Air Pollution Control History

What is the Environment ?

The totality of circumstances surrounding an organism or a group of organisms, especially: **a.** The combination of external physical conditions that affect and influence the growth, development, and survival of organisms: *"We shall never understand the natural environment until we see it as a living organism"* Paul Brooks **b.** The complex of social and cultural conditions affecting the nature of an individual or a community. (American Heritage Dictionary)

NOTE: Paul Brooks wrote a biography of Rachel Carson who is the author of "Silent Spring"

Understanding of the Air Pollution

In 18'th of London, they realized the air pollution as Smog which is a compound word of Smoke and Fog associated with burning coal. The problems associated with the burning of coal is a result of the high content of sulfur. When burned, the sulfur is oxidized to SO_2 as a byproduct.

"The London Smog" is well known incident which is described as:

- The London smog of December, 1952 was one of a number of pollution episodes in the late 19th and early 20th centuries where an excess number of deaths was recorded in the city. These include over 4000 fatalities in 1952.
- The conditions were characterized by heavy fogs due to low inversion levels, which concentrated the pollutants into a small volume.
- Public and political reaction **resulted in the Clean Air Act** of 1956. Viewed as a turning point in urban pollution legislation.

Case Study 1 - Five days in Donora of USA

- On Tuesday, October 26, 1948, a **high pressure weather system** formed over Pennsylvania which remained stationary for nearly five days. As with most areas of high pressure, gradual **sinking air** from aloft resulted in a strong upper level **inversion** over the area.

- In Donora, a small town in western PA, **nighttime cooling** resulted in the formation of fog on Tuesday morning. This cooling intensified the **inversion** aloft. **Pollutants from the towns** steel mill, zinc smelter and sulfuric acid plant slowly spread among the fog.

- The fog lingered into Wednesday with its **high concentration of pollutants**. The dense layer blocked sunlight reaching the ground. Without surface heating, the **mixing layer** lowered towards the ground, and further concentrated the pollutants.

- The location of the **town in a valley** also prevented horizontal mixing of the air. Unable to mix or disperse, the layer became stagnant.

- Factories continued to produce pollutants from relatively **short stacks**. By Thursday, visibility was reduced to less than the width of a street. The air had the penetrating odor of **SO_2**. A large portion of the population became ill.

- By Sunday, an approaching storm generated **enough wind** to vertically mix the air and disperse the pollutants. **Rain** further cleaned the air.

- In all, 22 people died during the episode, and approximately 7,000 experienced some ill effects of the pollution.

(Lecture note from School of Public and Environmental Affairs Indiana Univ. Bloomington)

Case Study 2 - The Los Angeles Smog

- In 1944, **damage to some vegetable** crops were noticed in LosAngeles county. It was determined that the known toxic agents (SO_2, etc.) were not responsible for the damage.

- It was soon discovered that a major contributor to the crop damage was **ozone (O_3)**. Ozone is not directly emitted into the air from human activity But, it is a product of the **reaction of certain pollutants** emitted from **motor vehicles**. It is hazardous to the lungs, complicates respiratory and/or heart problems.

- Combustion of **fossil fuels** produces **carbon monoxide** (CO), **hydrocarbons** and **nitrogen oxides**. These by-products are released into the air through the tailpipe, and a **photochemical chain reaction** occurs as:
  CO + Hydrocarbons +nitrogen oxides + **light** = OZONE and other pollutants

- It was **not really a Smog** (Smoke and fog are not key components of photochemical air pollution. But similar to the London Smog, certain **meteorological conditions** concentrate the pollutants into a small volume.

- Not just a Los Angeles problem, because of the **predominance of automobiles** and year-round intense **sunlight**. Many cities suffer from the same effect, such as Denver, MexicoCity, Paris and Tokyo.

- Timeline to emission control
  Los Angeles: 1960's - began control of major pollutants (mainly carbon monoxide and hydrocarbons)
  National: 1970's - **regulations** requiring **catalytic converters** in passenger vehicles (CAA'70,'77,'90)

(Lecture note from School of Public and Environmental Affairs Indiana University Bloomington)

Case Study 3 - Air Pollution from the Mae Moh power plant

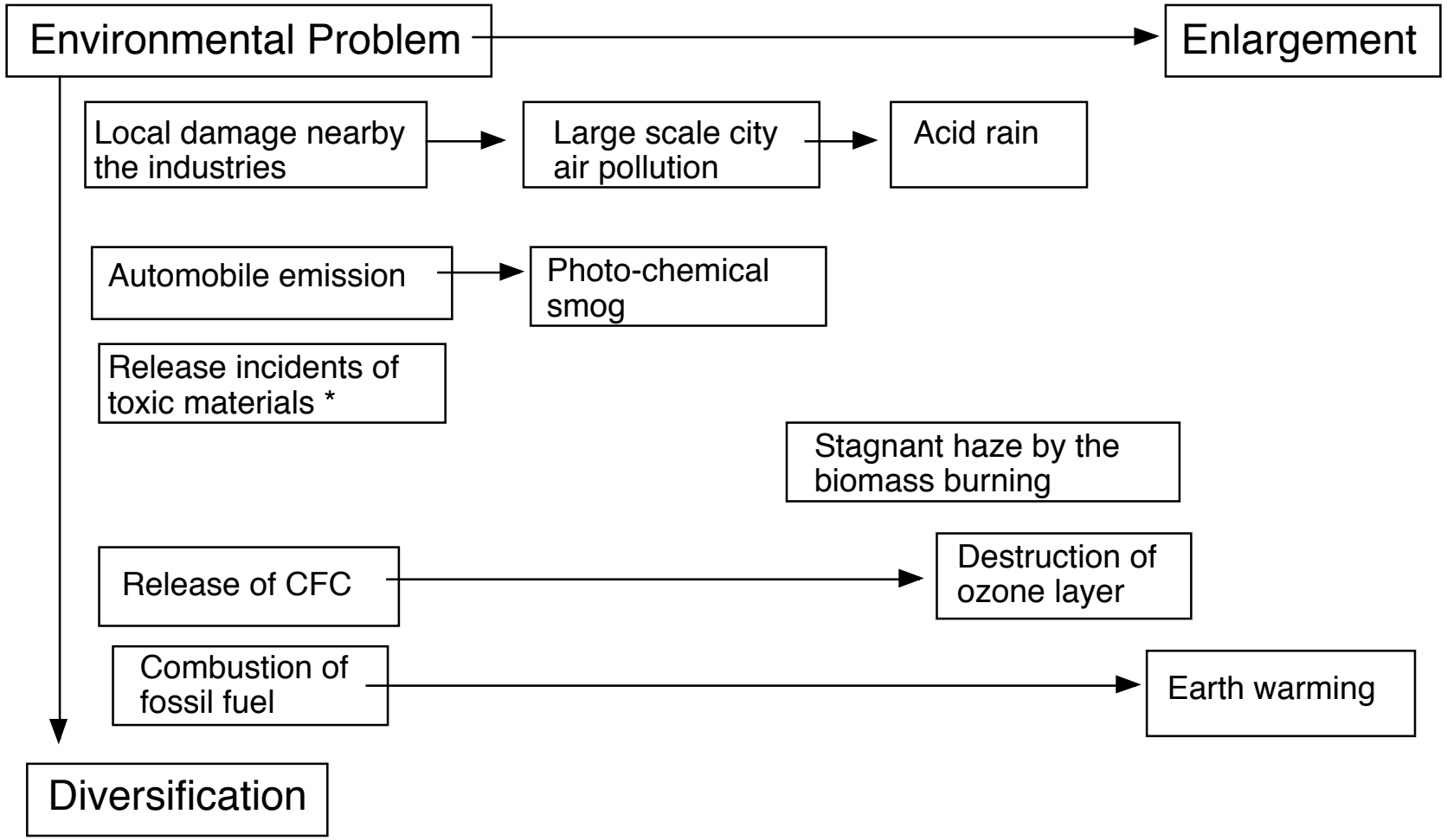
Air Pollution from a Lignite Power Plant Thailand's largest lignite-fired power plant is located in the Mae Moh district, Lam Pang province. With 11 generating units and a total production capacity of 2,625 megawatts, approximately 15 million tons of lignite are needed to run the machines. Prior to 1992, the plant emitted considerable amounts of air pollutants through high smoke stacks and discharged wastewater into its immediate surroundings.

High atmospheric pressure in October 1992 caused sulphur dioxide (SO2) generated from the plant to drift above Mae Moh district. Analysis showed that rainwater had 50 per cent higher sulphate concentration levels as compared with acceptable international standards, and at peak pollution levels, more than 2,000 micrograms per cubic metre of SO2 were found in the air. High levels of toxic acid rain continued in the locality until January 1993. The October 1992 pollution episode caused widespread damage. More than 900 people had difficulty breathing and experienced sore throats and other related illnesses. Domestic livestock also suffered, some becoming ill or dying. Cash crops and trees were destroyed or experienced subsequent growth problems. The Electricity Generating Authority of Thailand (EGAT) had to compensate rural households for losses, and affected persons were resettled in safer areas. EGAT had to reduce production by almost 60 percent (to 800 megawatts) while negotiations with affected parties went on.Several measures were implemented to avoid future problems: approximately US$280 million was invested in pollution control, a limit was imposed on the scale of operation, and the quality of coal was improved by mixing it with high-quality coal. Due to the implementation of prompt control measures, air quality in the vicinity of the plant was under control by late 1993 to early 1994.

The SO2 concentration had been reduced to within 300 micrograms per cubic metre by then. This case illustrates the need for thorough environmental impact assessments of large investment projects. It shows that good management can effectively reduce potential environmental hazards. It also illustrates the high costs associated with combating the adverse environmental effects of improperly planned operations.

(United Nations Environment Programme, Global State of the Environment Report 1997, http://www.grida.no/prog/global/geo1/ch/ch3_13.htm)

Transition of the Environmental Problem Types



NOTE: On the 2nd - 3rd December 1984, the worst industrial disaster of this century was caused by Union Carbide Corporation in Bhopal of India. Over 40 tones of Methyl Isocyanate leaked in the northern end of the city killing over 8,000 people in its immediate aftermath and causing multisystemic injuries to over 500,000 people.

Atmospheric Pollution and the Scale

Whenever approaching to the air pollution problem, you must consider the scale of the phenomenon described as:

Term of Scale	Size (km)	Atmospheric Phenomenon
Global-scale	$10^3 \sim 10^4$	Global warming, Ozone layer destruction
Regional-scale	$10^2 \sim 10^3$	Acid Rain
Meso-scale	$10^1 \sim 10^2$	Smog, Photo-chemical smog, Heat island over the megalo city
Local-scale	$10^0 \sim 10^1$	Diffusion from the tall stack
Micro-scale	$< 10^0$	Air pollution near roadways

Accommodation between the Industry and the Environment Quality

Generally, counter measures against the pollution for the industry were regarded as the negative cost, however, our experience showed that the compensational costs sometimes overwhelmed the cost of the counter measures which could evade the damage.

Historical change of the policy in the industries is:

1. No action on the environmental protection
2. Obliged counter measures
3. Counter measures based on the environmental assessment
4. Consideration upon the NGO activities
5. Develop the new business relating the environmental protection