adjustments.

Switching energy systems from fossil fuels to renewables like solar or wind will reduce the emissions driving climate change. But we have to start right now. While a growing coalition of countries is committing to net zero emissions by 2050, about half of emissions cuts must be in place by 2030 to keep warming below 1.5°C. Fossil fuel production must decline by roughly 6 per cent per year between 2020 and 2030.

Adapting to climate consequences protects people, homes, businesses, livelihoods, infrastructure and natural ecosystems. It covers current impacts and those likely in the future. Adaptation will be required everywhere, but must be prioritized now for the most vulnerable people with the fewest resources to cope with climate hazards. The rate of return can be high. Early warning systems for disasters, for instance, save lives and property, and can deliver benefits up to 10 times the initial cost.

Vietnam has adopted the National Climate Change Strategy for 2050, which guides action, including during the 2021-2025 period, by enhancing climate resilience and adaptation across natural, economic, and social systems. Key strategies include building resilient agriculture, strengthening forest protection, developing adaptive infrastructure, and improving disaster preparedness through modern monitoring and forecasting systems. The nation is also working on reducing methane emissions and managing greenhouse gases, with a specific action plan targeting a 30% reduction by 2030 compared to 2020 levels.

Vietnam is one of the countries most vulnerable to the impacts of climate change, particularly sea-level rise and extreme weather. To mitigate these risks, the country must implement a comprehensive strategy that includes both global cooperation and domestic action.

*Transition to renewable energy:* Vietnam should accelerate its shift from fossil fuels to renewable energy sources like solar, wind, and hydropower. The country has significant potential for solar and wind energy, especially in its coastal and central regions. Investing in smart grid technology and energy storage will be crucial for this transition.

*Promote sustainable agriculture:* The agricultural sector is a major source of emissions. Solutions include: Adopting climate-smart farming techniques that reduce methane emissions from rice paddies; improving livestock management to capture and utilize methane; promoting efficient use of fertilizers to cut nitrous oxide emissions.

*Coastal and urban adaptation:* With a long coastline, Vietnam is highly susceptible to sea-level rise. The country must invest in building resilient coastal infrastructure, restoring mangrove forests, and developing urban planning strategies that account for rising sea levels and increased flood risks.

*International cooperation:* Vietnam must actively participate in global climate initiatives, such as the Paris Agreement. By collaborating with international partners, Vietnam can gain access to crucial funding, technology, and expertise to support its green transition.

*Education and awareness:* A national effort to educate the public and policymakers about the urgency of climate change is essential. This can drive behavioral changes and build public support for green policies.

In conclusion, addressing climate change and GHG emissions requires a multifaceted approach that combines technological innovation, policy reform, and international collaboration. For Vietnam, the path forward involves a strategic shift toward a sustainable, low-carbon economy to protect its people, environment, and long-term economic prosperity ■

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