GE 2211 Environmental Science and Engineering

Unit – IV

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Global Warming

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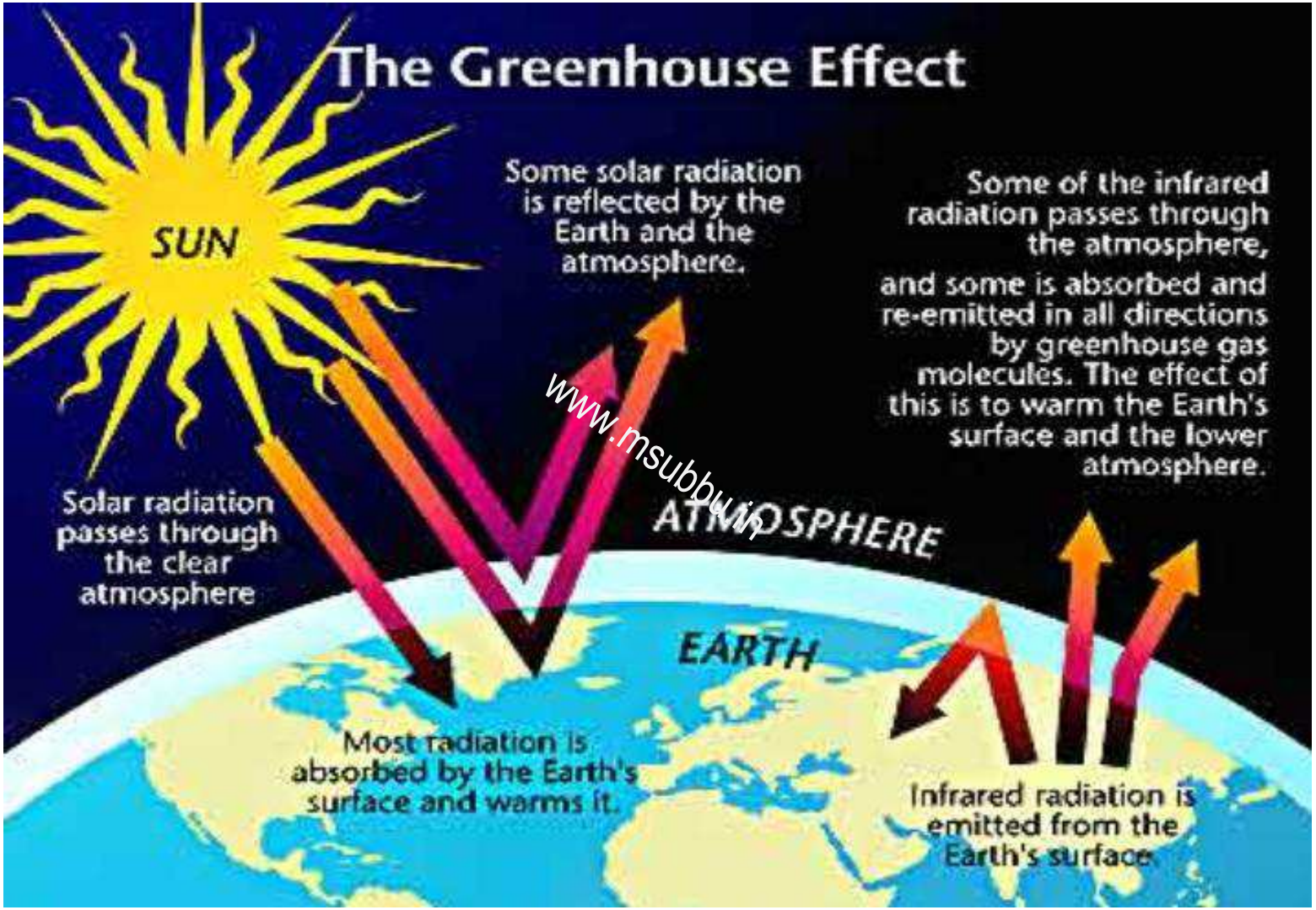
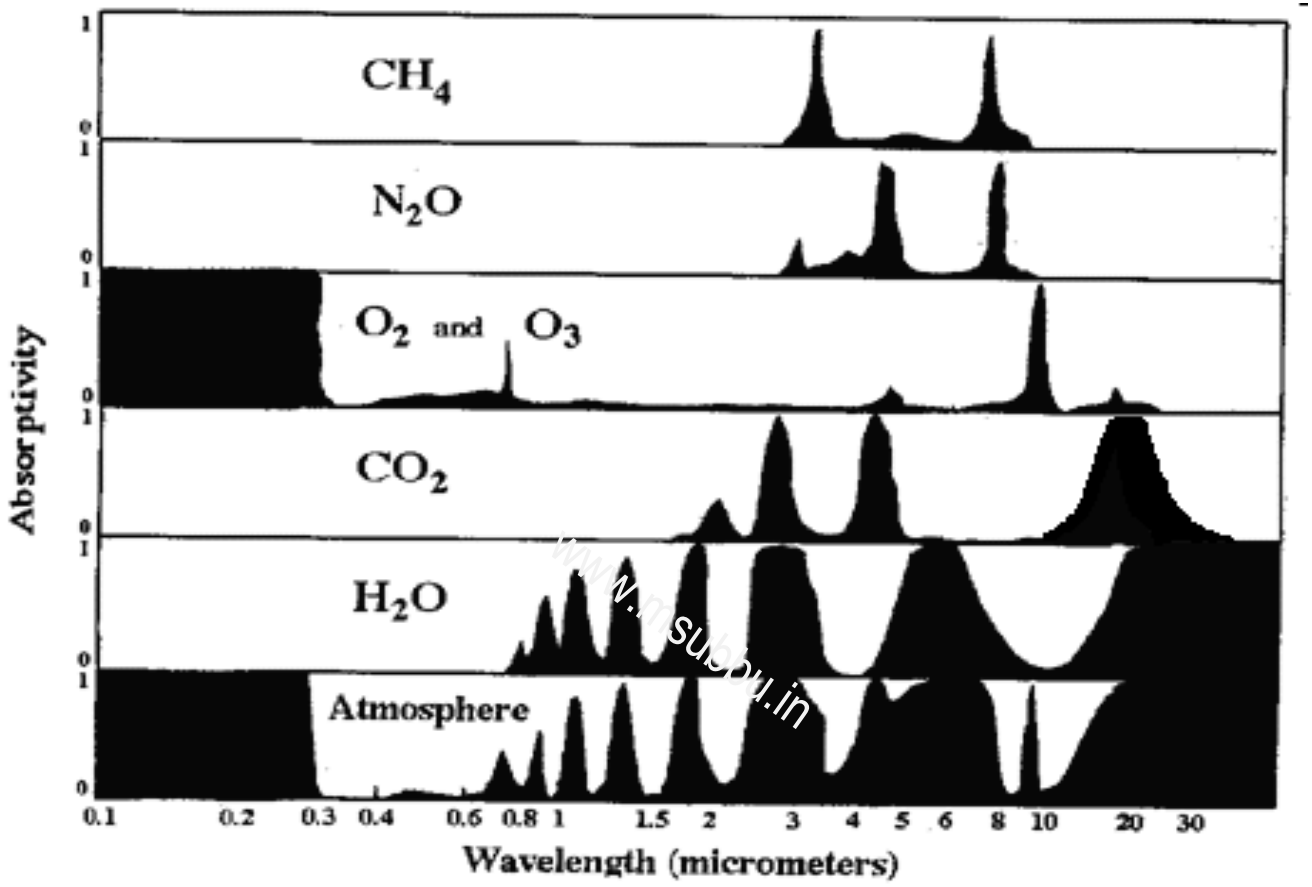
What is Global Warming and Climate Change?

- Global warming and climate change refer to an increase in average global temperatures
- Natural events and human activities are believed to be contributing to an increase in average global temperatures
- This is caused primarily by increases in "greenhouse" gases such as Carbon Dioxide (CO_2)

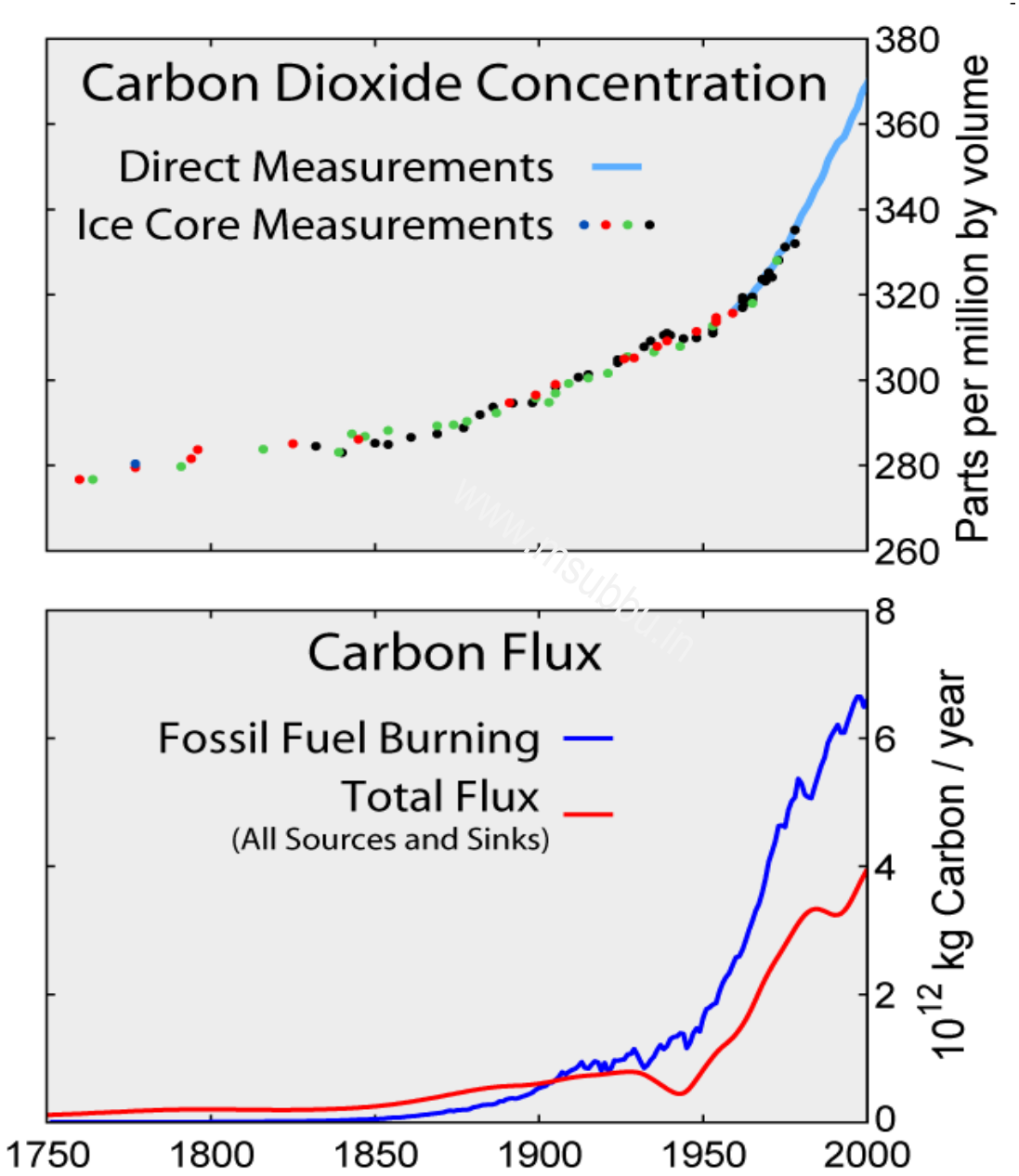
What is Greenhouse Effect?

- Energy from the sun drives the earth's weather and climate, and heats the earth's surface;
- In turn, the earth radiates energy back into space;
- Some atmospheric gases (water vapor, carbon dioxide, and other gases) trap some of the outgoing energy, retaining heat somewhat like the glass panels of a greenhouse; These gases are therefore known as greenhouse gases.
- The greenhouse effect is the rise in temperature on Earth as certain gases in the atmosphere trap energy.





Absorptivity of various gases of the atmosphere and the atmosphere as a whole as a function of the wavelength of radiation. An absorptivity of zero means no absorption while a value of one means complete absorption. The dominant absorbers of infrared radiation are water vapor (H_2O) and carbon dioxide (CO_2). Oxygen (O_2) and ozone (O_3) absorb much of the sun's ultraviolet radiation.

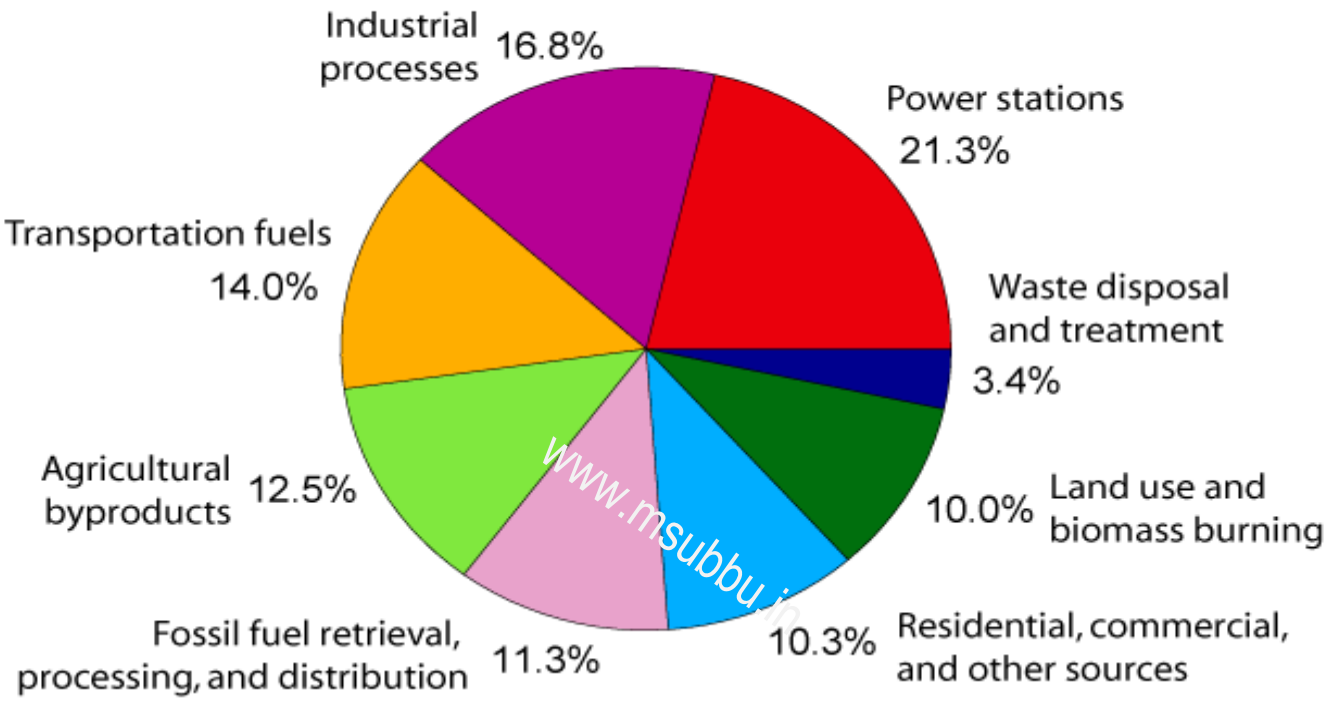

Carbon Dioxide Concentration
Direct Measurements
Ice Core Measurements
380
360
340
320
300
280
260
Parts per million by volume
Carbon Flux
Fossil Fuel Burning
Total Flux
(All Sources and Sinks)
8
6
4
2
0
10^12 kg Carbon / year
1750
1800
1850
1900
1950
2000

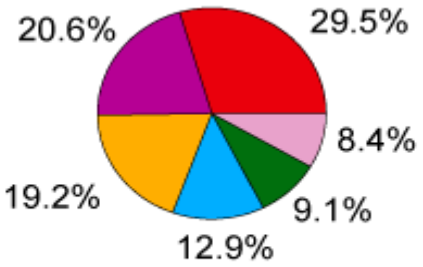
Greenhouse Gases

- Six main greenhouse gases are:
  - carbon dioxide (CO_2)
  - methane (CH_4) (which is 20 times as potent a greenhouse gas as carbon dioxide)
  - nitrous oxide (N_2O), plus
  - three fluorinated industrial gases:
    - hydrofluorocarbons (HFCs),
    - perfluorocarbons (PFCs) and
    - sulphur hexafluoride (SF_6).
- Water vapor is also considered a greenhouse gas

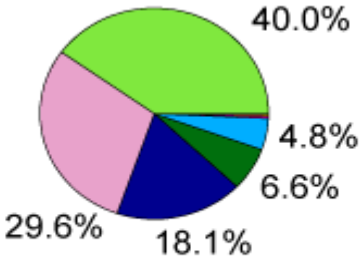
Gas	Pre-industrial Level	Current Level	Increase since 1750
Carbon dioxide	280 ppm	387ppm	104 ppm
Methane	700 ppb	1,745 ppb	1,045 ppb
Nitrous oxide	270 ppb	314 ppb	44 ppb
CFC-12	0	533 ppt	533 ppt

Annual Greenhouse Gas Emissions by Sector

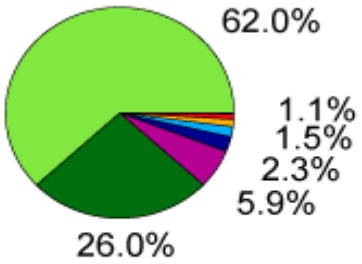




Carbon Dioxide
(72% of total)



Methane
(18% of total)



Nitrous Oxide
(9% of total)

The Greenhouse effect is natural. What do we have to do with it?

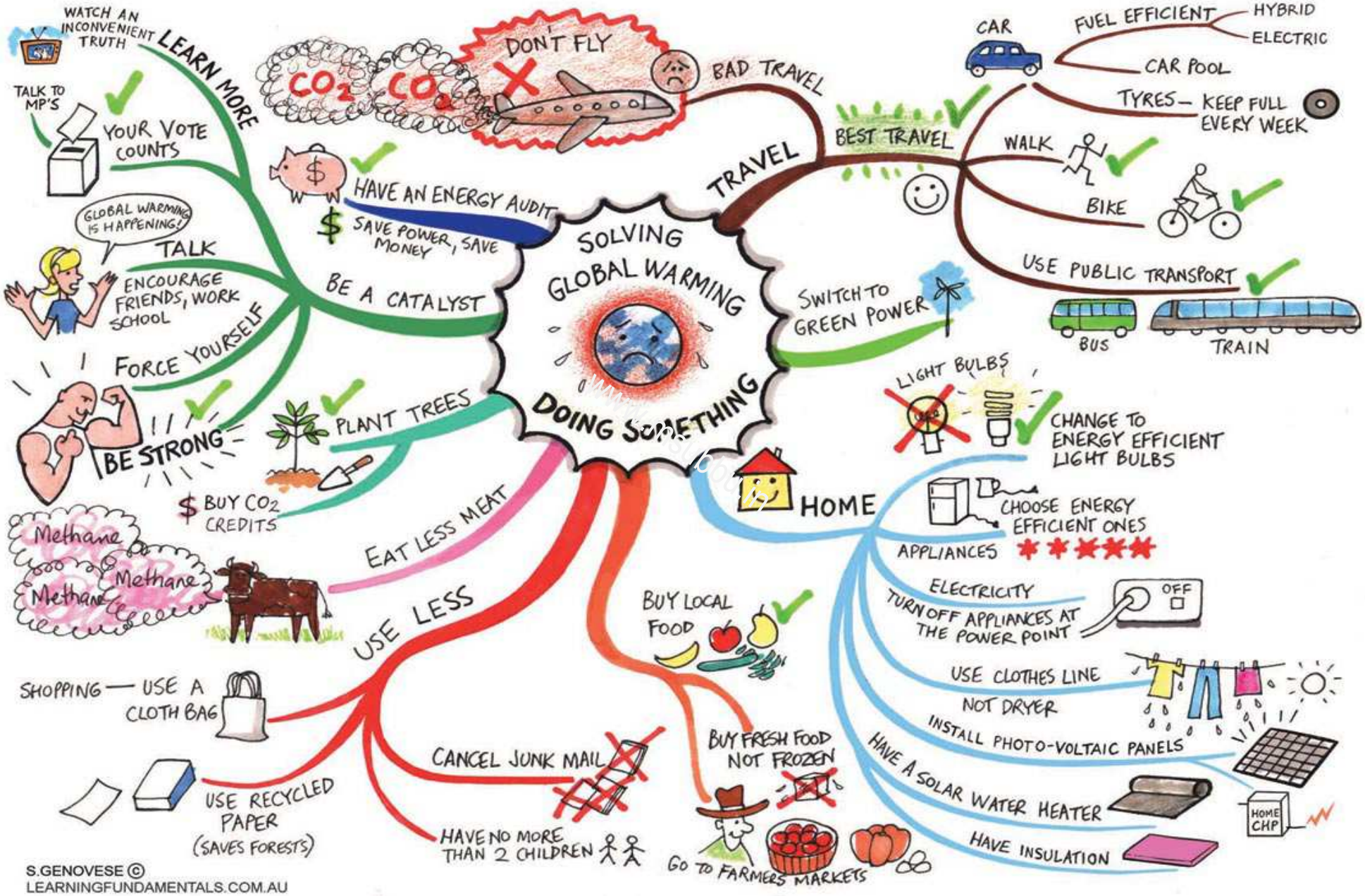
- Many of these greenhouse gases are actually life-enabling, for without them, heat would escape back into space and the Earth's average temperature would be a lot colder.

- However, if the greenhouse effect becomes stronger, then more heat gets trapped than needed, and the Earth might become less habitable for humans, plants and animals.

- Carbon dioxide, though not the most potent of greenhouse gases, is the most significant one. Human activity has caused an imbalance in the natural cycle of the greenhouse effect and related processes

Impacts of Global Warming

- Rapid changes in global temperature
- Extreme Weather Patterns
  - More hurricanes or drought
  - Longer spells of dry heat or intense rain
  - Scientists have pointed out that Northern Europe could be severely affected with *colder* weather if climate change continues, as the arctic begins to melt and send fresher waters further south. It would effectively cut off the Gulf Stream that brings warmth from the Gulf of Mexico, keeping countries such as Britain warmer than expected
- Ecosystem Impacts
- Rising sea levels
- Increasing ocean acidification
- Increase in pests and disease
- Failing agricultural output; Increase in World hunger


SOLVING GLOBAL WARMING
DOING SOMETHING
LEARN MORE
WATCH AN INCONVENIENT TRUTH
TALK TO MP'S
YOUR VOTE COUNTS
BE A CATALYST
GLOBAL WARMING IS HAPPENING!
TALK
ENCOURAGE FRIENDS, WORK SCHOOL
FORCE YOURSELF
BE STRONG
HAVE AN ENERGY AUDIT
SAVE POWER, SAVE MONEY
PLANT TREES
BUY CO_2 CREDITS
EAT LESS MEAT
Methane
Methane
Methane
USE LESS
SHOPPING — USE A CLOTH BAG
USE RECYCLED PAPER (SAVES FORESTS)
CANCEL JUNK MAIL
HAVE NO MORE THAN 2 CHILDREN
BUY LOCAL FOOD
BUY FRESH FOOD NOT FROZEN
GO TO FARMERS MARKETS
CO_2
CO_2
DON'T FLY
BAD TRAVEL
TRAVEL
BEST TRAVEL
CAR
FUEL EFFICIENT
HYBRID
ELECTRIC
CAR POOL
TYRES — KEEP FULL EVERY WEEK
WALK
BIKE
USE PUBLIC TRANSPORT
BUS
TRAIN
SWITCH TO GREEN POWER
HOME
LIGHT BULBS
CHANGE TO ENERGY EFFICIENT LIGHT BULBS
CHOOSE ENERGY EFFICIENT ONES
APPLIANCES
ELECTRICITY
TURN OFF APPLIANCES AT THE POWER POINT
OFF
USE CLOTHES LINE
NOT DRYER
INSTALL PHOTO-VOLTAIC PANELS
HAVE A SOLAR WATER HEATER
HOME CHP
HAVE INSULATION
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Differences in Greenhouse Gas Emission around the World

- In terms of historical emissions, *industrialized countries account for roughly 80% of the carbon dioxide buildup in the atmosphere to date*. Since 1950, the U.S. has emitted a cumulative total of roughly 50.7 billion tons of carbon, while China (4.6 times more populous) and India (3.5 times more populous) have emitted only 15.7 and 4.2 billion tons respectively (although their numbers will rise).

- *Annually, more than 60 percent of global industrial carbon dioxide emissions originate in industrialized countries*, where only about 20 percent of the world's population resides.

Differences in Greenhouse Gas Emission around the World (contd.)

- Much of the growth in emissions in developing countries results from the provision of *basic human needs for growing populations*, while emissions in industrialized countries contribute to growth in a standard of living that is already far above that of the average person worldwide

- The United States is the World's Largest Emitter of Greenhouse Gases Per Capita

- Around 2007, China surpassed the US as the world's largest emitter of greenhouse gases in terms of total output. Per person ("per capita"), however, China's emissions are much smaller.

Kyoto Protocol

- The objective is the "stabilization and reconstruction of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system

- The Kyoto Protocol was the climate change treaty negotiated in 1997, setting targets for emissions of greenhouse gases.

- 1997, at the Conference of Parties III (COP3), Kyoto, Japan, the Kyoto conference on climate change took place. There, developed countries agreed to specific targets for cutting their emissions of greenhouse gases

- In order to be binding under international law, the treaty would need ratification from the countries responsible for around 55% of the global greenhouse gas emissions of 1990.

- The United Nations Framework Convention on Climate Change agreed to a set of a "common but differentiated responsibilities

Implementing Kyoto Protocol

- Industrialized countries were committed to an overall reduction of emissions of greenhouse gases to 5.2% below 1990 levels for the period 2008 - 2012
- National limitations range from 8% reductions for the European Union and some others to 7% for the United States, 6% for Japan, and 0% for Russia. The treaty permitted GHG emission increases of 8% for Australia and 10% for Iceland
- Came into force from 2005
- Some opponents of the Convention argue that the split between Annex I and developing countries is unfair, and that both developing countries and developed countries need to reduce their emissions unilaterally.
- Some countries claim that their costs of following the Convention requirements will stress their economy.

Flexible Mechanisms of Kyoto Protocol

- **Emission trading** - is an administrative approach used to control pollution by providing economic incentives for achieving reductions in the emissions of pollutants. It is sometimes called **cap and trade**

- **Clean Development Mechanism** - is an arrangement under the Kyoto Protocol allowing industrialized countries with a greenhouse gas reduction commitment to invest in projects that reduce emissions in developing countries as an alternative to more expensive emission reductions in their own countries