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AIR POLLUTION

IN VIET NAM

UNIDO COUNTRY OFFICE IN VIET NAM

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This document has been produced without formal United Nations editing. The designations employed and the presentation of the material in this document do not imply the expression of any opinion whatsoever on the part of the Secretariat of the United Nations Industrial Development Organization (UNIDO). The document is a summary of chapters 1, 2, and 3 of the State of the Environment published in 2014 by the Ministry of Natural Resources and Environment.

The document was translated from Vietnamese into English using google translate and was then revised to remain coherent. The Ministry of Natural Resources and Environment is looking for sponsors to translate, print, and distribute the State of the Environment 2013 on air pollution. For more information, please contact: Ms. Phan Nhung from the Vietnam Environment Administration (VEA) - nhungphanvn@gmail.com .

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Introduction by the author

This executive summary of the State of Environment 2014 will give a short introduction on the state of air pollution in Viet Nam. The Ministry of Natural Resources and Environment is awaiting sponsors to translate, print, and distribute the State of Environment 2014, dedicated to air pollution. The PDF in Vietnamese of the State of Environment 2014 can be retrieved on the following link:

http://cem.gov.vn/VN/BAOCAO_Content/tabid/356/Cat/101/nfriend/1020001/language/vi-VN/Default.aspx

Air pollution is a rising concern in Viet Nam and is especially of real concerns in urban areas and industrial zones. In 2010, the Global Burden of Disease found that air pollution is a much more public health risk than previously known-contributing annually up to 2.1 million deaths in Asia (Lim, S., et al., 2013). Viet Nam is affected in many ways by air pollution. Indeed, air pollution is not only a health concern but is also an environmental hazard. Viet Nam ranks the sixth most vulnerable country to climate change and is frequently cited as the one of the most environmentally vulnerable countries in the world (German Watch, 2014). Viet Nam is prone to devastating storms and rising sea levels, especially in the Mekong Delta and Red River Basin.

Viet Nam is involved in the process of mitigating its greenhouse gas emissions. The country has committed itself to mitigate its greenhouse gas, as part of the green growth strategy, and to reduce the intensity of greenhouse gas emissions by 8 to 10% by 2050, compared to 2010 levels. The commitment of Viet Nam sets an example for middle-income countries to do the same. Economic development is often seen in opposition to environmental protection. Mechanisms however, exist to mitigate air pollution. In Viet Nam, UNIDO is involved for instance, in retrofitting existing industrial parks into eco-industrial parks. The project is expected to save 182,000 tons of CO2 a year. Although incomplete, the executive summary of the State of the Environment 2014 introduces the issues of today and the challenges of tomorrow for a country that is and will even more be in the future affected by climate change.

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List of main air pollutants

Pollutant	Pollutant Details	Sources	Harmful effects
PM10	Particulate matter: particles or droplets in the air that are up to 10 micrometers in size	Motor vehicles, factories, power plants, agriculture, fires, burning of solid fuels	Lung diseases (WHO Air Quality Guidelines: 20 µg/m3 annual mean, 50 µg/m3 24-hour mean)
PM2.5	Fine particulate matter: particles or droplets in the air that are up to 2.5 micrometers in size	Motor vehicles, factories, power plants, agriculture, fires, burning of solid fuels	Can travel deeper into lungs, causing lung and heart problems. (WHO Air Quality Guidelines: 10 µg/m3 annual mean, 25 µg/m3 24-hour mean)
CO	Carbon monoxide	Internal combustion engines including motor vehicles, incomplete burning of various fuels	Can cause harmful health effects by reducing oxygen delivery to the body's organs and tissues
SO2	Sulfur dioxide	Fossil fuel combustion at power plants and other industrial facilities, industrial processes	Adverse respiratory effects including bronchoconstriction and increased asthma symptoms; acid rain
NO2	Nitrogen dioxide. Contributes to the formation of ground-level ozone and fine particle pollution	Motor vehicles, power plants	Adverse effects on the respiratory system
Ozone (O3)	Ground-level ozone is created by chemical reactions between oxides of nitrogen (NOx) and volatile organic compounds (VOC) in the presence of sunlight. Today, ground-level ozone is often the main component of photochemical smog.	Motor vehicles, industrial facilities, electric utilities, gasoline vapors, chemical solvents	Chest pain, coughing, throat irritation, and congestion. Can worsen bronchitis, emphysema, and asthma, can reduce lung function and inflame the linings of the lungs. Repeated exposure may permanently scar lung tissue
Lead (Pb)	Lead (Pb) is a metal found naturally in the environment as well as in manufactured products. The major sources of lead emissions have historically been from fuels in on-road motor vehicles (such as cars and trucks) and industrial sources.	Ore and metals processing and piston-engine aircraft, waste incinerators	Affect the nervous system, kidney function, immune system, reproductive and developmental systems and the cardiovascular system. Lead exposure also affects the oxygen carrying capacity of the blood.

List of Abbreviations

AQI	Air Quality Index
BTX	Benzene, Toluene, Xylene
CH4	Methane
CO	Carbon monoxide
HW	Hazardous Waste
GDP	Gross Domestic Product
HCMC	Ho Chi Minh City
HTMT	Environmental status
IZ	Industrial Zone
H2S	Hydrogen Sulfide
HCl	Hydrogen chloride
NOx	Nitrogen Oxide
NO2	Nitrogen Dioxide
O3	Ozone
ODA	Official Development Assistance
Pb	Lead
PM1	Particulate Matter less than or equal to 1 micron
PM2,5	Particulate Matter less than or equal to 2.5 microns
PM10	Particulate Matter less than or equal to 1 micron
QCVN	Viet Nam National Technical Regulations
SO2	Sulfur dioxide
VEA	Vietnam Environment Administration
TCVN	Vietnamese Standard
TSP	Total Suspended particules
VOCs	Volatile Organic Compound

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CHAPTER 1

NATURAL AND ECONOMICS CONDITIONS

1.1. Introduction on climate, weather, forests, and urban areas in Viet Nam

1.1.1. Climate and weather

Air quality is affected by climate, weather, and many environmental elements. Natural elements such as speed wind, wind direction, temperature, solar radiation, humidity, rainfall, cloudiness, atmospheric steam, and their interactions, have a significant impact on the environment and thus on air quality. Air quality varies a lot in Viet Nam since it is a narrow country stretching over 15 latitudes with a diverse ecosystem. Air quality tends to vary much more in the Northern regions than in Viet Nam's Southern regions.

1.1.2. Urban Parks

Trees have the capacity to considerably reduce air pollution. Trees play a regulatory role in cities where air pollution is high. In Viet Nam, urbanization is rapid and green areas are not enough to absorb harmful pollutants. In cities, trees should ideally absorb 10m^2 of emitted gases per person. In Hanoi and Ho Chi Minh City, green areas absorb 2m^2 and 3,3m^2 of emitted gases per person, respectively. The lack of trees and green areas in cities contribute to the degradation of the urban air quality.

1.2. Economic Development

1.2.1. Economic growth and Urbanization

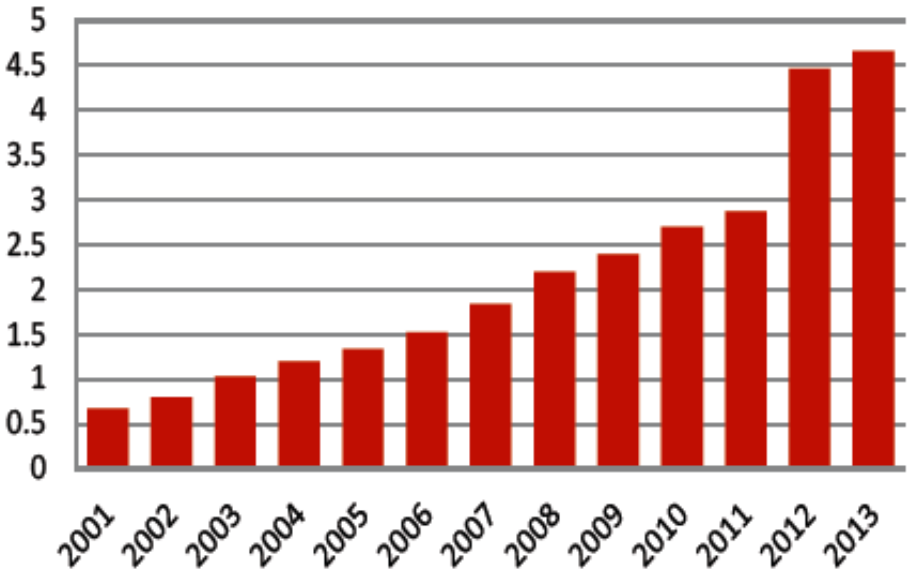
Viet Nam's rapid economic transformation and urbanization have accentuated environmental pressures. In the last 20 years, the number of urban areas has rapidly increased. While in 1990, there were 500 urban areas, in 2012 the country had 765 urban areas. The lack of urban planning, the use of private motor vehicles, and the limited public transportation systems are the main causes of the acceleration of air pollution in Vietnamese cities.

Table1. Number of motor vehicles nationwide for the period 2007-2011.

Year	2007	2009	2010	2011
Cars	1,106,617	1,137,933	1,274,084	1,428,002
Trucks	316,914	476,401	552,244	609,200
Motorcycles	21,721,282	-	-	33,906,433

Source: Department of Registration in Vietnam, 2011

Figure 1. Number of motorcycles in Hanoi for the period 2001- 2013



Source: Ministry of Transport, 2013

1.2.2. Industrial Activities

Mining operations

Viet Nam is a country rich in bauxite, iron, coal, titanium, and rare earth… It is estimated that there are around 5,000 mines. Industrial mining is concentrated in the northern region (coal, ore iron, ferrous...), and in the central and western regions (gold and other ores). Mining releases dust, wastewater, and toxic gases, which contribute to water and air pollution.

Energy industries

Energy production accounts for a large chunk or CO emissions in Viet Nam. It is estimated that up to 90% of energy production comes from fossil fuels, mostly coal, natural gas, or oil. Thermal power plants, using oil and gas, account for 44 to 46 percent of the total electricity produced, hydropower accounts for 32 to 36 percent of the total electricity produced, and the remaining 19 to 24 percent comes for coal and electricity coming from China. Power plants are using different levels of technologies. Some power plants are using state of the art technologies while others are using outdated technologies and are causing a high level of air pollution.

Manufacturing activities

The production of materials used for construction is resources-intensive. Between 2008 and 2012, the production of construction materials such as cement, clay bricks, brick kilns, and ceramic... has considerably increased. The production of construction materials is resources- and labor- intensive and lack in efficiency due to obsolete technologies. The production of cement is especially hazardous to air quality. Indeed, inefficiencies in the production of cement, which use furnace and rotary kiln, are consuming large amount of energy.

CHAPTER 2

SOURCES OF ENVIRONMENTAL AIR POLLUTION

2.1. Sources of Air Pollution

The main sources of air pollution include: transportation, manufacturing, building construction, agriculture, landfills, and waste treatment.

2.1.1. Transportation

In urban areas, transportation is the main source of air pollution. The air pollutants derived from burning motor fuels and include: CO, NOx, SO2, petrol vapor (CnHm, VOCs), PM10, and dust. The quantity of emissions from motor vehicles depends on the quality of the vehicle, the fuel, and the roads. Motorcycles are the largest emitters of CO, VOCs, TSP, while cars are the main contributors SO2, and NO2 emissions.

2.1.2. Manufacturing activities

Industries are significant contributors to air pollution. Production processes are most of the time inefficient and resources-intensive. The pollutants come from the combustion of fuels, boiler emissions, and volatile chemicals… Air pollution from industrial activity is often highly toxic. The emissions include dust, NO2, SO2, VOCs, TSP, chemicals, and metals, of these emissions SO2, NO2, and TSP are the main pollutants. The industrial activities, that have the most adverse effect on the environment, are: coal's mining and processing, steel production, construction materials, and thermal power plants.

Table 2. Industry groups and typical gases generated Sectors that produce emissions.

Energy production	SO2, CO, CO2, NO2, VOCs, black smoke
Thermal Power industry	Dust, CO, CO2, H2S, SO2, and NOx
Cement industry	Dust, NO2, CO2, F
Steel Industry	Dust, rust containing metal oxide (FeO, MnO, Al2O3, SiO2, CaO, MgO); contain CO2 emissions, SOx.
Apparel industry	Dust, Cl, SO2, PINGMENT, formaldehyde, HC, NaOH, NaClO
Manufacturing industry	CN, HCl, SiO2, CO, CO2
Metal industry	Dust, chemical fumes, solvent vapor, SO2, NO2
Chemical industry	Dust H2S, NH3, organic solvent vapors, chemical specialties, dust, SO2, CO, NO2
Crude oil industry	CO, SO2, NOx, HC steam
Coal processing	Dust, SO2, NOx, CO, CO2

Table 3. Estimated quantity of air pollutants coming from industrial activity in 2009.

Pollutants	(tons / year)	Percentage
NO2	655 899	18.52
SO2	1,117,757	31.56
VOC	267 706	7.56
TSP	673 842	19.02
Gases	143 569	4.05
Metal	960	0.03

Source: World Bank, 2010

Mining and coal processing: Coal's mining is using outdated technologies and thus cannot cope with the mining's adverse effects on air pollution. The pollutants from coal's mining primarily are: dust (TSP, PM10) and SO2, CO, NO2, CH4. The industry has implemented several mitigation measures such as covering trucks, filtering equipment… in order to minimize the impact of coal's mining on the environment.

Landfill and waste treatment: The effects of temperature, moisture, and the decomposition of organic materials in open landfills produce gases, CH4, 63.8%, CO2, 33.6%, and other gases). It is estimated that CH4 and CO2 emissions from landfills account for 3 to 19% of the total emission generated in Viet Nam.

2.2. Greenhouses gas emissions

Greenhouse gas emissions (CO2, CH4, N2O...) are rapidly globally growing rapidly. Viet Nam has monitored its CO2 emissions in 1993, 1998, and 2000. In 2000, the emissions were of 150.9 million tons CO2 equivalent. The rate of CO2 emission per capita in Viet Nam in comparison with the rest of the world is low.

Table 4. Est. % of greenhouse gas emissions per capita (tons of CO2 equ. / person).

	2004	2010
US *	20	21.6
Europe *	11	11
World average *	5	-
China *	4	-
Vietnam**	1.5	1.6

Source: (*) 101 Climate Change: Understanding and Responding to Global Climate Change, 2007. (**) Convention on Climate Change of the United Nations, 2003.

In 2000, the CO2 inventory shows that agriculture emitted 65 million tons of CO2 equivalent (accounting for 43.1%), followed by the energy sector (35%), the forestry sector account for 15.1 million tons, accounting for 10% of the total emissions.

CHAPTER 3

STATUS OF AIR QUALITY

The assessment of air quality is based on data from monitoring done by the VEA. Field samplings are realized at the local level 2 to 6 times a year. In addition, there are automated monitoring stations installed in large cities that provide with continuous data. The Ministry of Natural Resources and Environment uses 2 networks to monitor air quality in Viet Nam. A network of 10 stations for meteorological monitoring carried out in Hanoi, Haiphong, Ninh Binh, Vinh, Da Nang, Ho Chi Minh, Pleiku, Tho, and Son La. A network of 7 stations for environmental monitoring by the VEA in 556, Nguyen Van Cu (Hanoi) in operation since 2009; Ho Chi Minh Mausoleum (Hanoi) in operation since January 2012; Danang station in operation since 2011; Khanh Hoa station in operation since May 2012; Hue and Phu Tho stations in operations since May 2013, and Quang Ninh station in operation since October 2013.

The Air Quality Index (AQI) is frequently used by the government and agencies to communicate on air quality. The AQI is calculated by measuring the concentration of the following elements: SO2, CO, NOx, O3, and PM10.

Table 5. Air Quality Index (AQI) in the United States.

Air Quality Index (AQI) Values	Levels of Health Concern	Colors
When the AQI is in this range:	*...air quality conditions are:*	*...as symbolized by this color:*
0 to 50	Good	Green
51 to 100	Moderate	Yellow
101 to 150	Unhealthy for Sensitive Groups	Orange
151 to 200	Unhealthy	Red
201 to 300	Very Unhealthy	Purple
301 to 500	Hazardous	Maroon

Source: epa.gov

3.1. Air quality in urban areas

In Vietnamese urban areas, air quality has been deteriorating in the last years. In Hanoi for instance, from 2010 to 2013, 40 to 60 percent of the total observation had AQI rated unhealthy for sensitive groups (between 101 to 200). The concentration of dust is particularly high and can affect human health. There is a large discrepancy of the dust concentration between the dry and rainy season. In large cities, the noise level is frequently exceeding the noise limit of 70 dBA from 6am to 8pm, fixed by QCVN 26: 2010 / BTNMT.

Table 6. Sources of Air pollution in Vietnamese's main cities.

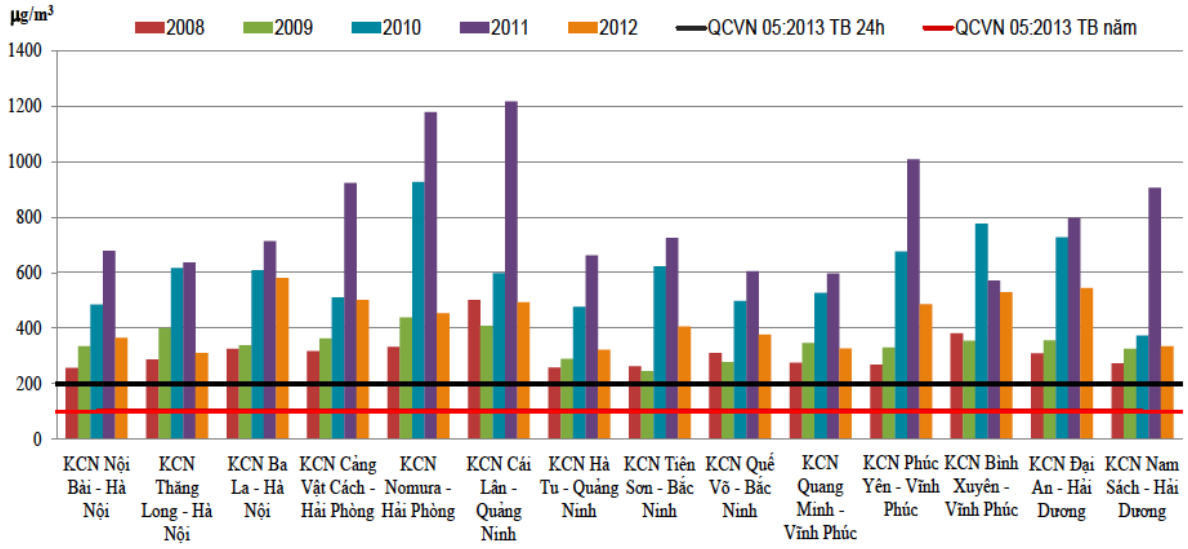
Province/City	Potential Sources of Air Pollution
Hanoi	Transport, construction, textile industry, glass factories
Ho Chi Minh City	Transport, construction, thermo-electric power, iron & steel processing
Da Nang City	Iron and steel processing, transport
Haiphong City	Cement factories, glass factories, transport
Can Tho City	Transport, construction
Dalat	Transport
Vinh City	Cement factories, paper mills
Bien Hoa	Transport
Thai Nguyen Province	Mining activities, steel production, thermo-electric power

Source: Camp Vietnam (2010).

3.2. Air quality in industrial zones

Industrial activities are one the most important contributors to the deterioration of air quality in Viet Nam. Industrial production is mostly performed in the 300 industrial zones that are currently in operation in the country. Although, the country experienced an economic slowdown, the air quality has deterioted in industrial zones.

Figure 2. TSP dust concentration in key industrial parks for the period 2008 – 2013.



Dust

Observation of dust concentration around industrial areas are well higher than thresholds allowed by QCVN 05: 2013. 2011 was the year with the highest dust concentration ever recorded. TSP concentrations were sometimes three times higher than the allowed threshold. The TSP concentration in industrial zones depends on the type of activities and technologies used. For the cement industries for instance, the quality of the furnace used will greatly limit air pollution. The TSP concentration around cement activities is quite high and range from 1.5 to 60 times the regulatory thresholds. In the mining activities for instance, TSP concentration is 8 to 12 times higher that of the allowed regulations.

SO2, NO2

The SO2 and NO2 concentrations surrounding industrial areas are low. The level of SO2 increased sharply near power plants, refineries, and industrial incinerators. NO2 tend to be higher the North than the South of Viet Nam, probably due to the difference between the type of industries in the Northern and Southern parts of the country.

Noise

In most of the industrial zones that are being monitored, noise levels are close to or exceed the regulations under NTR 26: 2010 / BTNMT. According to a study conducted by the VEA in residential areas adjacent to Bien Hoa Industrial Zone, half of the residents found the industrial zone to be noisy.

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