NPTEL ONLINE CERTIFICATION COURSES

Introduction to Environmental Engineering and Science – Fundamentals and Sustainability Concepts

Faculty Name: Dr. Brajesh Kumar Dubey
Department : Civil engineering

Week-11: Basics of Air Pollution Issues – Global and Local

Lecture 51: Introduction

CONCEPTS COVERED

- Basic of Air pollution
- Local and Global Issue

Pollution

Pollution is the introduction of contaminants into the natural environment that cause adverse change.

Types of pollutants

- On the basis of the form in which they persist

Primary Pollutants: These are the substance which are directly emitted from the source and will remain in that form. Examples: smoke, fumes, ash, dust, nitric acid and sulphur dioxide.

Secondary Pollutants: The substance which are formed by chemical reaction between the primary pollutants and constituent of the environment. Example: smog, ozone Sulphur trioxide, nitrogen dioxide.

- On the basis of degradation

Biodegradation: These are broken-down by the activity of microorganisms. Example of such pollutants are domestic waste products, urine and facial matter, sewage, agriculture residue, paper, wood and cloth, etc.

Non biodegradation: These are stronger chemical bondage, do not breakdown into simpler and harmless products. These include various insecticides and other pesticides, mercury, lead, arsenic, aluminium, plastics, radioactive waste, etc.

Types of Environmental Pollution

- Air pollution
- Water Pollution
- Land Pollution
- Noise Pollution
- Radioactive
- Thermal

Air pollution A Growing Hazard to Human Health

- Air pollution refers to the release of pollutants into the air that are detrimental to human health and the planet as a whole.
- Air pollution occurs when harmful or excessive quantities of substances including gases, particles, and biological molecules are introduced into Earth's atmosphere

Photo: www.thepinsta.com

- A rural stove usese biomass cakes, fuelwood and trash as cooking fuel. Surveys suggest over 100 million households in India use such stoves (chullahs) every day, 2–3 times a day.
- It is a major source of air pollution in India, and produces smoke and numerous indoor air pollutants at concentrations 5 times higher than coal. Clean burning fuels and electricity are unavailable in rural parts and small towns of India because of poor rural highways and limited energy generation infrastructure.

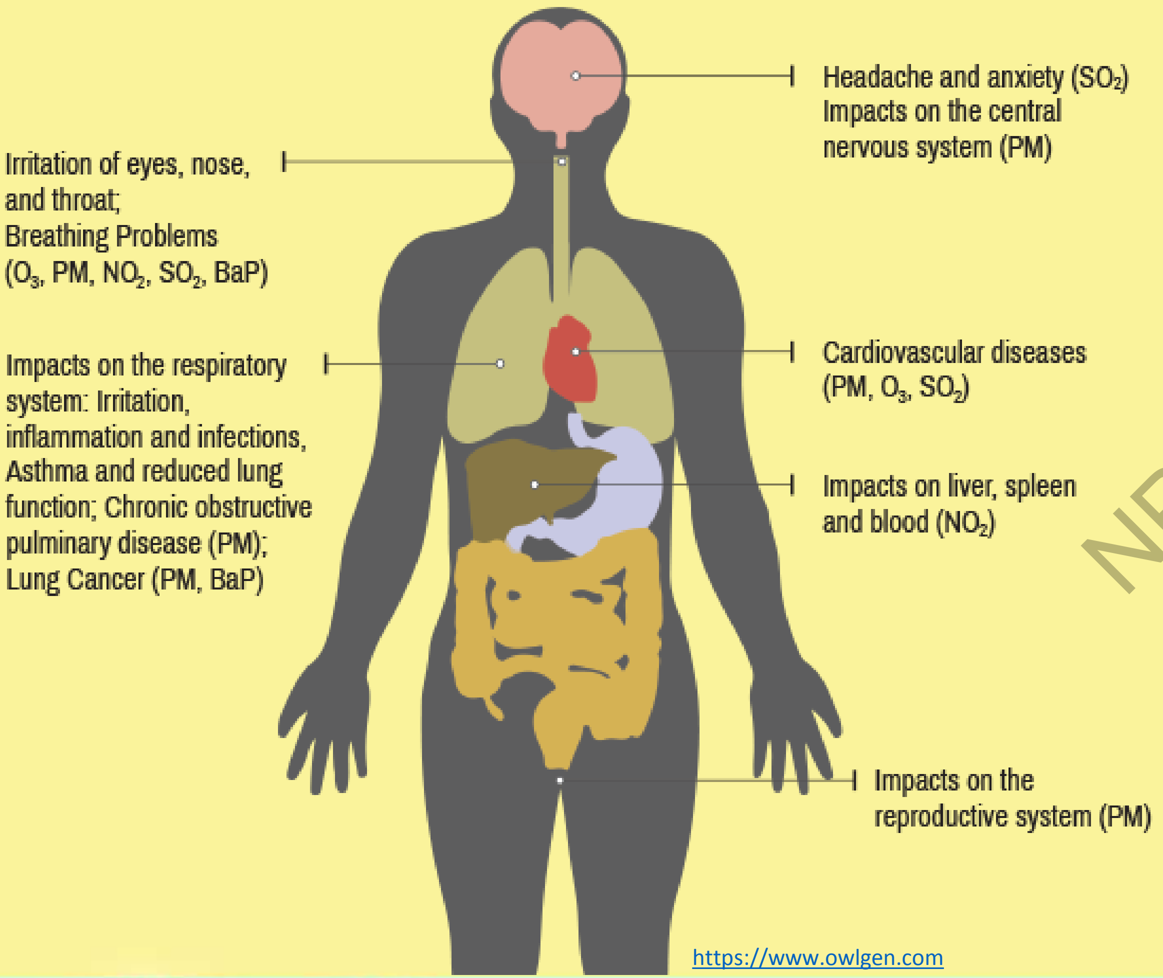
wikipedia.org

Residential biomass burning, open waste burning responsible for highest PM 2.5 exposure: Study

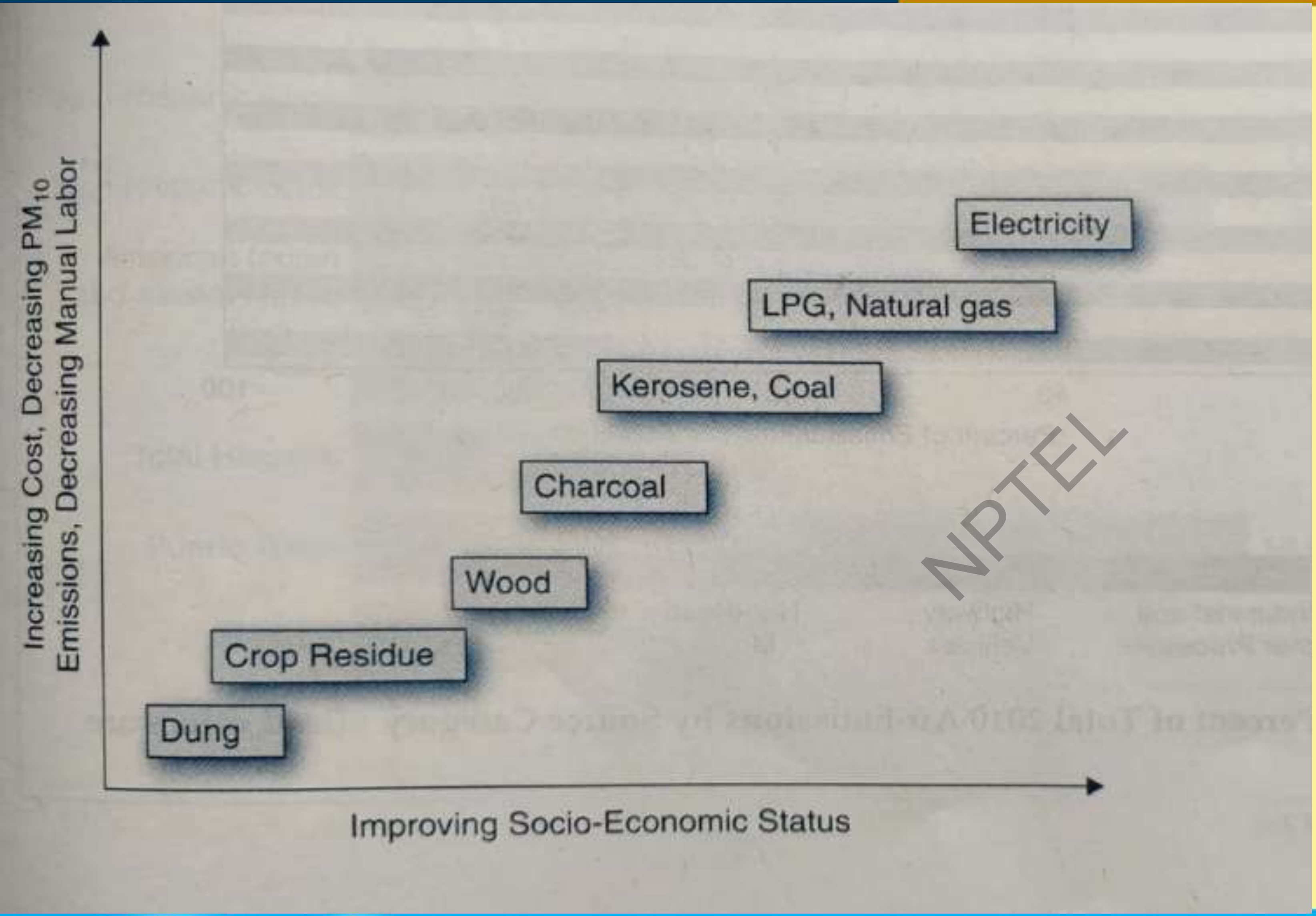
The smoke resulting from burning crop residues combined with vehicular emissions make the air we breathe deadly.

https://www.downtoearth.org.in/news/air/burning-paddy-fields-deteriorate-air-quality-in-delhi-51687

HEALTH EFFECTS OF AIR POLLUTION



https://www.owlgen.com



Energy ladder showing how changes in fuel type and PM_{10} emission are impacted by a household social and economic status.

Sources, Health Effects, and Other Information Associated with Criteria Air Pollutants (adapted from EPA, 2012a).

Pollutant	Sources	Health Effects	Other
articulate atter(PM)	Fuel combustion (for example, burning coal, wood, diesel); industrial processes; agriculture(plowing and burning fields); and emissions from unpaved roads.	Short-term exposures can aggravate heart or lung disease leading to respiratory symptoms, increased use of medication, hospital admissions, emergency room visits, and premature mortality. Long-term exposures can lead to the development of heart or lung disease and premature mortality.	Particulate matter is categorized by particle size; one grouping is into fine particles, or particles smaller than 2.5 µm in diameter ($PM_{2.5}$) and coarse particles, particles larger than that cutoff. Another commonly used category is PM_{10}, or particles smaller than 10 µm in diameter. Primary particles are generated directly from a source (for example, construction sites, agriculture fields, unpaved roads, fires, and smokestacks). Secondary particles are formed from reactions in the atmosphere (for example, precursors originate from power plants, industry, and vehicles).

Sources, Health Effects, and Other Information Associated with Criteria Air Pollutants (adapted from EPA, 2012a).

Pollutant	Sources	Health Effects	Other
Carbon monoxide (CO)	Fuel combustion (especially from vehicles)	Short-term exposures can aggravate heart or lung disease leading to respiratory symptoms, increased use of medication, hospital admission, emergency room visits, and premature mortality.	Produced from incomplete combustion of fuels, usually arising from an insufficient amount of air for the amount of fuel. Inadequate air-to-fuel ratio can be due to poorly operated or maintained equipment, airflow limitations, or low temperatures. While high levels are rarely encountered in the ambient atmosphere , asphyxiation can occur in indoor environments, often through a combination of poorly functioning heating systems and inadequate ventilation.

Sources, Health Effects, and Other Information Associated with Criteria Air Pollutants (adapted from EPA, 2012a).			
Pollutant	**Sources**	**Health Effects**	**Other**
Nitrogen oxides (NO_x) = (NO + NO_2)	Fuel combustion (for examples, electric utilities, industrial boilers, vehicles) and wood burning. From Results from the fact that air is rich in nitrogen.	Aggravate lung diseases leading to respiratory symptoms, hospital admissions, and emergency department visits. Increased susceptibility to respiratory infection.	Large amounts of air (that contains> 78% N_2) are used during the combustion of fossil fuels. The high temperature (and sometimes pressure) that can exist during fuel combustion produces NO, which is then quickly transformed to NO_2. Precursor to formation of ground-level ozone (O_3) (an important component of urban smog). NO_2 reacts to form nitric acid (HNO_3) in the atmosphere and important contributor to acid rain. Harms historical buildings and structures made of limestone or marble.

Sources, Health Effects, and Other Information Associated with Criteria Air Pollutants (adapted from EPA, 2012a).

Pollutant	Sources	Health Effects	Other
Sulfur dioxide (SO_2)	Fuel combustion (especially high sulfur coal); electric utilities and industrial processes. Natural sources such as volcanoes.	Aggravates asthma and increased respiratory symptoms. Contributions to particle formation with associated health effects.	Sulfur is present in many raw materials, including coal, oil, iron, aluminum, and copper. SO_2 reacts with water vapor to form sulfuric acid (H_2SO_4), the most important contributor to acid rain and to secondary particle formation. Harms historical buildings and structures made of limestone or marble.

Sources, Health Effects, and Other Information Associated with Criteria Air Pollutants (adapted from EPA, 2012a).

Ozone (O_3)	**Only criteria pollutant that has no direct sources. This secondary pollutants is typically formed by chemical reaction of VOCs and nitrogen oxides (NO_x) in the presence of sunlight.**	**Decreases lung function and causes respiratory symptoms, such as coughing and shortness of breath. Aggravates asthma and other lung diseases leading to increased medication use, hospital admissions, emergency room visits, and premature mortality.**	**Can damage sensitive plants, reducing crop yields and forest productivity. Reduces visibility, causing haze in the atmosphere.**

Sources, Health Effects, and Other Information Associated with Criteria Air Pollutants (adapted from EPA, 2012a)			
Pollutant	**Sources**	**Health Effects**	Other
Lead	Smelters(metal refineries) and other metal industries. Combustion of leaded gasoline in piston engineer aircraft. Waste incinerators Battery manufacturing	Damages the developing nervous system, resulting in IQ loss and impacts on learning, memory, and behavior in children. Cardiovascular and renal effects in adults and early effects related to anemia.	Leaded gasoline and paints are still used in many parts of the world, especially sub-Saharan Africa and parts of Asia. Contributes 11% of the global environmental risk.

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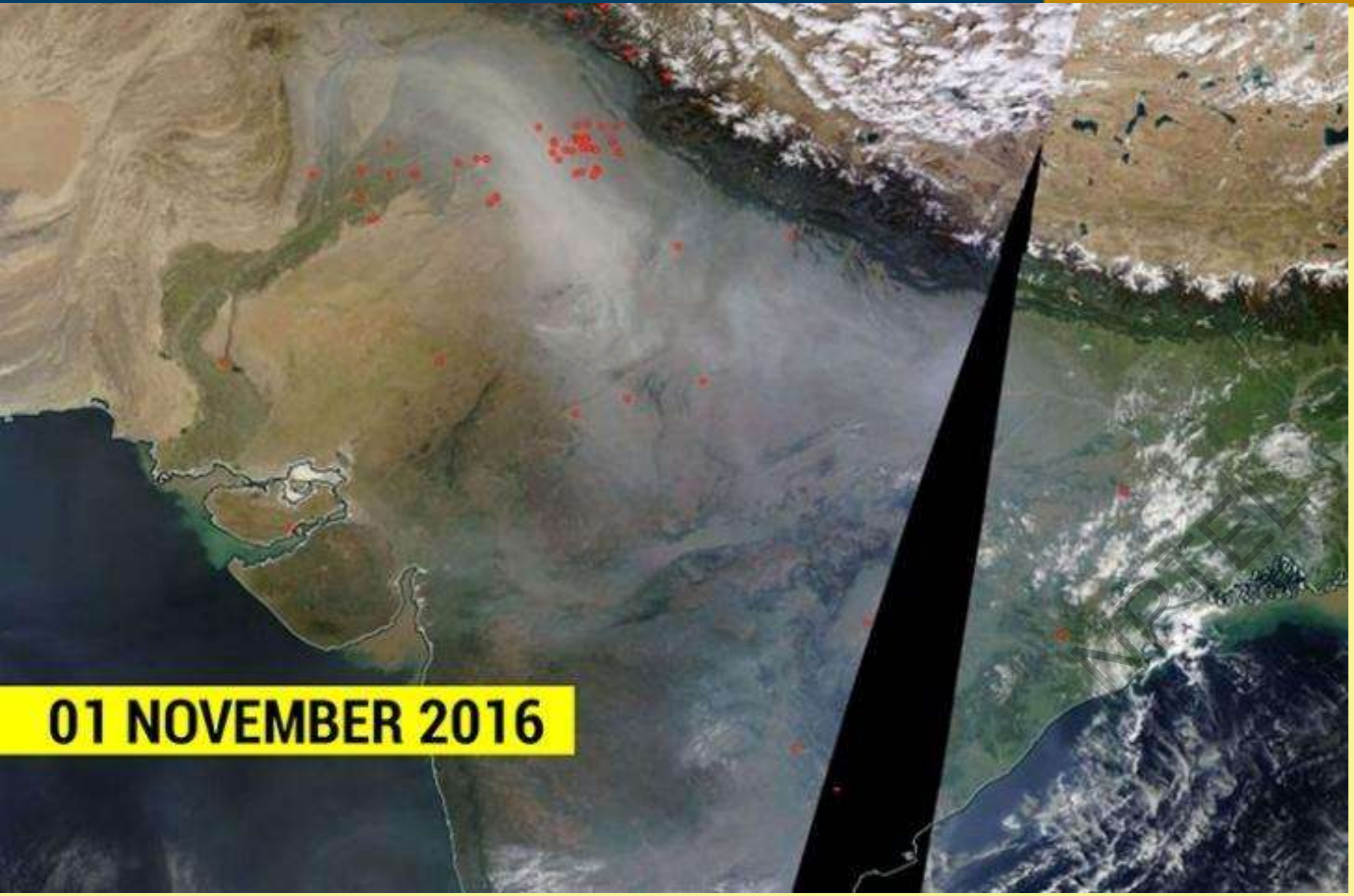
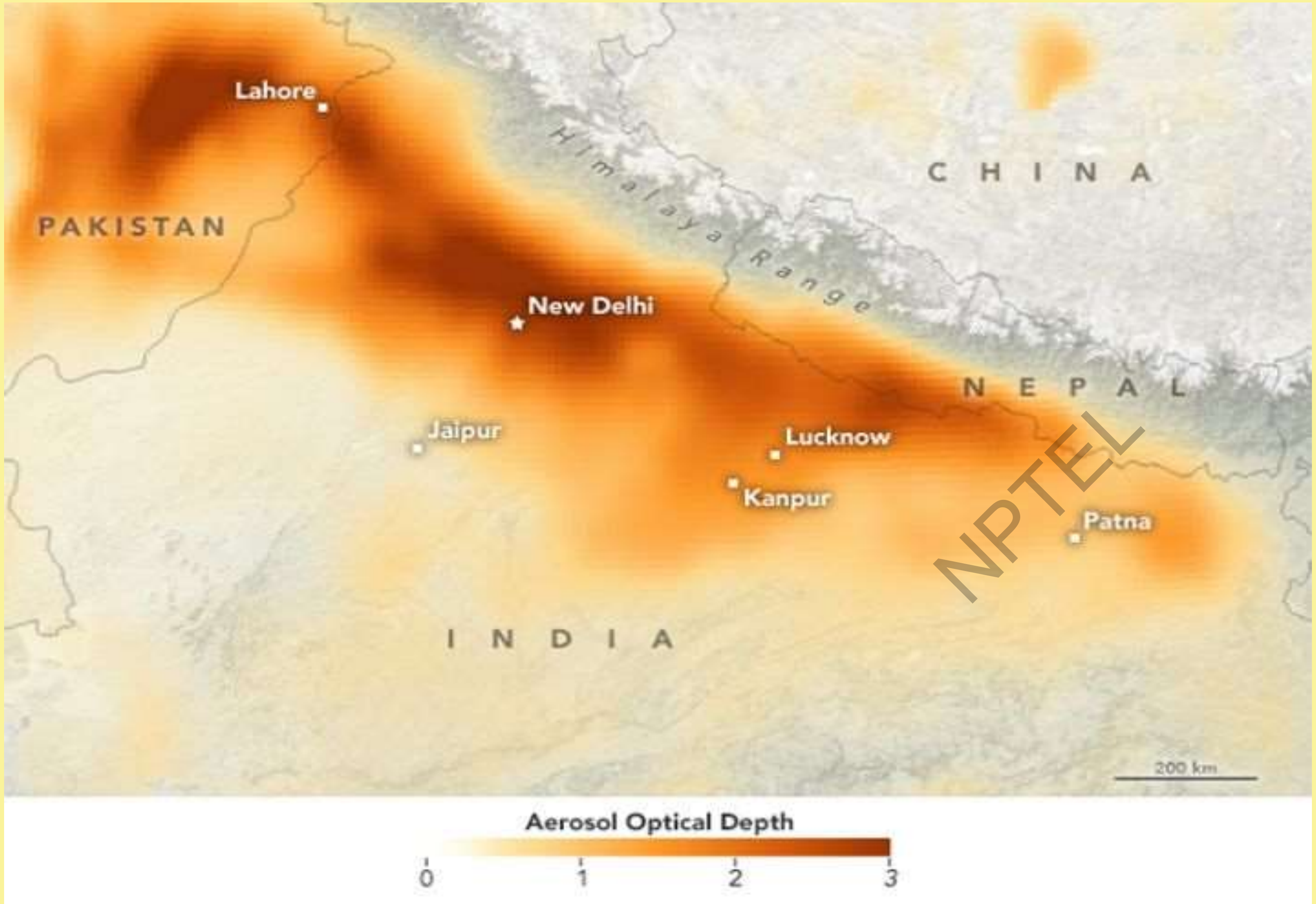
Lec 52: Air Pollutants & Air Pollution Index



NASA

A recently released NASA forecast shows high levels of ‘fires and thermal anomalies’ in the Punjab region of India and Pakistan. According to New York Times report, farmers are burning around 32 million tons of leftover straw.


CHINA
Fog
PAKISTAN
Haze
NEPAL
INDIA
200 km


Lahore
PAKISTAN
Himalaya Range
CHINA
New Delhi
NEPAL
Jaipur
Lucknow
Kanpur
Patna
INDIA
200 km
Aerosol Optical Depth
0
1
2
3

Mumbai chokes on garbage dump haze

https://edition.cnn.com/2016/02/05/asia/mumbai-giant-garbage-dump-fire/index.html

AQI Category, Pollutants and Health Breakpoints								
AQI Category (Range)	PM_{10} 24-hr	$PM_{2.5}$ 24-hr	NO_2 24-hr	O_3 8-hr	CO 8-hr (mg/m^3)	SO_2 24-hr	NH_3 24-hr	Pb 24-hr
Good (0-50)	0-50	0-30	0-40	0-50	0-1.0	0-40	0-200	0-0.5
Satisfactory (51-100)	51-100	31-60	41-80	51-100	1.1-2.0	41-80	201-400	0.5 – 1.0
Moderately polluted (101-200)	101-250	61-90	81-180	101-168	2.1- 10	81-380	401-800	1.1-2.0
Poor (201-300)	251-350	91-120	181-280	169-208	10-17	381-800	801-1200	2.1-3.0
Very poor (301-400)	351-430	121-250	281-400	209-748*	17-34	801-1600	1200-1800	3.1-3.5
Severe (401-500)	430 +	250+	400+	748+*	34+	1600+	1800+	3.5+

*One hourly monitoring (for mathematical calculations only)

http://pib.nic.in/newsite/PrintRelease.aspx?relid=110654

AQI Category	Associated Health Impact
Good (0 to 50)	Minimal impact
Satisfactory (51 to 100)	May cause minor breathing discomfort to sensitive people
Moderately Polluted (101 to 200)	May cause breathing discomfort to the people with lung disease such as asthma and discomfort to people with heart disease, children and older adults
Poor (201 to 300)	May cause breathing discomfort to people on prolonged exposure and discomfort to people with heart disease
Very Poor (301 to 400)	May cause respiratory illness to the people on prolonged exposure. Effect may be more pronounced in people with lung and heart diseases
Severe (401 to 500)	May cause respiratory effects even on healthy people and serious health impacts on people with lung/heart diseases. The health impacts may be experienced even during light physical activity

http://www.indiatogether.org/air-quality-index-colour-coding-in-india-cities-environment

National Ambient Air Quality Standards (NAAQS)

Pollutant	Time Weighted Average	Concentration of Ambient Air industrial Area	Residential Rural and Other Area	Sensitive Area	Method of Measurement
Respirable particulate matter (RPM)	Annual 24 h	120 µ g/m^3 150 µ g/m^3	60 µ g/m^3 100 µ g/m^3	50 µ g/m^3 75 µ g/m^3	Respirable particulate matter sampler
Lead (Pb)	Annual 24 h	1.0 µ g/m^3 1.5 µ g/m^3	0.75 µ g/m^3 1.0 µ g/m^3	0.50 µ g/m^3 0.75 µ g/m^3	AAS method after sampling using EPM 2000 or equivalent filter paper
Carbon Monoxide (CO)	8 h 1 h	5.0 µ g/m^3 10.0 µ g/m^3	2.0 µ g/m^3 4.0 µ g/m^3	1.0 µ g/m3 2.0 µ g/m3	Non-disbersive infrared spectroscopy

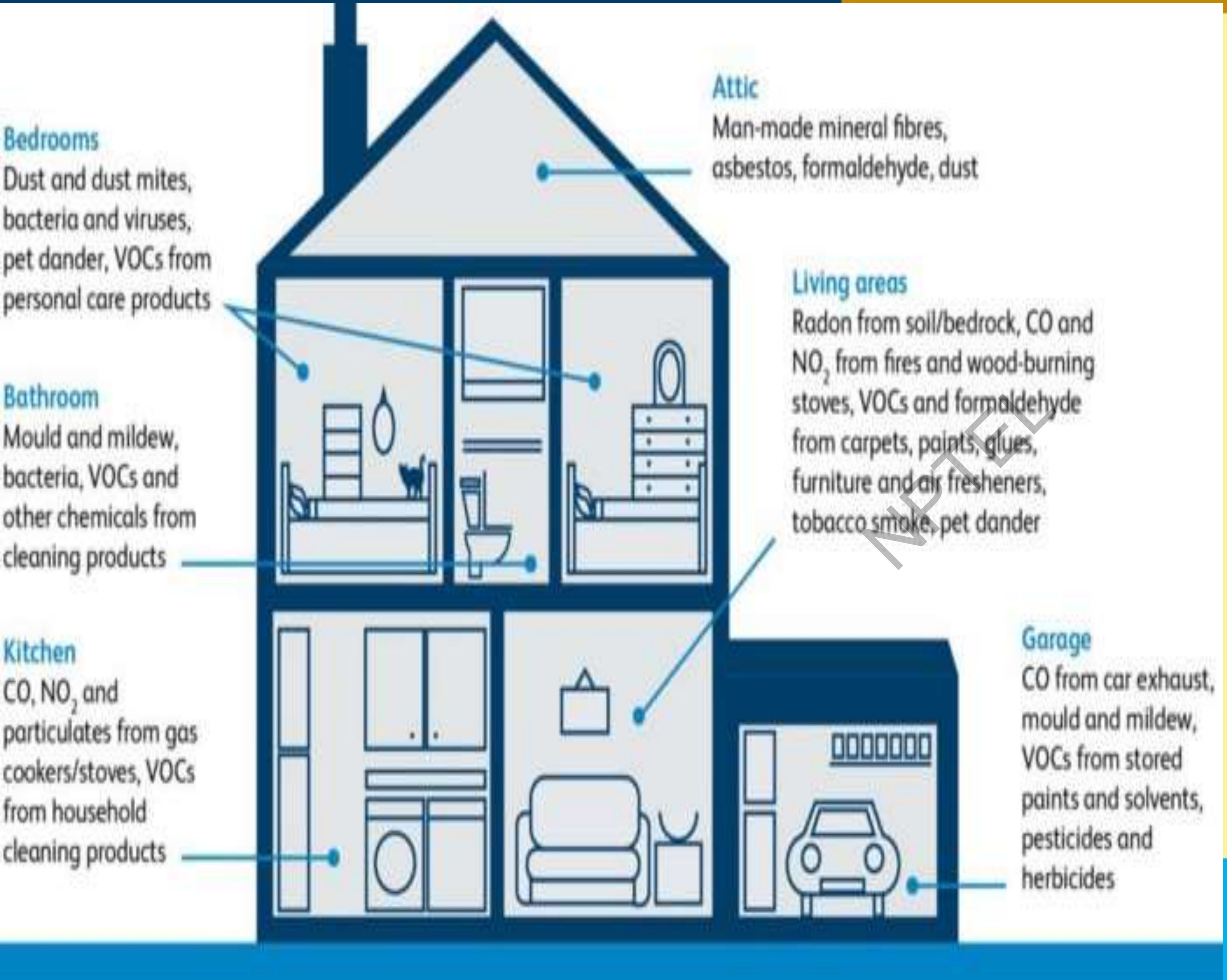
Sulphur dioxide (SO_2)	**Annual 24 h**	**80 µ g/m^3 120 µ g/m^3**	**60 µ g/m^3 80 µ g/m^3**	**15 µ g/m^3 30 µ g/m^3**	**Improved west and Gacke method Ultraviolet fluorescence**
Oxides of nitrogen (NO_2)	Annual 24 h	80 µ g/m^3 120 µ g/m^3	60 µ g/m^3 80 µ g/m^3	15 µ g/m^3 30 µ g/m^3	Jacab Hochheister modified(Na-Arsertine method) Gas phase chemilumine scene
Suspended particulate matter (SPM)	Annual 24 h	360 µ g/m^3 600 µ g/m^3	140 µ g/m^3 200 µ g/m^3	70 µ g/m^3 100 µ g/m^3	High volume sampling (average floe rate not less than 1.1 m^3/minute

Indoor Air Pollution (IAP) Statistics

- 4.2 million deaths every year as a result of exposure to ambient (outdoor) air pollution.
- 3.8 million deaths every year as a result of household exposure to smoke from dirty cookstoves and fuels.
- 91%of the world's population lives in places where air quality exceeds WHO guideline limits.
- Exposure to household air pollution almost doubles the risk for childhood pneumonia and is responsible for 45% of all pneumonia deaths in children less than 5 years old.
- Household air pollution is also risk for acute lower respiratory infections (pneumonia) in adults, and contributes to 28% of all adult deaths to pneumonia.

Source: World Health Organisation

Sources of Indoor Air Pollution



https://medium.com/@AirmidHealth/air-pollution-not-just-an-outdoors-problem-ece46cb6a775

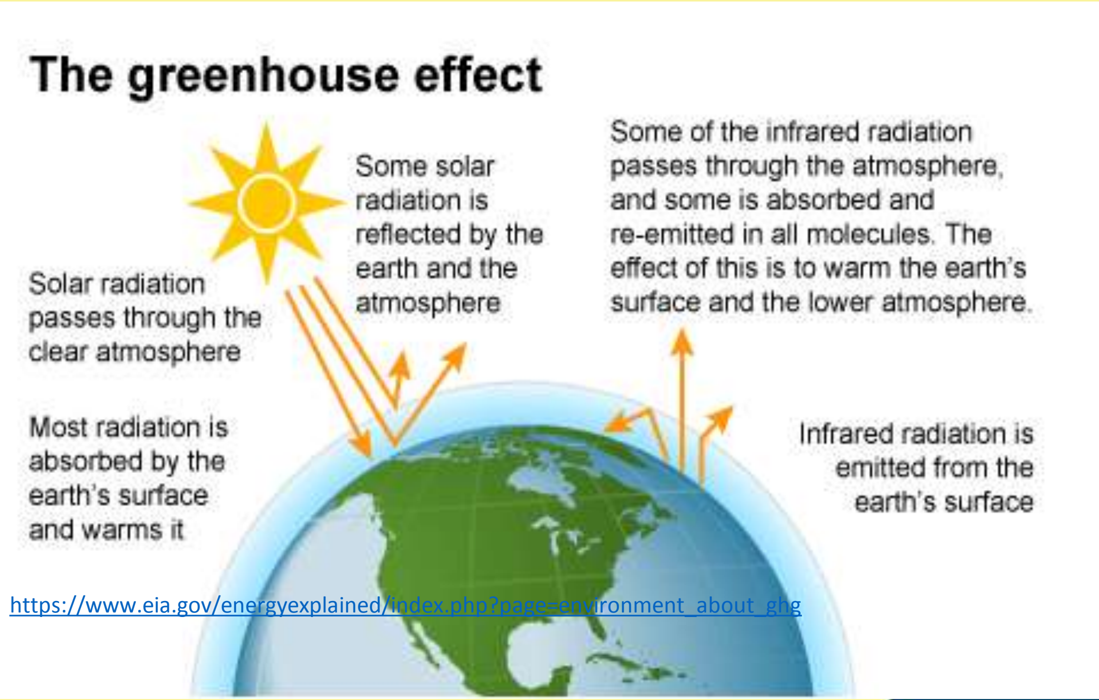
Global climate Change and Global Warming

- Around 3 billion people cook using polluting open fires or simple stoves fuelled by kerosene, biomass (wood, animal dung and crop waste) and coal.
- Each year, close to 4 million people die prematurely from illness attributable to household air pollution from inefficient cooking practices using polluting stoves paired with solid fuels and kerosene.
- Household air pollution causes non-communicable diseases including stroke, heart disease, chronic obstructive pulmonary disease (COPD) and lung cancer.
- Close to half of deaths due to pneumonia among children under 5 years of age are caused by particulate matter (soot) inhaled from household air pollution.

Source: World Health Organisation 2006

Greenhouse Effect

Many of the chemical compounds in the earth's atmosphere act as greenhouse gases. When sunlight strikes the earth’s surface, some of it radiates back toward space as infrared radiation (heat). Greenhouse gases absorb this infrared radiation and trap its heat in the atmosphere, creating a greenhouse effect that results in global warming and climate change.



https://www.eia.gov/energyexplained/index.php?page=environment_about_ghg

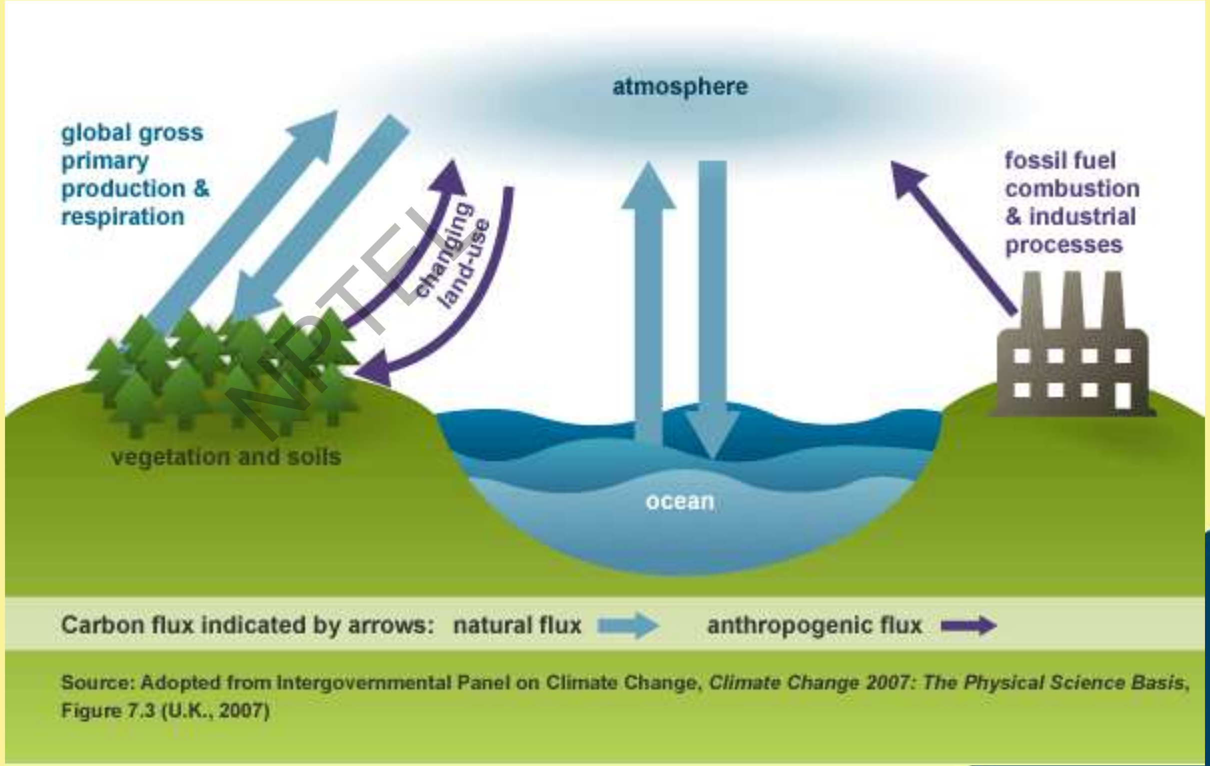
Did you know?

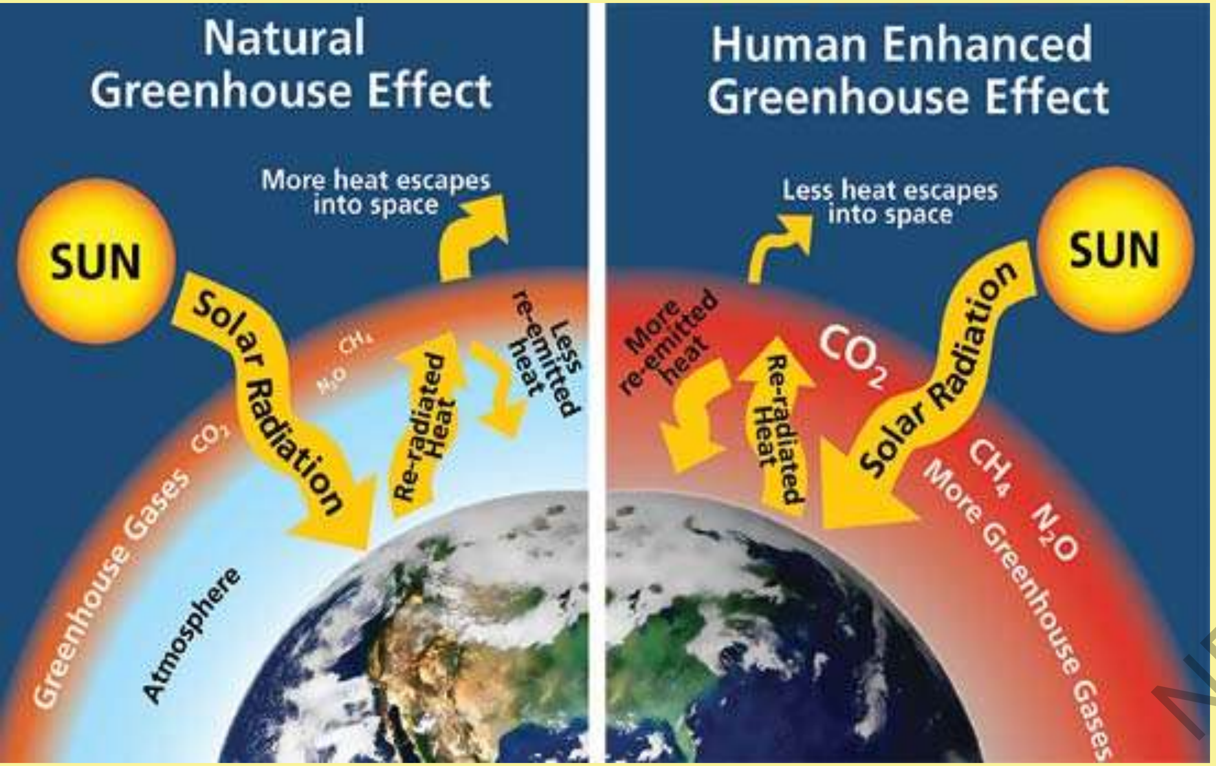
Without naturally occurring greenhouse gases, the earth would be too cold to support life as we know it. Without the greenhouse effect, the average temperature of the earth would be about -2°F rather than the 57°F we currently experience.

What are the types of greenhouse gases?

Several major greenhouse gases that result from human activity are included in U.S. and international estimates of greenhouse gas emissions:

- Carbon dioxide (CO_2)
- Methane (CH_4)
- Nitrous oxide (N_2O)
- Industrial gases:
    - Hydrofluorocarbons (HFCs)
    - Perfluorocarbons (PFCs)
    - Sulfur hexafluoride (SF_6)
    - Nitrogen trifluoride (NF_3)





https://socratic.org/questions/what-is-the-different-between-the-greenhouse-effect-and-global-warming

What is the relationship between global warming and the greenhouse effect?

The greenhouse effect is a natural process traps heat in the atmosphere - global warming tends to be when additional greenhouse gases are released into the atmosphere and this causes a warming event.

What are the long-term effects of climate change/global warming ?

Scientists have predicted that long-term effects of climate change will include a decrease in sea ice and an increase in permafrost thawing, an increase in heat waves and heavy precipitation, and decreased water resources in semi-arid regions.

https://climate.nasa.gov/effects/

Below are some of the regional impacts of global change forecast by the Intergovernmental Panel on Climate Change:

- North America: Decreasing snowpack in the western mountains; 5-20 percent increase in yields of rain-fed agriculture in some regions; increased frequency, intensity and duration of heat waves in cities that currently experience them.
- Latin America: Gradual replacement of tropical forest by savannah in eastern Amazonia; risk of significant biodiversity loss through species extinction in many tropical areas; significant changes in water availability for human consumption, agriculture and energy generation.
- Europe: Increased risk of inland flash floods; more frequent coastal flooding and increased erosion from storms and sea level rise; glacial retreat in mountainous areas; reduced snow cover and winter tourism; extensive species losses; reductions of crop productivity in southern Europe.

- Africa: By 2020, between 75 and 250 million people are projected to be exposed to increased water stress; yields from rain-fed agriculture could be reduced by up to 50 percent in some regions by 2020; agricultural production, including access to food, may be severely compromised.
- Asia: Freshwater availability projected to decrease in Central, South, East and Southeast Asia by the 2050s; coastal areas will be at risk due to increased flooding; death rate from disease associated with floods and droughts expected to rise in some regions

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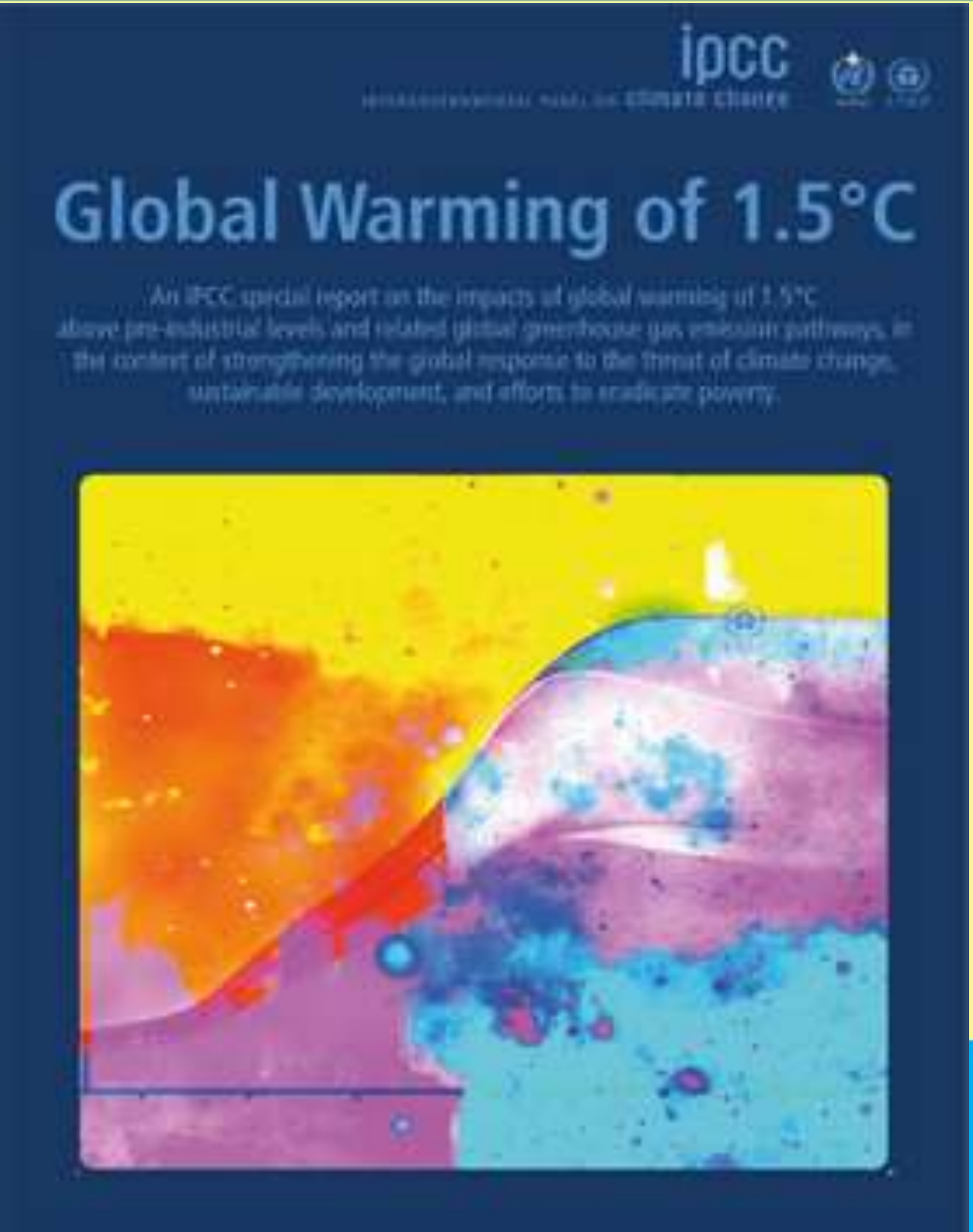
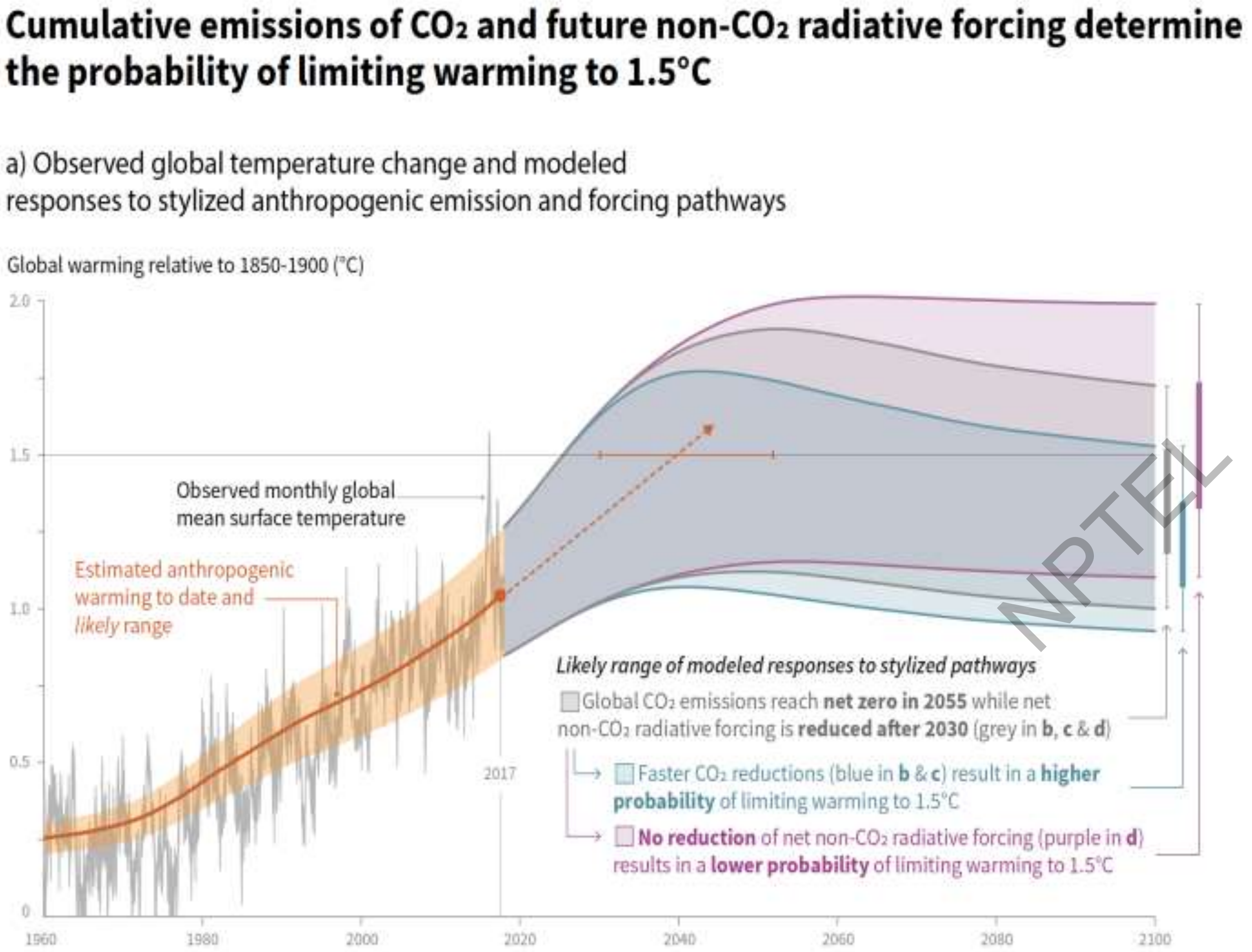
Lec 53: Global Warming and Climate Change

Special Report on Global Warming of 1.5 °C



It has been described as the most important report ever published in the 30-year history of the Intergovernmental Panel on Climate Change (IPCC) and an “ear-splitting wake-up call to the world.”



Limiting warming to 1.5 °C is technically possible within the laws of physics, according to the report. But this would entail global emissions of carbon dioxide declining by about 45% from 2010 levels by 2030 to zero by 2050. At the current rate of emissions, the world will reach 1.5 °C warming by between 2030 and 2052 and is on track for more than 3 °C to 4 °C warming by 2100.

“This report by the world’s leading climate scientists is an ear-splitting wake-up call to the world. It confirms that climate change is running faster than we are – and we are running out of time,”
declared UN Secretary-General António Guterres.

The report highlights a number of impacts which could be limited by lower temperature increases.

Sea level rise

•Sea level will continue to rise well beyond 2100, when it is projected to be 26 to 77 cm higher than the 1986–2005 baseline under a 1.5 °C temperature increase, about 10 cm lower than for a global warming of 2 °C.

•This would mean that up to 10 million fewer people would be exposed to related impacts such as saltwater intrusion, flooding and damage to infrastructure in low-lying coastal areas and small islands.

•Exceeding 1.5 °C risks triggering instabilities in the Greenland and Antarctic ice sheets, which could result in multi-metre rise in sea level over hundreds to thousands of years.

Ocean health

Limiting global warming would slow the increases in ocean temperature and acidity and decreases in ocean oxygen levels and so would reduce risks to marine biodiversity, fisheries, and ecosystems. But with 1.5 °C, coral reefs are expected to decline by 70–90%, whereas more than 99% would be lost with 2 °C.

Sea ice

The likelihood of an Arctic Ocean free of sea ice in summer would be once per century with global warming of 1.5 °C, compared with at least once per decade with 2 °C.

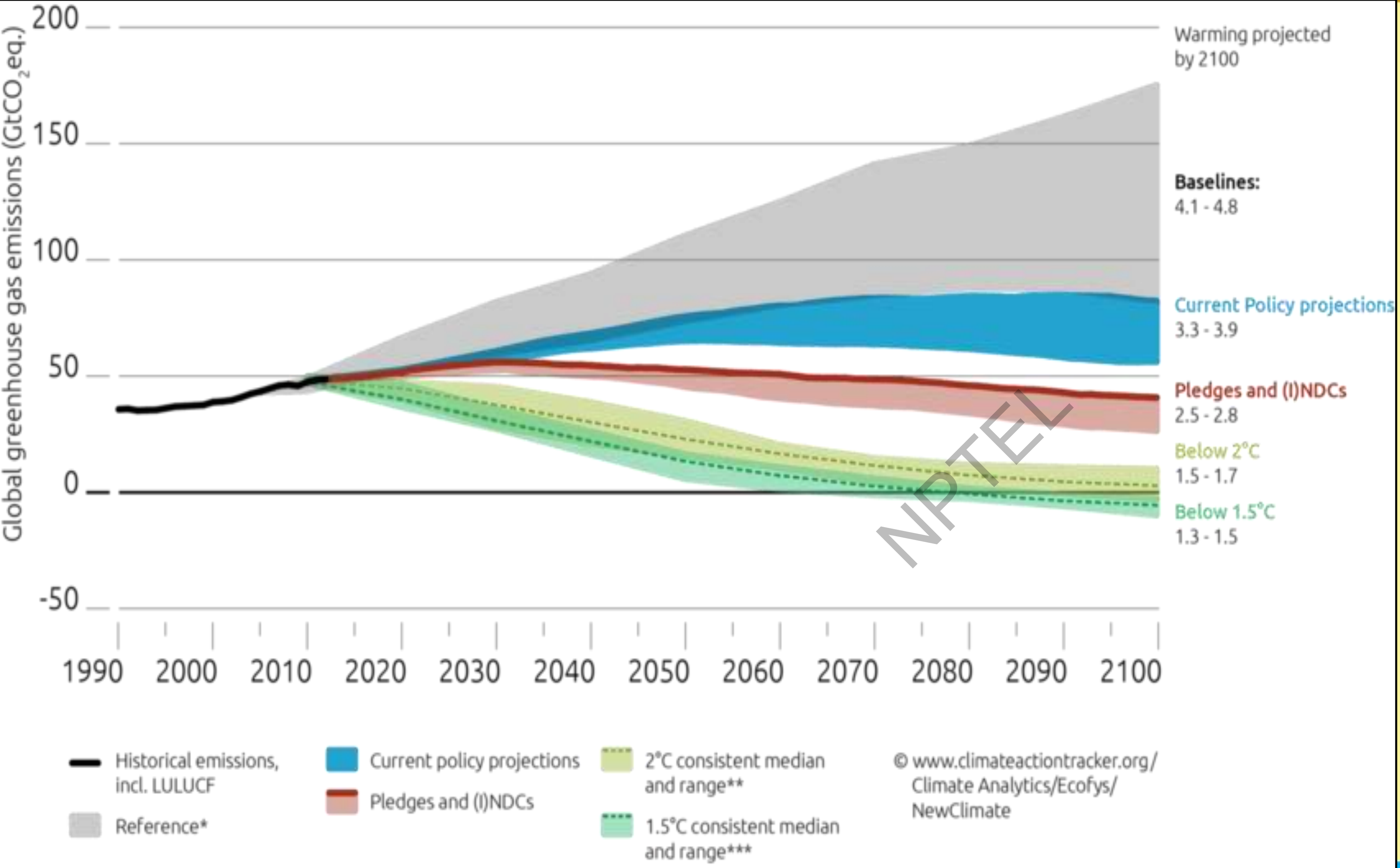
Biodiversity

Impacts on biodiversity and ecosystems, including species loss and extinction, will be lower at 1.5 °C but will still hit thousands of species. Six percent of insects, 8% of plants and 4% of vertebrates are projected to lose over half of their climatically determined geographic range for global warming of 1.5 °C, compared with 18% of insects, 16% of plants and 8% of vertebrates for global warming of 2 °C. High-latitude tundra and boreal forests are particularly at risk of climate change-induced degradation and loss.

- Extreme events: Climate models predict increases in mean temperature in most land and ocean regions, hot extremes (increased number of days with temperature up to 3 °C higher) in most inhabited regions, increased frequency, intensity and/or amount of heavy precipitation in several regions, and increased intensity and frequency of droughts and precipitation deficits in some regions. There are big regional differences, with a particularly high risk for the Mediterranean, sub-Saharan Africa and Small Island States.
- Human welfare: Climate-related risks to health, livelihoods, food security, water supply, human security, and economic growth are projected to increase with global warming of 1.5 °C and increase further with 2 °C. Limiting warming to 1.5 °C rather than 2 °C could result in 420 million fewer people being exposed to severe heat waves.

- Water

Depending on future socioeconomic conditions, limiting global warming to 1.5 °C, compared to 2 °C, might reduce the proportion of the world population exposed to a climate change induced increase in water scarcity by up to 50%.



* 5%-95% percentile of AR5 WGIII scenarios in concentration category 7, containing 64% of the baseline scenarios assessed by the IPCC

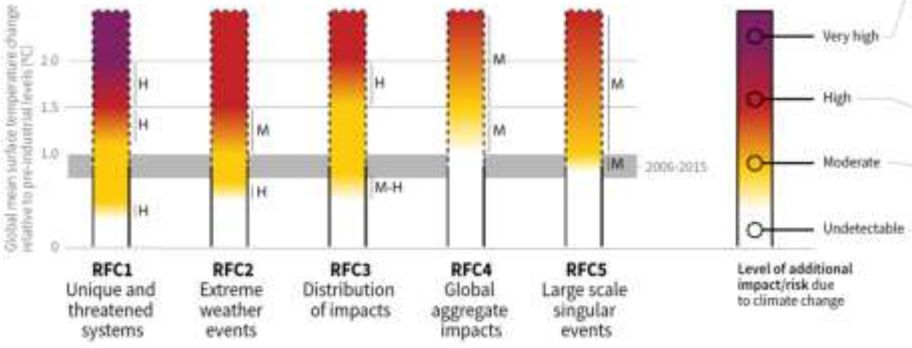
** Greater than 66% chance of staying within 2°C in 2100. Median and 10th to 90th percentile range. Pathway range excludes delayed action scenarios and any that deviate more than 5% from historic emissions in 2010.

*** Greater than or equal to 50% chance of staying below 1.5°C in 2100. Median and 10th to 90th percentile range. Pathway range excludes delayed action scenarios and any that deviate more than 5% from historic emissions in 2010.

How the level of global warming affects impacts and/or risks associated with the Reasons for Concern (RFCs) and selected natural, managed and human systems

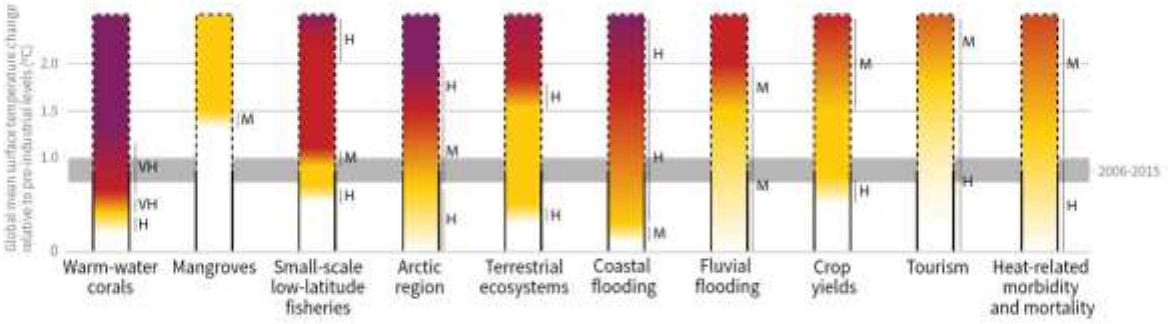
Five Reasons For Concern (RFCs) illustrate the impacts and risks of different levels of global warming for people, economies and ecosystems across sectors and regions.

Impacts and risks associated with the Reasons for Concern (RFCs)



Purple indicates very high risks of severe impacts/risks and the presence of significant irreversibility or the persistence of climate-related hazards, combined with limited ability to adapt due to the nature of the hazard or impacts/risks.
Red indicates severe and widespread impacts/risks.
Yellow indicates that impacts/risks are detectable and attributable to climate change with at least medium confidence.
White indicates that no impacts are detectable and attributable to climate change.

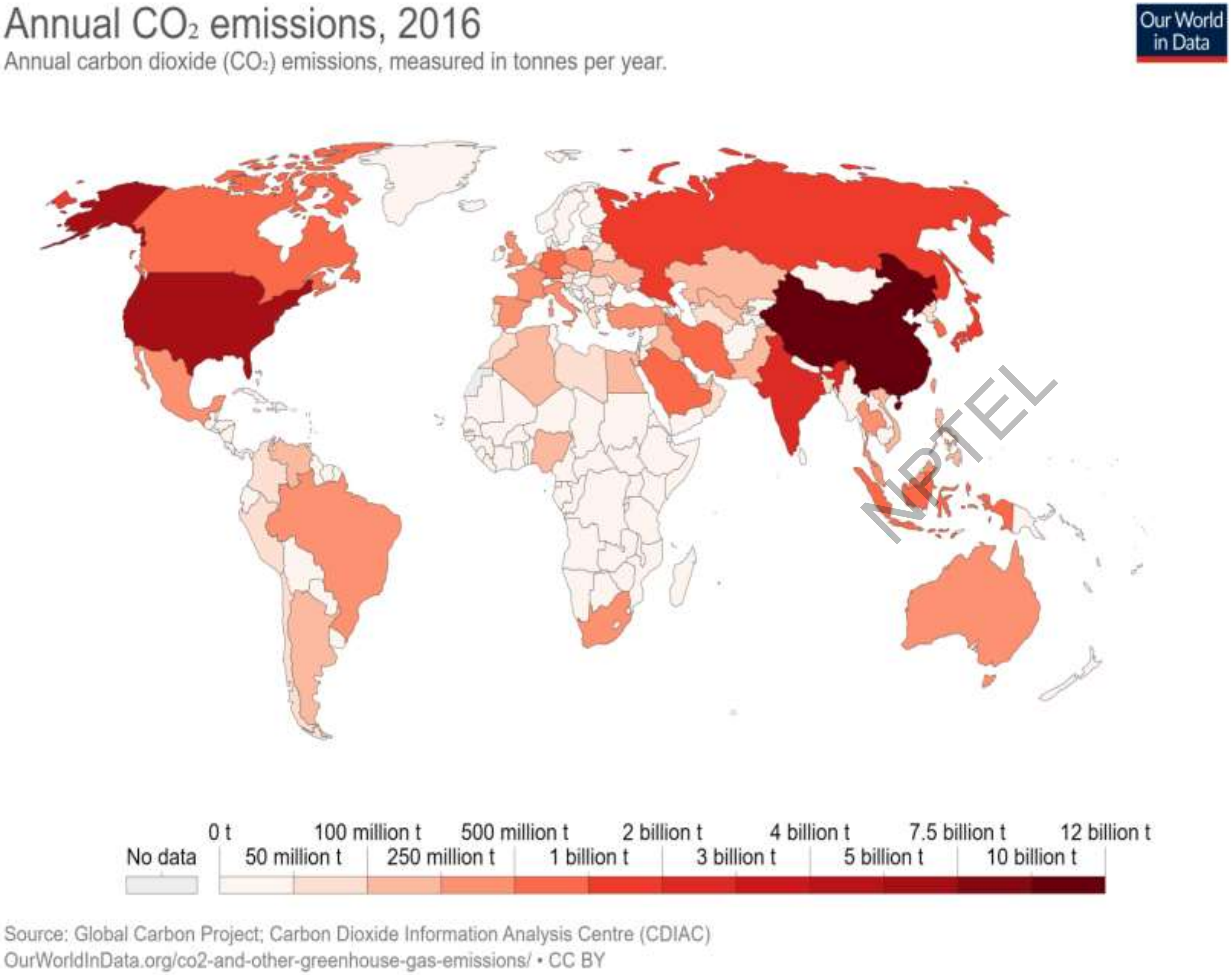
Impacts and risks for selected natural, managed and human systems



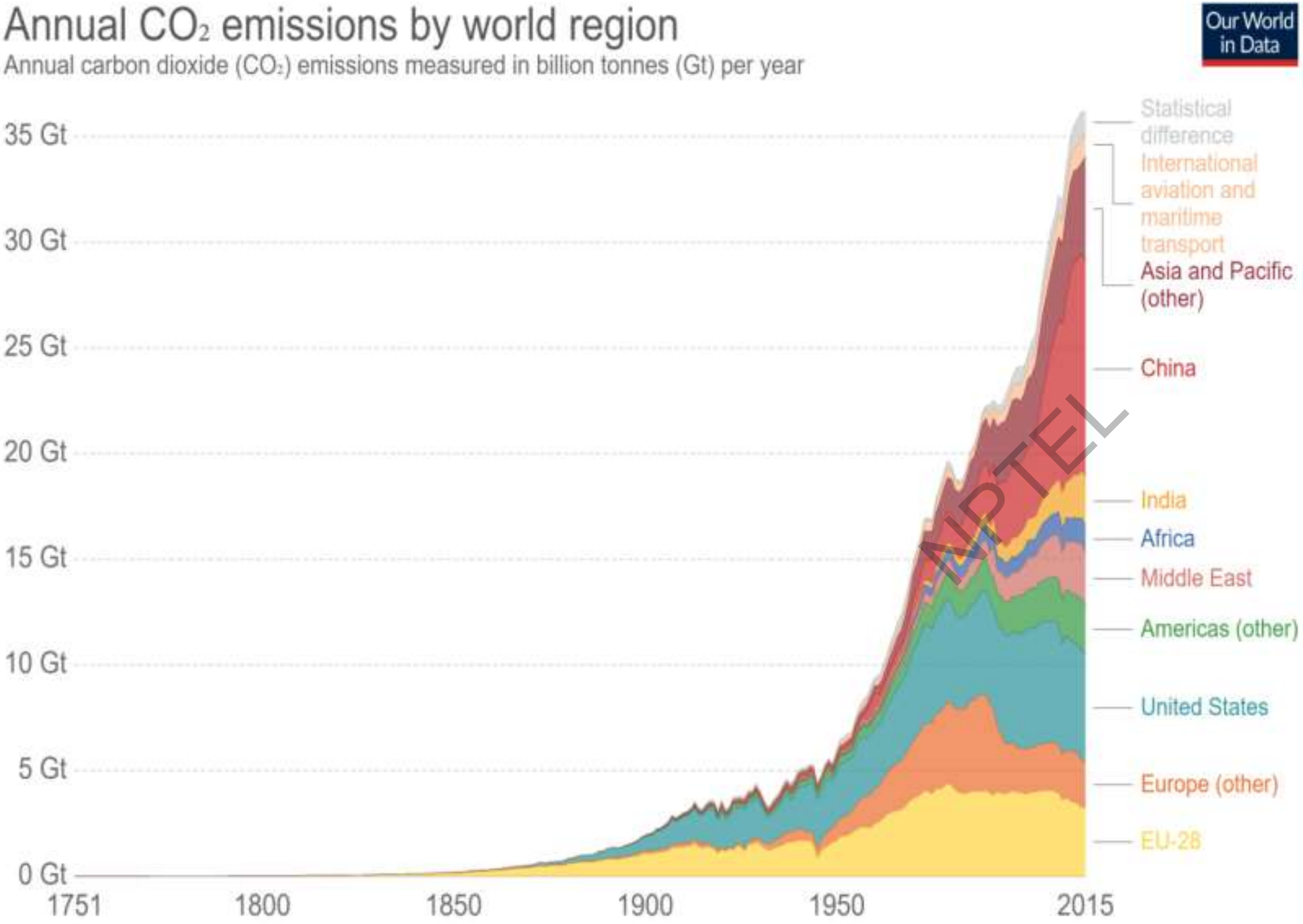
Confidence level for transition: L=Low, M=Medium, H=High and VH=Very high

Source: IPCC Special Report on Global Warming of 1.5°C


MOST IMPORTANT SHORT TERM
STEPS FOR A 1.5°C WORLD
Sustain renewables growth
Climate Action Tracker
No new coal power plants
Last fossil fuel car sold before 2035
BEV
Develop 1.5°C vision for aviation & shipping
New industrial installations low carbon after 2020
low-e
Zero deforestation by 2020s
Best practice in agriculture
New buildings zero emissions from 2020
zero-e
Renovate 3–5% of buildings per year
www.climateactiontracker.org



Annual CO_2 emissions, 2016
Annual carbon dioxide (CO_2) emissions, measured in tonnes per year.
Our World in Data
No data
0 t
50 million t
100 million t
250 million t
500 million t
1 billion t
2 billion t
3 billion t
4 billion t
5 billion t
7.5 billion t
10 billion t
12 billion t
Source: Global Carbon Project; Carbon Dioxide Information Analysis Centre (CDIAC)
OurWorldInData.org/co2-and-other-greenhouse-gas-emissions/ • CC BY
NPTEL

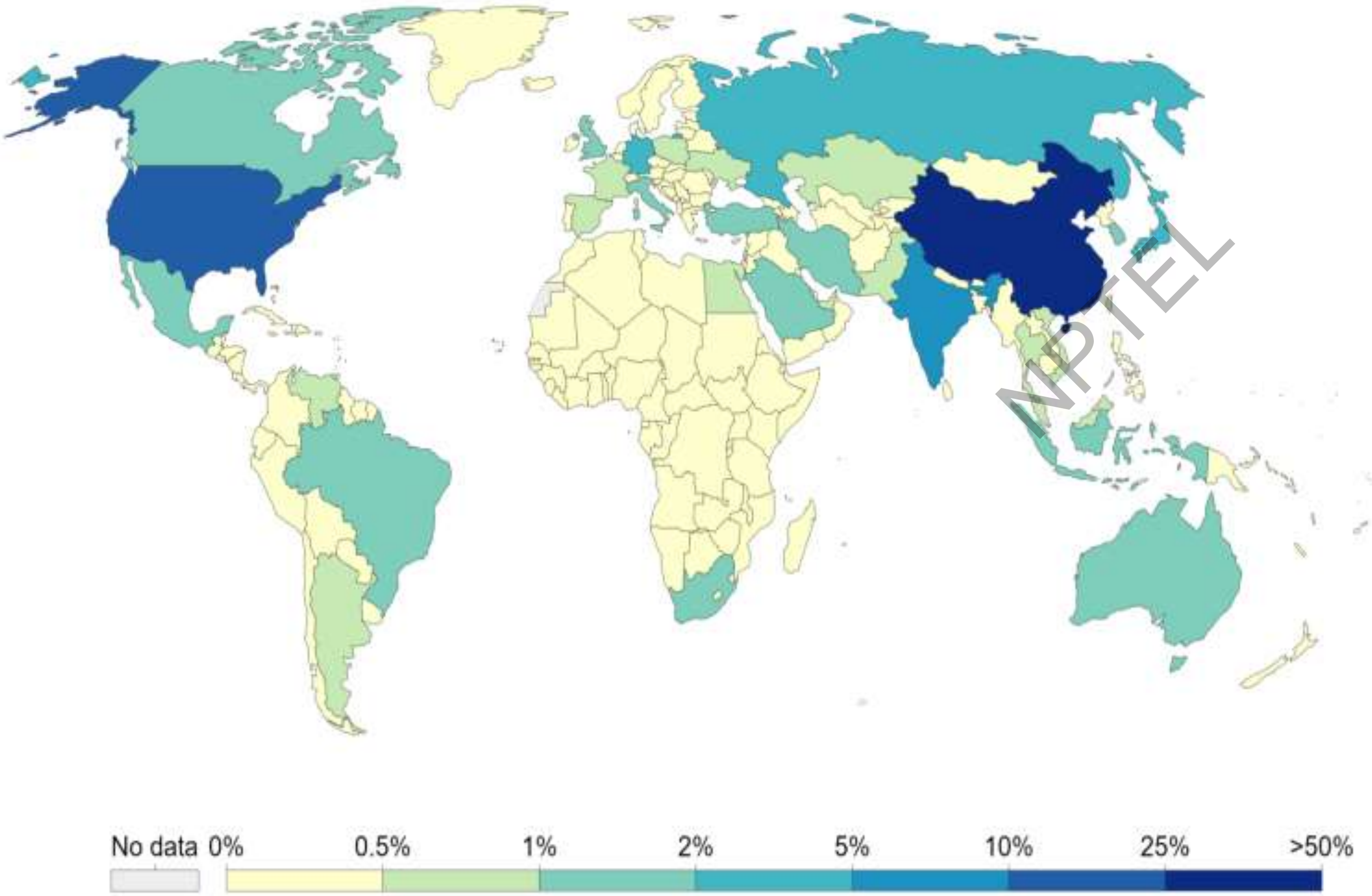


Source: Carbon Dioxide Information Analysis Center (CDIAC)

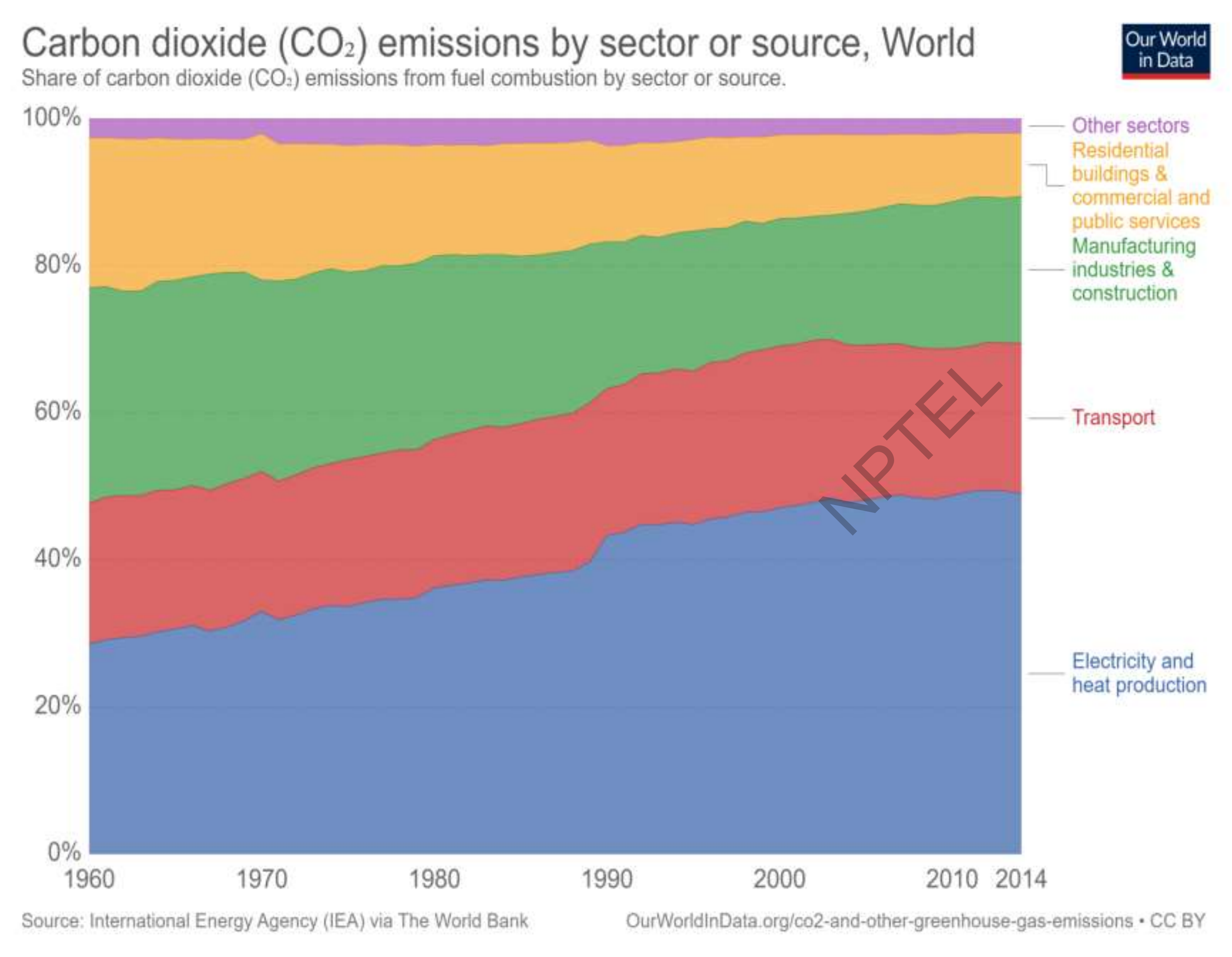
Note: Emissions data have been converted from units of carbon to carbon dioxide (CO2) using a conversion factor of 3.67. Regions denoted "other" are given as regional totals minus emissions from the EU-28, USA, China and India. Here, we have rephrased the general term "bunker (fuels)" as "international aviation and maritime transport" for clarity.

Annual share of global CO_2 emissions, 2016

Each country's share of global carbon dioxide (CO_2) emissions. This is measured as each country's emissions divided by the sum of all countries' emissions in a given year; this does not include international aviation and shipping (known as 'bunkers') and 'statistical differences' in carbon accounts.



Source: Our World in Data based on Global Carbon Project (2017)

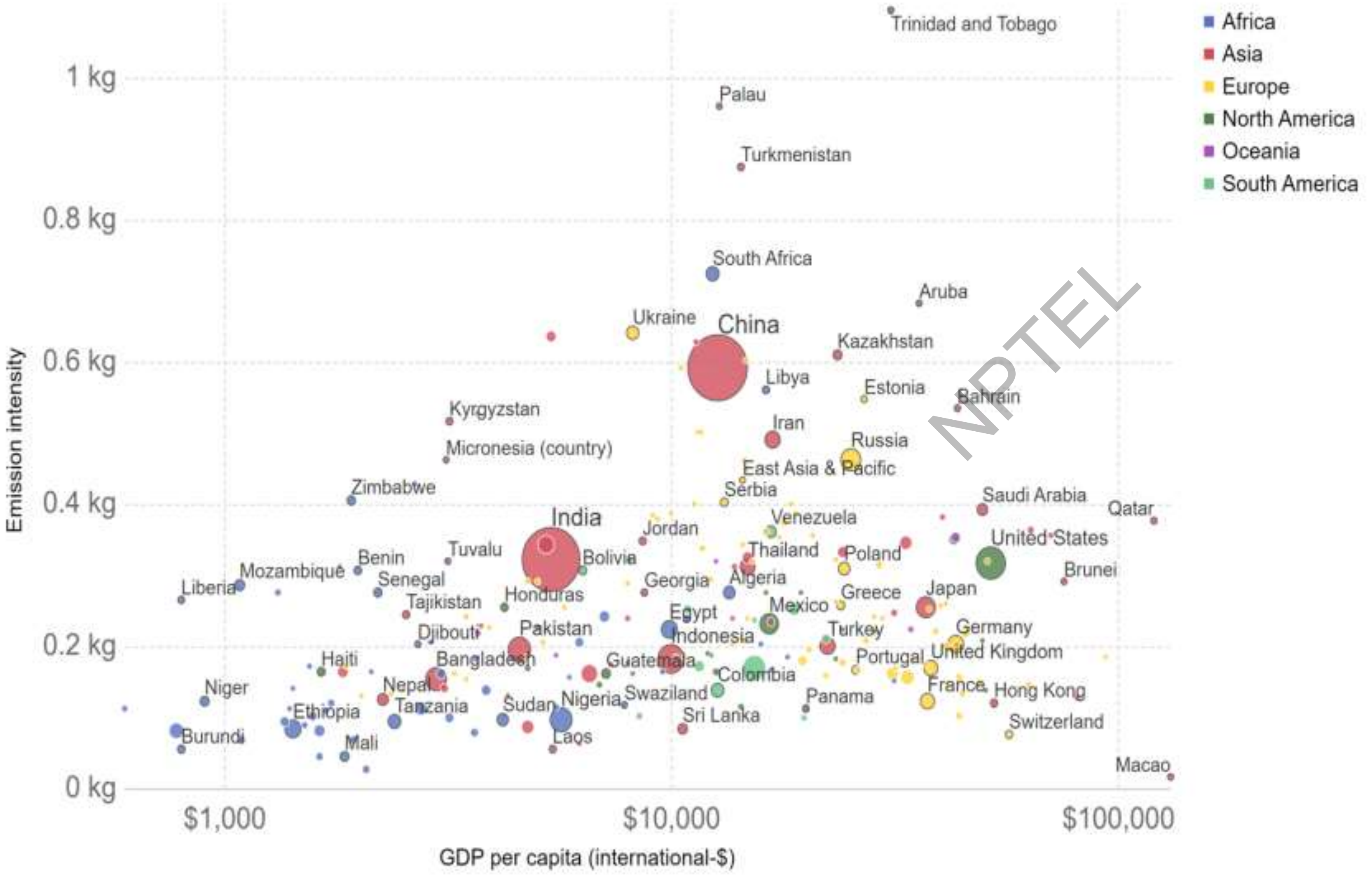


Carbon dioxide (CO_2) emissions by sector or source, World
Share of carbon dioxide (CO_2) emissions from fuel combustion by sector or source.
Our World in Data
100%
80%
60%
40%
20%
0%
1960
1970
1980
1990
2000
2010
2014
Other sectors
Residential buildings & commercial and public services
Manufacturing industries & construction
Transport
Electricity and heat production
NPTEL
Source: International Energy Agency (IEA) via The World Bank
OurWorldInData.org/co2-and-other-greenhouse-gas-emissions • CC BY

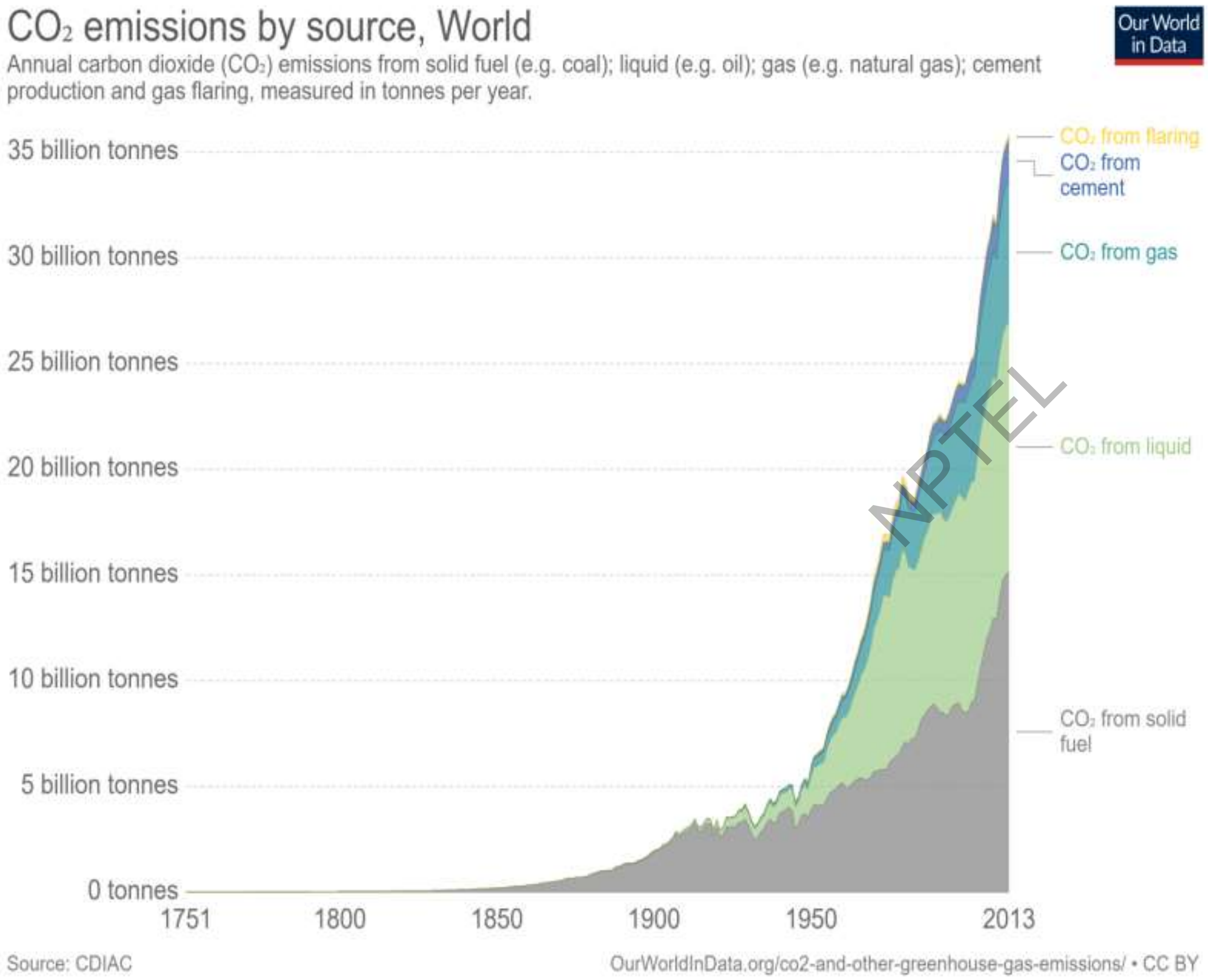
Carbon emission intensity vs GDP per capita, 2014

Carbon emission intensity is the ratio between emissions of CO_2 (in kg) to the output of the economy (in international-$).

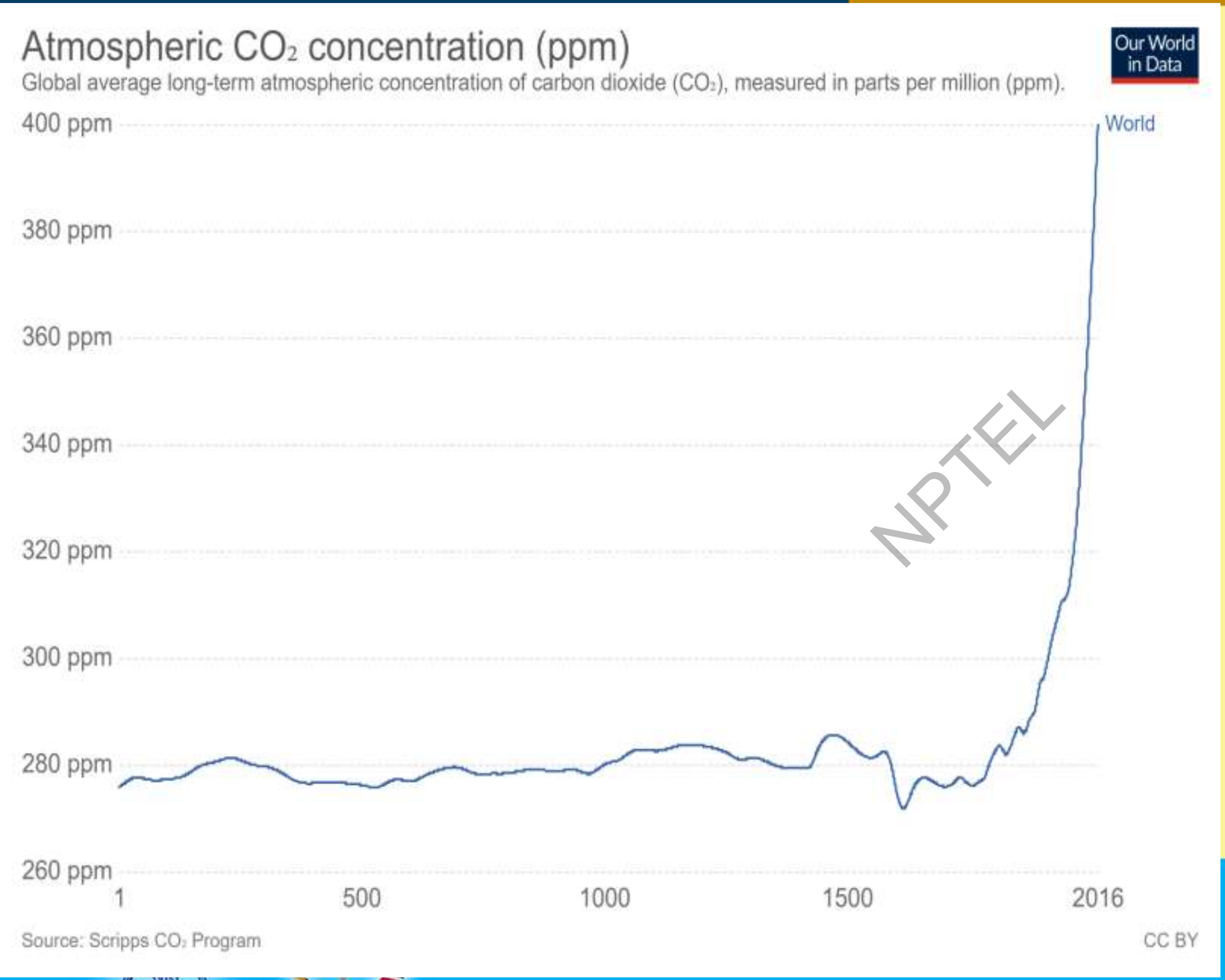
Our World in Data



Source: World Bank

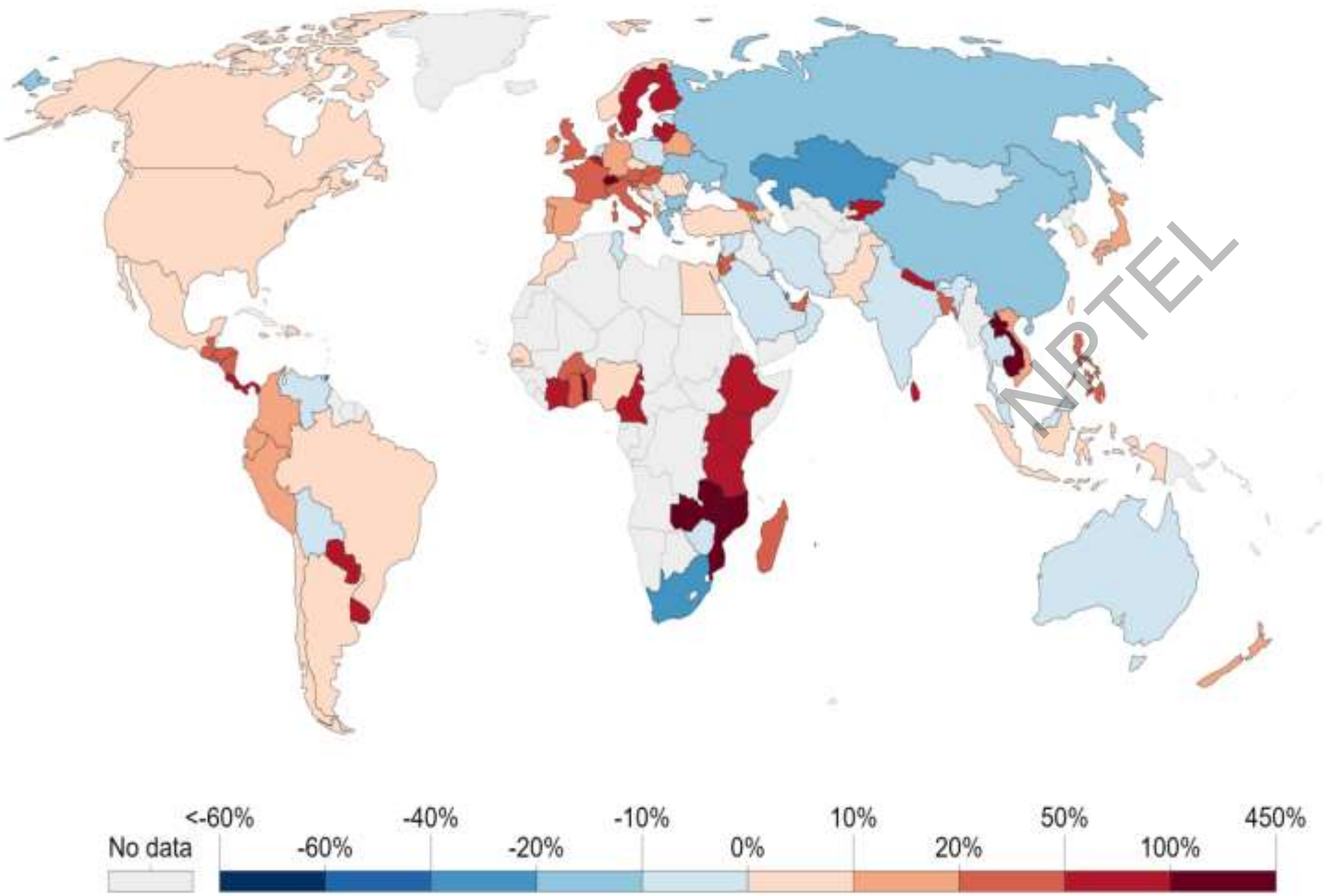


CO₂ emissions by source, World
Annual carbon dioxide (CO_2) emissions from solid fuel (e.g. coal); liquid (e.g. oil); gas (e.g. natural gas); cement production and gas flaring, measured in tonnes per year.
Our World in Data
35 billion tonnes
30 billion tonnes
25 billion tonnes
20 billion tonnes
15 billion tonnes
10 billion tonnes
5 billion tonnes
0 tonnes
1751
1800
1850
1900
1950
2013
CO_2 from flaring
CO_2 from cement
CO_2 from gas
CO_2 from liquid
CO_2 from solid fuel
NPTEL
Source: CDIAC
OurWorldInData.org/co2-and-other-greenhouse-gas-emissions/ • CC BY


Atmospheric CO₂ concentration (ppm)
Global average long-term atmospheric concentration of carbon dioxide (CO₂), measured in parts per million (ppm).
Our World in Data
400 ppm
380 ppm
360 ppm
340 ppm
320 ppm
300 ppm
280 ppm
260 ppm
World
1
500
1000
1500
2016
NPTEL
Source: Scripps CO₂ Program
CC BY

CO_2 emissions in imported goods as a share of domestic emissions, 2014

Share of carbon dioxide (CO_2) emissions embedded in trade, measured as emissions exported or imported as the percentage of domestic production emissions. Positive values (red) represent net importers of CO_2 (i.e. "20%" would mean a country imported emissions equivalent to 20% of its domestic emissions). Negative values (blue) represent net exporters of CO_2.

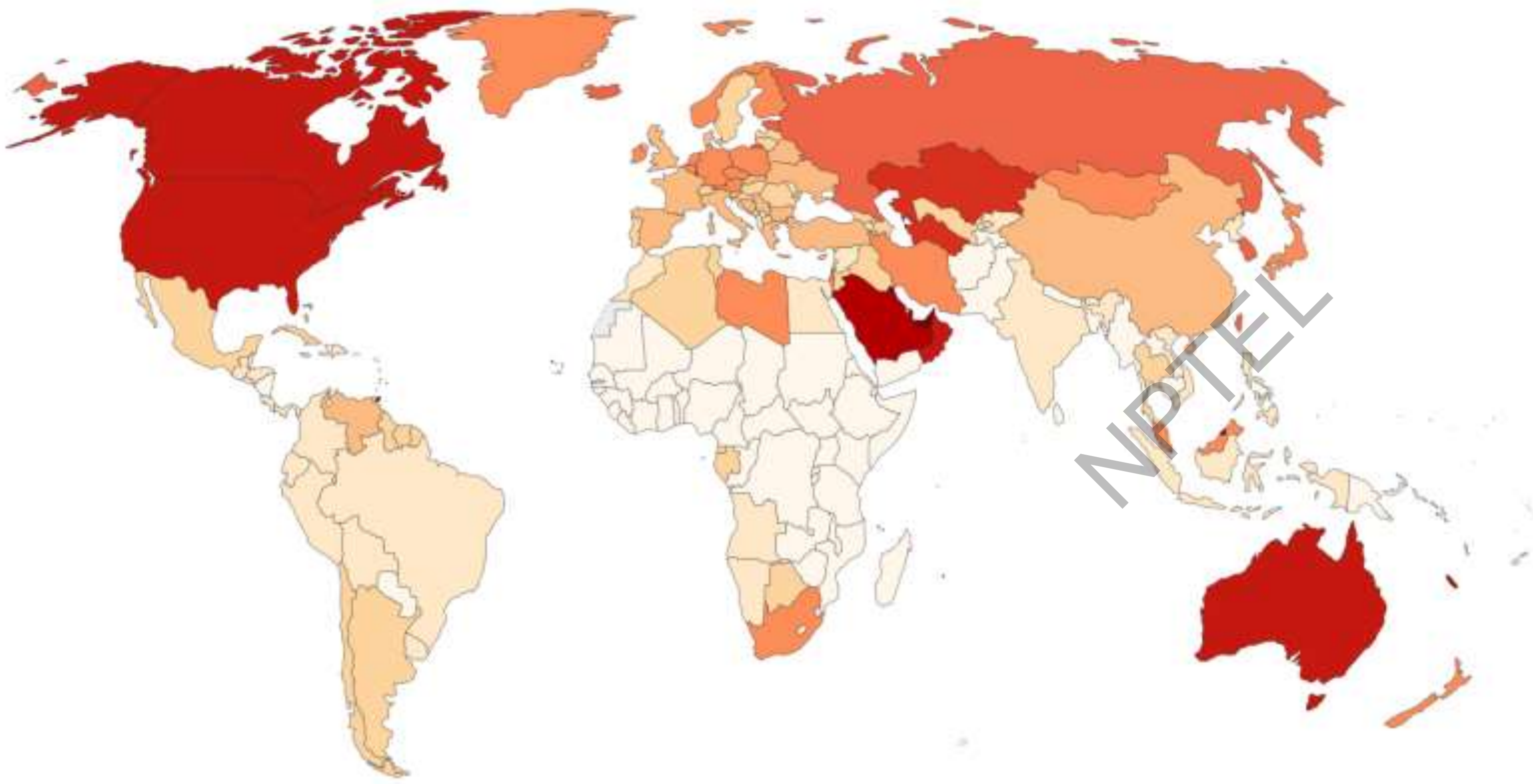


Source: Peters et al. (2012 updated); Global Carbon Project

CO_2 emissions per capita, 2016

Average carbon dioxide (CO_2) emissions per capita measured in tonnes per year.

Our World in Data



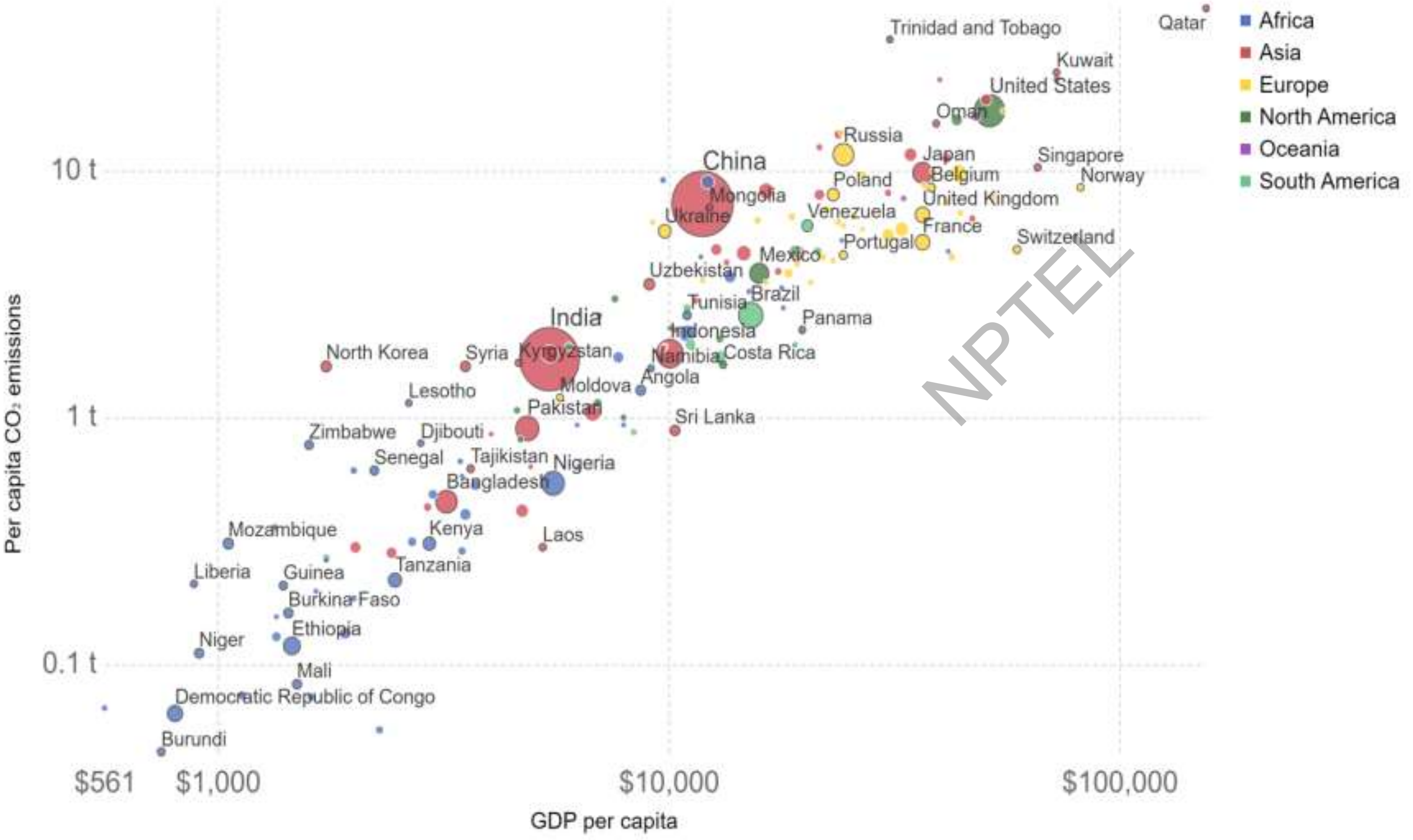
No data 0 t 1 t 2.5 t 5 t 7.5 t 10 t 12.5 t 15 t 17.5 t 20 t 25 t >50 t

Source: OWID based on Global Carbon Project; Gapminder & UN

OurWorldInData.org/co2-and-other-greenhouse-gas-emissions/ • CC BY

CO_2 emissions per capita vs GDP per capita, 2014

Carbon dioxide (CO_2) emissions per capita are measured in tonnes per person per year. Gross domestic product (GDP) per capita is measured in international-$ in 2011 prices to adjust for price differences between countries and adjust for inflation.

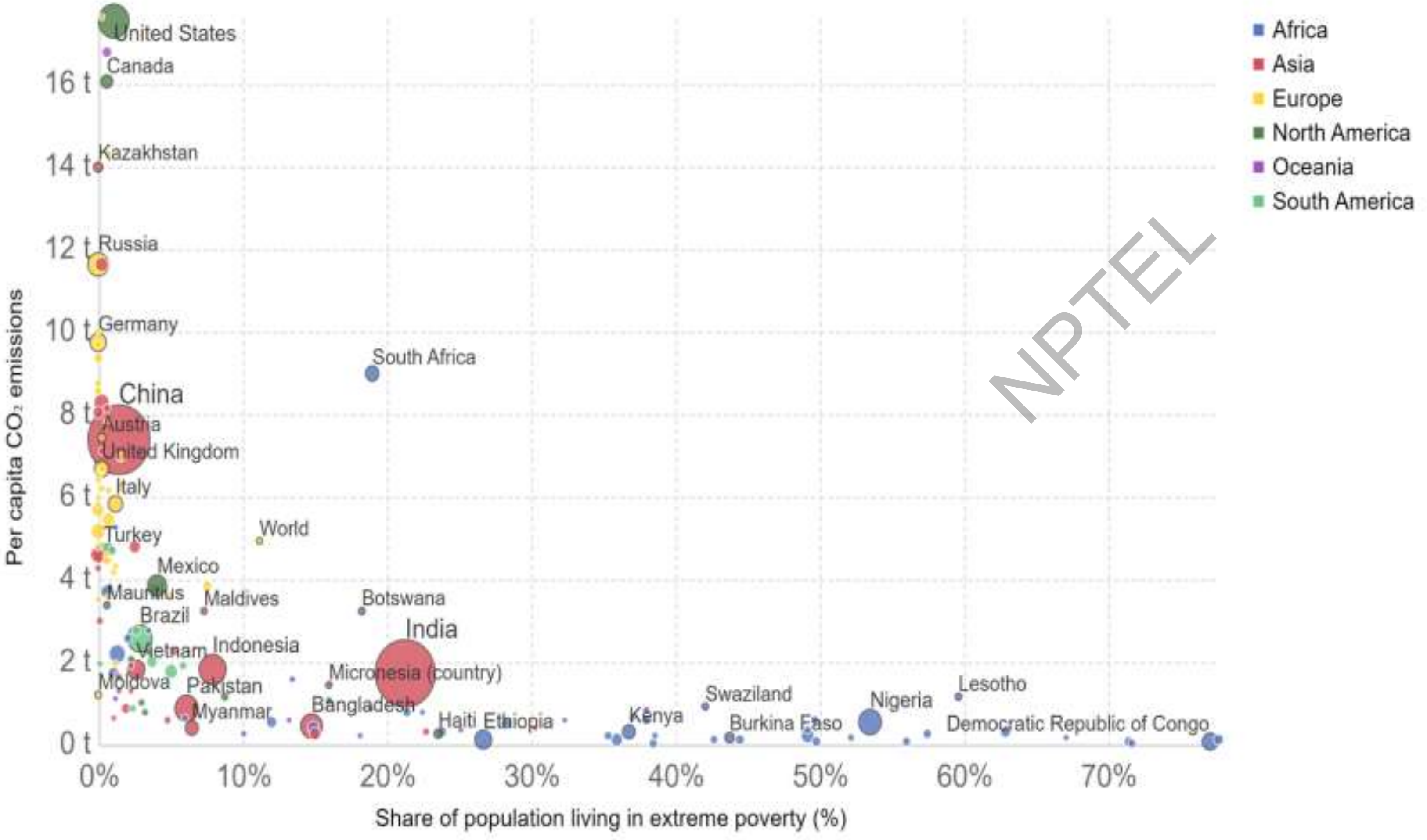


Source: Global Carbon Project, Maddison (2017)

CO_2 emissions per capita vs. the share of people living in extreme poverty, 2014

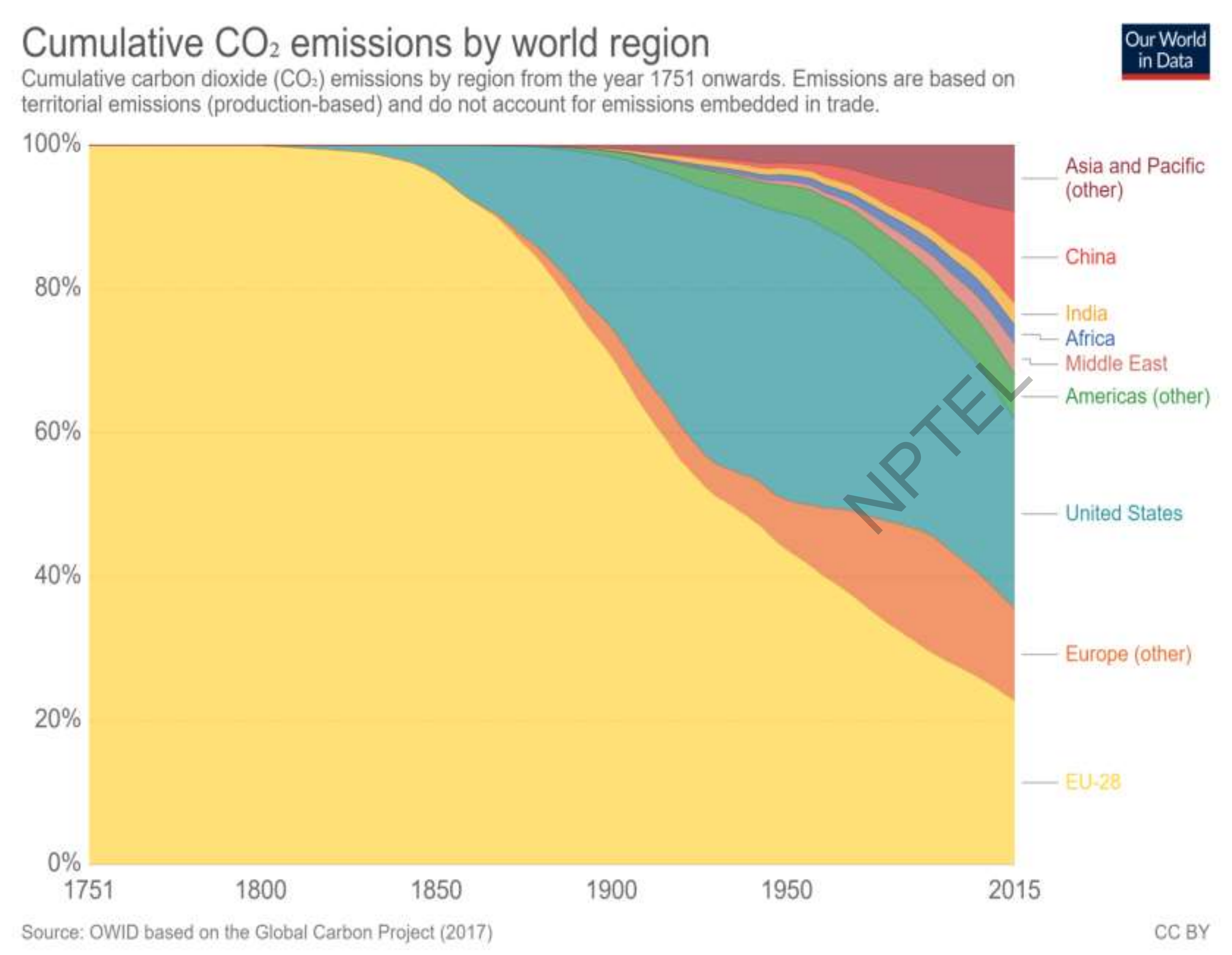
Our World in Data

Average CO_2 emissions per capita are measured in tonnes per year. Extreme poverty is defined as living at a consumption (or income) level below 1.90 "international-$" per day. International $ are adjusted for price differences between countries and price changes over time (inflation).



Source: Per capita CO_2 emissions (Global Carbon Project; Gapminder; UN), World Bank

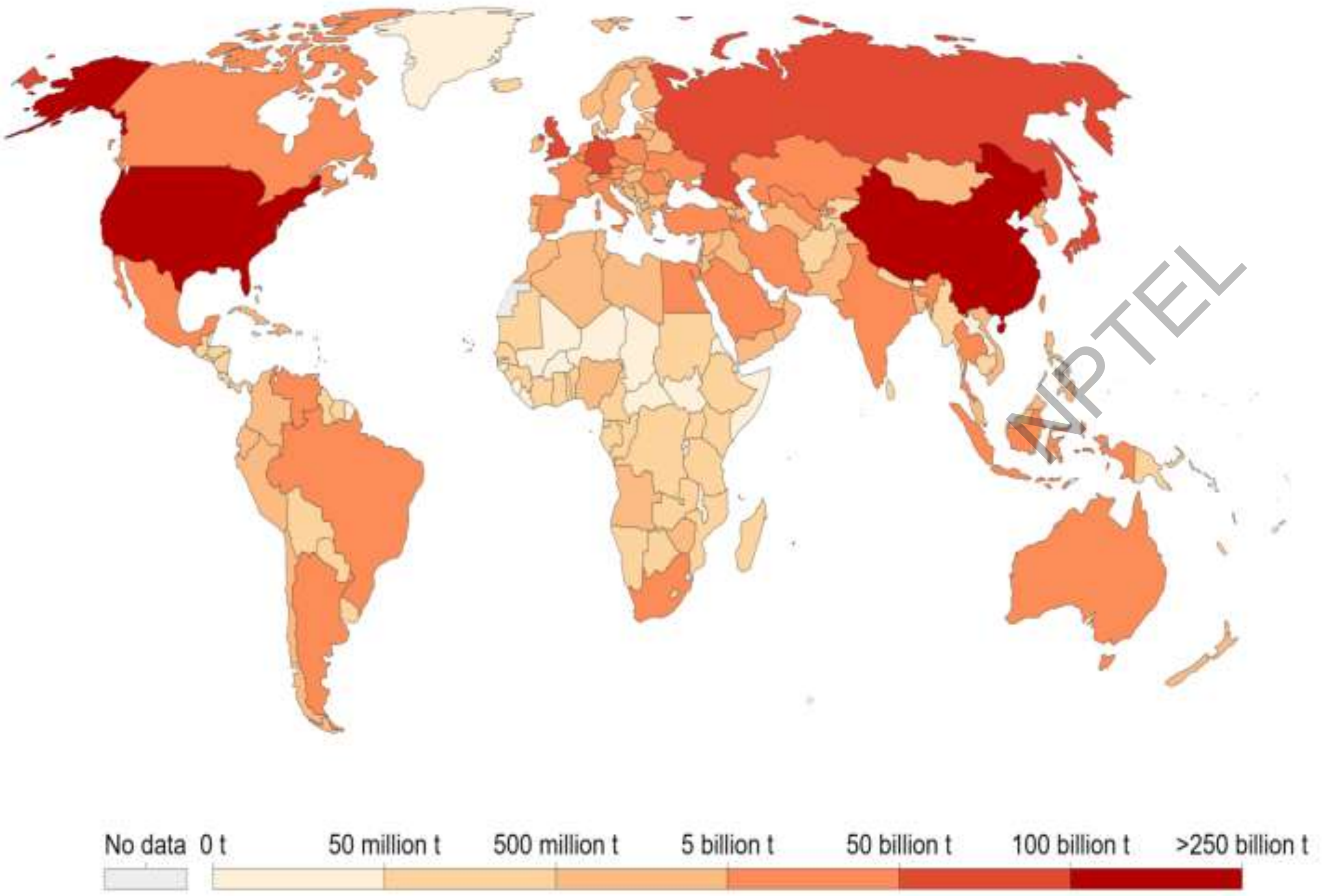
OurWorldInData.org/co2-and-other-greenhouse-gas-emissions/ • CC BY



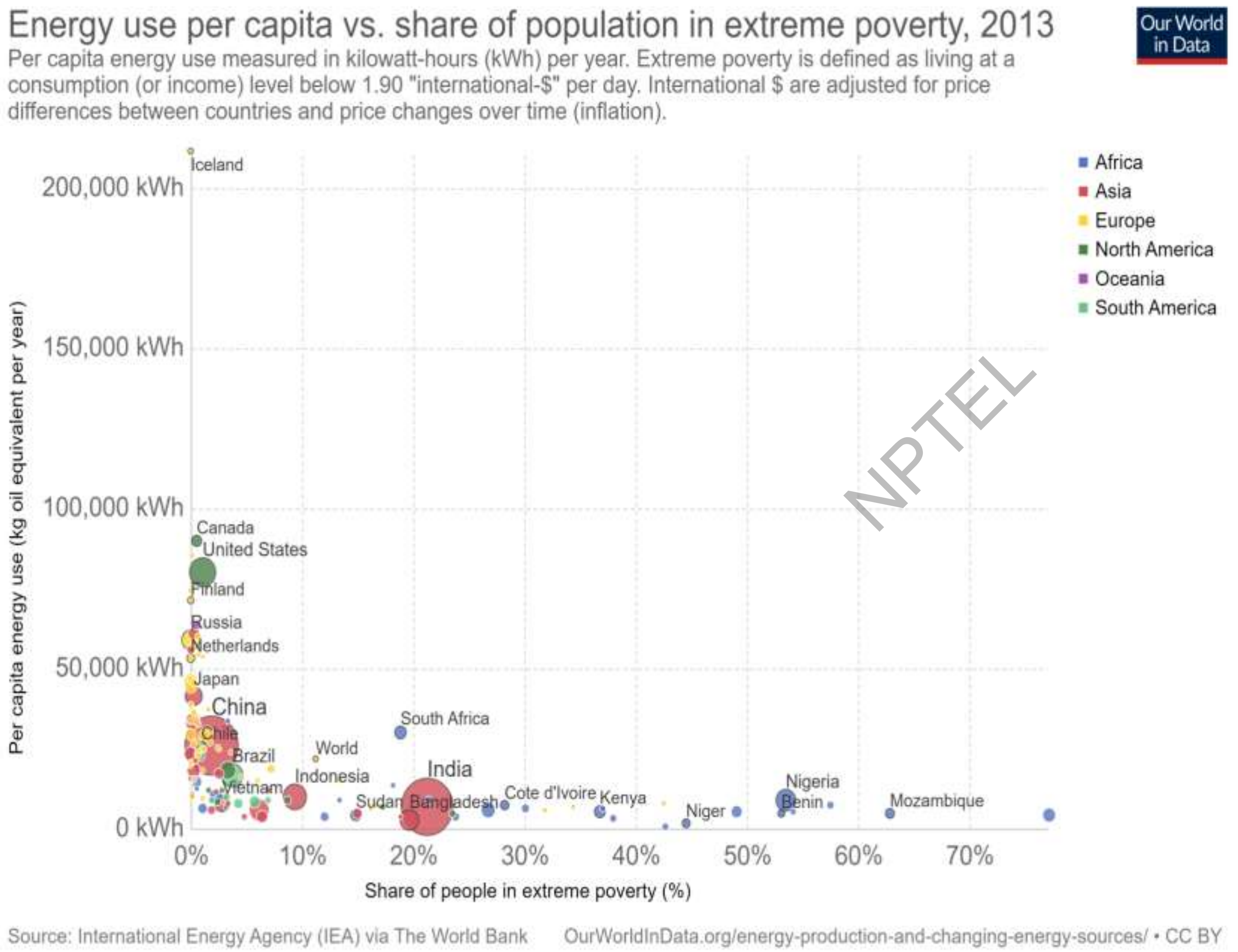
Cumulative CO_2 emissions by world region
Cumulative carbon dioxide (CO_2) emissions by region from the year 1751 onwards. Emissions are based on territorial emissions (production-based) and do not account for emissions embedded in trade.
Our World in Data
100%
80%
60%
40%
20%
0%
1751
1800
1850
1900
1950
2015
Asia and Pacific (other)
China
India
Africa
Middle East
Americas (other)
United States
Europe (other)
EU-28
NPTEL
Source: OWID based on the Global Carbon Project (2017)
CC BY

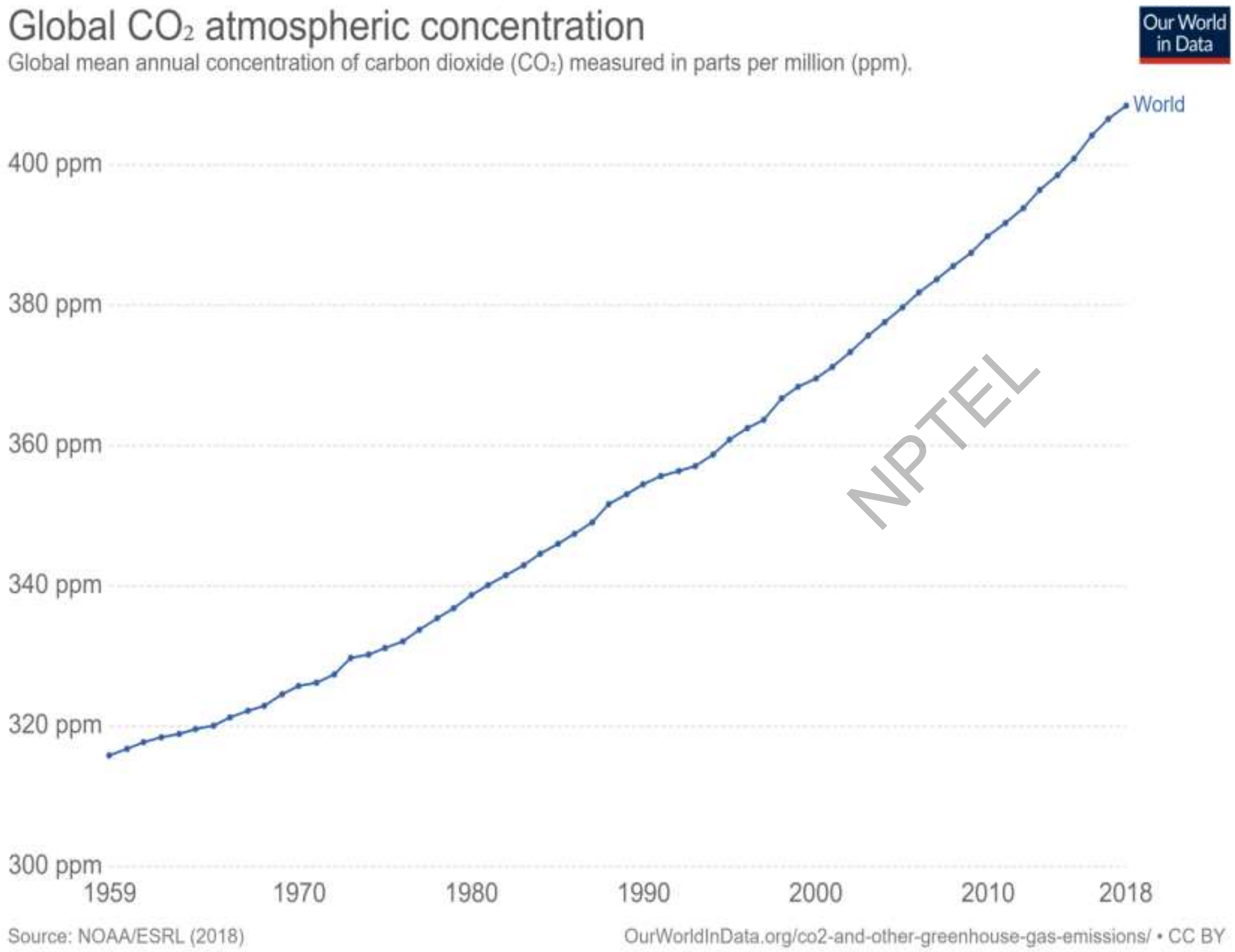
Cumulative CO_2 emissions, 2016

Cumulative carbon dioxide (CO_2) emissions represents the total sum of CO_2 emissions since 1751, and is measured in tonnes.



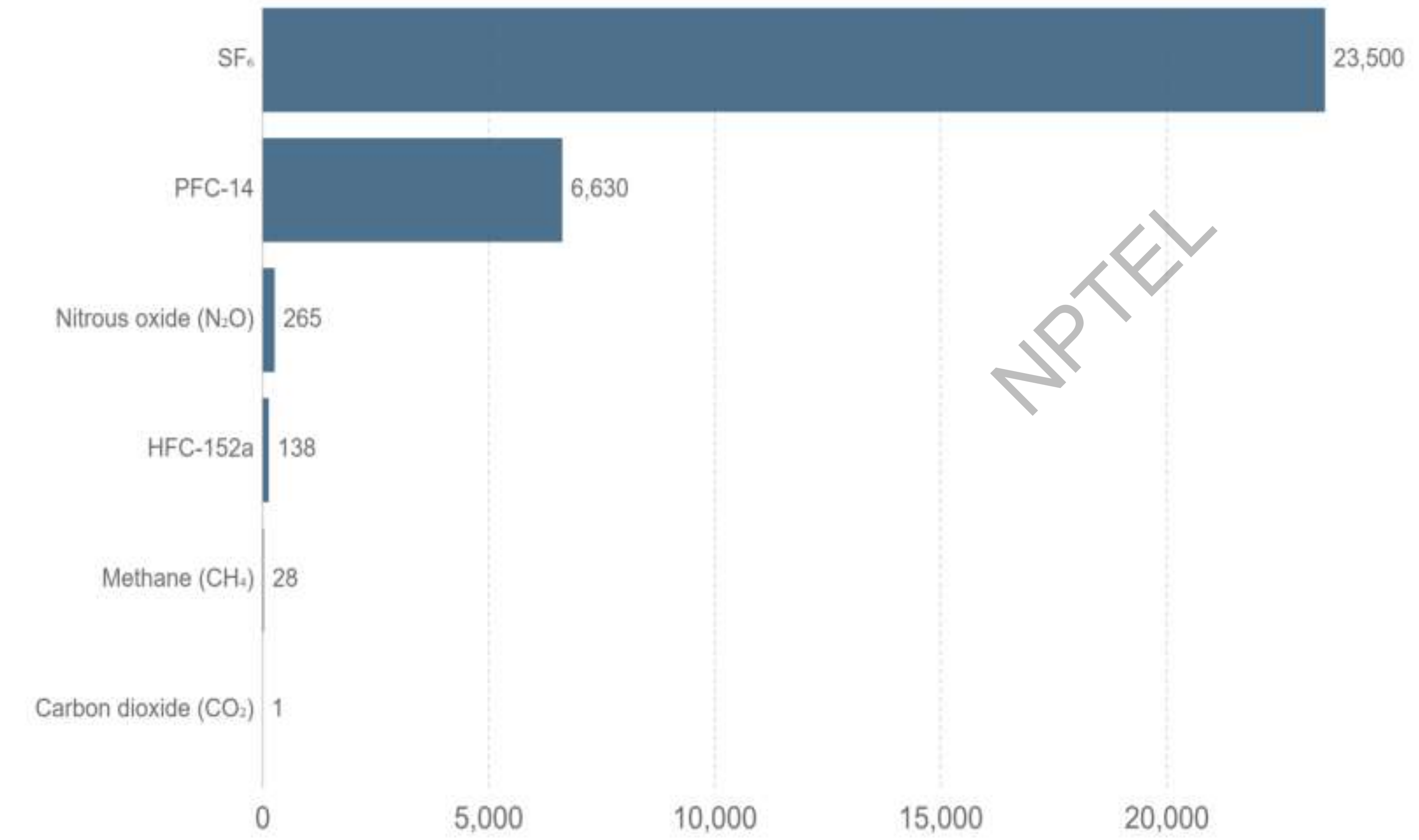
Source: Global Carbon Project (GCP); Carbon Dioxide Information Analysis Centre (CDIAC)
OurWorldInData.org/co2-and-other-greenhouse-gas-emissions/ •


Energy use per capita vs. share of population in extreme poverty, 2013
Per capita energy use measured in kilowatt-hours (kWh) per year. Extreme poverty is defined as living at a consumption (or income) level below 1.90 "international-$" per day. International $ are adjusted for price differences between countries and price changes over time (inflation).
Our World in Data
Per capita energy use (kg oil equivalent per year)
200,000 kWh
150,000 kWh
100,000 kWh
50,000 kWh
0 kWh
Iceland
Canada
United States
Finland
Russia
Netherlands
Japan
China
Chile
Brazil
Vietnam
Indonesia
World
South Africa
India
Sudan
Bangladesh
Cote d'Ivoire
Kenya
Niger
Nigeria
Benin
Mozambique
0%
10%
20%
30%
40%
50%
60%
70%
Share of people in extreme poverty (%)
Africa
Asia
Europe
North America
Oceania
South America
Source: International Energy Agency (IEA) via The World Bank
OurWorldInData.org/energy-production-and-changing-energy-sources/ • CC BY
NPTEL

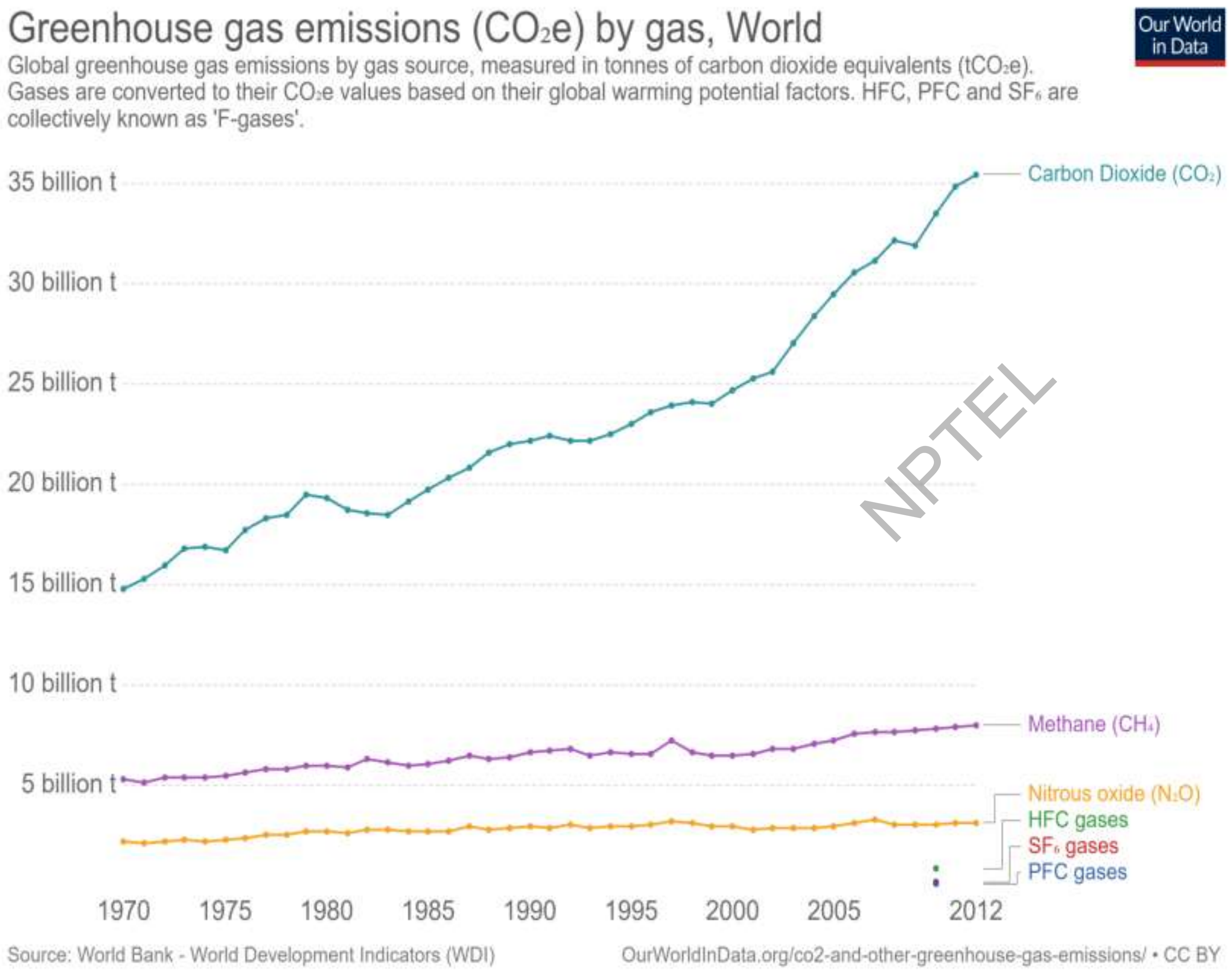

Global CO₂ atmospheric concentration
Global mean annual concentration of carbon dioxide (CO₂) measured in parts per million (ppm).
Our World in Data
World
400 ppm
380 ppm
360 ppm
340 ppm
320 ppm
300 ppm
1959
1970
1980
1990
2000
2010
2018
Source: NOAA/ESRL (2018)
OurWorldInData.org/co2-and-other-greenhouse-gas-emissions/ • CC BY

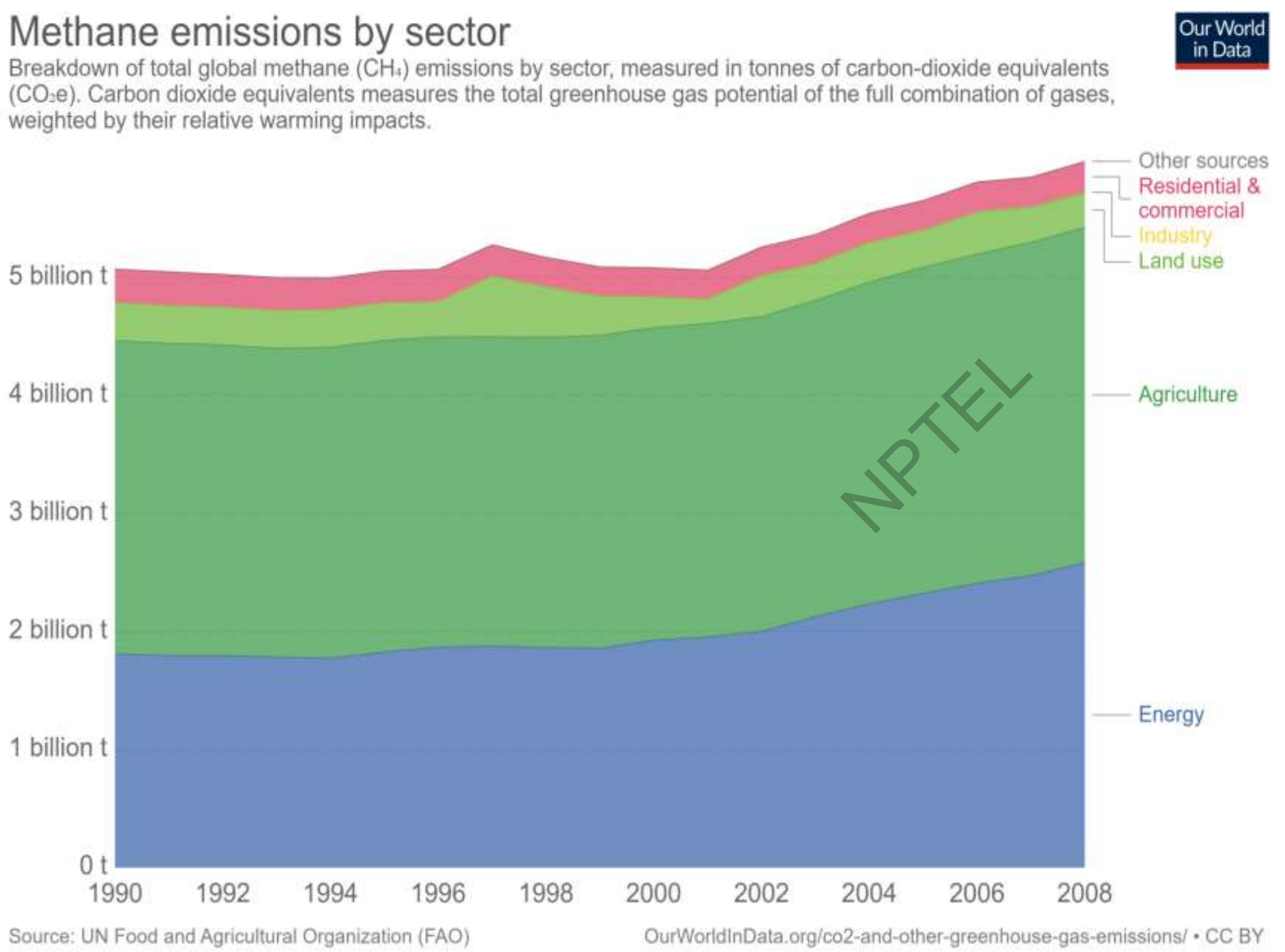
Global warming potential of greenhouse gases over 100-year timescale (GWP_{100})

Global warming potential factors of greenhouse gases as measured over a 100-year timescale (GWP_{100}). GWP measures the relative warming impact of one unit mass of a greenhouse gas relative to carbon dioxide. A GWP_{100} value of 28 therefore means one tonne of methane has 28 times the warming impact of one tonne of carbon dioxide over a 100-year timescale.



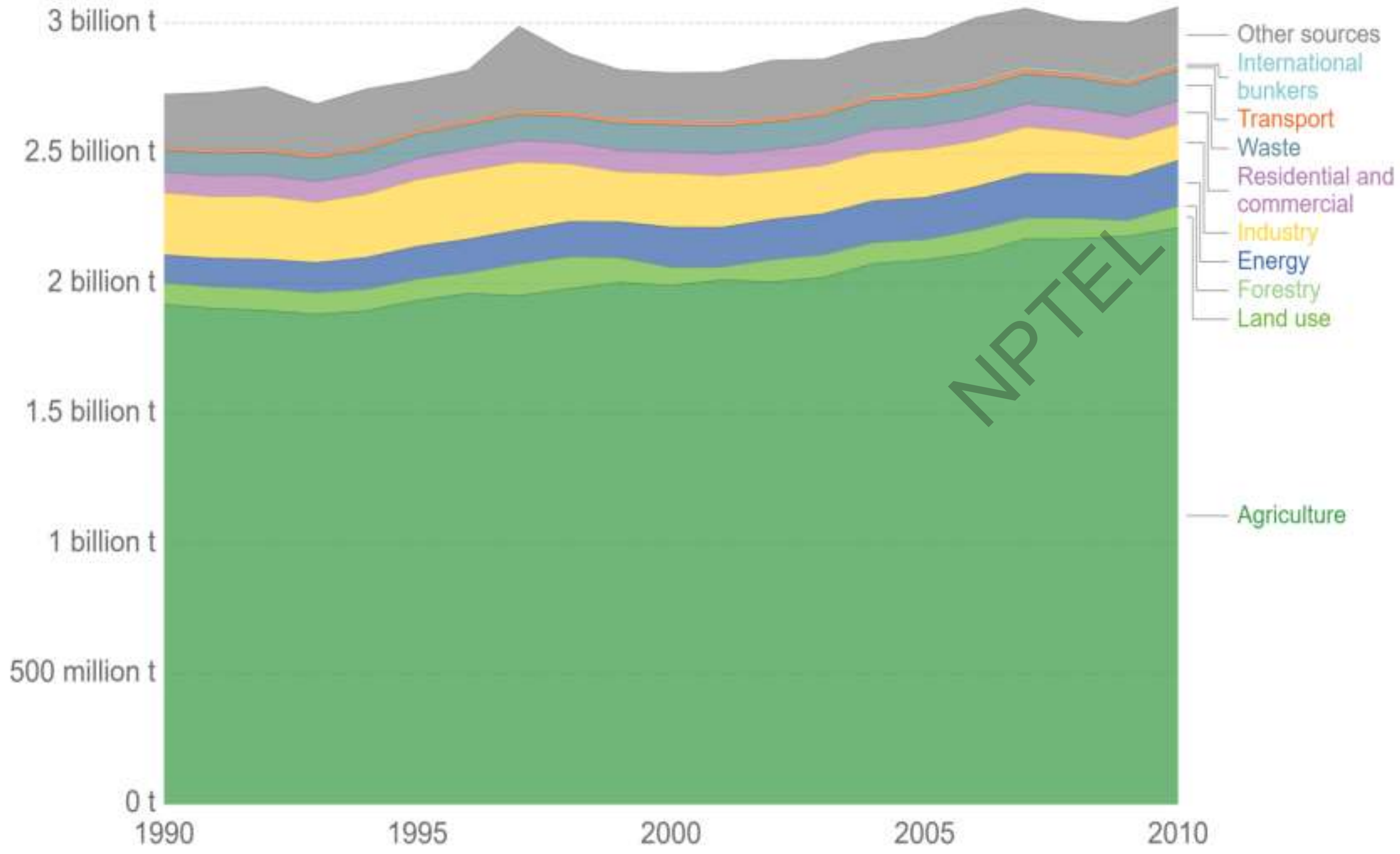
Source: Global warming potential factors (GWP100) - IPCC (2014)


Greenhouse gas emissions (CO₂e) by gas, World
Global greenhouse gas emissions by gas source, measured in tonnes of carbon dioxide equivalents (tCO₂e). Gases are converted to their CO₂e values based on their global warming potential factors. HFC, PFC and SF₆ are collectively known as 'F-gases'.
Our World in Data
35 billion t
30 billion t
25 billion t
20 billion t
15 billion t
10 billion t
5 billion t
Carbon Dioxide (CO₂)
Methane (CH₄)
Nitrous oxide (N₂O)
HFC gases
SF₆ gases
PFC gases
1970
1975
1980
1985
1990
1995
2000
2005
2012
Source: World Bank - World Development Indicators (WDI)
OurWorldInData.org/co2-and-other-greenhouse-gas-emissions/ • CC BY
NPTEL

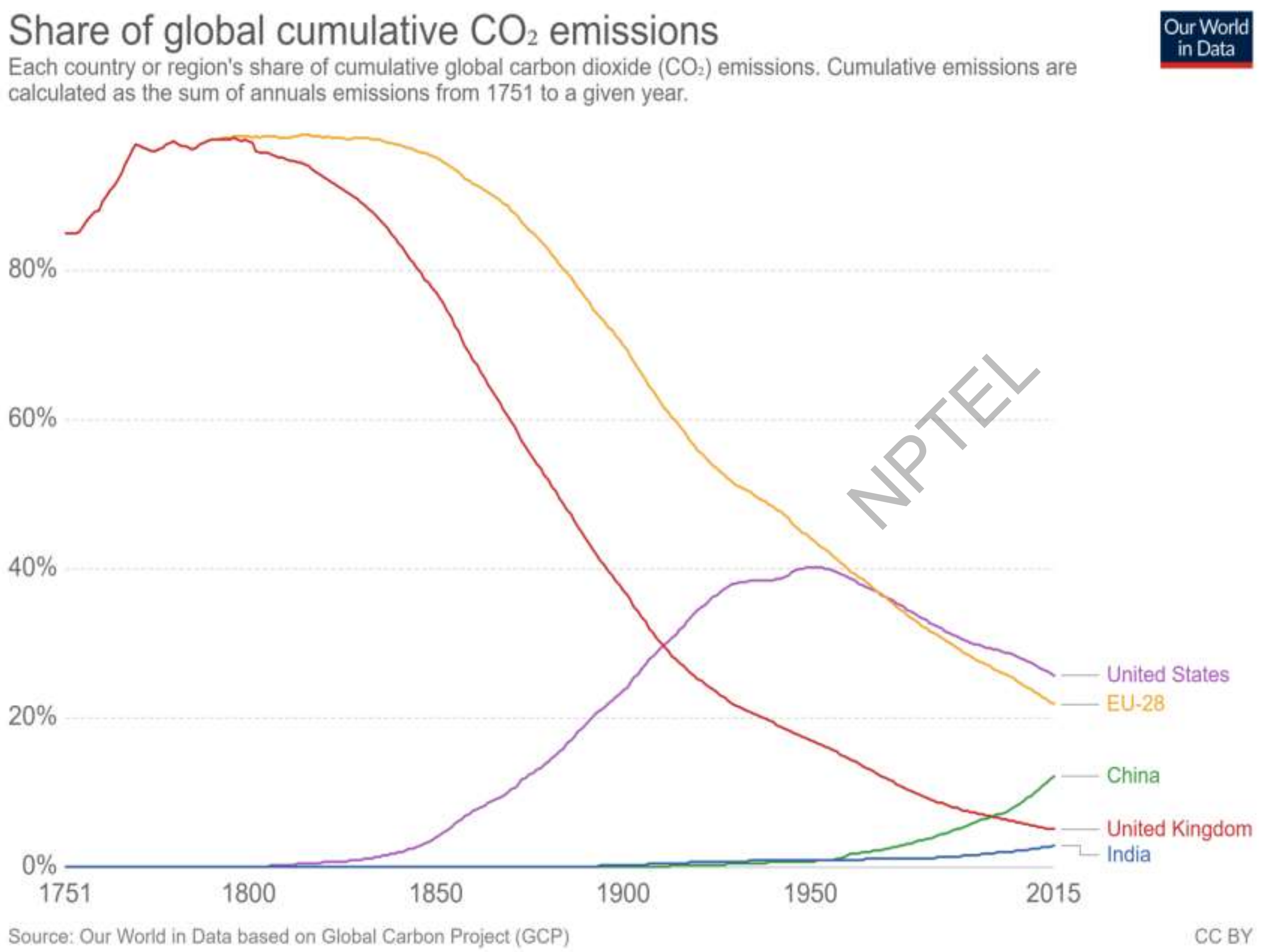

Methane emissions by sector
Breakdown of total global methane (CH_4) emissions by sector, measured in tonnes of carbon-dioxide equivalents (CO_2e). Carbon dioxide equivalents measures the total greenhouse gas potential of the full combination of gases, weighted by their relative warming impacts.
Our World in Data
5 billion t
4 billion t
3 billion t
2 billion t
1 billion t
0 t
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
Other sources
Residential & commercial
Industry
Land use
Agriculture
Energy
NPTEL
Source: UN Food and Agricultural Organization (FAO)
OurWorldInData.org/co2-and-other-greenhouse-gas-emissions/ • CC BY

Nitrous oxide emissions by sector, World

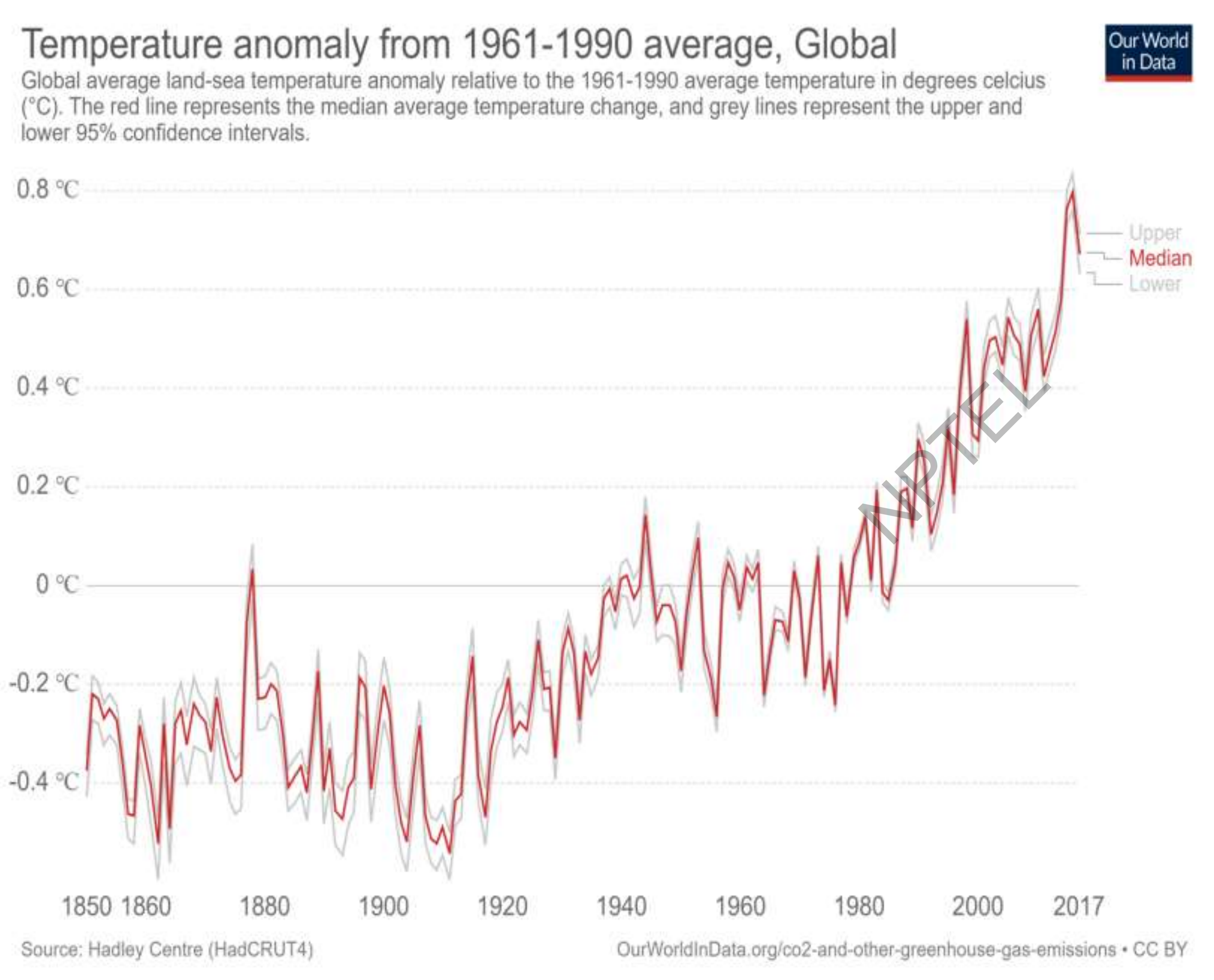
Breakdown of total global nitrous oxide (N_2O) emissions by sector, measured in tonnes of carbon dioxide equivalents (CO_2e). Carbon dioxide equivalents measures the total greenhouse gas potential of the full combination of gases, weighted by their relative warming impacts.



Source: UN Food and Agricultural Organization (FAO)

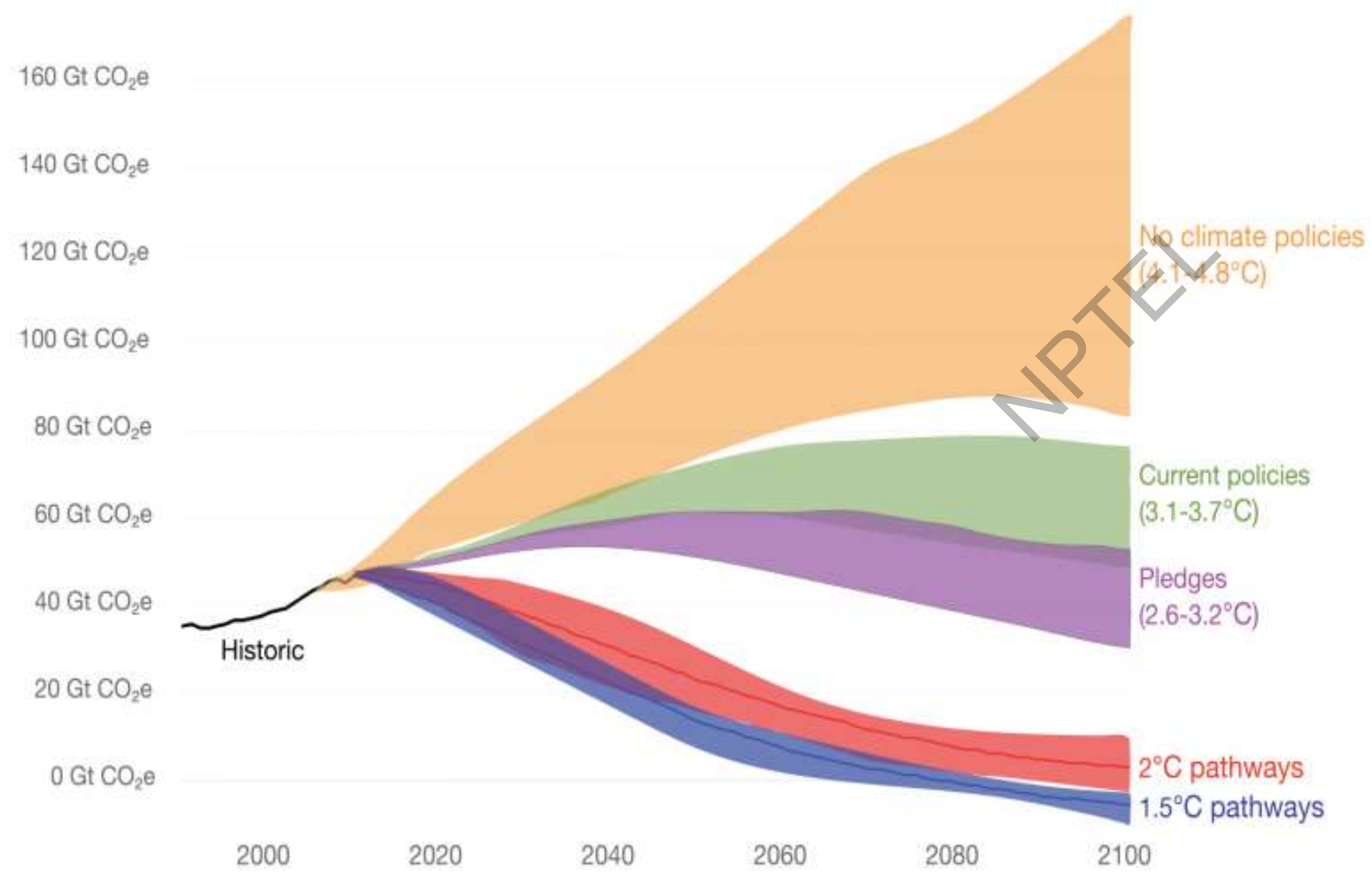


Share of global cumulative CO₂ emissions
Each country or region's share of cumulative global carbon dioxide (CO₂) emissions. Cumulative emissions are calculated as the sum of annuals emissions from 1751 to a given year.
Our World in Data
80%
60%
40%
20%
0%
1751
1800
1850
1900
1950
2015
United States
EU-28
China
United Kingdom
India
NPTEL
Source: Our World in Data based on Global Carbon Project (GCP)
CC BY


Temperature anomaly from 1961-1990 average, Global
Global average land-sea temperature anomaly relative to the 1961-1990 average temperature in degrees celcius (°C). The red line represents the median average temperature change, and grey lines represent the upper and lower 95% confidence intervals.
Our World in Data
0.8 °C
0.6 °C
0.4 °C
0.2 °C
0 °C
-0.2 °C
-0.4 °C
Upper
Median
Lower
1850
1860
1880
1900
1920
1940
1960
1980
2000
2017
NPTEL
Source: Hadley Centre (HadCRUT4)
OurWorldInData.org/co2-and-other-greenhouse-gas-emissions • CC BY

Global greenhouse gas emissions scenarios

Potential future emissions pathways of global greenhouse gas emissions (measured in gigatonnes of carbon dioxide equivalents) in the case of no climate policies, current implemented policies, national pledges within the Paris Agreement, and 2°C and 1.5°C consistent pathways. High, median and low pathways represent ranges for a given scenario. Temperature figures represent the estimated average global temperature increase from pre-industrial, by 2100.



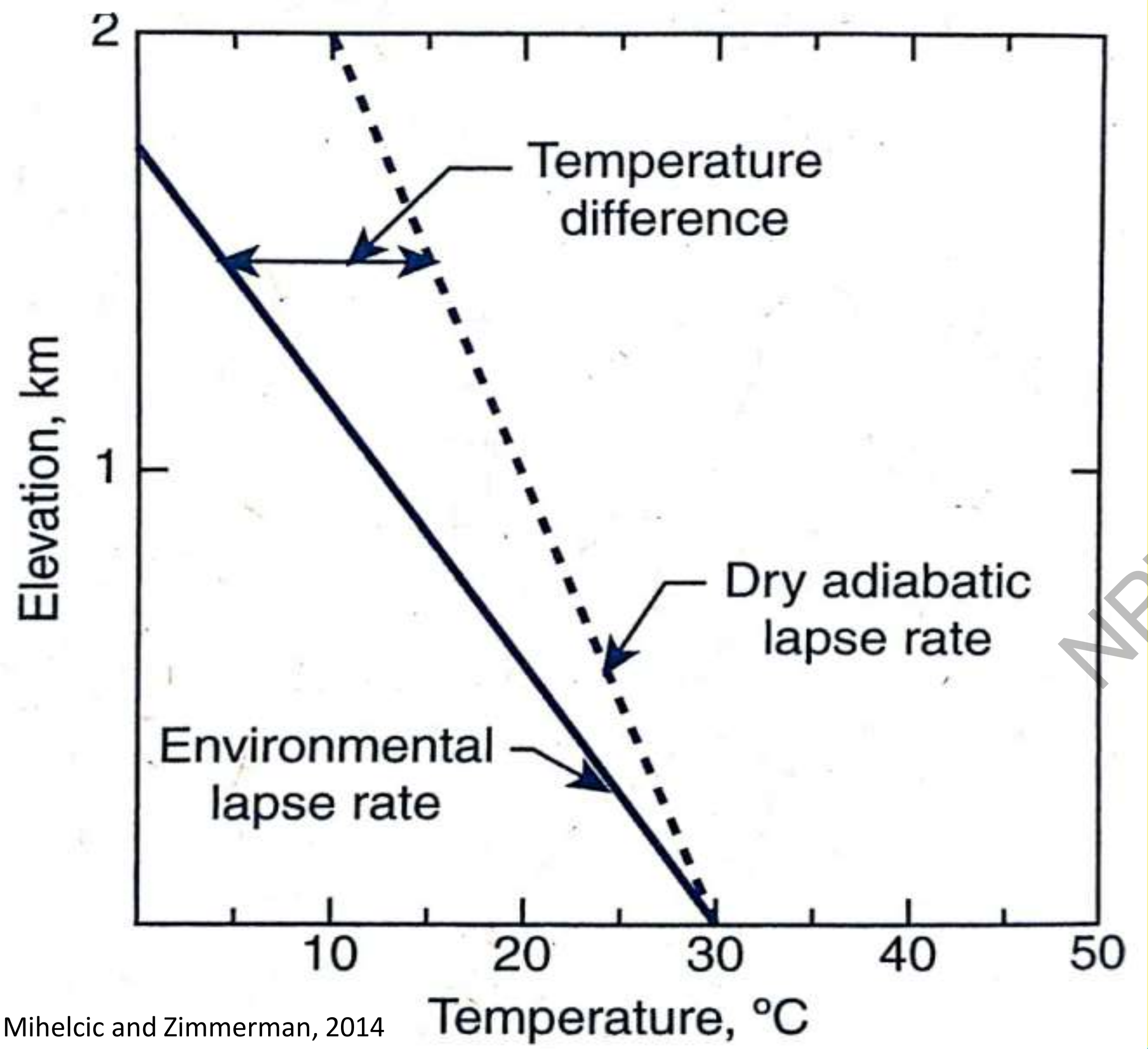
Based on data from the Climate Action Tracker (CAT).
The data visualization is available at OurWorldinData.org. There you find research and more visualizations on this topic.

NPTEL ONLINE CERTIFICATION COURSES

Introduction to Environmental Engineering and Science – Fundamentals and Sustainability Concepts

Faculty Name: Dr. Brajesh Kumar Dubey
Department : Civil engineering

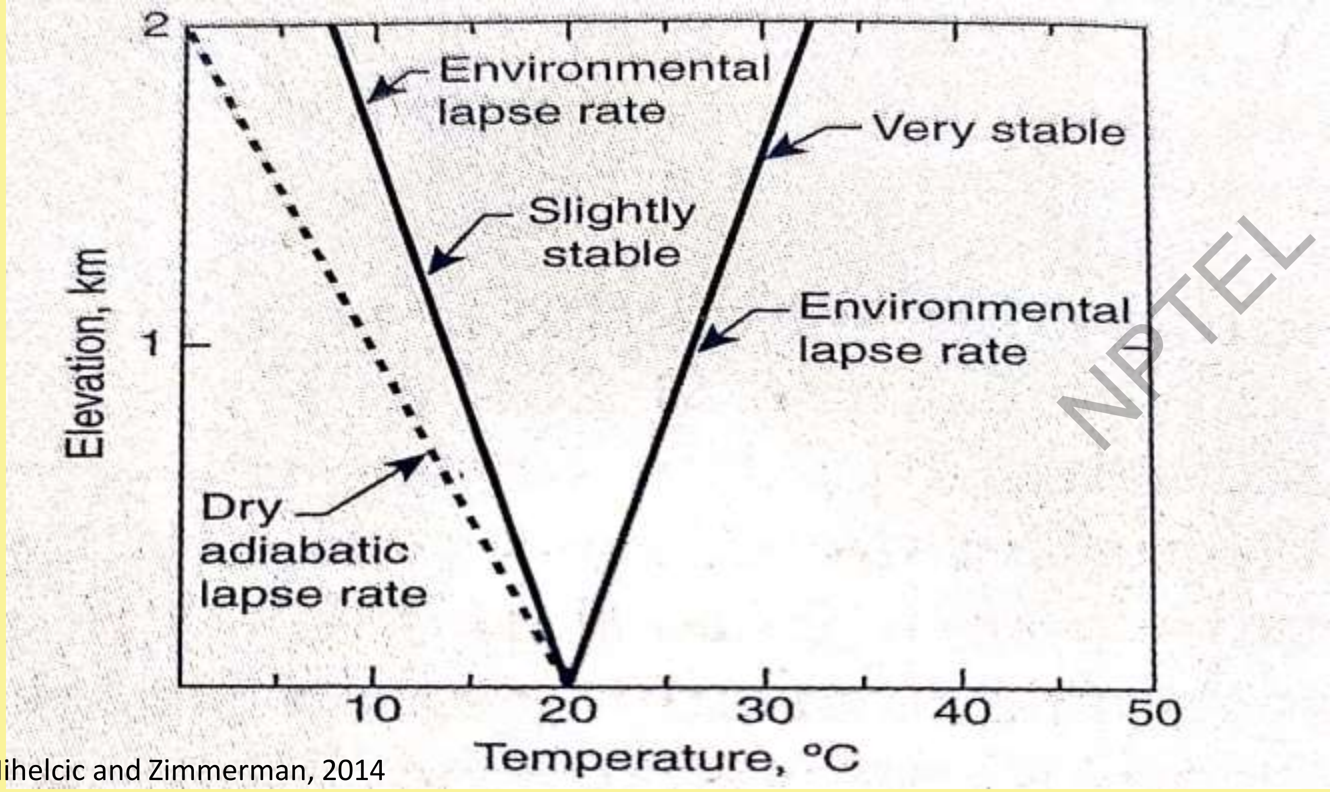
Week-11: Basics of Air Pollution Issues
Lecture 54: Air Pollution Models



Mihelcic and Zimmerman, 2014

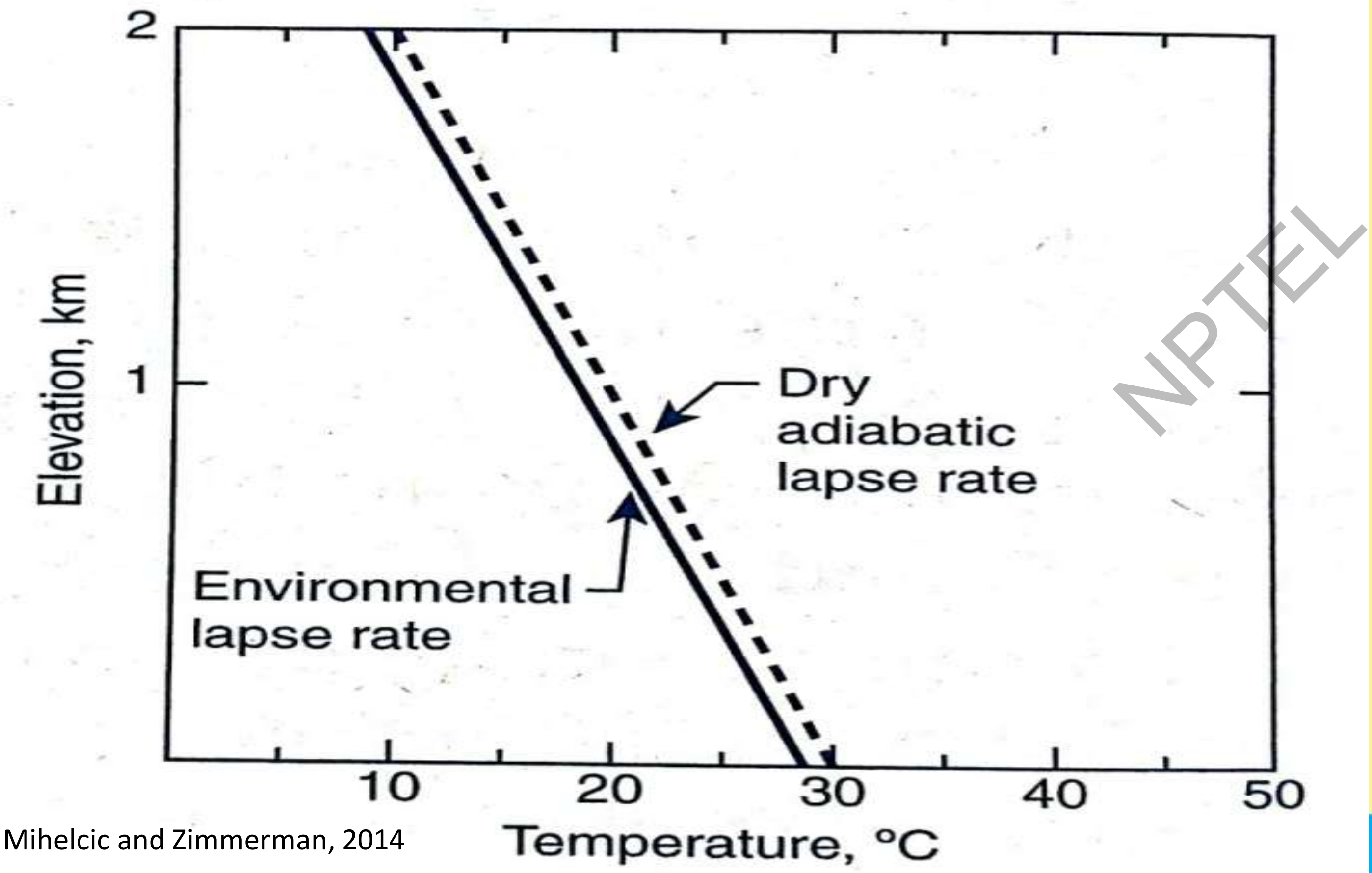
During unstable conditions, vertical movement of an air parcel in the atmosphere is encouraged upward or downward. Unstable conditions most commonly develop on sunny days with low wind speeds. The land surface quickly absorbs heat and transfers some heat to the surface air layer. This air warms, becomes less dance (and thus more buoyant) than the surrounding air so it rises vertically.

During stable conditions, vertical movement of an air parcel is discouraged. Under very stable conditions, a cooler layer of an air near the land surface is capped by an upper warmer air layer. This condition is called an inversion and prevents vertical motion of an air parcel.



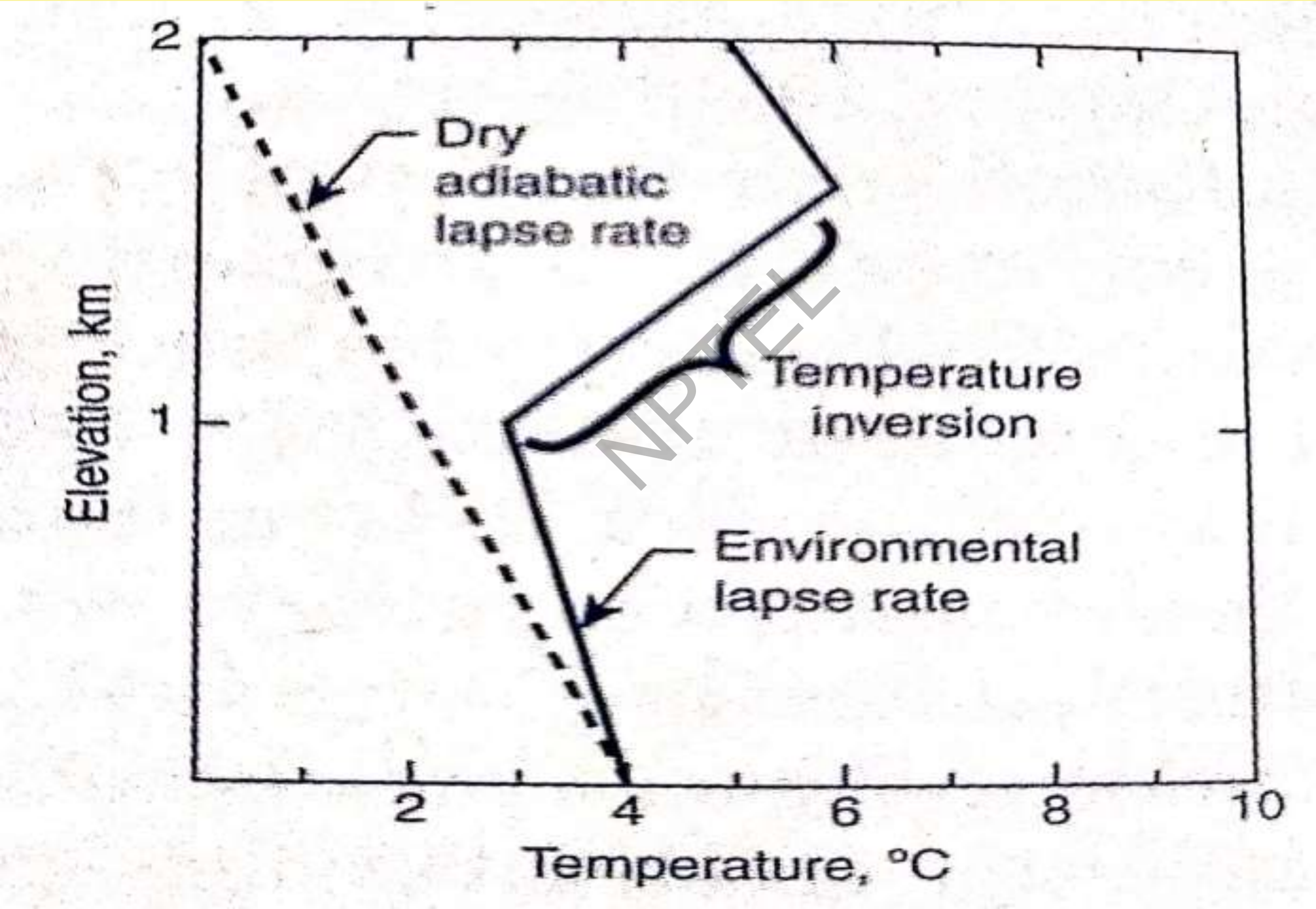
Mihelcic and Zimmerman, 2014

Neutral stability occurs when the environmental lapse rate is the same as the dry adiabatic lapse rate. The vertical movement of air is neither encouraged nor supported under these conditions. Neutral stability typically occurs on a windy day when cloud cover prevents strong heating or cooling of the land.



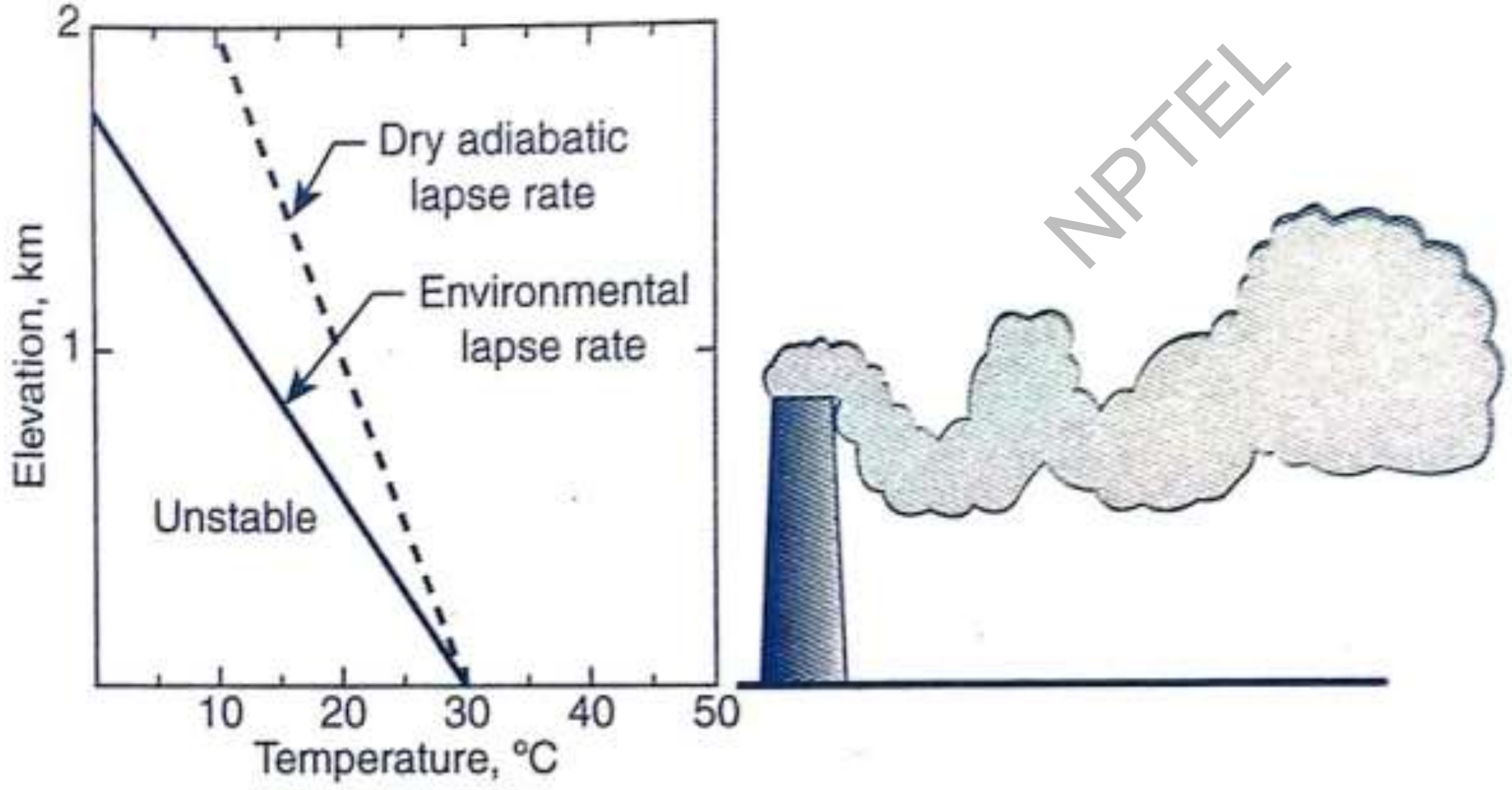
Mihelcic and Zimmerman, 2014

A temperature inversion occurs when a warmer layer of air resides above a cooler surface layer (from EPA,2012h). Areas that are prone to inversion occur where large populations of human reside. These areas include coastal zones, valleys, and locations near mountains.



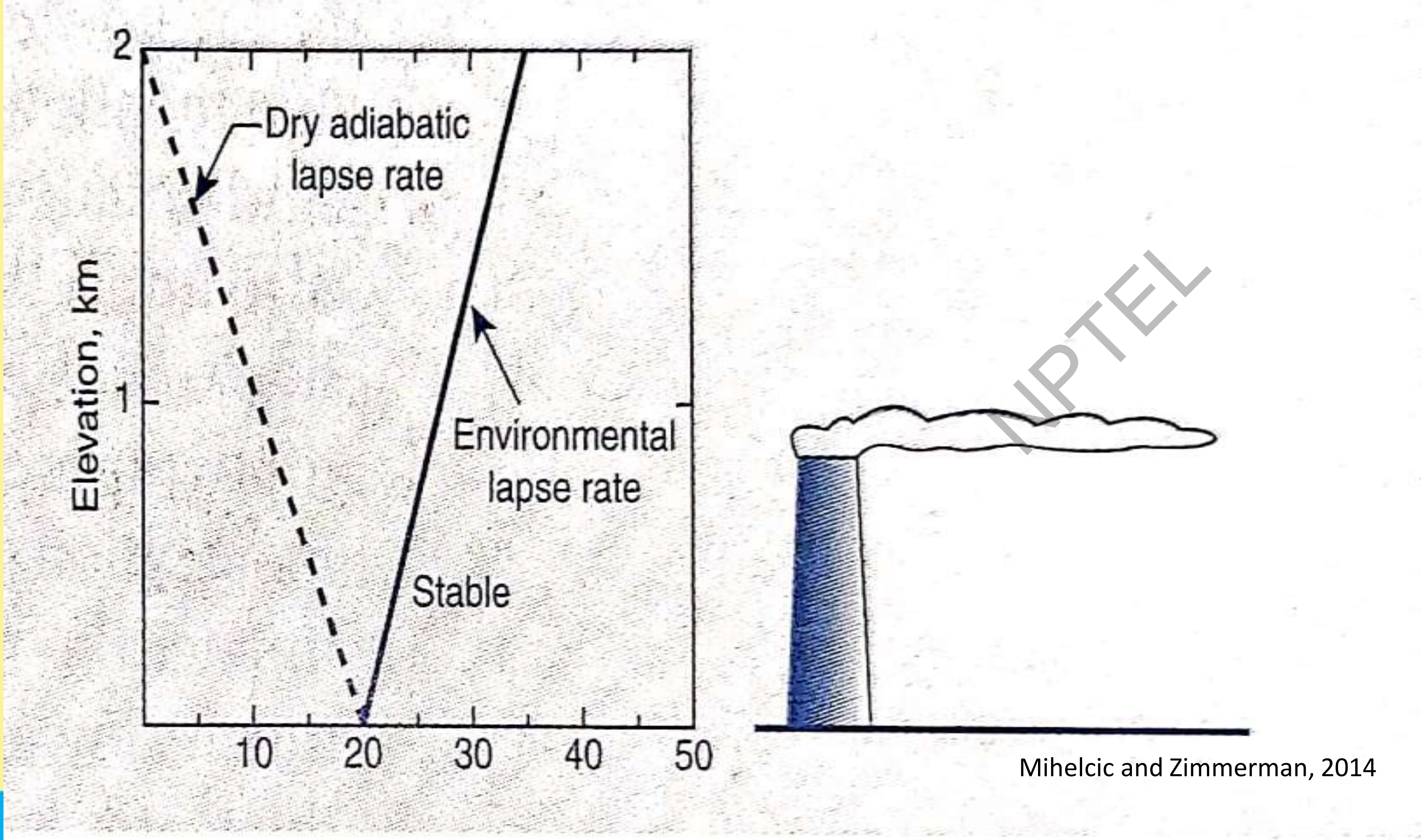
Mihelcic and Zimmerman, 2014

Looping- Occurs in highly unstable conditions. A rapid turnover of air causes turbulence. Looping plumes are usually favorable for dispersion of air pollutants and usually result in low exposure to low pollutant concentrations. However, there may be short episodes of exposure to higher concentrations of air pollutants where the plume loops downward to ground level.



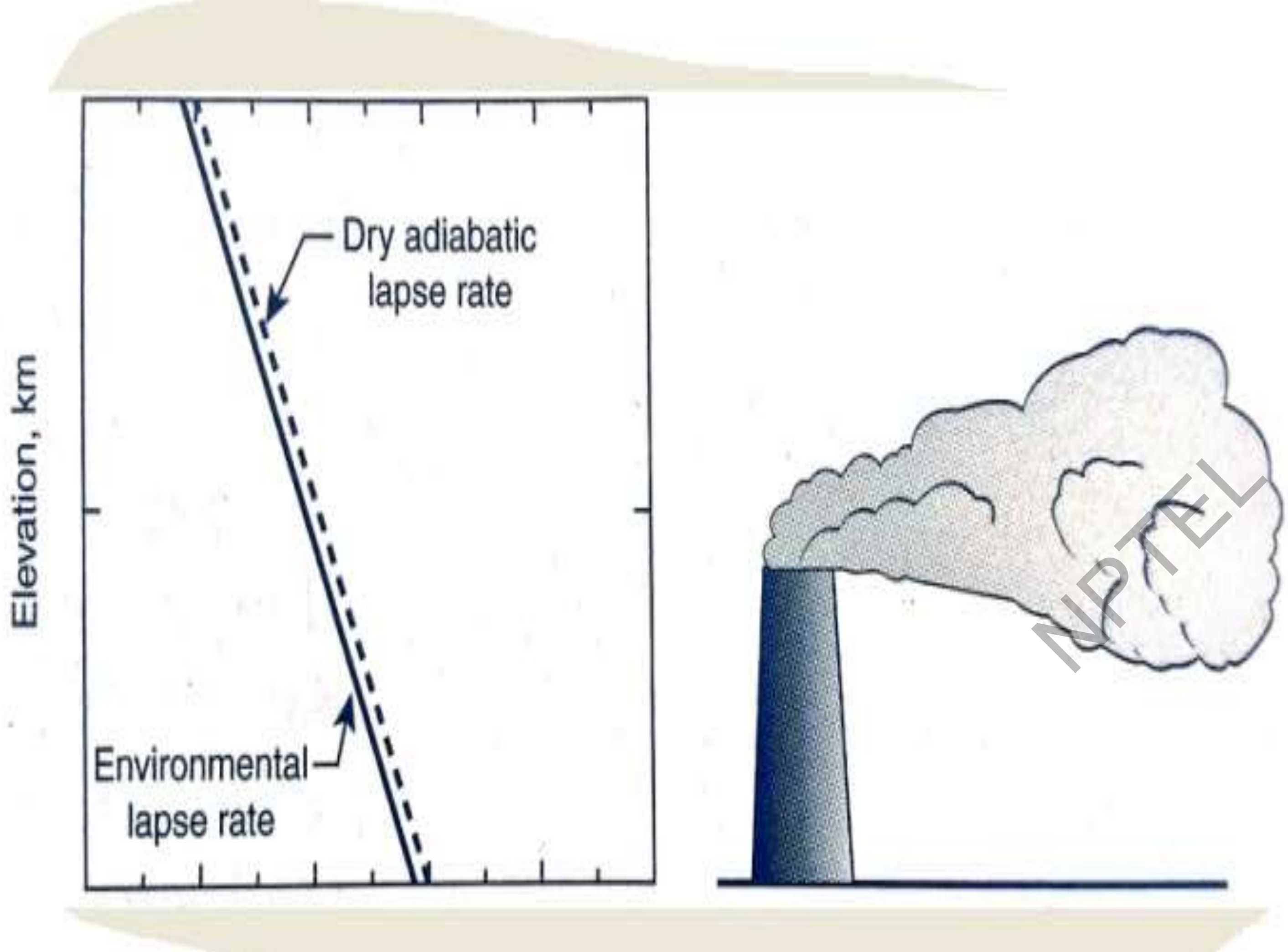
Mihelcic and Zimmerman, 2014

Fanning- Occurs in very stable conditions. An inversion prevents vertical motion of the plume, but horizontal motion of the plume is not prevented downwind.



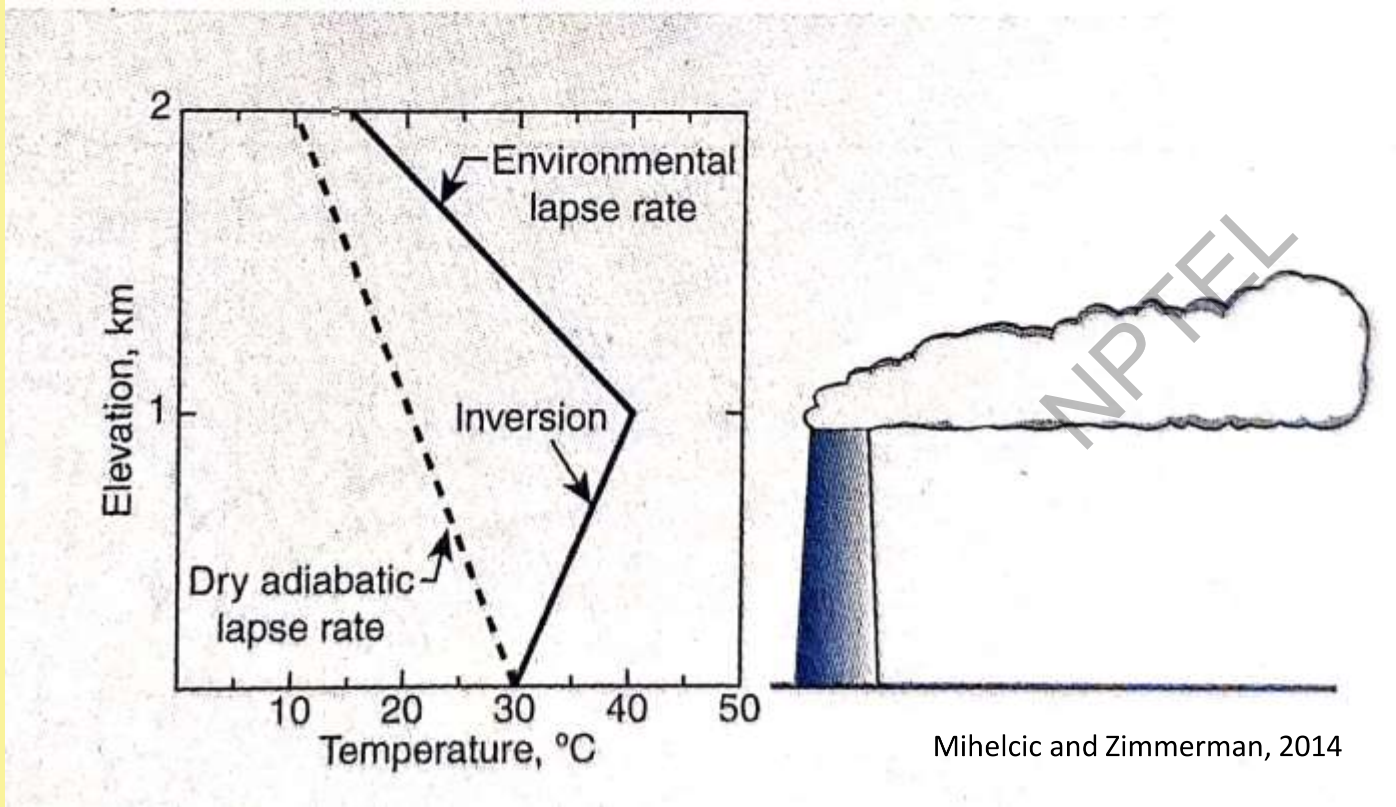
Mihelcic and Zimmerman, 2014

Coning- Occurs under neutral conditions where atmosphere conditions are slightly stable.



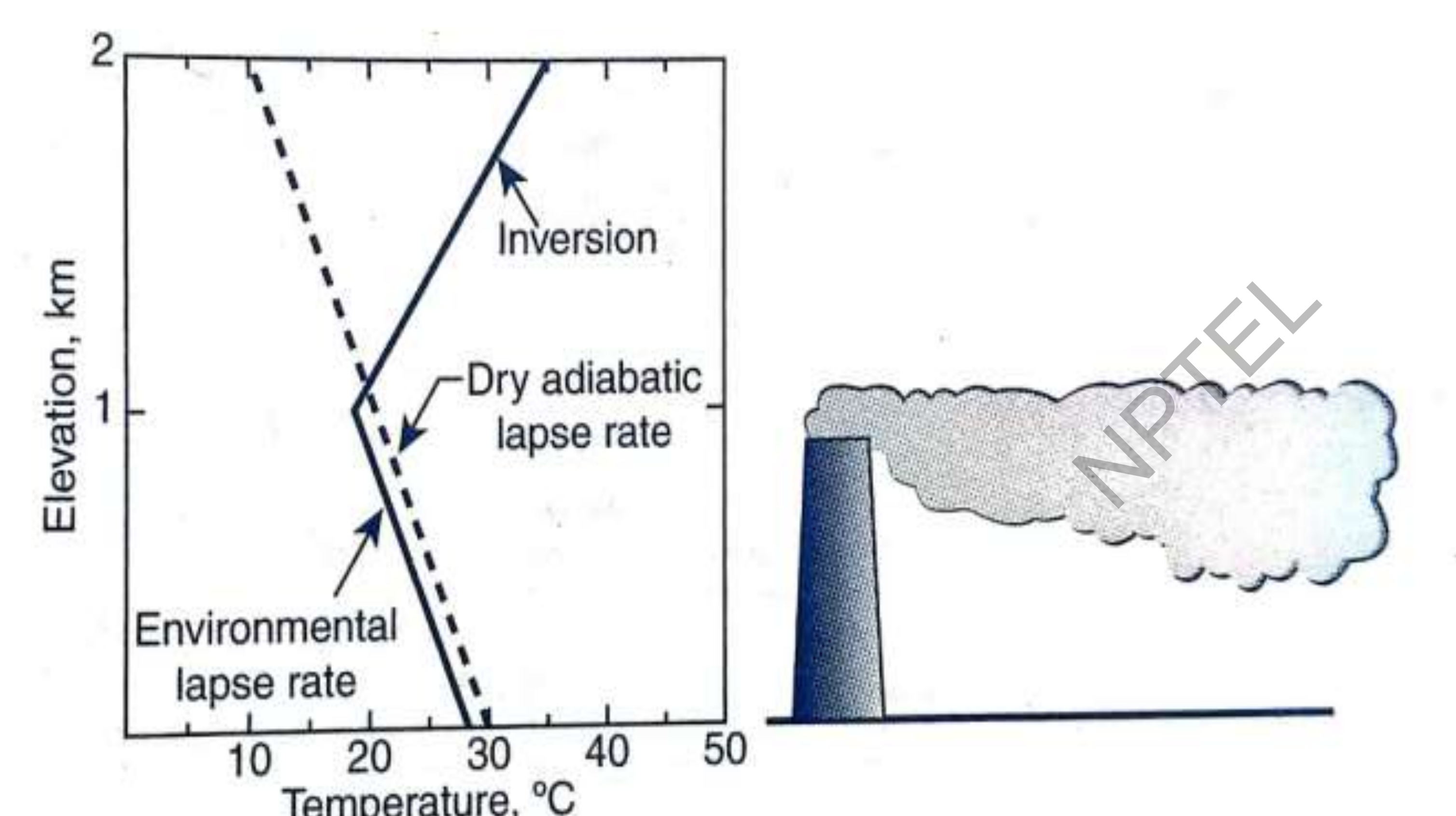
Mihelcic and Zimmerman, 2014

Lofting- Release of air pollutants occurs just above the inversion. The air above the inversion is unstable, which encourages vertical mixing above the inversion layer. In this case ground-level receptors are fortunate because stack height is above the elevation of the inversion.



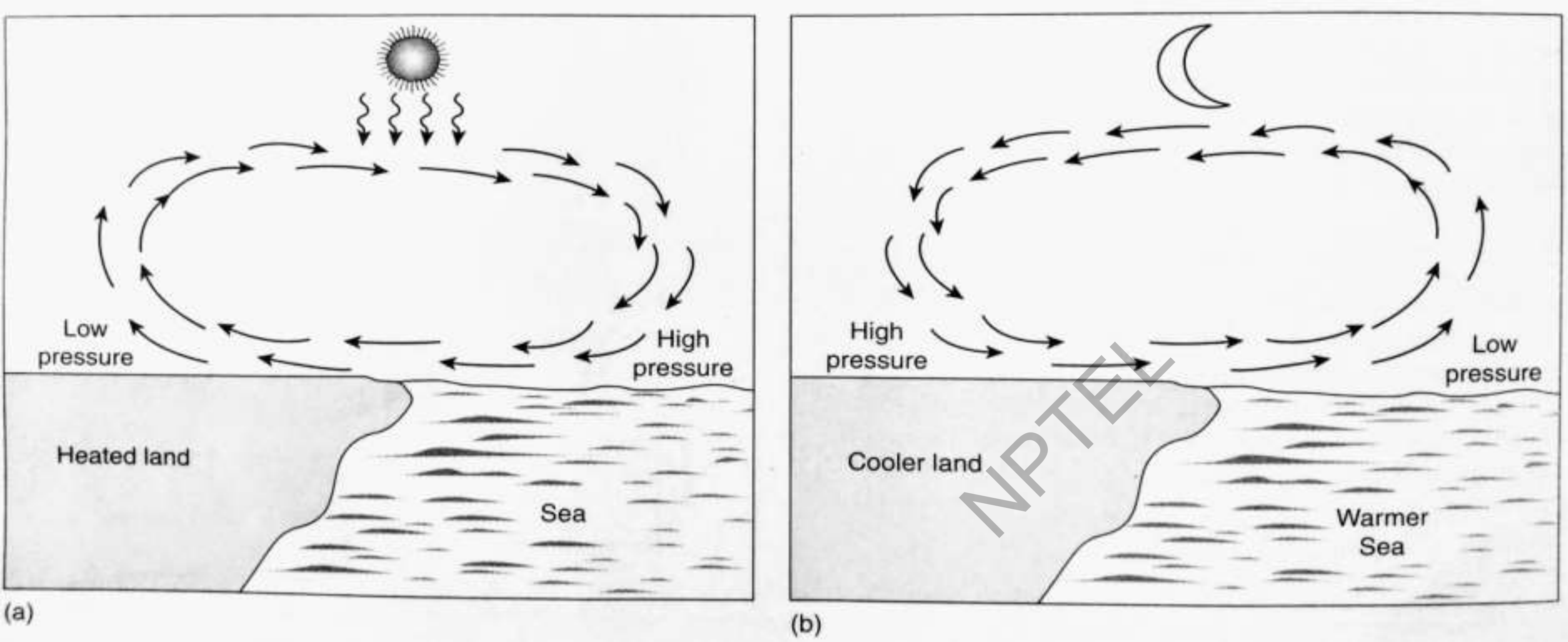
Mihelcic and Zimmerman, 2014

Fumigation- Air pollutants are released just below an inversion layer. The air below the plume in this case in unstable. Ground – level receptors can be exposed to high levels of air pollutants.



Mihelcic and Zimmerman, 2014

Terrain effect on atmospheric stability



Mihelcic and Zimmerman, 2014

Differential heating between water and land leads to (a) Sea Breeze and (b) Land Breeze.

Fundamentals of dispersion modeling

$$C(x, y, z) = \frac{S}{2\pi u \sigma_y \sigma_z} \exp\left(-\frac{y^2}{2\sigma_y^2}\right) \left\{\exp\left(-\frac{(z-H)^2}{2\sigma_z^2}\right)\right\}$$

C: Concentration of an air pollutant at any spatial location.

x: Downwind distance

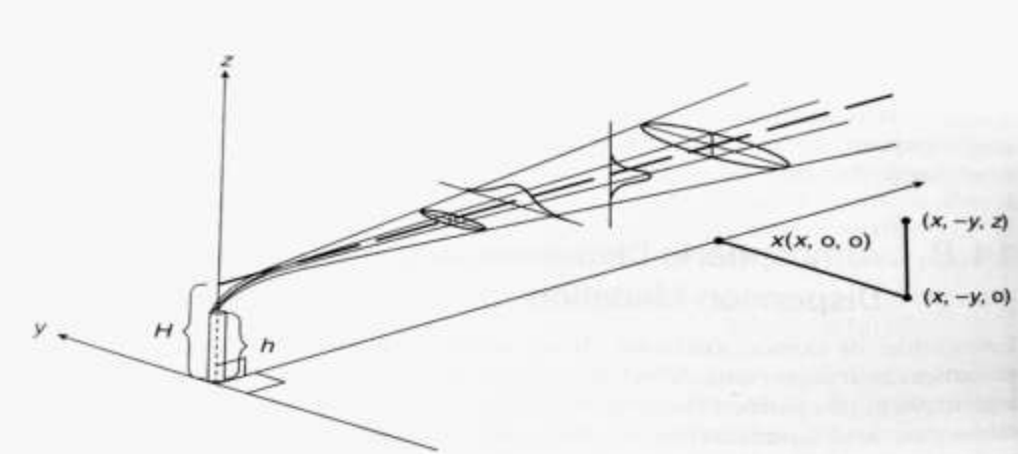
y: crosswind coordinate

z : Vertical coordinate

H: Effective release height above the ground surface

S: continuous pollution emissions rate

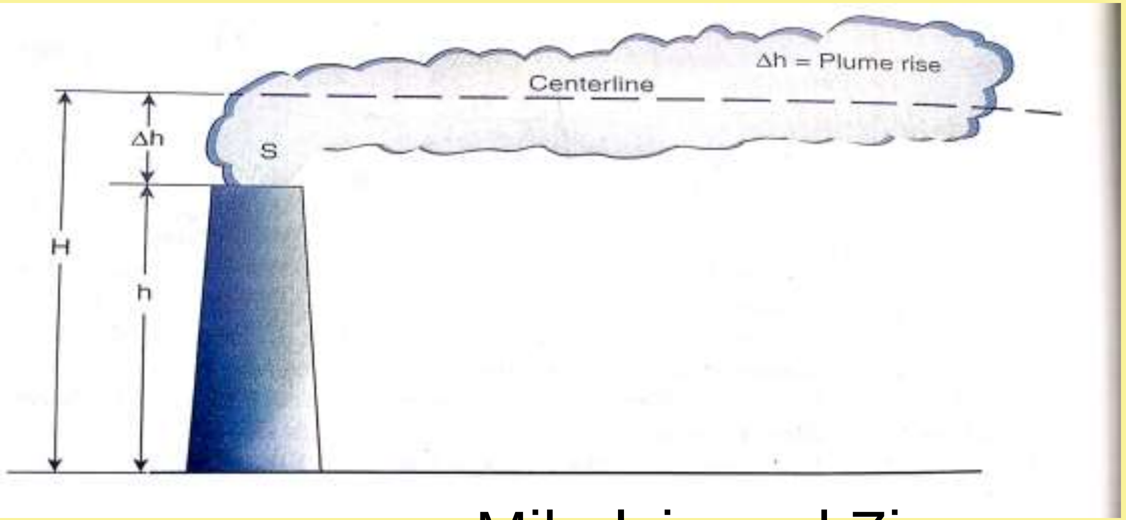
σy and σz : Dispersion coefficient.



Mihelcic and Zimmerman, 2014

$$C(x,y,z) = \frac{S}{2\pi u \sigma_y \sigma_z} \exp\left(-\frac{y^2}{2\sigma_y^2}\right)\left\{\exp\left(-\frac{(z-H)^2}{2\sigma_z^2}\right)\right\}$$

- The first term to right of the equal sign provides concentration directly at the centerline of the plume.
- Second term adjust the concentration as you move in the sideway (y) direction .
- The third term adjust the concentration in the vertical (z) direction.



Mihelcic and Zimmerman, 2014

v = Exit velocity of the stack gas (m/s)
d: Inner diameter of the stack
Ts: Exit temperature of the stack gas
Ta: Ambient air temperature
P : Ambient pressure

$$\Delta h = \frac{v\,d}{u}\left(1.5 + 2.68 \times 10^{-3} P \left(\frac{T_s - T_s}{T_a}\right) d\right)$$

Form of Gaussian plume model

We are also most times concerned with the concentration of an air pollutant at the ground level because this is where exposure of human and crops would tale place.

$$C(x, y, 0) = \frac{S}{\pi u \sigma_y \sigma_z} \exp\left(-\frac{y^2}{2\sigma_y^2}\right) \exp\left(-\frac{H^2}{2\sigma_z^2}\right)$$

A manufacturing process emits 2.4 g of the pollutant SO_2 every minute. The stack height is 15 m and there is zero plume rises. Assume the wind speed is 3 m/s and the horizontal dispersion coefficient (σ_y) is 25 m and the vertical dispersion coefficient (σ_z) is 15 m for this situation. What is the concentration of the air pollutant 0.5 km downwind of the release along the centreline?

The problem is asking us to estimate the ground –level concentration of the pollutant in two location, both estimation are at ground level se we will use following equation

$$C(x, y, 0) = \frac{S}{\pi u \sigma_y \sigma_z} \exp\left(-\frac{y^2}{2\sigma_y^2}\right) \exp\left(-\frac{H^2}{2\sigma_z^2}\right)$$

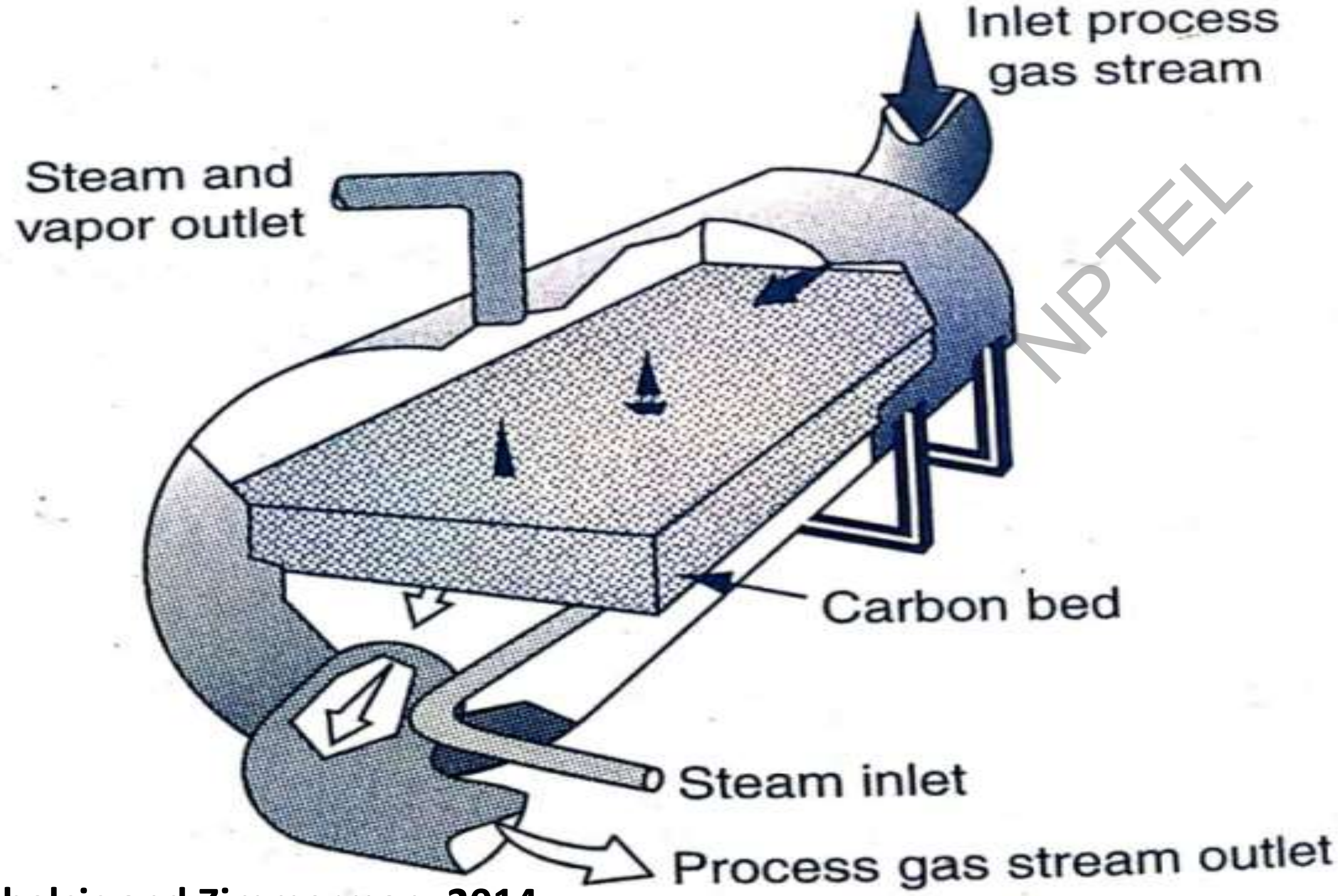
Therefore, putting all the given value in the equation we get

$$c(500,0,0) = \frac{2.4\ \text{g/min} \times \frac{\text{min}}{60\ \text{s}}}{\pi \times 3\ \text{m/s} \times 25\ \text{m}\ \times 15\ \text{m}} \exp\left(-\frac{(0\ \text{m})^2}{2 \times (25\ \text{m})^2}\right) \exp\left(-\frac{(15\ \text{m})^2}{2 \times (15\ \text{m})^2}\right)$$

$$c = 6.9 \times 10^{-6}\ \text{g/m}^3 \times 10^6\ \mu\text{g/g} = 6.9\ \mu\text{g/m}^3$$

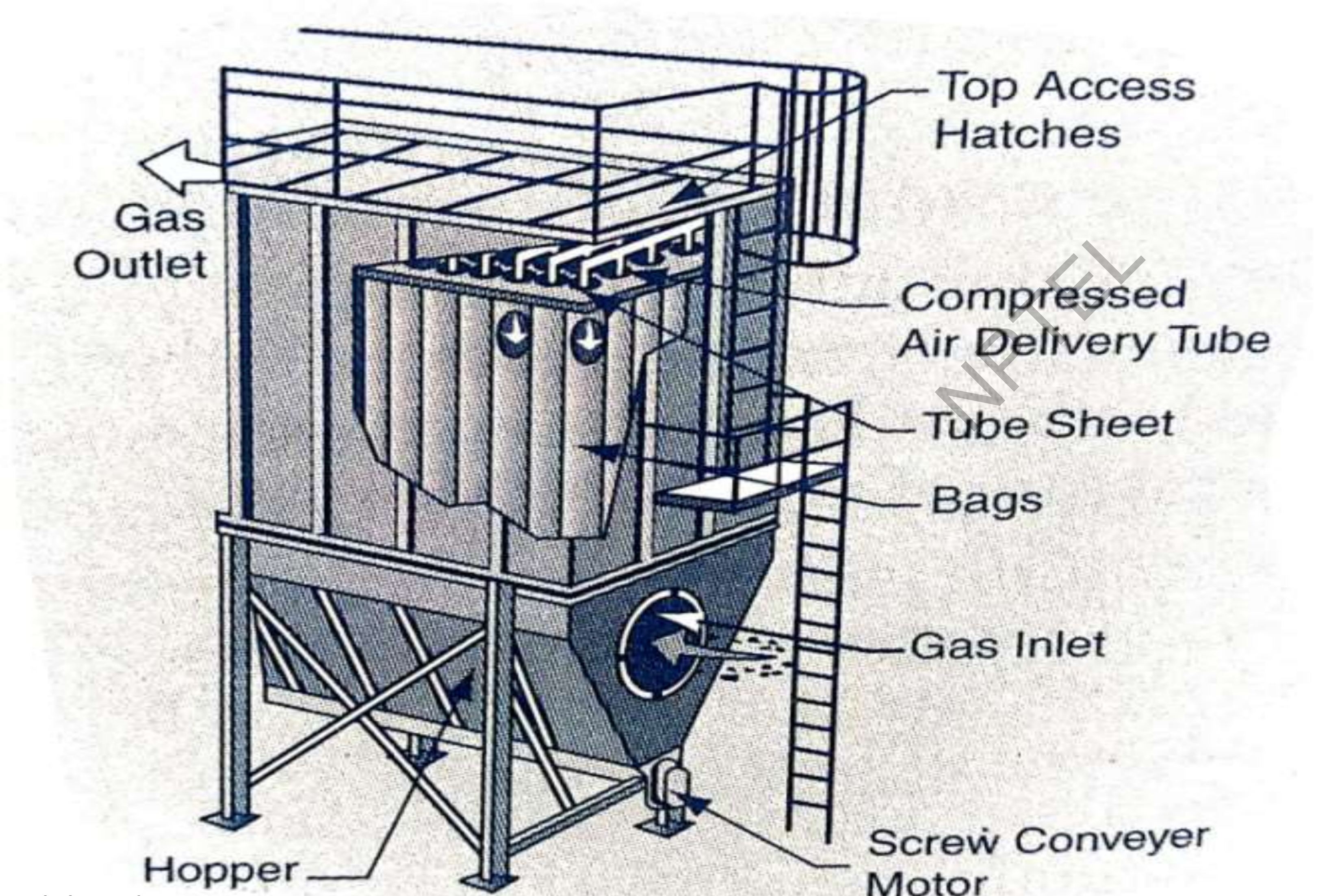
Control Technology and Operating

Adsorption processes allow for gaseous pollutants like VOC_S and SO_2 to be transferred from the air to a solid adsorbent. The horizontal bed absorber shown here is commonly used for larger flow rates.



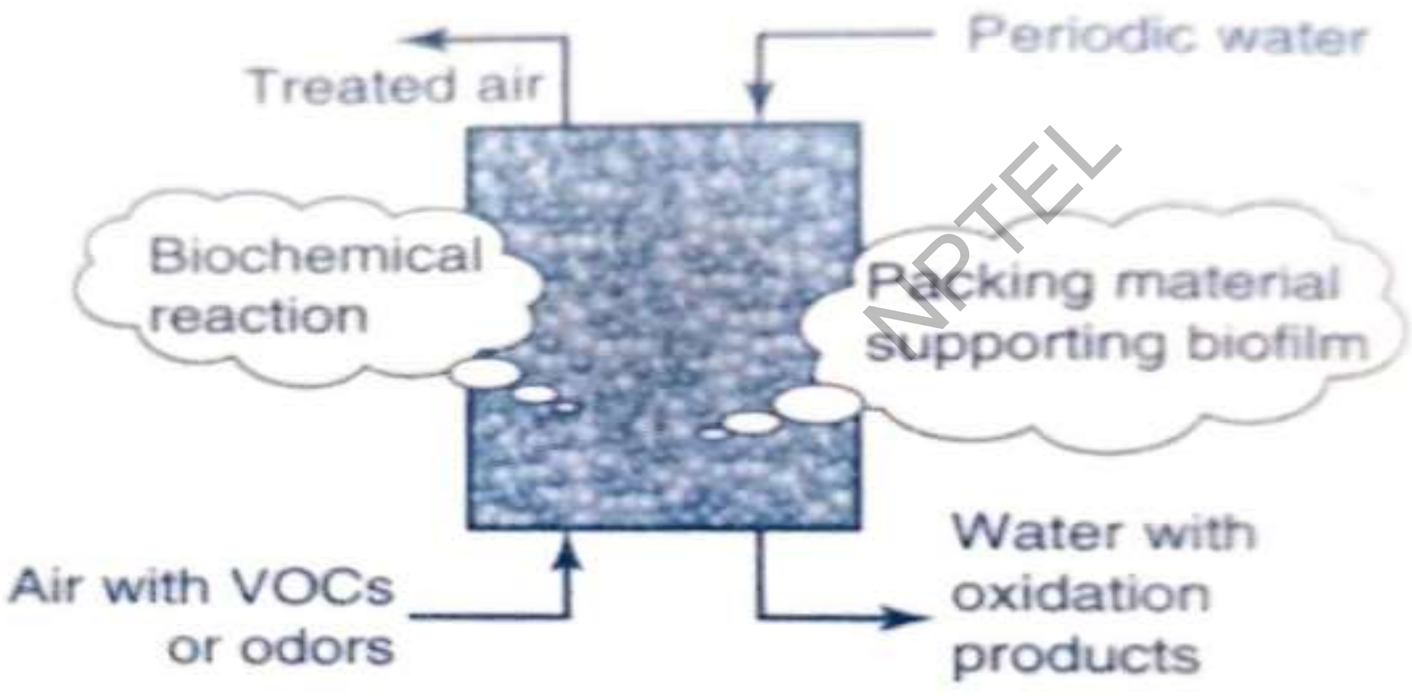
Mihelcic and Zimmerman, 2014

A baghouse allows for particulate matter to be filtered by a set of fabric filter bags. The bags are periodically shaken to remove the particulate matter into an underlying hopper from where it can be collected.

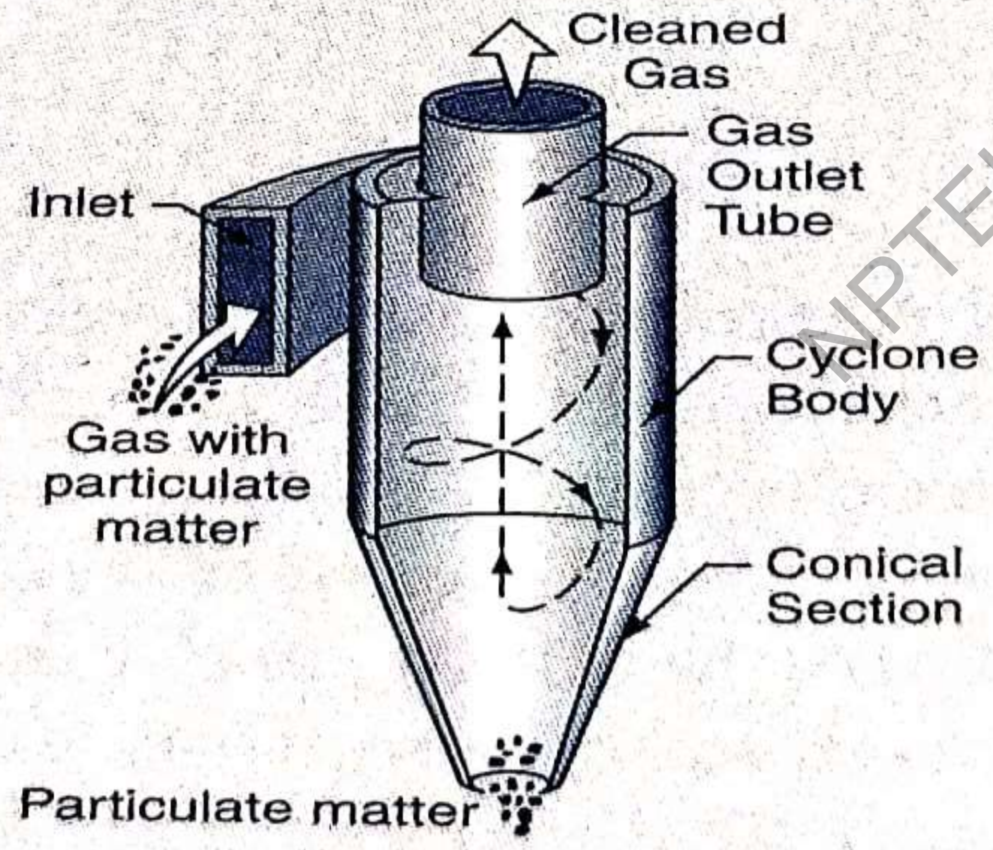


Mihelcic and Zimmerman, 2014

A biofilter degrades gaseous pollutants (VOC_S and odors) by use of microorganisms that reside on the filter media. The filter medium could be something such as lava rock or a mixture of compost and woodchips. Air is typically passed up through the bed. Periodically, moisture may be added to the filter.

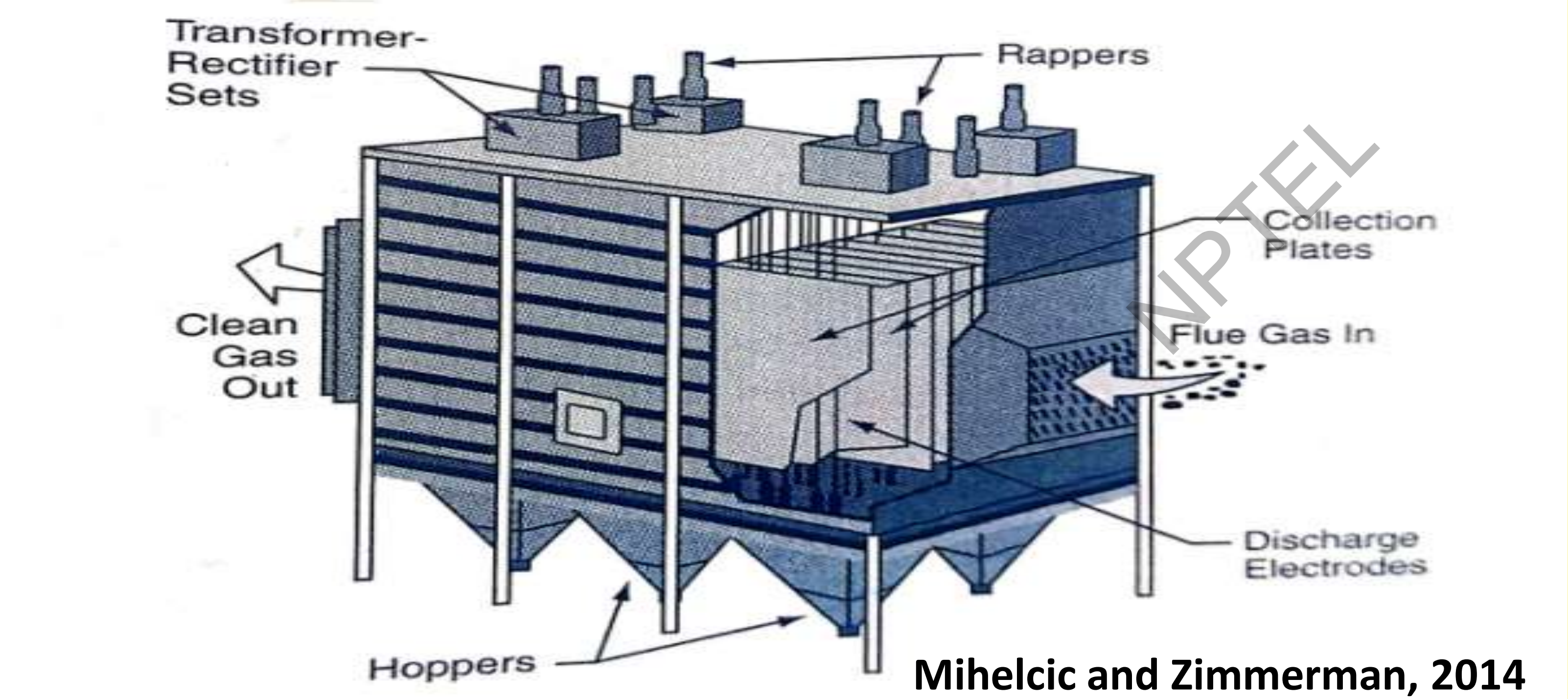


In a cyclone, particulate pollutants enter with the gas and are removed by centrifugal forces because the particles have more momentum and cannot turn with the gas. The air moves in a helical pattern. Particles that impact the cyclone outer wall then fall by gravity into a hopper where they can be collected.



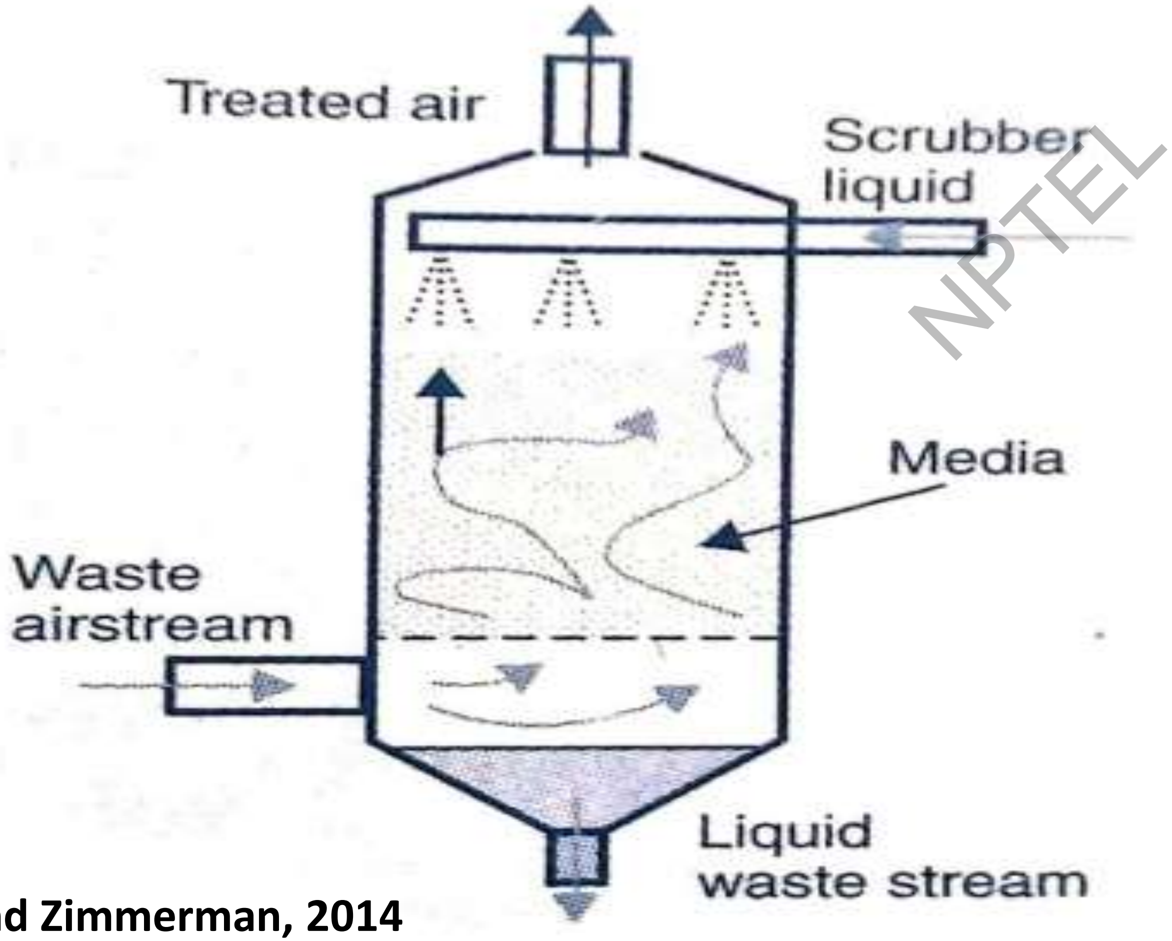
Mihelcic and Zimmerman, 2014

In an electrostatic precipitator, particulate matter is first charged by applying a high voltage, which produces ions that attach to the particles. The charged particles are then forced to collection plates. Rappers use impulse or vibrating methods to remove the particles from the collection plate so they fall into the hopper, where they can be removed.



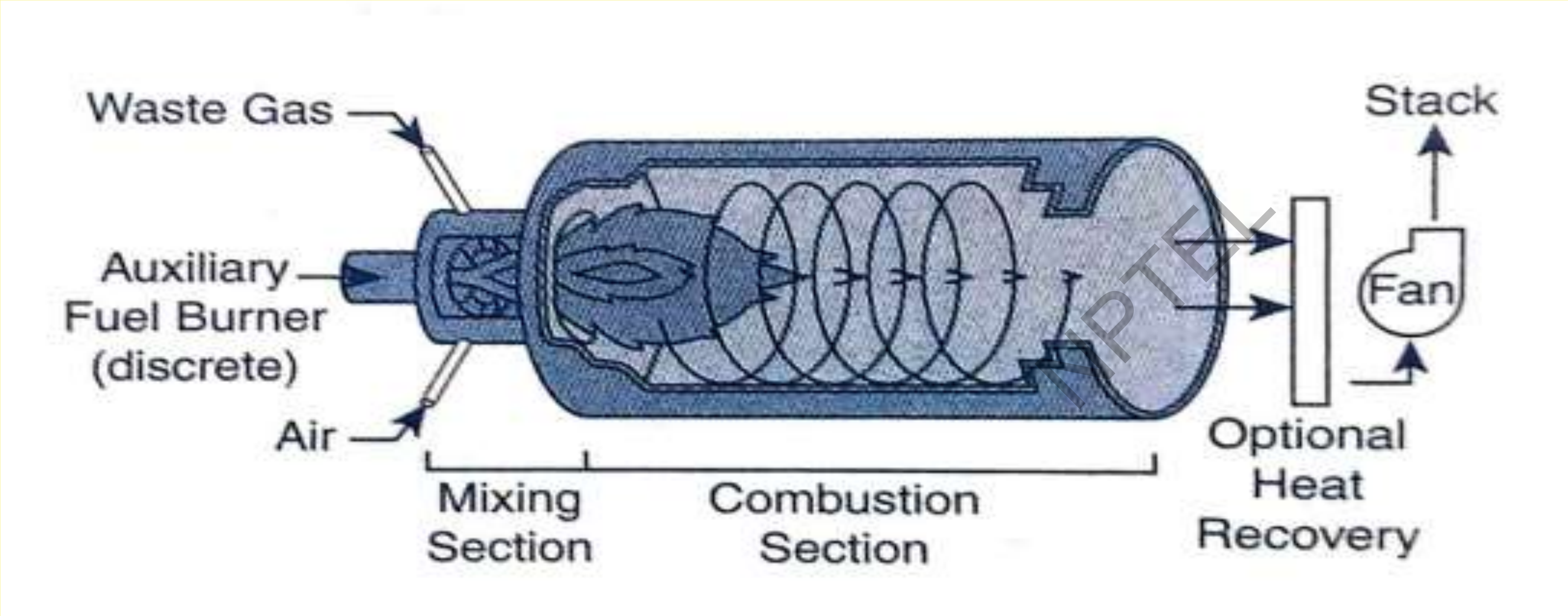
Mihelcic and Zimmerman, 2014

In a packed bed absorption, scrubber pollutants (such as SO_2,NH_3,HCL) are transferred from the air to liquid. A key performance indicator is how well equilibrium between the gaseous and aqueous phase (as determined by a Henry's constant) favors the liquid phase. Also important is the rate at which the pollutant transfers from the air to liquid phase.



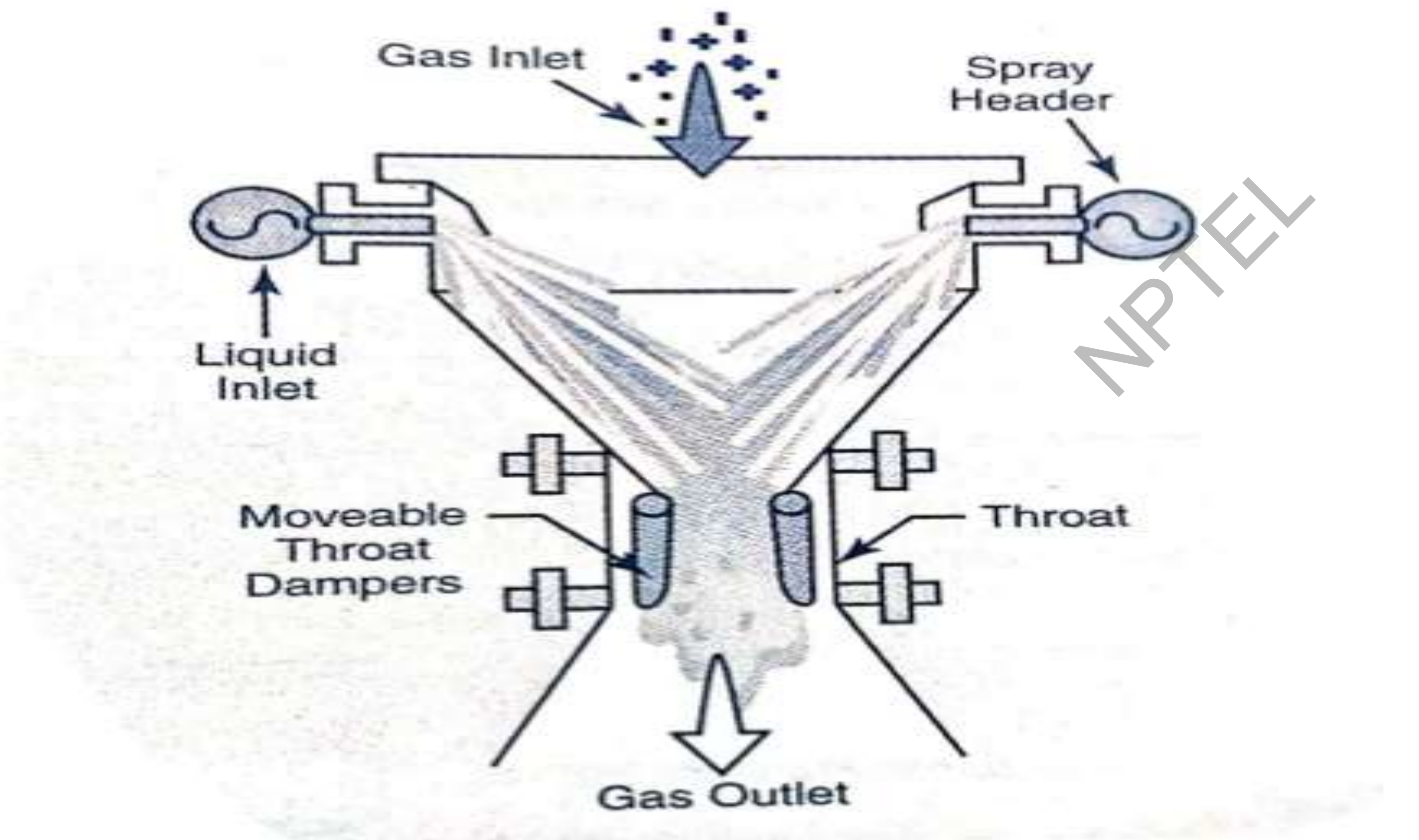
Mihelcic and Zimmerman, 2014

In a thermal oxidizer, the pollutants (VOC, CO, odor) is oxidized through high –temperature combustion. The system consists of a burner and reaction chamber. Removal is better with greater temperatures, turbulence, and gas residence times.



Mihelcic and Zimmerman, 2014

In a venturi scrubber, particulate matter and other pollutants such as SO_2 and HCL can be removed together by impaction of airborne pollutants on water droplets. A water spray can be added by several methods, including injection into flowing gas.



Mihelcic and Zimmerman, 2014

INDOOR AIR POLLUTANTS

Sources of Indoor Air Pollutants

Sources	Example Sources and Specific Pollutants
Combustion sources	Burning oil, gas, kerosene, coal, wood, and tobacco products can release fine particulate matter, CO, hazardous air pollutants into the indoor environment.
Outdoor Sources	Pesticides and outdoors air pollutants can enter the indoor environment through open windows, cracks, the ventilation intake, and from dust carried into the building on shoes. Radon can enter through the building's foundation.
Building materials and household furnishings	Asbestos and lead are found in building insulation and paint in older homes. Formaldehyde and other VOCs are emitted from pressed wood products found in the building structure and furniture. VOCs are also emitted from sealants, adhesives, and paints. Flame retardants are emitted from furniture, electronics, mattresses, and even baby clothes.

INDOOR AIR POLLUTANTS

Sources of Indoor Air Pollutants	
Sources	**Example Sources and Specific Pollutants**
Household products	VOCs, hazardous air pollutants, and fragrance are emitted from common household cleaners, maintenance products, personal care and hobby products, and printer ink.
Dampness and water leaks	Biological pollutants such as mold.
Household inhabitants, pests, and their activities	Pets, people, rodents, insects, and plants all can shed or off-gas biological particles, allergens, and some gases. Inhabitant activities such as vacuuming with a poor quality filter also resuspend deposited particles into the air.

Around 3 billion people around the world depend on burning solid fuels or kerosene for household energy, which can have serious negative health impacts when burned indoors. Women and children, primarily in lower income countries, are most at risk from this threat. Switching to cleaner fuels can not only improve air quality and health, but also help reduce gender inequality.

https://archive.indiaspend.com/special-reports/indian-women-most-prone-to-death-by-fire-61951

NPTEL ONLINE CERTIFICATION COURSES

Introduction to Environmental Engineering and Science – Fundamentals and Sustainability Concepts

Faculty Name: Dr. Brajesh Kumar Dubey
Department : Civil engineering

Week-11: Basics of Air Pollution Issues

Lecture 55 : SDGs, Noise and Soil Pollution

Related Sustainable Development Goals

Goal 3
Good Health and Well-Being

Goal 7
Affordable and Clean Energy

Goal 11
Sustainable Cities and Communities

Goal 12
Sustainable Consumption and Production

Goal 13
Climate Action

Goal 17
Partnerships for the Goals

Goal 3

Good Health and Well-Being

Targets linked to the environment:

- **Target 3.9:** By 2030, substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water and soil pollution and contamination

Goal 7

Affordable and Clean Energy

Facts:

- 3 billion people rely on wood, coal, charcoal or animal waste for cooking and heating
- Energy is the dominant contributor to climate change, accounting for around 60 per cent of total global greenhouse gas emissions
- Since 1990, global emissions of CO_2 have increased by more than 46 per cent.
- Hydropower is the largest single renewable electricity source today, providing 16% of world electricity at competitive prices. It dominates the electricity mix in several countries, developed, emerging or developing.
- Bioenergy is the single largest renewable energy source today, providing 10% of world primary energy supply.

Targets linked to the environment:

- **Target 7.1:** By 2030, ensure universal access to affordable, reliable and modern energy services
- **Target 7.2:** By 2030, increase substantially the share of renewable energy in the global energy mix
- **Target 7.3:** By 2030, double the global rate of improvement in energy efficiency
- **Target 7.a:** By 2030, enhance international cooperation to facilitate access to clean energy research and technology, including renewable energy, energy efficiency and advanced and cleaner fossil-fuel technology, and promote investment in energy infrastructure and clean energy technology
- **Target 7.b:** By 2030, expand infrastructure and upgrade technology for supplying modern and sustainable energy services for all in developing countries, in particular least developed countries, small island developing States, and land-locked developing countries, in accordance with their respective programmes of support

Goal 7

Affordable and Clean Energy

Methods to Control Indoor Air Pollution

Control Method	Description
Source control	•Preferred and most effective because it eliminates the source of the pollutant. Strategically placed carpets as you enter the house can capture dust particles. •Purchase and use vacuum cleaners with high capture and filtration efficiencies for small particles. •Eliminate synthetic carpets and their adhesives that emit VOC and store pollutants. Use natural floor coverings (with zero or low VOC adhesives) such as wood, tile, and organic wool. •Eliminate use the synthetic fragrances found in perfumes, candles, odor control devices, and cleaning products that contain synthetic chemicals. •Purchase adhesives, paints, coverings, and furniture that have zero or very low VOC emission rates. Use of natural and organic products will minimize emissions of VOC s and other hazardous air pollutants such as flame retardants. Ensure product bottles remain sealed when not in use. •Eliminate water leaks that release moisture into building structure.

Methods to Control Indoor Air Pollution

Control Method	Description
Ventilation improvements	•Mechanical ventilation systems draw outside air into the building and can employ energy efficiency through use of air-air heat exchangers. •Operating ceiling and attic fans can improve a home's ventilation rate. •Strategic placement and use of windows that open and take advantage of natural ventilation. •Use of well-designed chimneys and appliance ventilation are important to removing gaseous emission from combustion and other human activities.
Air cleaners	•This is a least preferred method of the pollution prevention hierarchy, because it typically is less effective than source control or improved ventilation. •Cleaners are generally not designed to remove gaseous pollutants and fine particulate matter. Further, their effectiveness varies, and high throughput rates may be necessary for cleaning a large room.

Definition of Some Major Anthropogenic Sources of Air Emission

Emission source	Major Sources
Point sources are emitted from a stack.	Power plants, industrial boilers, petroleum refineries, industrial surface coatings, and chemical manufacturing industries.
Area sources are those emission that are not associated with a stack and are individually too small to be treated as point sources.	Solvents used for surface coating operations, degreasing, graphic arts, dry cleaning and gasoline stations from tank truck unloading, and vehicle refueling.
Mobile sources are categorized for highway and off-highway sources.	Highway sources include automobile, buses, trucks, and other vehicles travelling on local and highway roads. Off-highway sources are any mobile combustion sources such as railroads, marine vessel, off-road motorcycle, snowmobiles, farm, construction, industrial and ;awn/garden equipment.
Fugitive emission are releases of gases and particulates that are not through a collection system.	Usually associated with industrial activities. Emissions that escape capture by hoods are emitted during material transfer, are emitted to the atmosphere from a source area, or are emitted from process equipment. They can include those from pressurized equipments, leaks from valves and pipe connections, emissions from wastewater treatment ponds and waste storage tanks.

Control Technologies and Pollution Prevention activities to control Emission of Some Specific

Pollutants(s)	Treatment Control Technology	Pollution Prevention Activity
Particulate matter	Electrostatic precipitator, bag house filters, particle scrubbers, and cyclones.	Reduce demand for electricity by providing incentives to purchase energy efficiency lighting and appliances. Energy star programs provide consumers with information on energy efficiency of appliance purchases.
Sulfur dioxide	Flue gas desulfurization or cleaning sulfur from coal for combustion.	Reduce demand for coal generated electricity through demand strategies such as described above for particulate matter. Fuel switching to coal with lower sulfur content, a different type of fuel, or renewable energy source.
VOCs	Thermal or catalytic oxidation, adsorption systems (for example, activated carbon), and biofilters. Hoods and other technologies for capture of fugitive emission.	Substitute solvent-based paints with water-based paints for the coatings used in the automobile and appliance industries. Improve fuel efficiency of highway and off-road vehicles.

Control Technologies and Pollution Prevention activities to control Emission of Some Specific

Pollutants(s)	Treatment Control Technology	Pollution Prevention Activity
NO_x	Catalytic converters for reduction in NO_x emission from vehicular sources. Selective reduction, scrubbers, and adsorption systems for point sources.	Use demand management strategies that promote and provide incentives for the public to use mass transportation, walk, or cycle.
Ozone	Control of NO_x and VOCs as discussed above.	Reduce vehicle miles traveled and demand for electricity.
Mercury	Inject activated carbon into the flue gas followed by a particle collection technology.	Reduce demand for electricity. Reduce use of mercury in consumer, medical, and scientific products. Separate mercury-containing products from medical and municipal waste incineration streams.

Common Cause for Fabric Failures in a Baghouse

Cause	Results in	Reason
Improper bag installation	Holes or tears in bags Reduces bag strength.	Lack of proper vendor instructions poor access to bags by installer improper tensioning or rough handling such as bending or stepping on the bags. Bags to tight for cages. Sharp edges on cages.
High temperatures (fabric specific and maximum temperatures range from 180^0 F to 550^0F)	Loss of fabric strength. Attack on the bag's finish that causes abrasion.	Improper fabric for service. No high temperature alarm. Continual operation at close to fabric temperature limits.
Condensation	Alters adhesion characteristics of the particles to the bag materials resulting in muddling or building. Chemical attack non the fabric	Unit not preheated or purged properly. Air leakage or inadequate insulation.

Common Cause for Fabric Failures in a Baghouse

Cause	Results in	Reason
Chemical degradation	Attacks fibers of the fabric resulting in loss of strength.	Change in manufacturing process.
High-temperature drop	Increases bag abrasion that results in tears in the fabric.	Poor cleaning, blind bags, increase in gas velocity.
Bag abrasion	Worn or torn bags.	Contact between bag and another surface. High particle loadings. Large particle inspection on bag.

Important Terms to Understand the Vertical Mixing and Stability of Air

Term	Description
Air parcel	A relatively well-defined body of air that acts as a whole and has a constant number of molecules. **Air parcels** can be thought of as the air inside a balloon. We assume the air parcel does not mix with surrounding air and the temperature within the parcel is uniform.

Important Terms to Understand the Vertical Mixing and Stability of Air

Term	Description
Buoyancy	An air parcel will expand and cool. If the air temperature within an air parcel is warmer than surrounding air (which is usually true for air pollutants emitted during combustion and other industrial processes), it will be less dense than the cooler surrounding air, become **buoyant,** and therefore rise. An air parcel that cools has the opposite effect; it will become denser and thus less buoyant, so it will descend.

Important Terms to Understand the Vertical Mixing and Stability of Air

Term	Description
Lapse rates	By definition, the **lapse rate** (Γ) is the ratio of the decrease in air temperature with increase in height ($\Gamma = - \Delta T / \Delta z$). It describes the lapse in temperature with altitude. A positive lapse rate is one where the temperature decreases with height. A negative lapse rate is one where the temperature increases with height. In the troposphere, the average environmental lapse rate is 6-7^0 C/km increase in altitude but can vary widely locally. Remember, lapse rates are positive when the temperature decreases with altitude.

Important Terms to Understand the Vertical Mixing and Stability of Air

Term	Description
Stable atmosphere	A **stable atmosphere** resists vertical motion and thus will have a low ability to disperse air pollutants that are emitted to it.

Important Terms to Understand the Vertical Mixing and Stability of Air

Term	Description
Dry adiabatic lapse rate	Adiabatic processes are ones where no transfer of heat or mass occurs across the boundaries of the air parcel. A dry air parcel rising in the atmosphere cools at a **dry adiabatic lapse rate** of 9.8^0 C/km. A dry parcel sinking in the atmosphere heats at a rate of 9.8^0 C/km.

Important Terms to Understand the Vertical Mixing and Stability of Air

Term	Description
Wet adiabatic lapse rate	A rising parcel of dry water that contains water vapor will cool at the dry adiabatic lapse rate until it reaches its dew point temperature (when the water vapor pressure equals the saturation vapor pressure at that temperature). Condensation releases latent heat into the air parcel; thus, the cooling rate of the parcel decreases In the middle of the troposphere, the **wet adiabatic lapse rate** is about 6-7^0 C/km.

Important Terms to Understand the Vertical Mixing and Stability of Air

Term	Description
Environmental lapse rate	The **environmental lapse rate** is the actual temperature profile of the atmosphere as a function of altitude. It is also referred to as the prevailing or atmosphere lapse arte. Temperature usually decrease with height except in the case of a temperature inversion where the temperature of the atmosphere increases with height, thus preventing vertical mixing.

Important Terms to Understand the Vertical Mixing and Stability of Air

Term	Description
Mixing height	The **mixing height** is the maximum height an air parcel can ascend. It is usually the height at which a rising air parcel that is cooling at the dry adiabatic lapse rate intersects the ambient temperature profile. At this point the air parcel loses its buoyancy because it is no longer warmer than the surrounding air (it is the same temperature).

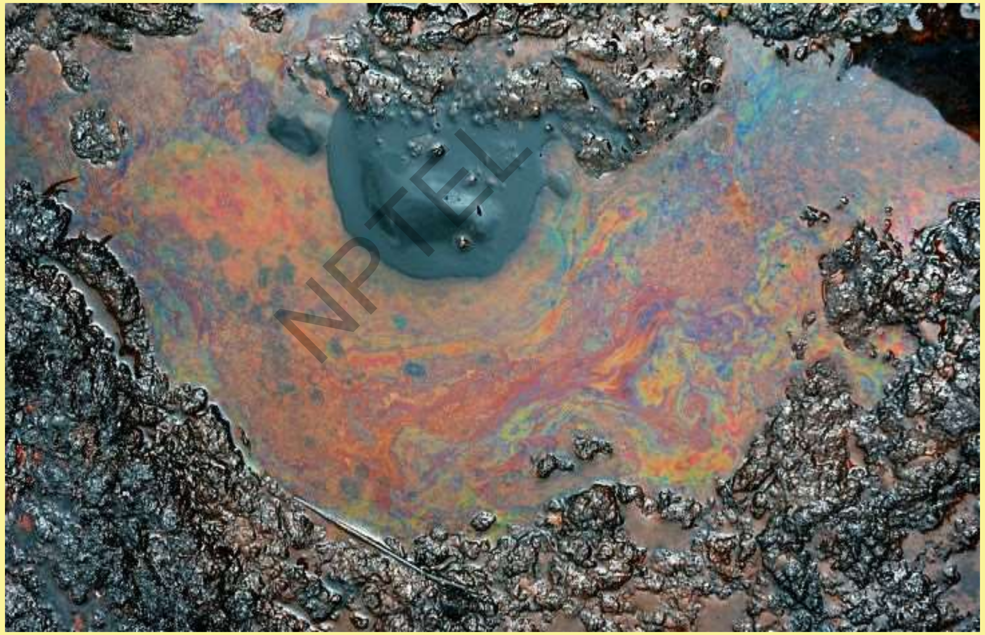
Important Terms to Understand the Vertical Mixing and Stability of Air

Term	Description
Mixing layer	The **mixing layer** is the air below the mixing height to the point of the air emission release. The larger the mixing layer, the greater volume of air into which air pollutants can be dispersed (and thus diluted).

Soil pollution

- <u>Soil Pollution:</u> The soil pollution is defined as the presence of materials in the soil which are harmful to the living beings when they cross their threshold concentration levels.

(Image: baselactionnet work)



WorldAtlas.com

- NATURAL POLLUTANTS
- Natural processes can lead to an accumulation of toxic chemicals in the soil. This type of contamination has only been recorded in a few cases, such as the accumulation of higher levels of perchlorate in soil from the Atacama Desert in Chile, a type of accumulation which is purely due to natural processes in arid environments.

- Examples:
- Natural accumulation of compounds in soil due to imbalances between atmospheric deposition and leaking away with precipitation water (e.g., concentration and accumulation of perchlorate in soils in arid environments)
- Natural production in soil under certain environmental conditions (e.g., natural formation of perchlorate in soil in the presence of a chlorine source, metallic object and using the energy generated by a thunderstorm)
- Leaks from sewer lines into subsurface (e.g., adding chlorine which could generate trihalomethanes such as chloroform).

- MAN-MADE POLLUTANTS
- Man-made contaminants are the main causes of soil pollution and consist of a large variety of contaminants or chemicals, both organic and inorganic. They can pollute the soil either alone or combined with several natural soil contaminants. Man-made soil pollution is usually caused by the improper disposal of waste coming from industrial or urban sources, industrial activities, and agricultural pesticides.

Examples:

- Accidental spills and leaks during storage, transport or use of chemicals (e.g. leaks and spills of gasoline and diesel at gas stations);
- Foundry activities and manufacturing processes that involve furnaces or other processes resulting in the possible dispersion of contaminants in the environment;
- Mining activities involving the crushing and processing of raw materials, for instance, heavy metals, emitting toxic substances;
- Construction activities
- Agricultural activities involving the diffusion of herbicides, pesticides and/or insecticides and fertilizers;
- Transportation activities, releasing toxic vehicle emissions
- Chemical waste dumping, whether accidental or deliberate – such as illegal dumping;
- The storage of waste in landfills, as the waste products may leak into groundwater or generate polluted vapors.Cracked paint chips falling from building walls, especially lead-based paint.

Types of Soil Pollutants

- BIOLOGICAL AGENTS
- Biological agents work inside the soil to introduce manures and digested sludge (coming from the human, bird and animal excreta) into the soil.

- AGRICULTURAL PRACTICES
- The soil of the crops is polluted to a large extent with pesticides, fertilizers, herbicides, slurry, debris, and manure.

OER Commons

- RADIOACTIVE POLLUTANTS
- Radioactive substances such as Radium, Thorium, Uranium, Nitrogen, etc. can infiltrate the soil and create toxic effects.

- URBAN WASTE
- Urban waste consists of garbage and rubbish materials, dried sludge and sewage from domestic and commercial waste.

Scrap Register

- INDUSTRIAL WASTE
- Steel, pesticides, textiles, drugs, glass, cement, petroleum, etc. are produced by paper mills, oil refineries, sugar factories, petroleum industries and others as such.

https://www.researchgate.net/publication/321463001_Phytoremediation_A_Green_Sustainable_Technology_for_Industrial_Waste_Management/figures?lo=1&utm_source=google&utm_medium=organic

Noise pollution

Manoramaonline

Noise pollution is generally defined as regular exposure to elevated sound levels that may lead to adverse effects in humans or other living organisms.

Ambient Air Quality Standards in Respect of Noise as Specified under the India's Environment Protection Act, 1986

Area code	Category of Area/Zone	Limits in dB(A) Leq*	
		Day Time	Night Time
(A)	Industrial Area	75	70
(B)	Commercial Area	65	55
(c)	Residential Area	55	45
(D)	Silence Area	50	40

Acceptable Noise Levels for Residential Areas, as per I.S. code 4954-1968

21	Acceptable outdoor noise levels in residential areas		S. No	Acceptable indoor noise levels for various	
	Locations	**Noise Levels dB(A)**		**Locations**	**Noise Levels dB(A)**
1.	Rural Areas	25-35	1.	Radio and TV studios	25-30
2.	Suburban areas	30-40	2.	Music rooms	30-35
3.	Urban Residential areas	35-45	3.	Hospitals, class rooms, auditoria	35-40
4.	Residential and business urban areas	40-50	4.	Apartments, hotels, homes Conference-rooms, small offices	35-40
5.	City areas	45-55	5.	Court rooms, private offices, libraries	40-45
6.	Industrial areas	50-60	6.	Large public offices	45-50

Noise Levels of Different Sources of Traffic

S. No	Source of Noise	Noise level in dB
1.	Air traffic (i) Jet aircraft at take off stage at about 300 m (ii) Propeller type aircraft at take off stage at about 300 m	 100-110 90-100
2.	Rail traffic (at about 30 m)	90-110
3.	Heavy road traffic (highway)	80-90
4.	Medium road traffic (main streets)	70-80
5.	Light road traffic (side streets)	60-70

GoI Noise Standards of different Types of Vehicles

S. No. (1)	Type of vehicles (2)	Noise level in dB (3)
1.	Two wheelers	80
2.	Cars	82
3.	Passenger or commercial vehicles	
4.	(i) Upto 4 MT (Tonnes) (ii) Between 4 MT to 12 MT (iii) More than 12 MT	85 89 91

Sound

- Sound is a vibration that propagates as a mechanical wave of pressure and displacement, through some medium (i.e. air or water).

- Sound refers to only those vibrations with frequencies that are within the range of hearing for human.

Noise

- Noise is basically any unwanted sound.
- It is measured in dB units.

Health Effects

- According to the USEPA, there are direct links between noise and health. Also, noise pollution adversely affects the lives of millions of people.

- Noise pollution can damage physiological and psychological health.

- High blood pressure, stress related illness, sleep disruption, hearing loss, and productivity loss are the problems related to noise pollution.

- It can also cause memory loss, severe depression, and panic attacks.

Solutions for Noise Pollution

- Green barriers- Planting bushes and trees in and around sound generating sources is an effective solution for noise pollution

- Regular servicing and tuning of automobiles can effectively reduce the noise pollution.

- Buildings can be designed with suitable noise absorbing material for the walls, windows, and ceilings.

- Workers should be provided with equipments such as ear plugs and earmuffs for hearing protection.

Solutions for Noise Pollution

- Similar to automobiles, lubrication of the machinery and servicing should be done to minimize noise generation.

- Soundproof doors and windows can be installed to block unwanted noise from outside.

- Regulations should be imposed to restrict the usage of play loudspeakers in crowded areas and public places.

- Factories and industries should be located far from the residential areas.

Solutions for Noise Pollution

- Community development or urban management should be done with long-term planning, along with an aim to reduce noise pollution.
- Installation of Panels and Enclosures
- Green Belt development
- Social awareness programs should be taken up to educate the public about the causes and effects of noise pollution.

- To protect healthy life, there is an urgent need to come up with an enforceable law on Noise Pollution in each state.

NPTEL ONLINE CERTIFICATION COURSES

Thank you