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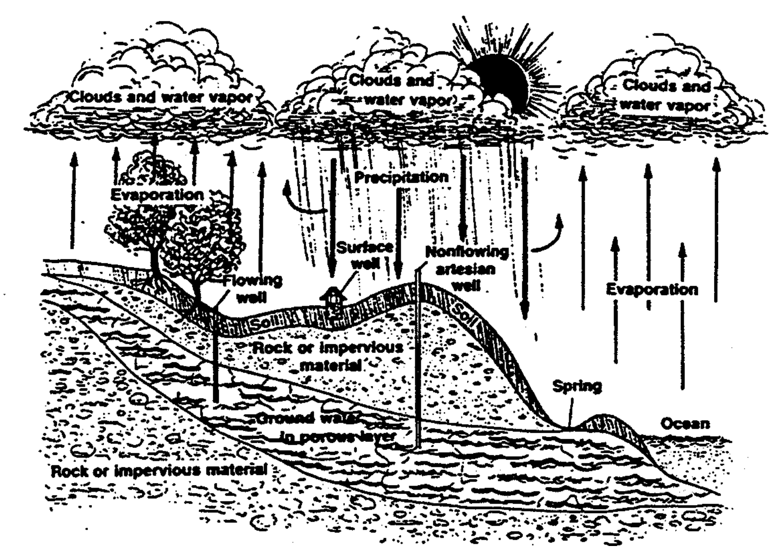

THE ROLE SOIL PLAYS IN WATER QUALITY AND POLLUTION PREVENTION

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One of the best approaches to protect water quality is to protect soil quality. High quality soils can aid in preventing water pollution by absorbing and partitioning rainfall and by breaking down chemicals, waste products and other potential pollutants.

I'm going to use <u>the five-sphere approach</u> to explain the big picture of Earth and its environment, and then zero in on the role that soil plays in pollution prevention.

Lets assume you are approaching Earth in a spaceship. One of the first things you notice as you get within visual range is the predominantly blue color because of all the liquid water that covers about 70% of the Earth's surface. That's why we call Earth the blue planet.

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As your spaceship gets closer, your first physical contact with Earth is its **atmosphere,** that gaseous envelope surrounding the planet. Its primary components are: nitrogen, 78%; oxygen, 21%; argon, 1%; carbon dioxide, .035%; and very small amounts of other gases.

The atmosphere extends out to 300 miles, but some atmospheric molecules may be found out as far as 1000 miles. (This 300-mile radius would be equivalent to about 1/2-inch on a 12-inch globe.) The atmosphere consists of sub-layers called the troposphere (0 to 7mi), stratosphere (7 to 31mi), mesosphere (31 to 56mi), and thermosphere (56 to 300mi). The most active parts of the atmosphere (troposphere and stratosphere) make up 99% of the atmosphere and would be equivalent to about 1mm thickness on a 12-inch globe.

Now as you descend even closer to Earth, you soon find yourself within an Earthen layer called the **hydrosphere,** which extends up into the lower atmosphere. The hydrosphere is made up of all the free water in gaseous, liquid or solid form on or surrounding the surface of the Earth. Although you could see the oceans from outer space, your first real contact with the hydrosphere is the water vapor and clouds in the lower atmosphere.

It is this hydrosphere that makes earth a living planet. Water is needed for the photosynthetic process that converts electromagnetic energy from the sun to chemical energy in green plants. It is the basis for all life as we know it, typically making up 65-70% of human body weight and 80 to 95% of the fresh weight of non-woody plants. Water movement controls a major part of the Earth's overall climate.

The oceans, which are saline, account for 97% of Earth's free water supply. Two-thirds of the remaining 3%, most of which is fresh, is held in polar ice caps and glaciers. Therefore, only 1% of the Earth's total water supply is available to humans as fresh water. Even though we have a variety of stream shapes and sizes that traverse the landscape, over 98% of the liquid fresh water is found as groundwater. This is why we are becoming more concerned for groundwater pollution.

Although the atmosphere contains only a small amount of water at any given time, about .001%, this atmospheric water circulates very rapidly through the water cycle. This water cycle distributes water around the globe, although some areas receive very small amounts on an annual basis. About 60 inches of water evaporates and returns to the oceans each year. Enough water falls on the U.S. each year to cover the U.S. to an average depth of about 30 inches. Of this amount about 22 inches is returned to the atmosphere each year through evaporation and transpiration by growing plants, while 8 inches flows over and through the ground into the oceans.

Long-term average precipitation for Alabama is about 55 inches per year, with 33 inches going to evaporation and transpiration and 22 inches to stream outflow. About 7 inches of the 22-inch outflow per year goes to infiltration, then moves through the ground and eventually to stream outflow from groundwater.

Before you actually touch down on the Earth's surface in your spaceship you will likely see evidence of its **biosphere,** that part of the Earth's crust, waters and atmosphere where living organisms can subsist. You probably saw land-based vegetation before you landed, but birds in the air or other animals may be your first indication of life, depending on when and where you land. However, most of the living organisms on Earth are microscopic in size. Carbon is the most important element found in the biosphere because all organic life as we know it is based on carbon.

The biosphere is not a uniform layer. It is very unevenly distributed around the Earth because conditions may be too hot, too cold or too dry to support life in some areas. The biosphere is a very complicated world of its own. We now have a number of specific life sciences that deal with the study of different organisms or different aspects of this organic world. Ecology is that branch of biology that deals with the relationships between organisms and their environment.

If you did not crash and you preferred a dry landing, you are now in contact with the **lithosphere,** the outer layer of the Earth's crust and mantle. Earth's biosphere actually includes parts of the lithosphere as well as parts of the hydrosphere and atmosphere. The highest densities of living organisms are found within surface waters and those highly-weathered surface layers of the lithosphere.

The lithosphere is somewhat like a layer of skin that goes under the oceans and across the landscape. We know very little of what goes on beneath the lithosphere down in the core of the Earth. The primary components of the Earth's crust are: oxygen, 46.6%; silicon, 27.7%; aluminum, 8.1 %; iron, 5.0%; calcium, 3.6%; sodium, 2.8%; potassium, 2.6%; magnesium, 2.0%; and other elements, 1.6%.

The lithosphere is considered to be somewhat rigid but the theory of plate movement is generally accepted as being responsible for sea-floor spreading, continental drift, and subduction which results in creation of new oceanic crusts, the growth of continents, volcanism, earthquakes and mountain building. Lithology is that science dealing with mineral composition and structure of rocks. Geology is the science that deals with physical history and physical changes of the Earth.

The surface layer of the lithosphere is called the **pedosphere.** It is the outermost, thin and weathered covering of the pedosphere that we commonly refer to as **soil.** It is within this soil layer that many living organisms thrive and receive their nourishment across Earth's landscape. Pedology is the science dealing with the study of soils and pedogenesis is the study of soil formation.

Just What is Soil?

Soil may be defined as a naturally occurring mixture of inorganic chemicals, air, water, decaying organic material and living organisms. Thus, soil is made up of minerals and chemicals from the lithosphere, air from the atmosphere, water from the hydrosphere, and organic matter and living organisms from the biosphere. Less than 10% of the living organisms that thrive in soil have been isolated and studied.

A primary point that I want to make is that the five spheres I have mentioned are not mutually exclusive of each other. They interact on a regular basis and soil is a mixture of all. All spheres can suffer degradation and degradation of one can impact others.

Water Quality and Pollution

Water quality is a relative term and has no exact meaning. Water quality depends on a status or condition—and that condition relates to the requirements of certain living organisms, or to the requirements and/or preferences of humans.

Although we normally refer to water quality in terms of the amount and types of contaminants it contains, water contamination and water pollution are not necessarily the same. A number of contaminants are being added to and removed from water on a regular basis as it moves throughout the hydrosphere in its hydrologic cycle. Thus water can become contaminated without the influence of humans. On the other hand, water quality may be degraded either directly or indirectly due to the actions of humans. This is pollution. It is not always easy to separate natural water contamination from pollution.

The five major categories of contaminants or polluting agents that affect water quality are physical, chemical, biological, radiological and thermal. The two subclasses of physical contaminants or pollutants that affect water quality are mineral and organic. The most common contaminant found in water on Earth is sodium chloride, common table salt. The most common pollutant and greatest water pollutant by volume is sediment, the product of accelerated soil erosion due to human land-disturbing activities. Sediment is also a common natural contaminant of water because of natural geologic erosion. The category of water contaminants or pollutants which poses the greatest threat to human health is microbial agents. The category of water contaminants or pollutants the general public fears most is chemicals.

Standards for water quality may be based on concentrations of both naturally occurring contaminants and pollutants. Such is the case with U.S. federal public drinking water standards.

Pollutants in water are often defined as coming from either a **point source or nonpoint source.** If they reach water through a distinct discharge pipe or channel they are considered point source; otherwise, they are considered to be nonpoint pollutants.

Linking Soil Quality and Water Quality

Since soil is that living dynamic substance that acts as an interface between many human activities, including agriculture, and other spheres of the environment, there are definite **linkages between soil quality and water quality.**

Agricultural production, for example, cannot take place without generating certain residual products such as nutrients, pesticides, sediments, salts, biological agents and trace elements, all of which may become pollutants. Most agricultural production, which includes food, fiber and energy products, is tied to the soil. For example, over 3/4 of the world's human food supply comes from soil and we are not going to stop using it for that purpose.

Ancient history tells us that many agrarian civilizations once thrived and then disappeared from the face of the Earth because they did not maintain the quality of their soils—primarily through erosion prevention. Thus, most soil quality efforts in the U.S. have focused on erosion control, but protecting soil quality is not synonymous with reducing erosion. It is much broader than that. This is not to say erosion control is not important, because erosion is one of the most destructive forces in nature and sediment is the leading water pollutant from land-disturbing activities.

Soil quality is determined by a combination of factors including physical, chemical, and biological properties such as texture, water-holding capacity, porosity, organic matter content, and depth. Some soils because of their texture or depth, for example, are inherently more productive because they can store and make available larger amounts of water and nutrients to plants. Similarly, some soils because of their organic matter content and living organisms are able to immobilize or degrade larger amounts of pollutants.

High-quality soils can prevent water pollution by absorbing and partitioning rainfall and by breaking down agricultural chemicals, wastes, and other potential pollutants. Thus, protecting soil quality is an important step toward protecting water quality. Soil quality is even becoming a measure of general ecosystem health and some scientists prefer to speak in terms of soil health rather than soil quality.

Erosion, compaction, salinization, sodification, acidification, and pollution with toxic chemicals can degrade soil quality and reduce a soil's productive capacity and its ability to produce healthy plants and maintain good water quality. Increasing soil protection by crop residues and plants; adding organic matter to the soil through crop rotations, manures, or crop residues; and careful management of fertilizers, pesticides, tillage equipment and other elements of the farming system can improve soil quality.

Protecting soil quality alone will not assure the prevention of all water pollution and it may not even be cost effective to protect soil quality in some cases. However, protecting soil quality is certainly an important public goal for environmental improvement.