Monitoring Water Quality

The quantity of chemicals in the environment can be monitored. Monitoring keeps track of something for a specific purpose. Clarity may be one indicator, but clear water does not indicate what chemicals are present.

Water Quality is determined using chemical and biological indicators according to what the water is going to be used for. There are five categories of water use:

- human drinking water
- recreation
- livestock drinking water
- irrigation
- protection of aquatic life

Biological Indicators

Microbiological Indicators - Microscopic organisms (bacteria) can cause serious health problems if they are present in sufficient numbers. Samples are taken to identify their presence to avoid contamination of the water supply.

Aquatic Invertebrate - Species of aquatic organisms (invertebrates – animals without a backbone) require certain amounts of oxygen in the water to survive

Aquatic Environments

The place where aquatic organisms live can vary, depending on the pH level and the amount of dissolved oxygen present.

… there will likely be no fish in water that has a pH below 5.0

... worms and midge larva thrive in polluted water, as they require only small amounts of dissolved oxygen for survival

Chemical Factors That Affect Organisms

Chemical indicators of water quality include: dissolved oxygen, acidity, heavy metals, nitrogen, phosphorus, pesticides, salts – such as sodium chloride and magnesium sulfate.

Measuring Chemicals in the Environment

The concentrations of chemical indicators is usually measured in

parts per million (ppm), $$\text{ppm} = \frac{\text{grams of solute}}{\text{grams of solution}} \times 10^6$$

Or, in milligrams per Litre (mg/L). $$\text{ppm} = \frac{\text{mg of solute}}{\text{L solution}}$$

One part per million means that one unit of an element or chemical can be found in one million units of solution.

Dissolved Oxygen

Abiotic factors - water temperature, rate of flow (turbulence), obstacles in the water, wind, amount of photosynthesis by water plants,

Biotic factors - number of organisms using oxygen
Most organisms need 5 milligrams per Litre (5 ppm) of dissolved oxygen to survive. The diversity of species often gives us a relative idea of the amount of dissolved oxygen present. A large number of different species means a high level (likely 8 ppm or more) of dissolved oxygen, whereas a few species indicates a low level (below 5 ppm) of dissolved oxygen.

Phosphorus and Nitrogen Content

Phosphates and Nitrates often enter the water supply by sewage and runoff – They increase the growth of algae and weeds in the water. This then increases the food supply for bacteria, which decompose the plants, as they die. The presence of more and more bacteria uses up the available supply of dissolved oxygen and many of the aquatic organisms die as a result.
pH Testing

Acid Rain & Acid Shock

Sulfur and nitrogen oxides emitted from industries (such as smelters) combine with water vapor in the air to produce sulfuric and nitric acid. These pollutants then fall to the ground as acid rain (with a pH lower than normal rain - which is about 5.6)

... causes chemical changes in the soil reduces soil fertility
... retards tree growth
... kills organisms in lakes & streams
... corrodes exposed metal surfaces
... breaks down stone and limestone
... leaches toxic chemicals from the soil

Acidity is measured on the pH scale with 7.0 being neutral and anything below 7 is acidic. A decrease of one unit indicates the acidity has been multiplied by a factor of 10. Periods of extreme acidity (like in the spring when the acid snow melts and the acidic water enters the waterways) are called acid shock.

Pesticides
Some insects have become pesticide-resistant and so, new pesticides have to be developed. When these chemicals remain in the environment, a toxin is created. Several pesticides mixed together can have a cumulative effect and become very toxic. A toxic substance is poisonous.

Measuring Toxicity
Toxins, or poisons are substances that produce serious health problems, or death when introduced into an organism. Scientist measure toxins in **LD50** amounts. LD stands for 'Lethal Dose' and 50 represents 50% of the subject group that will die if they are given the specified dose, all at once.

Table - http://users.rcn.com/jkimball.ma.ultranet/BiologyPages/L/LD50.html

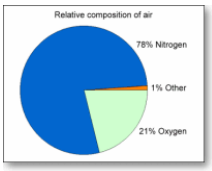
Heavy Metals
Heavy metals have a density of 5g/cm3 or more. Examples include: mercury, copper, lead, zinc, cadmium and nickel. These metals occur naturally and are also processed into a wide variety of products. Heavy metals can be toxic to a wide range of organisms, so concentrations are constantly monitored. Heavy metals can enter the water supply by the action of acid rain and improper solid waste disposal (which can leach heavy metals into the groundwater). Heavy metals are especially toxic to children cause abnormal development, brain damage or even death.

Suspended Solids
- Turbidity
- unpleasant appearance
- blocks sunlight
- decreases oxygen production

Testing: Use the filtration method to separate the sample into residue and filtrate
Phosphates: nutrients that enhance growth of plants (excess phosphates stimulate the growth of algae and

Monitoring Air Quality

Composition of Air
Nitrogen (78%)
Oxygen (21%)
Carbon Dioxide (0.03%)
Hydrogen & Neon (tiny amounts only) (Argon (<1%)



Air quality can be measured in two ways: by measuring the levels of pollutants in the air and by estimating the amount of emissions from pollution sources.

Sulfur Dioxide
Sulfur Dioxide (SO2(g)) is a major air pollutant (forming smog and acid rain). It can affect your respiratory system and irritate your eyes. It is produced through industrial processes. Scrubbers are used to reduce sulfur dioxide emissions by up to 99%. They use limestone to convert it to a useful product – gypsum.

2 SO2(g) sulfur dioxide	+	4 H2O(l) Water	+	2 CaCO3(g) limestone	+	O2(g) oxygen	--->	2 CaSO4-2H2O(s) gypsum	+	2 CO2(g) carbon dioxide

Nitrogen Oxides
Nitrogen Oxides (NOx(g)) are mixtures of NO and NO_2 and are major contributors to smog and acid rain as well. Vehicle emissions and the burning of fossil fuels are the main contributors of Nitrogen Oxides.

Carbon Monoxide
Carbon monoxide is called the silent killer because it is a colorless, odorless gas. It is caused by the burning of fossil fuels and not enough oxygen to produce carbon dioxide. Motor vehicles are the main producers of carbon monoxide, but other sources include the burning of wood (forest fires produce large quantities) in fireplaces and stoves, natural gas, industrial processes, airplanes and cigarettes. If inhaled, carbon monoxide reduces the amount of oxygen in the blood and can cause headaches, sleepiness, chest pains, brain damage and death. Catalytic converters are used to convert carbon monoxide into carbon dioxide.

Ground-Level Ozone
Ozone (O3(g) is an odorless, colorless gas that has 3 oxygen atoms. It protects us from harmful ultraviolet rays from space, but at ground-level it can be harmful, because it can affect the respiratory system, deteriorate plastics and can have serious effects on crops. Ground-level ozone forms from reactions between oxygen, nitrogen oxides and compounds that are volatile organic compounds (VOC's), in the presence of sunlight and heat. Fuel combustion is the major source.

Techniques for Controlling Air Pollution

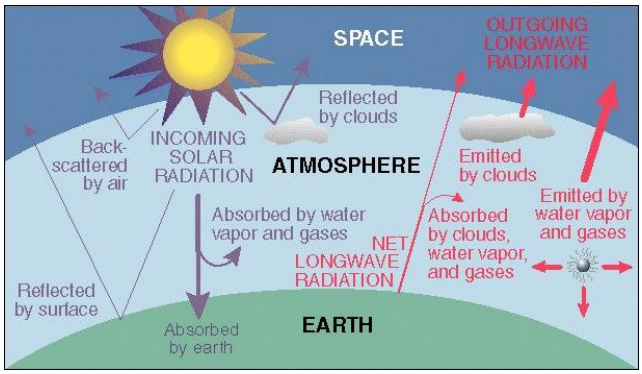
Tall smokestacks	to carry the pollutants higher in the atmosphere, mixing them with larger amounts of air, thus diluting them.
Scrubbers	to remove most of the sulfur dioxides before they leave the smokestacks.
Other fuels with less sulfur	natural gas, non-leaded fuel
Alternative energy sources	solar power, wind power, tidal (water) power.
Catalytic converters	carbon monoxide is converted into carbon dioxide before it is released from the exhaust system.
Electrostatic precipitator	to reduce particulate emissions from industries

Monitoring The Atmosphere

Chemicals in the air can cause mild to serious effects in local areas, but chemicals in the atmosphere can have serious global effects. Ozone depletion and climate change are the primary concerns internationally.

Carbon Dioxide As A Greenhouse Gas

Carbon dioxide occurs naturally in the environment, but increasing amounts that are being produced by various human activities is creating a concern globally. The increasing population and increasing use of fossil fuels is creating some issues.



The Greenhouse Effect

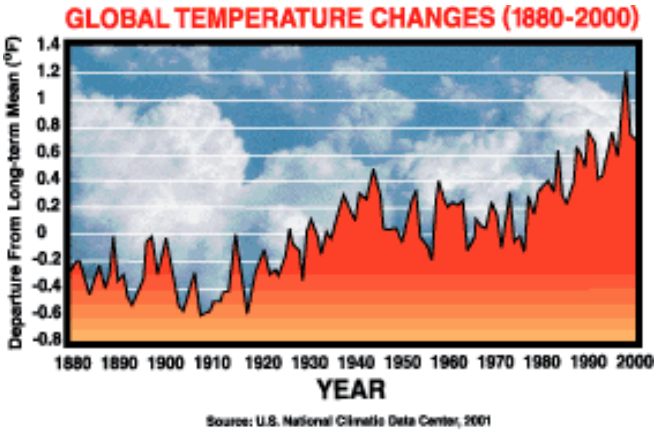
The Greenhouse Effect is a naturally occurring event, the result of greenhouse gases (water vapor, carbon dioxide, and other gases) trapping some of the outgoing energy - retaining heat in a way somewhat similar to the glass panels of a greenhouse – helping to maintain the Earth's average surface temperature of 15°C.

The Enhanced Greenhouse Effect

Many scientists support the theory that the enhanced greenhouse effect is causing temperatures to increase around the world. Human activities – essentially, the burning of fossils fuels is the primary reason. Monitoring stations are set up to record the higher levels and governments are trying to find ways to reduce the emissions of carbon dioxide which is fueling this enhanced greenhouse effect and depleting the ozone layer.

Global Warming

It is not just human activities that are contributing to global warming, but volcanoes and forest fires are also part of the cause. The questions remain – What should be done? – or, Can we do anything about it at all?



The Ozone Layer

Ground-level ozone can have dangerous effects. Atmospheric ozone is the chemical that occurs high in the atmosphere where it maintains a shield around the Earth protecting everyone from harmful UV radiation from the Sun. The ozone layer is a natural formation 15 to 50 kilometers above us. Since the late 1970's Scientists who have been monitoring this protective layer, have noticed that it is becoming thinner. They have also discovered 'holes' in the layer. This results in more UV radiation getting through to the surface of the Earth and increasing the likelihood of more organisms getting skin cancer and cataracts. It is also affecting the plankton population – which is an important food supply for many animals.

Chlorofluorocarbons (CFC's)

The thinning of the atmosphere is caused by our use of chlorofluorocarbons (CFC's). These chemicals eventually get into the upper atmosphere where they are broken down into elements like chlorine – which destroys ozone. (1 chlorine atom can destroy 100,000 ozone molecules. Many countries have signed agreements to reduce their use of these chemicals.