CHAPTER 40

CONTROLLING AIR POLLUTION AND NOISE

40. 1. AIR POLLUTION

40. 1. 1. Definition

Air pollution is the contamination of the air by waste products produced by human activities in an industrialized society. Waste products in the air take many forms. These can rust and corrode metals, eat away bricks and concrete, discolor clothes and buildings, and destroy vegetation. Even a small amount of some types of air pollution is a serious threat to human health and can shorten life spans. Impurities in the air irritate our eyes, noses and lungs, and are unsightly when they build up to high levels.

Here we discuss human-caused air contaminants, not those naturally caused. In the past thirty years, air pollution has become a serious problem world-wide, even on our islands here in the Pacific. The public is now concerned about air quality. The problem is what to do about it.

We have the scientific knowledge and the technology to solve many of the air pollution problems we cause. The real difficulties are political and economic. Elected officials must pass effective laws to control air pollution. However, they will not do so until enough people express their concern.

In addition, air pollution control equipment is expensive. To pay for pollution control, polluters in the business sector must take less profit, or pass their costs on to customers. Neither solution is totally acceptable to everyone.

Still, this problem must be solved. The first step in solving any problem is to understand it. Learning about the causes, effects, and the costs of air pollution is especially important.

40. 1. 2. Types of Air Pollution

Human activity creates several major types of air pollutants. These are found everywhere that humans with technology live. Other unusual pollutants occur in particular areas due to certain manufacturing processes, but these are relatively isolated. They are still dangerous, but in this chapter, we will concentrate on just our most common pollutants.

Air pollution is harmful to the health of humans, plants, and animals and it causes destruction of property. In the past thirty years, air pollution has become a serious problem worldwide.

The major air pollutants include particles, carbon monoxide gas, hydrocarbons, nitrogen compounds, sulfur compounds, and dust. How much of each type occurs in any one place depends mainly on the number of people and automobiles present.

Smoke is the most easily recognized air pollutant. It is made up of very small particles of ash, soot, oil, and microscopic bits of metals.

Air movement can transport pollutants long distances, so one country's pollution can become a problem for another. Air pollution created here may affect animals and plants very far away.

Particles

Smoke is the most easily recognized air pollutant. It is made up of very small particles of ash, soot, oil, and microscopic bits of metals. Particles in smoke are generally of two types.

One is formed by the break-up of larger particles, such as from the grinding of solids, or from the ashes of burned matter. These particles are relatively large, and can be seen as dirt or dust when they settle out of the atmosphere.

The second type of particle is extremely small. These are formed when gas molecules and bits of metal and oil come together. These are the product of all types of burning.

Particles made of **asbestos** are formed mostly today from the brake linings of automobiles. These particles are so fine that they do not settle out of the air; instead, they are caught by the lungs of humans and animals. Asbestos is a known careinogen.

Automobiles are the primary source of air pollution in the CNMI. Among the pollutants produced are carbon monoxide gas, hydrocarbons, and nitrogen compounds.

Carbon Monoxide Gas

Carbon monoxide gas (**CO**) is another major pollutant, and is the most common one found in the air today. This gas is tasteless, colorless, and odorless. Even so, it is highly poisonous. In high concentrations it can cause death in just a few minutes.

The reason for this is that our blood picks up carbon monoxide easier than it picks up oxygen. Therefore, when breathing it, we are in danger of suffocating even though our lungs may be full of air!

This gas is mostly produced from the incomplete combustion of fuels—mainly from fuels in automobiles. Carbon monoxide gas also constitutes a major portion of cigarette smoke.

Hydrocarbons

Hydrocarbons (**HC's**) are a group of naturally occurring compounds that are made up of long molecules of hydrogen and carbon. These are the main ingredients in petroleum that cause it to burn.

They are released during incomplete combustion of fuels, chiefly from combustion in automobiles and diesel engines. These compounds are harmful, but only when their concentration is high. However, in the atmosphere, hydrocarbons react with other pollutants in the presence of sunlight to produce other very toxic compounds.

Gasoline that evaporates from fuel tanks and during fueling is also a major source of the unburned hydrocarbons in the earth's atmosphere.

Nitrogen Compounds

Nitrogen compounds (**NO_x**'s) are formed when fuels are burned with air that is more than three-fourths nitrogen. The x's in the chemical formula represents different numbers of oxygen atoms. These different numbers then form different molecular chemicals.

Nitrogen and oxygen combine in the high temperatures of combustion. Then the compound picks up more oxygen as the exhaust gases are released to the air. The result is a poisonous gas called **nitrogen dioxide (NO_2)**.

Nitrogen compounds and hydrocarbons combine chemically in the air in the presence of sunlight to produce something called **smog**.

Although smog does not occur in the CNMI because generally the trade winds carry it away, nitrogen compounds and hydrocarbons produced here can travel long distances and become part of someone else's smog.

Sulfur compounds make up a very large group of related pollutants produced mainly by electrical power plants.

Sulfur Compounds

Sulfur compounds (**SO_x**'s) make up a very large group of related pollutants produced mainly by electrical power plants. One of these compounds, **sulfur dioxide (SO_2)**, is thought to be the most corrosive and destructive of all air pollutants. Another compound, **sulfur trioxide (SO_3)** is almost equally destructive.

When sulfur oxide products enter the atmosphere, they can react with water vapor to produce the highly corrosive and toxic **sulfuric acid** (**H_2SO_4**).

This acid usually occurs in very fine mists and can even create an acid dew. It is so corrosive that in some parts of the world it is eating away buildings, bridges, and automobiles. It is even dissolving stone statues and buildings that have stood undamaged for thousands of years. Sulfuric acid is, of course, also very damaging to the delicate membranes in the lungs of animals and people.

Acid rain is so corrosive that in some parts of the world it is slowly dissolving stone statues and buildings that have stood undamaged for thousands of years. The image on the left was taken in 1908, the image on the right was taken in 1968.

Another product of sulfur compounds in the atmosphere is **hydrogen sulfide gas** (**H_2S**). This colorless gas is so highly poisonous that a concentration of just a few parts per million is enough to cause death. It is easily detected, though, because of its powerful rotten egg odor. It reacts easily with metals and is another major cause of corrosion.

Dust

Dust is generally not thought of as a pollutant, but in high concentrations it can be harmful and a nuisance. It is irritating to the nose, throat, and lungs, especially if it is made of a reactive substance such as limestone.

It settles on houses and clothing and makes a muddy mess when it rains. It can also cause increased wear on machinery, particularly on the rotating parts.

In the CNMI, dust is mainly the result of unpaved roadways in our rural areas, or from careless excavations and loaded, uncovered dump trucks from construction activities and quarry operations. By law all dump trucks must cover their payloads. To protect our

environment, people should report the license number, time, date, and location of trucks which do not have covers to DPS.

Other Sources
There are other dangerous air pollutants that result from our industrial lifestyles. These are such things as solvent vapors, pesticides, and vapors from lead and mercury sources.

Almost any hazardous substance can vaporize and enter the atmosphere. There are too many potential sources to list here, but we should be aware that atmospheric pollution comes from many different sources besides the major ones mentioned above.

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40. 1. 3. Causes and Sources of Air Pollution

Several conditions are typically associated with all types of pollution. These are people, automobiles, urbanization, electricity, and a material lifestyle.

When these factors come together in high concentration, pollution problems occur. All of these factors are interrelated and each is partly responsible as a cause of air pollution. Sometimes the relationship is unclear though, and needs to be explained.

Air pollution gets worse as populations grow, as more cars are driven more miles, as more electrical power is generated, and as more wastes and disposable items are produced and thrown away. There are more and more people on our islands, each wanting more and more goods and services, but our land area does not increase.

We must face the fact that our waste is beginning to pile up around us (on Saipan, Tinian, Rota, and all around the world) and that we can not live well in our own wastes.

We have discovered that the answer is not better treatments for pollution. Pollution treatment is expensive, and some pollution just cannot be controlled. The real answer is to pollute less.

Air pollution comes from the combustion (burning) of fuels.

Air pollution comes from the **combustion** (burning) of fuels. Burning fuel creates heat, light, and mechanical energy. The combustion process is needed to move automobiles and airplanes, to produce electricity for lights and for cooling buildings, and to power all the mechanical and electrical devices we have grown accustomed to using.

Complete combustion produces very little smoke, and in many cases, none at all. It also produces carbon dioxide and water vapor, naturally occurring parts of our atmosphere. These are the only products of complete combustion, and if we could burn all fuels in this way we would have very little air pollution.

However, this process needs great amounts of oxygen and very pure fuels. It can only be achieved on a very small scale and under strictly controlled conditions. To burn all our fuels with complete combustion would take more oxygen than there is on earth.

Our fuels are always burned by **incomplete combustion**, and this is the cause of serious air pollution problems. The result is all of the pollution problems discussed above. This is unavoidable.

40. 1. 4. Air Movement Here in the Marianas

Natural conditions can affect how much air pollution accumulates in a place. In the Marianas, air movement is mostly from northeast to southwest.

The land area of our islands is very small and fortunately there is usually enough wind to blow much of our air pollution out to sea. Nevertheless, this does not mean air pollution is not a problem here. Anyone who had stood on Micro Beach while the Puerto Rico dump was burning knows this.

Similarly, residents of Saipan are aware of how much pollution the power plants put out whenever the wind shifts to blow towards shore. Putting incinerators on the northeast part of Saipan would have resulted in a smoke plume passing over most of the island for practically the whole year. Luckily, this did not happen.

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40. 2. AIR POLLUTION AND DEVELOPMENT IN THE MARIANAS

40. 2. 1. Sources

Vehicles are a major source of air pollution in the CNMI. There are a lot of cars on our roads, and more are added every year. As our population increases, even more people are driving. As the number of our tourists grows, more buses are needed to take them around the island.

Each year, additional trucks are needed to move more goods from the ports to the stores. At the time of this book's writing, many of the vehicles in the CNMI do not have adequate pollution control devices and this makes the problem worse.

Autos and trucks are a major producer of carbon monoxide and nitrogen compounds. They also discharge large amounts of hydrocarbons and particles.

Gasoline and diesel engines discharge pollution from three vehicle points. These are the tailpipe, the crankcase, and the fuel tank. The tailpipe emits all the major pollutants except for sulfur compounds. The crankcase puts out the same types of pollution as the tailpipe, but less volume. Evaporation from the fuel tank puts large volumes of hydrocarbons into the air.

Although pollution from these points has been better controlled over the past thirty years, there is still a lot of pollution emitted from our autos and trucks. Because there are so many more cars now in the Marianas and in the world, pollution control has had very little overall effect on the global air pollution problem.

Generating electricity with fossil fuels such as coal or oil is another major source of pollution from sulfur compounds. These fossil fuels contain sulfur from the organic material they are made of. When they are burned, they release sulfur into the air.

All fossil fuels do not contain the same amount of sulfur. Natural gas contains very little. Some coal contains so much that it cannot be used for a fuel at all.

The fuel oil used to power the generators in the CNMI has a medium sulfur content, but since there is very little air pollution control here, most of the sulfur goes into the air.

Burning trash is the third major source of air pollution in our islands. As we learned in the previous chapter, every person in the CNMI throws away nearly six pounds of trash each day. When these materials are disposed of, they end up in the sea, in the dump, as roadside litter, and as fumes in the air.

Previous uncontrolled burning at the former Puerto Rico dump produced our most dangerous air pollution. The fumes contained acids, oils, metals, and highly poisonous gases and vapors.

A lot of cars are on our roads, and more are added every year. As our population increases, even more people are driving. As the number of our tourists grows, more buses are needed to take them around the island.

Burning textiles produce particularly hazardous wastes. Even controlled burning in an incinerator will produce dangerous pollution because of the nature of the trash we must incinerate.

As our population increases in the CNMI and as more tourists arrive each year, an expanding amount of trash accumulates. Prior to the use of the dredge spoils and building of Mt. Puerto Rico, it was nearly impossible to stop the uncontrolled blazes in the dump. Using incinerators will not completely solve the problem either.

Burning trash in the yard or on the farm used to be a common practice in the CNMI. This was acceptable when the trash volume was much smaller and contained mostly paper and wood wastes, and when the population was much smaller than it is now.

Trash today contains plastics and many other products that produce poisons when burned. Since houses are now located much closer together, burning at home has become a serious air pollution problem.

In general, as the population of Saipan grows, more sources of air pollution are created.

40. 2. 2. Effects

Nothing escapes the damaging effects of air pollution. It has severe effects on animals, plants and non-living matter. These effects often occur slowly and do not appear until many years later, long after the damage has been done.

Sometimes, however, they happen quickly and the effects can easily be seen. Air pollution is thought to upset the ecological relationship between living and non-living things in nature.

In many polluted areas of the world, an increase in death rates is directly linked to air pollution. Because plants are usually very sensitive to air pollution, agricultural production has decreased in some areas. The blackened surfaces of buildings and rapidly rusting steel are evidence that non-living matter is affected as well.

Air pollution can cause wide-spread damage to trees, fruits, and vegetables. Plants are more sensitive to air pollution than humans or animals are, since their cells are not protected by mucous membranes. They cannot cough to clear bad air from their tissues and they cannot move around to get away from air pollution.

Plants along roadways are greatly affected by vehicle exhausts. The greatest danger to plants in the CNMI is from the incineration of trash. This could result from open burning at the dump, from burning trash in our yards, or from operating incinerators.

Burning trash creates many poisonous compounds besides the major pollutants we have discussed. These pollutants have very serious effects on plant tissue and usually destroy the leaves first. Without leaves, plants cannot gather light for photosynthesis and soon die.

There are three general effects of air pollution on plants that can easily be seen. The first is a marking on leaves that indicates the death of cells or of whole leaves. These markings can be whitish or brownish spots or holes. The second indication is a yellowing of leaves. This usually occurs more slowly, over longer periods of time. The last effect is a reduced or stunted growth that results from insufficient photosynthesis. In addition, plants can accumulate pollutants from the air and store them in their tissues. Later, these plants may be eaten by animals, which are then also affected by the pollutants.

Air pollution has many of the same effects on animals that it does on humans. These are respiratory problems and an accumulation of pollutants in the body. There have been many cases when animals living downwind of incinerators and power plants have died because of the effects of pollution.

There are many negative effects of air pollution on property. Steel corrodes much faster in urban areas than it does in rural communities. Sulfur compounds are a major cause of property damage.

Hydrogen sulfide discolors paint and tarnishes exposed metals. Sulfuric acid is a powerful acid that eats away many natural and synthetic materials, including stone. The darkened surfaces of stone buildings is often the result of sulfur pollution.

40. 3. REDUCING AND CONTROLLING AIR POLLUTION

40. 3. 1. Control of Air Pollution

There are many major problems associated with the control of air pollution. These include social, economic, and technical concerns.

Air pollution is not the same from place to place and it does not follow man-made boundaries. The wind blows air pollution across local and national boundaries. Air pollution often affects those who did not cause it, and who do not benefit from the activities that caused it. Remember our discussion of market externalities?

The average citizen must become knowledgeable about the broad scope of the pollution problem, all pollution, not just that in the air. To fully understand the pollution problem, students must also understand ecology because our pollution affects all living things. Remember that we are one of these living things, and the laws of nature apply to us just as they do to plants and animals.

As responsible human beings we must come to understand that the responsibility for pollution is our own. Demand for material

Burning trash creates many poisonous compounds besides the major pollutants we have discussed.

wealth and energy has been satisfied too often at the sacrifice of the environment. The best we can do is to pollute less by changing our lifestyles, and to try to control the pollution we do create. If we do not do this, then we must continue to live in our wastes.

Noise can be created from either a stationary source....

To control air pollution we must control the amount and kinds of particles and gases we put into the air. Particles are smoke, grit, and liquid droplets. These can be removed from air by mechanical equipment such as scrubbers and filters.

Gases are much more difficult to control than particles and usually require the use of much more sophisticated and expensive equipment. Gases are sometimes absorbed into water in a treatment chamber. They can also be treated by collection on the surface of a solid. The most effective treatment method is by chemical reaction. A good example of combining chemical reaction and collection on a solid surface is the **catalytic converter** in an automobile.

40. 4. NOISE

40. 4. 1. Sources

Noise is any erratic, disturbing, unwanted sound. It is the direct result of energy use in our technical and industrialized society. Noise is created by three basic types of sources. Sources are either stationary, mobile, or temporary.

A **stationary** source does not move. Its noise affects humans and animals as they pass by it or spend time near it. This noise source may be a large power plant near one's home or a neighbor's air-conditioner or generator operating outside one's window.

A **mobile** source moves, and carries its sound with it. It affects us as it passes by. The most common mobile noise sources are those from transportation: from the almost endless stream of traffic on our roadways, from aircraft, and from boats.

or a mobile source.

Temporary sources are those that do not last long, or happen only very rarely. They may be very short in duration, like an explosion or a gunshot, or they may last longer, like the noise made on a construction site. However long they last, temporary noises are not expected to remain permanently.

Noise level is related to energy. In fact, noise is an energy form. Its intensity is a measure of how much energy is being used and at what rate it is expended.

Explosions are energy being used very rapidly. A small firecracker produces a lot of noise, even though it does not release a large amount of energy. It just releases it very quickly. If the firecracker were unrolled and the powder on the paper set afire, it would burn and sizzle, making noise but not as loud as if it exploded.

Similarly, detonating a gallon of gasoline would create a huge explosion; burning it slowly in one's car makes less noise, but lasts over a longer period of time. If no energy were used, there would be no noise.

40. 4. 2. Effects of Noise

Noise can interfere with our communication with one another, damage our hearing, and have other bad effects on our health. We have called noise an unwanted sound. Modern technology has a lot of noise associated with it.

When discussing pollution, we include a description of its effects on human beings. A human being is a very sensitive and complicated organism, and stresses and disturbances affect us in ways that we sometimes do not recognize or understand. Many researchers now think that loss of hearing is not the most serious consequence of too much noise.

The first effects of exposure to noise are anxiety and stress-related reactions. These may take the form of irritability, anger, confusion, or depression. These reactions also produce changes in the body, such as increased heart rate, constriction of blood vessels, or problems with digestion. The long-term effects of exposure to noise are difficult to determine.

Studies show that in animals long term exposure to excessive levels of noise damages the heart, brain, and liver, and causes emotional disturbances. The emotional effects on humans are difficult to predict because each person has different levels of tolerance. Everyone is aware however that noise makes us uncomfortable in some way.

One way to mitigate noise pollution is to have aircraft take-off patterns changed so planes fly over unpopulated areas.

40. 4. 3. Noise Control

Noise is produced by one of the sources we discussed (stationary, mobile, temporary). It travels through the air and impacts some type of receiver. The receiver we are most concerned with is our ears. To control noise we can either reduce it at the source, interrupt it as it travels, or protect the ear.

The best noise reduction is to eliminate the source. If this is not possible, we need to at least lower the power of the noise, or otherwise change it in some way. Fix the muffler on the truck or car, lubricate squeaky machinery, and turn down the volume of the music.

We could also schedule noisy activities, like construction, for times when people are away from the area. Similarly, aircraft take-off patterns can be changed so planes fly over unpopulated areas. Land use planning and zoning can help insure that high noise zones for runway approaches are designated for uses other than housing.

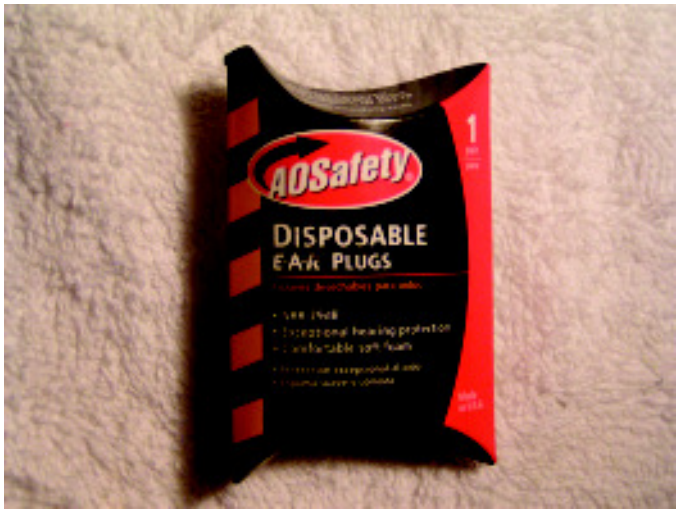
Different methods of noise reduction will work better for some sources than for others. We must evaluate the noise and decide the best way to deal with it.

If the noise cannot be reduced at its source, then it may be possible to interrupt it, or intercept it as it travels. The use of soundproofing materials in buildings is an excellent example of this. These materials catch the sound and only reflect some of it back.

Using rubber mounts to isolate noisy machinery is another good interruption method. The rubber motor mounts in automobile engines do this. You would be shocked at how noisy the inside of a car you were driving in would be if the motor was bolted directly to the frame.

The final method of dealing with noise is to protect one's ears. We do this instinctively when we cover our ears to shut out noise. Many types of ear protection are available for people who work around noise.

For example, a bulldozer operator or a power tool user can wear ear protectors while he or she operates the machine. These will protect the operator and tool user but other people in the area are less fortunate. Not everyone can carry around ear protection just in case they find themselves close to noise.



Those who work around noise can use hearing protection devices to avoid hearing damage.

Noise is a different kind of pollution than others we are studying. It is not a material and it does not accumulate in the environment. It is an energy form that is often the direct result of our use of fuels.

Like other pollutants, noise affects the quality of our lives, and it sometimes even affects our health. The noise of industry, transportation, and construction is usually associated with progress. Often one looks at the activity and hears the noise and thinks of economic prosperity.

In truth, noise in the environment affects our well-being in the same way as dirty air, dirty water, trash heaps, and toxic wastes. Noise is part of the price we pay for our technological society. As responsible resource managers we need to avoid and minimize it as much as we can.