

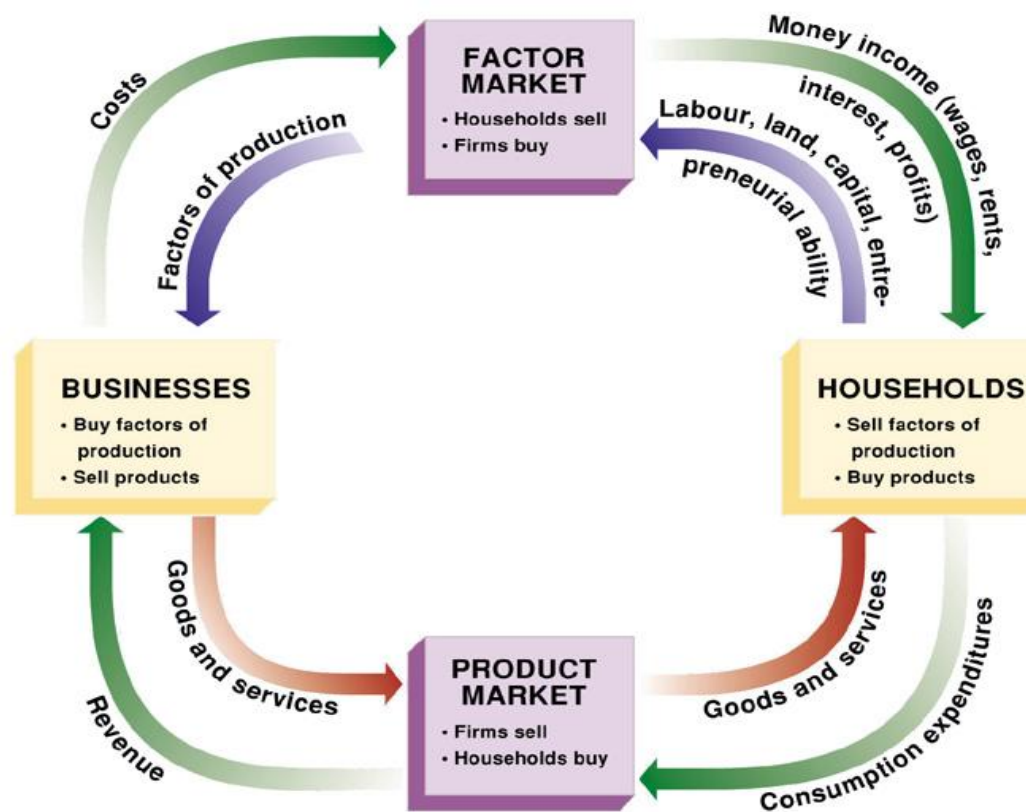


Part 1

Economy and the Environment

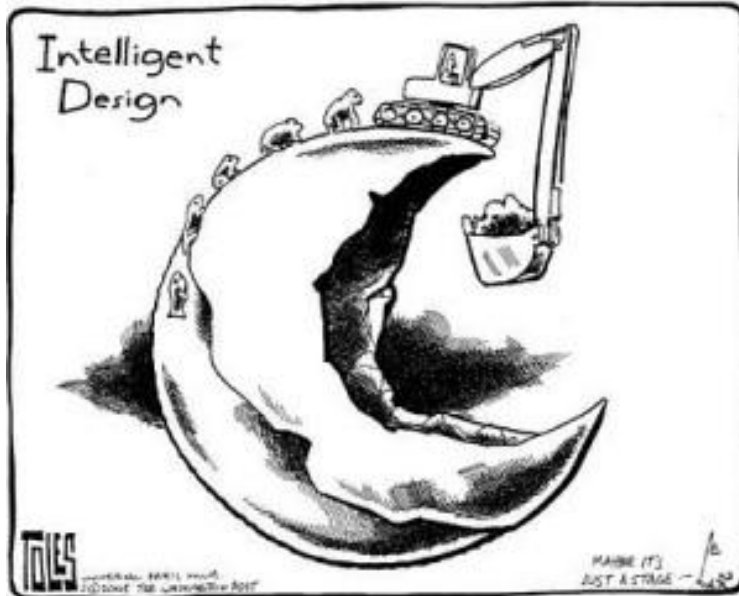
Economy and the Environment

- Elementary function of any economic system: production, distribution, and consumption



Economy and the Environment

In economics, the environment is viewed as a **composite asset** that provides a variety of services.

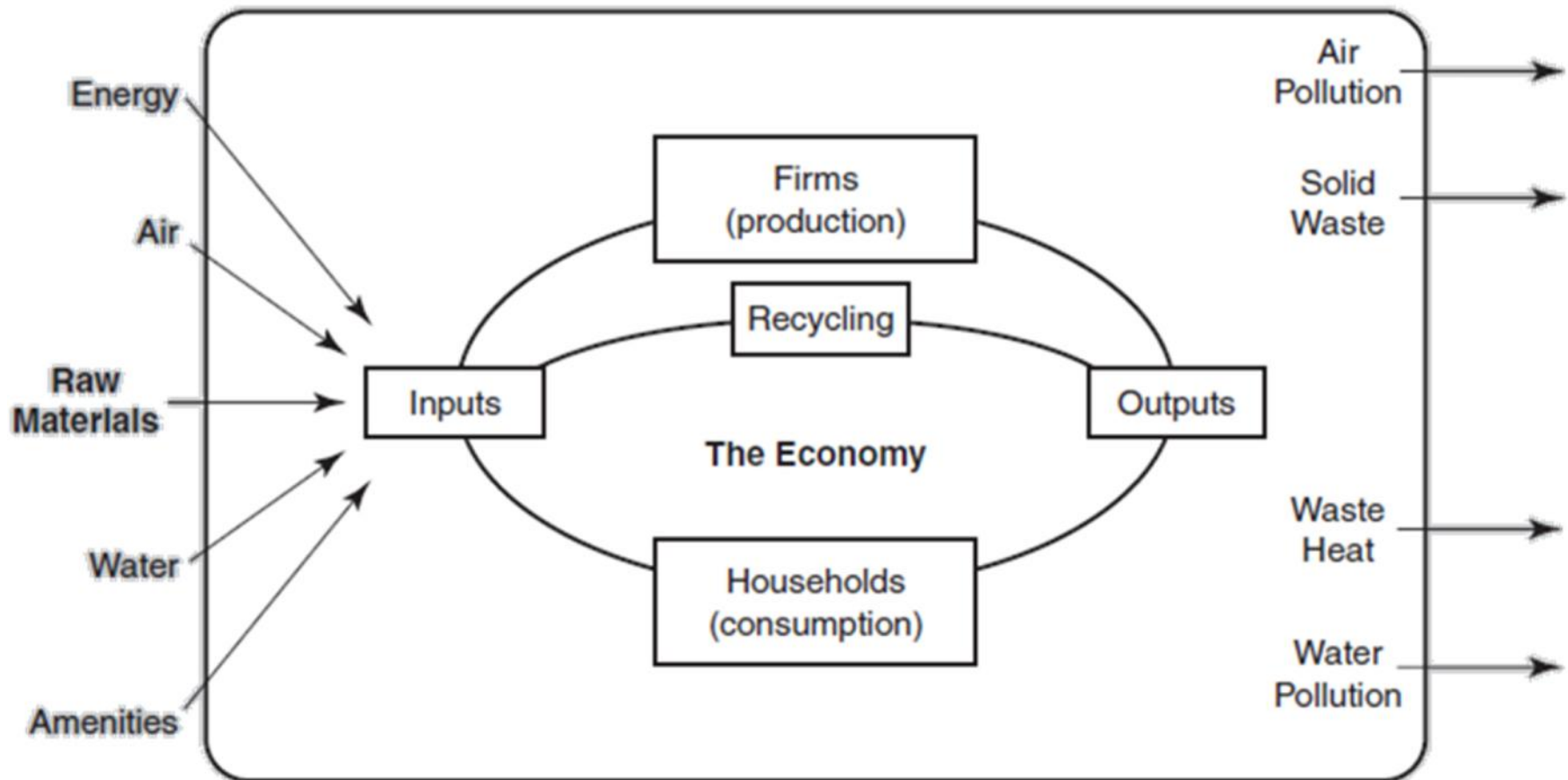


- The environment provides the economy
- the life support systems that sustain our very existence
 - raw materials, which are transformed into consumer products by the production process
 - energy, which fuels the transformation
 - Ultimately, these raw materials and energy return to the environment as waste products

Economy and System Entropy

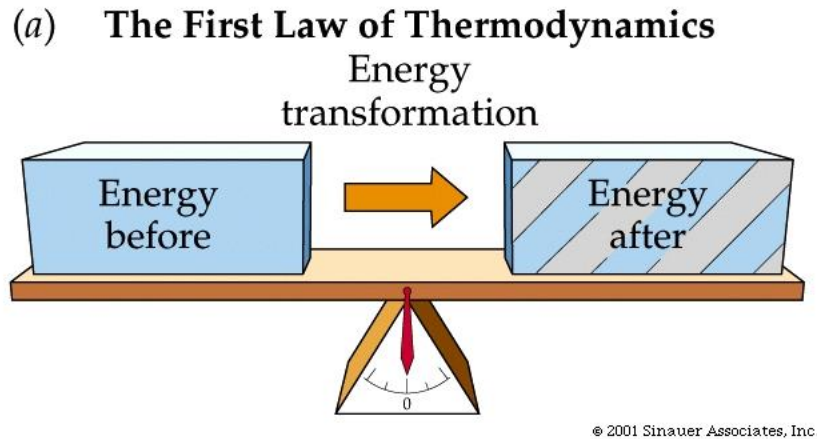
Nature as 'source'
of economic system

Nature as 'sink'
of economic system



Nature of Transformation

The first law of thermodynamics — energy and matter can neither be created nor destroyed

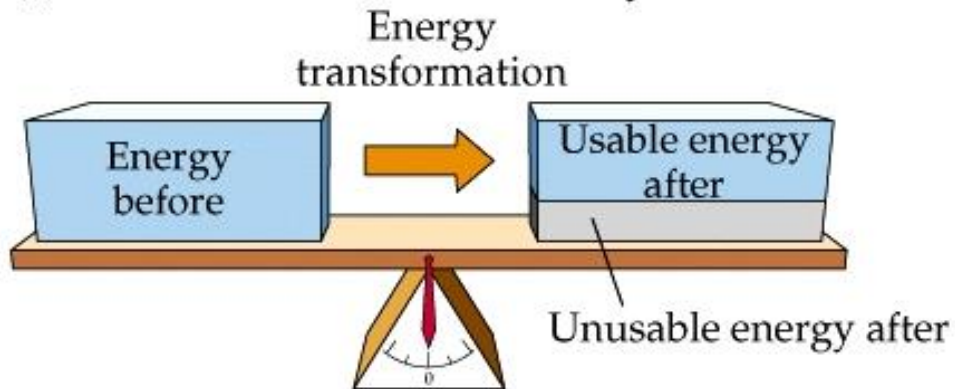


- The mass of materials flowing into the economic system from the environment has either **to accumulate in the economic system** or return to the environment as **waste**.
- The mass of materials flowing into the economic system is equal in magnitude to the mass of waste flowing into the environment.
- Excessive wastes can, of course, depreciate the asset; when they exceed the absorptive capacity of nature, wastes reduce the services that the asset provides.

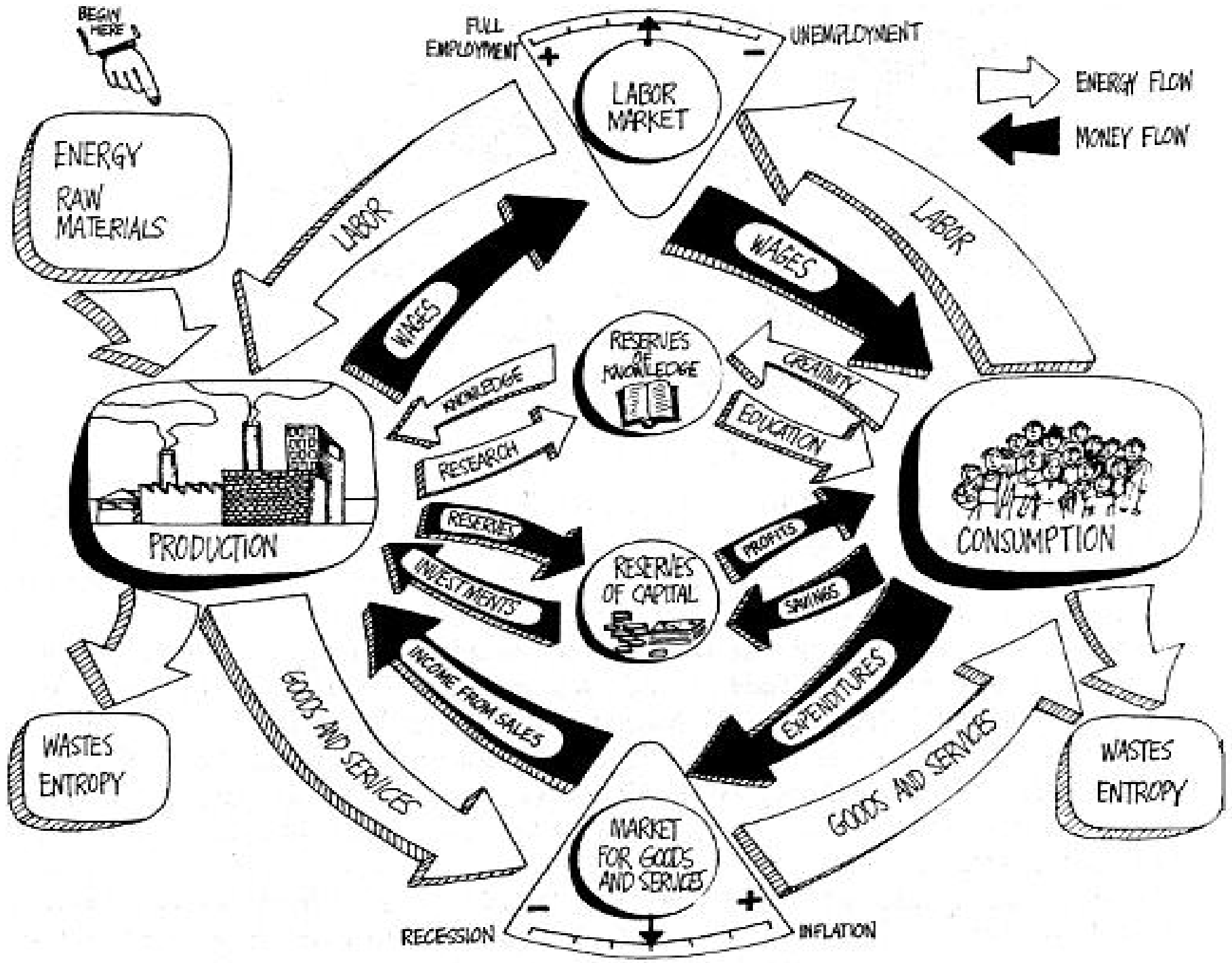
Nature of Transformation

- The *second law of thermodynamics*— **Entropy Law**: no conversion from one form of energy to another is completely efficient

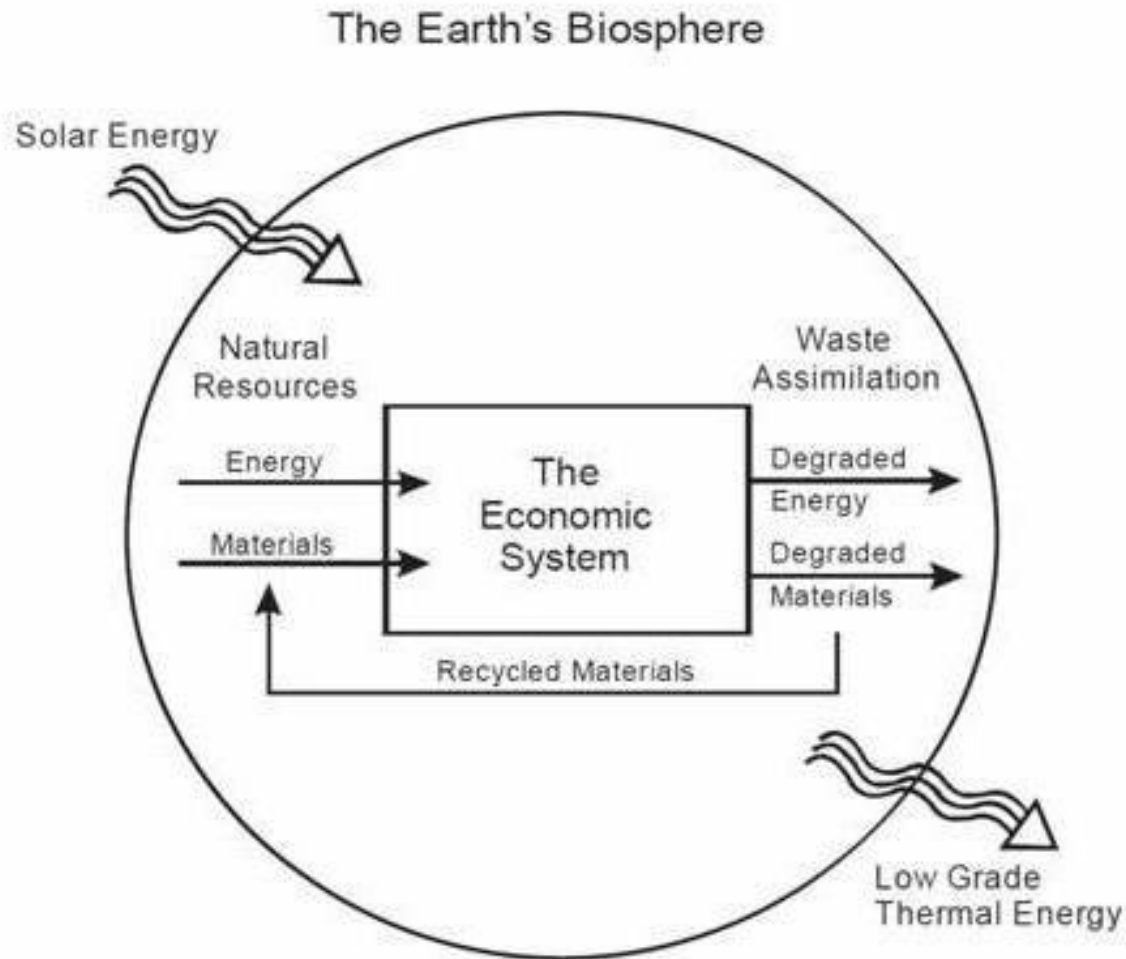
(b) The Second Law of Thermodynamics



- Some energy is always lost during conversion, and the rest, once used, is no longer available for further work.
- In the very long run, the growth process will be limited



Economy and System Entropy



Fundamental Balances

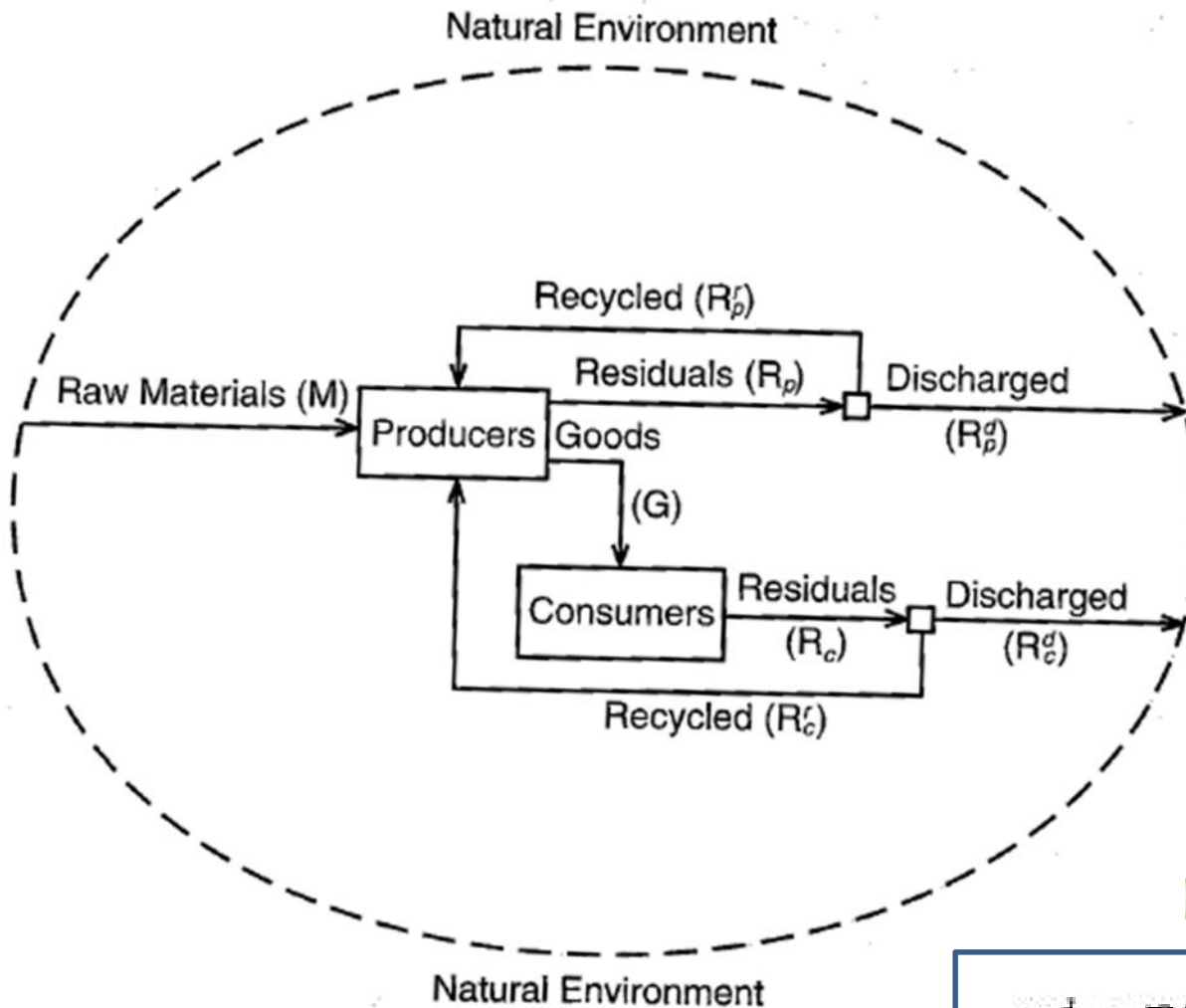
The first law of thermodynamics

$$M = R_p^d + R_c^d$$

(in the long run)

Balance Equation

$$R_p^d + R_c^d = M = G + R_p - R_p^r - R_c^r$$



A Pollution Taxonomy

Ambient Quality

- The quantity of pollutants in the environment

Residuals

- Material that is left over after something has been produced

Pollutants

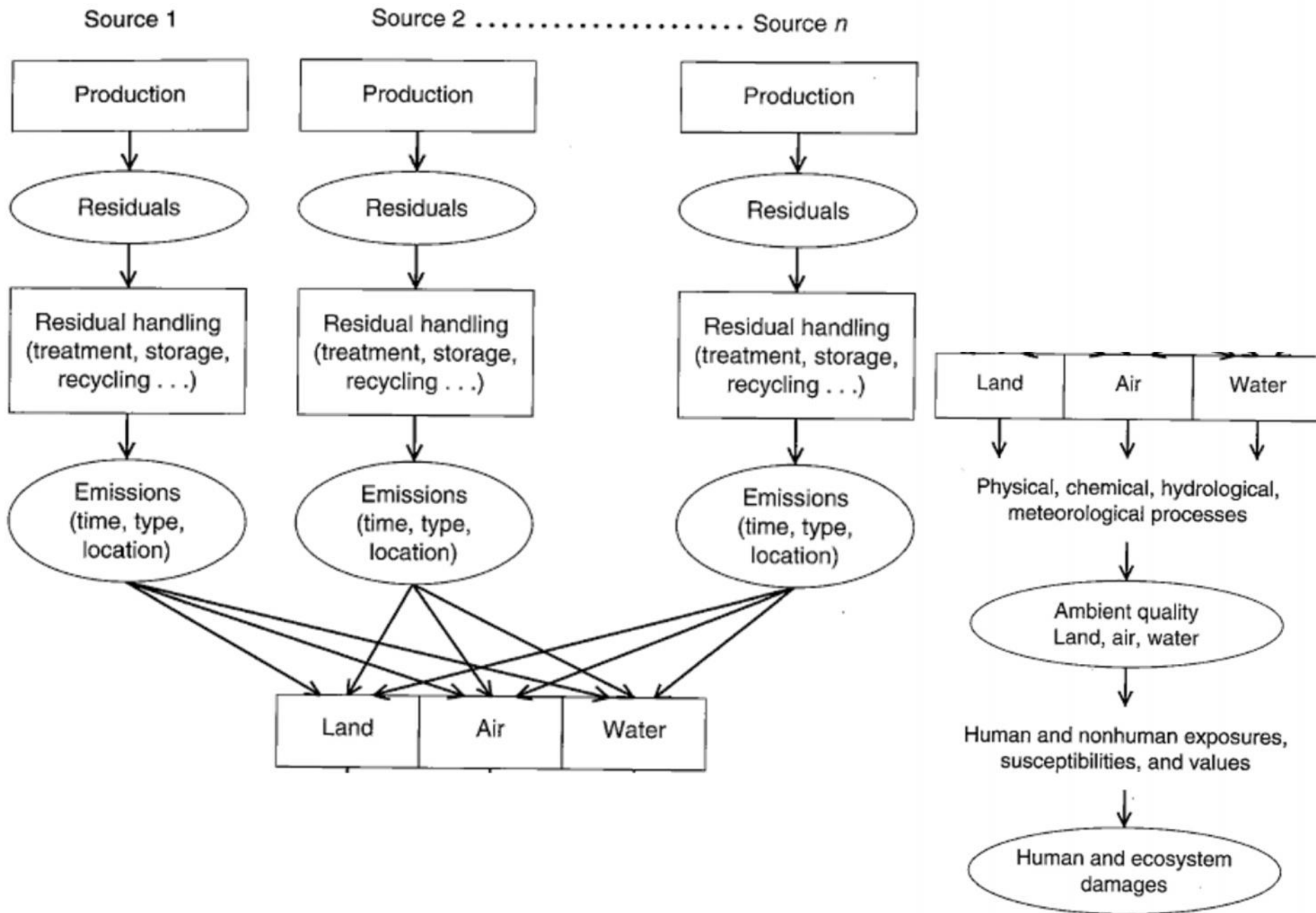
- A substance, energy form or action that results in lowering of ambient quality

Emission

- Portion of production or consumption residuals that are placed in the environment (directly or after treatment)

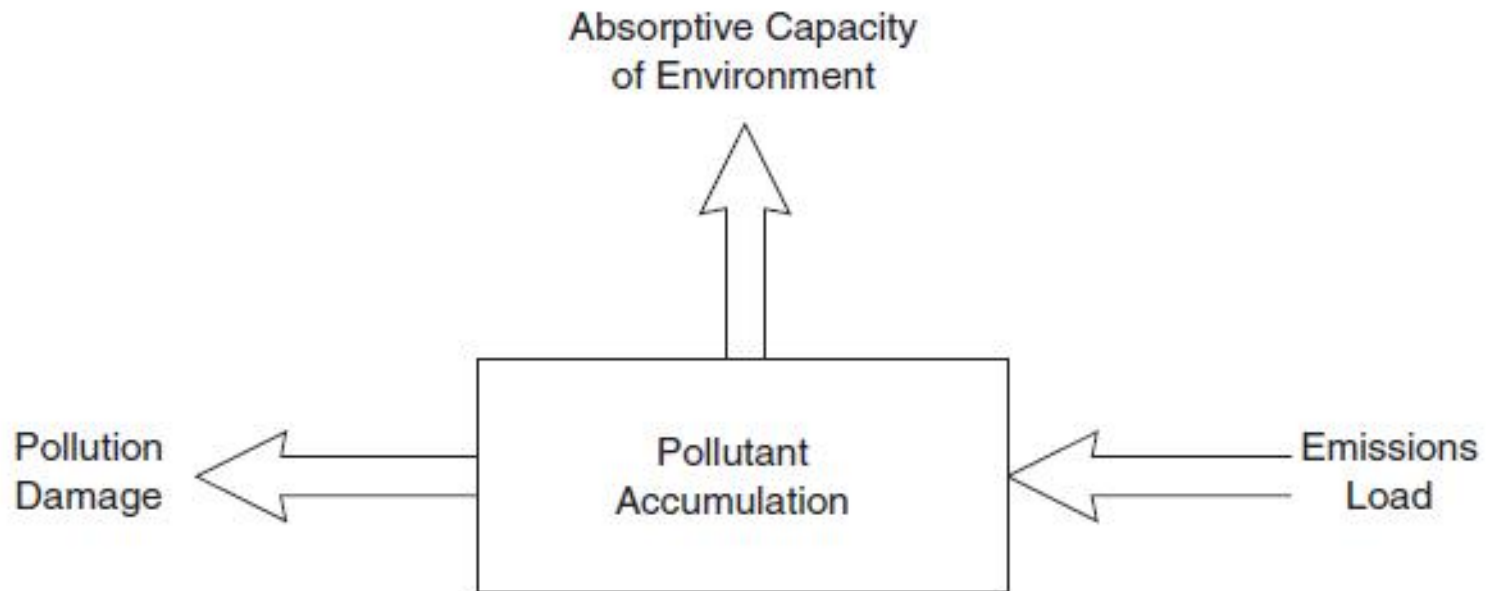
Effluent

- Water or air pollutants



A Pollution Taxonomy

- We call the ability of the environment to absorb pollutants its ***absorptive capacity*** or ***carrying capacity***



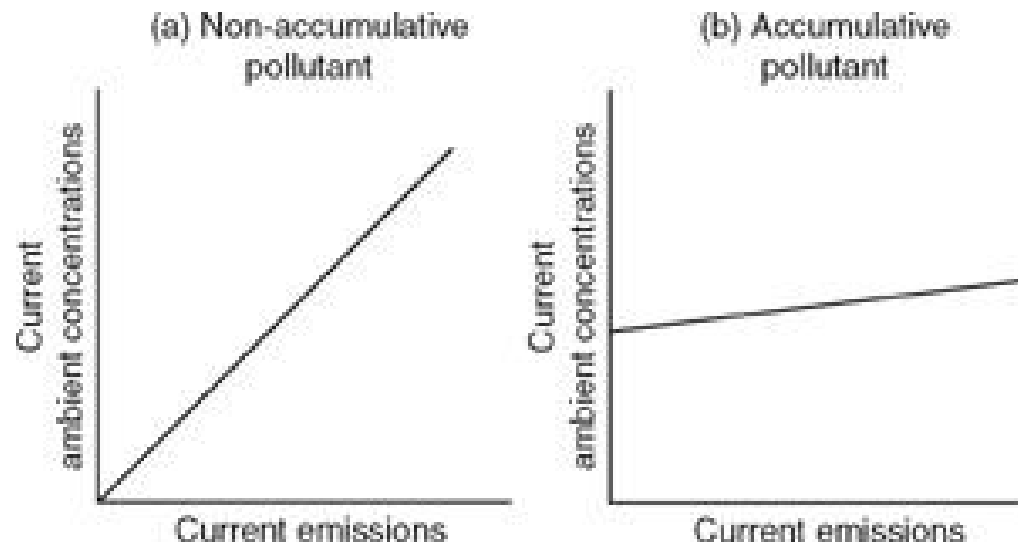
A Pollution Taxonomy

Cumulative Pollutants

- Pollutants that cumulate in the environment in nearly the same amounts as they are emitted
 - E.g. Radioactive waste, plastics, chemicals

Noncumulative Pollutants

- As soon as the pollution source is shut down, pollutant stops
 - E.g. Noise, diluted water discharge



A Pollution Taxonomy

Pollutants for which the environment has some absorptive capacity are called '*fund pollutants*'

- As long as the emissions rate does not exceed the absorptive capacity of the environment, the pollutants do not accumulate
- They may be diluted or transformed into substances that are not considered harmful to people or to the ecological system
- The level of future damage is independent of current emissions

Examples

- Carbon dioxide is absorbed by plant life and the oceans
- Organic pollutants injected into an oxygen-rich stream will be transformed by the resident bacteria into less harmful inorganic matter

A Pollution Taxonomy

Pollutants for which the environment has little or no absorptive capacity are called ***stock pollutants***.

- Damage imposed in the future depends on current actions and could harm human health, living organism, or inanimate objects
- Stock pollutants can create a burden for future generations by passing on damages that persist well after the benefits received from incurring the damages have been forgotten

Examples

- Non-biodegradable bottles tossed by the roadside
- Heavy metals, such as lead, that accumulate in the soils near the emissions source;
- Persistent synthetic chemicals, such as dioxin and PCBs (polychlorinated biphenyls)

A Pollution Taxonomy

Point-Source Pollutants

- Pollutants in which actual points of discharge are easy to identify
- E.g. sulfur dioxide from large power plant

Nonpoint Source Pollutants

- No well-defined point of discharge/ no single pipe nor stack from which pollutants are emitted
- E.g. agricultural chemical contamination in underground aquifers

A Pollution Taxonomy

Continuous Emission

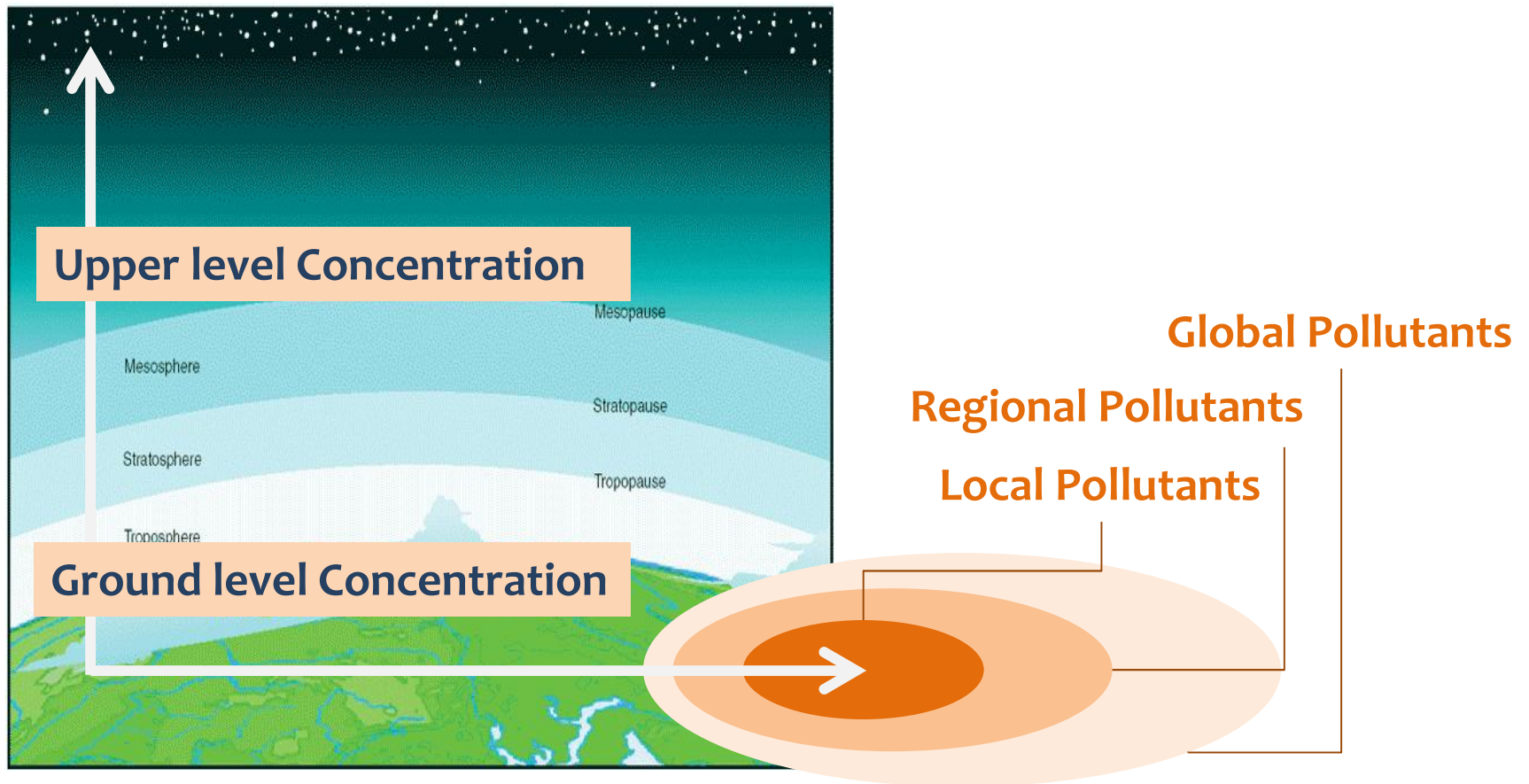
- E.g. Emissions from coal-fired electric power plants or municipal waste treatment plants
- The fact that emissions are continuous does not mean that damages are also continuous
- Meteorological and hydrological events can turn continuous emissions into uncertain damages
- Control programs are often easier to carry out

Episodic Emission

- E.g. accidental oil or chemical spills
- Policy problem is to design and manage a system so that the *probability* of accidental discharges is reduced

A Pollution Taxonomy

Horizontal & Vertical Classification



A Pollution Taxonomy

Environmental Damages Not Related to Emissions

- Not traceable to residuals discharges but destroys the environmental value of land, habitat or wetland, or its scenic value
- E.g. the conversion of land to housing and commercial area, logging or strip mining

A Pollution Taxonomy

- Airborne Residuals
- Waterborne Residuals
- Solid Residuals
- Visual Pollution







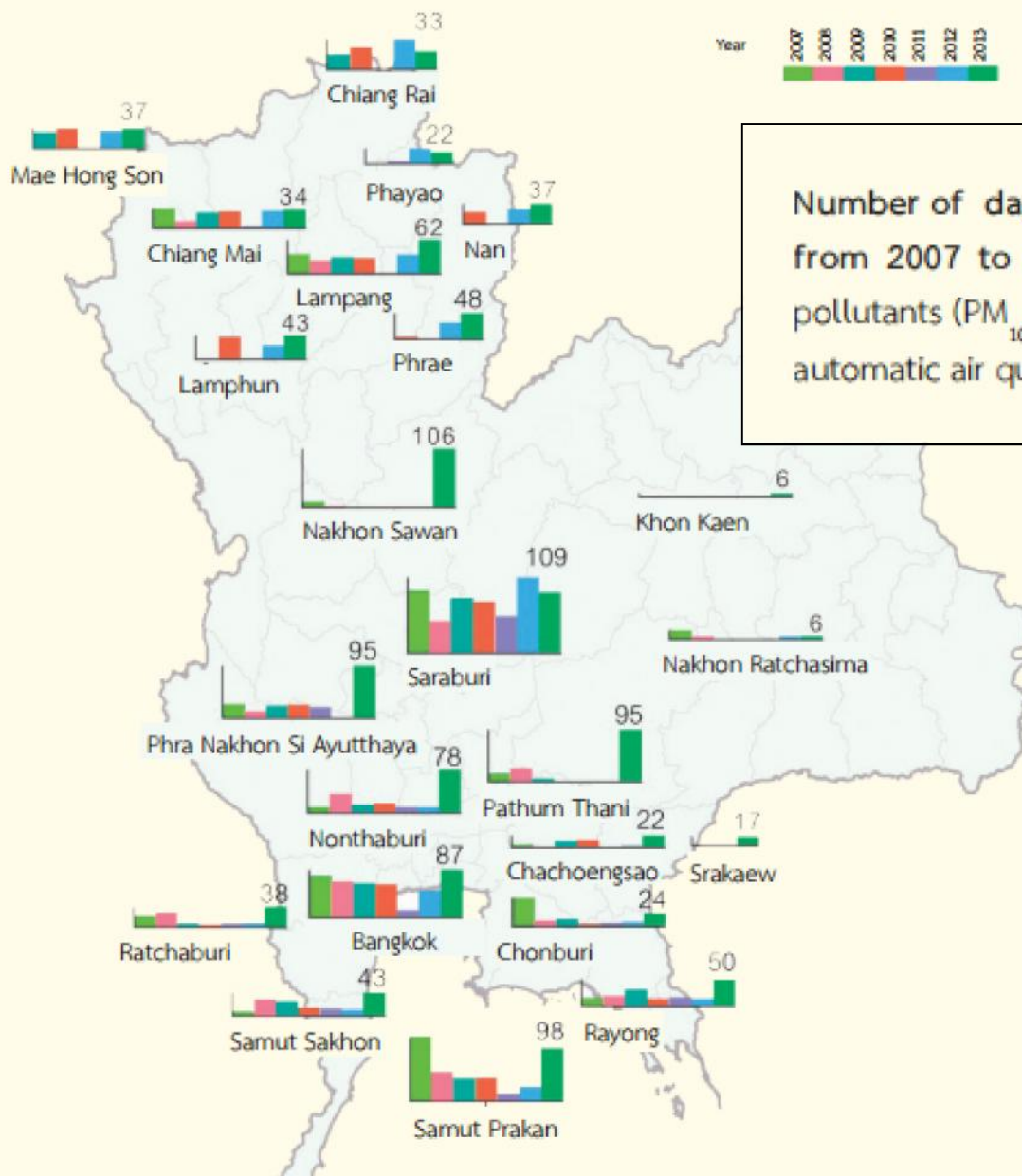




A Pollution Taxonomy

Five Common Air Pollutant

- Carbon monoxide (CO), sulfur dioxide (SO₂) and nitrogen dioxide (NO₂) are categorized as the primary air pollutants
- Ozone (O₃) is the secondary pollutant originating from the primary pollutants or the chemical reaction of other pollutants in the air.
- Particulate matter sized smaller than 10 microns (PM₁₀) can be classified either primary or the secondary pollutant

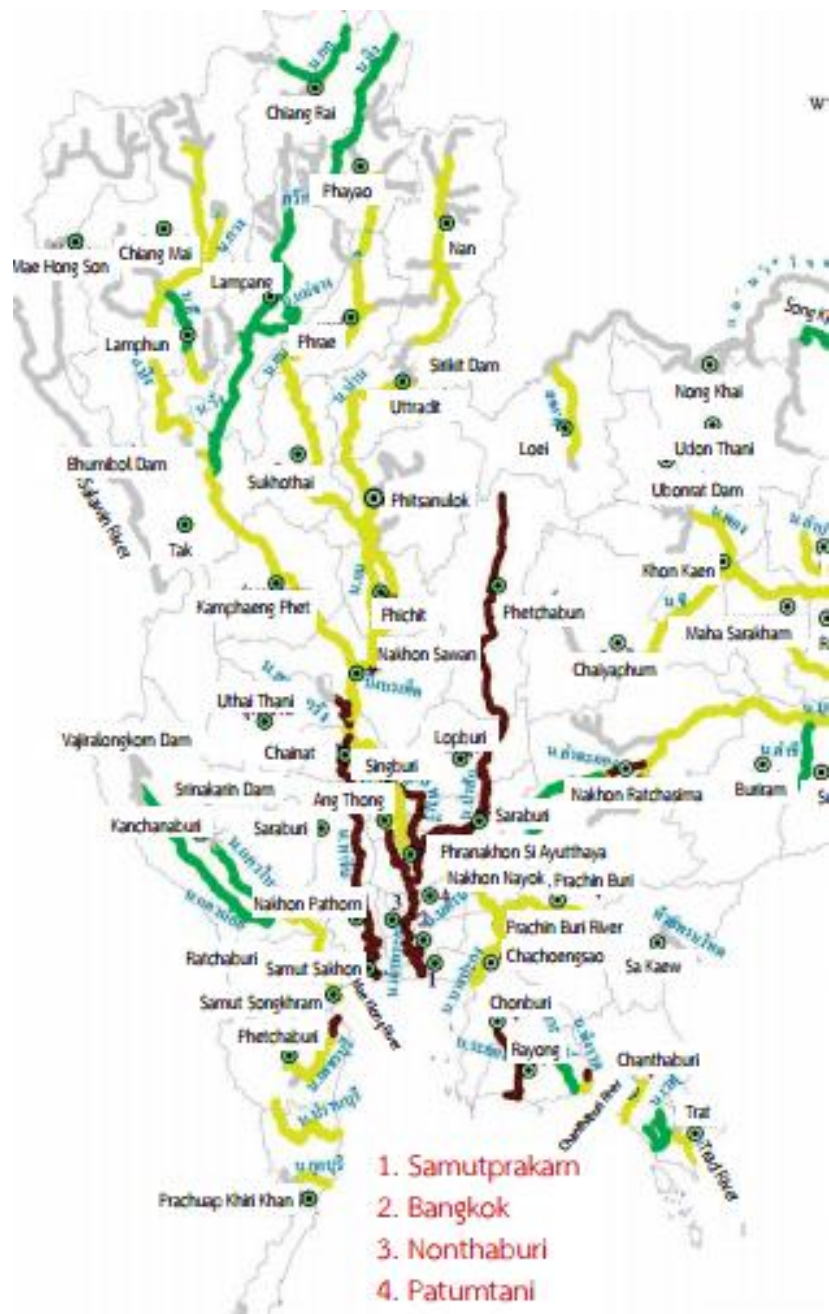


Number of days air quality exceeded the standard from 2007 to 2013, calculated from five common air pollutants (PM₁₀, O₃, NO₂, SO₂ and CO) in the provinces with automatic air quality monitoring stations.

A Pollution Taxonomy

Common Water Pollutant

- Water Quality Index (WQI) is considered from 5 water quality parameters : dissolved oxygen, Biochemical Oxygen Demand, all coliform bacteria, fecal coliform bacteria, and ammonia nitrogen



Water quality meanings

- Excellent
- Good
- Fair
- Deteriorated
- Reservoirs or Lakes
- Rivers/Canals
- Provinces
- Provincial border