DEGRADATION OF SOIL AND WATER RESOURCES

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Abstract: Soil and water resources are intricately linked and the degradation of one affects the other. The use and misuse of these resources had been going on for thousands of years. But as the Earth’s population continues to increase, a new awareness must occur. A brief overview of degradation of these two vital resources around the world is presented.

INTRODUCTION

The quality of the soil and water resources of planet Earth is critical to the survival of its flora and fauna. The very sustainability of life on Earth demands that those of us who inhabit this amazing celestial ecosystem do our utmost to conserve and preserve Earth’s precious resources. However, over the centuries humans have demonstrated their inability or unwillingness to neither conserve nor preserve these resources. Over time we have witnessed the accelerated and continuing degradation of these resources. From the beginning, all cultures have strived to sustain themselves by using the available resources to supply food, water and shelter. Many of these cultures, both by necessity or inadvertently, denuded the soils and opened their wounds to erosion and loss. Likewise, the requirement for water to support the daily needs of the population and for growing sufficient food stocks often stressed the available supply. In areas of low or limited rainfall and drought, pressures on the resources were greatly increased. As populations grew and urbanized, water resources were seen as easy avenues for human, animal and industrial waste disposal further degrading the resource.

Kranz and Kifferman restate this impression about water from a modern prospective – “without water, life on Earth would be non-existent: it is essential for everything on our planet to grow and prosper. …we disregard it by polluting our rivers, lakes, and oceans. We are slowly but surely harming our planet to the point where organisms are dying at a very alarming rate, our drinking water has become polluted and the recreational uses of our water resources are impaired. [1] Pollution and degradation of the Earth’s water resources exists on a global scale. Pick any water course or body, the Chesapeake Bay, the Black Sea, the Baltic Sea, a creek, stream, river or coastline, they are either currently degraded or threatened with sediment, nutrients, chemicals, pathogens and other pollutants.

As with water, without fertile soils, life on our “blue” planet would not exist. The human population on Earth is supported by an arable soil base equal to less that 1/32 of the surface of the Earth, about 4,700,000 sq km (470,000,000 ha) an area about the size of the
European Union. Around the globe, we see the destruction of soil resources by various cultures, ancient and modern. However, we see where other ancient and modern cultures have wisely used and conserved the soil. In the 1930’s the United States witnessed the folly of breaking the sod of the Great Plains area, which resulted in the severe dust storms, the loss of millions of tons of precious top soil and the subsequent displacement of thousands of people. In 1947, Faulkner in his book Ploughman’s Folly [2] described the dangerous effects of modern agriculture on the degradation of our soil resources. Bear, in his book, EARTH: The Stuff of Life [3], spoke of the intricate relationship between soil and water as essential resources to sustain all life on the planet Earth. However even today due to inappropriate cultural practices, we still witness great losses of top soil across the globe which translates into the irrevocable loss of agricultural productivity and water pollution issues.

Much of the world’s population considers the earth’s natural resources free to use, as they desire. People form the attitude that these resources are to a large extent unlimited or at least they do not need to worry about their immediate availability. These resources are often referred to as the ‘commons’, which are shared, by people or groups of people. Hardin in his essay The Tragedy of the Commons [4] in 1968 discussed this topic and suggests that the commons can be abused in at least two ways: (a) the public can take too much from of the commons for the common’s good, e.g. people grazing too many animals on public pastures and (b) the public can damage the commons by adding more pollutants to a common than the common can recycle e.g. too many chemicals in the soil or water. Much of the world’s population has grown up in lands where the natural resources were abundant in proportion to the population. They got use to the concepts of readily available resources and the ecosystems recycling and disposing of wastes and pollutants. In many impoverished countries the demands of time and energy just for existence is so great that the people have no time to worry about the diminishing quantity and quality of resources. Likewise, because of these same reasons, they disregard the capacity of the natural resources base to absorb the abuse and renew its self, resulting in abuse of the commons. [5] Sometimes the tragedy of commons translates into issues other than just the quantity and quality of resources. In her book The Mighty and the Almighty [6], former US Secretary of State Madeline Albright, presents a more tragic example; the conflict between the people themselves e.g. fighting between Nigerian Muslims and Christians over grazing rights and access to water for their cattle.

WATER RESOURCES

Ninety-five and one-half percent of the Earth’s water resources are stored in the oceans. Freshwater resources on Earth comprise less than 2.5 % (35,000,000 km$^3$) of the total water supply. Of this 35,000,000 km$^3$, 0.3 % is stored in lakes and rivers, 30.8 % as groundwater (including soil moisture, swamp water and permafrost) and 68.9 % exists in glaciers and permanent snow cover. Of the 1 % of the Earth’s freshwater, which is easily accessible, agriculture is by far the largest user. Globally agriculture withdraws 67 % and consumes 86 % of the total freshwater. Agriculture in the United States, consumes around 49 % of the total freshwater use, and 80 % of this water is used for irrigation. In Africa and Asia, 85-90 % of all the freshwater use is for agriculture, mostly for irrigation.

Domestic water use is related to the quantity of water available to populations in cities and towns. Often population settlements do not coincide with the location of freshwater resources. Many countries in Africa, the Middle East, Western Asia, and some Eastern
European countries have lower than average quantities of freshwater resources available to their populations. While the quantity of water may be disproportionately distributed, use is also disproportionate. People in developed countries consume about 10 times more water daily than those in developing countries (500-800 liters per day compared to 60-150 liters per day respectively). Globally the availability of freshwater is projected to drop by nearly 30% by 2025 placing an estimated three billion people in the water scarcity category. Industrial uses account for about 20% of global freshwater withdrawals, around 65% used power generation. [7]

While adequate water supplies are necessary, the quality of that available water must also meet the designated uses. Most land-based activities affect water quality in some respect through the pollutant load they contribute. Sediment itself is a major pollutant, often damaging finfish and benthic organism habitat, clogging shipping lanes, damaging industrial equipment and limiting recreation. Also sediment carries many types of pollutants from point and non-point sources, the quantity of which depends on the general land use and origin of the activities in the drainage basin. Asia exhibits the largest runoff volumes and, therefore, the highest levels of sediment discharge.

Most of the pollution of fresh waters, coastal waters and oceans originates from land-based activities, reaching the ocean directly, via rivers, or through atmospheric deposition. Nutrients, specifically high concentrations of nitrogen and phosphorus can significantly degrade both fresh and saline water resources. Eutrophication has been linked to the formation of 'dead zones' in all water systems. One of the largest known 'dead zones' is found along the USA shoreline of the Gulf of Mexico, which receives large volumes of nutrients from agriculture through the Mississippi River system10. In the North Sea, nitrate levels risen four-fold, and phosphate inputs eight-fold, since the 1970s. Northern Europe and North America had lowered the phosphate concentrations in their surface waters, while some watersheds in South Central Asia have experienced increased phosphorus concentrations. The Black Sea is experiencing a shortage of freshwater, which is exacerbated by increased salinity and pollution from land based activities, which are contributing industrial and municipal wastes, oil spills, nutrients. Over the last 30 years this has resulted in a devastated fishing industry, eutrophication of seas, streams and lakes with a resulting decrease in agriculture, tourism, recreation and increased unemployment. [7]

Unsurprisingly, the coastal areas with the greatest population densities are also those with the most shoreline water degradation. The areas surrounding the Black Sea, the Mediterranean and Southern Asia have the highest proportion of altered land, while the coastal zones of the Arctic, Northeast Pacific, South Pacific, West and Central Africa, East Africa, the Red Sea/Gulf of Aden, and Kuwait have the least modified land. Along the coasts of the USA, the northeast and Gulf coasts, 40% of the estuarine areas are in poor condition, while in the southeast and the west only 23% are in poor condition. The impacts on these regions result from rapid population growth in coastal areas, agriculture, surface mining, storm-water runoff, landfills and hazardous waste sites. These activities contribute pollutants such as toxic chemicals, pathogens, nutrients, sediment, raw sewage, oil spills and stimulate harmful algae growth. [8]
As stated earlier, either through deliberate misuse or the need to sustain one’s existence, our soil resources have been and continue to be degraded and lost. This degradation comes from all sectors of society; agriculture, industry, military, and urban uses. Degradation may be the loss of top soil due to either wind or water erosion followed by the loss of productivity as a result of decreased fertility, water infiltration and water holding capacity. Severe degradation of soil quality may result from the use of pesticides, which often decrease the flora and fauna of the soil and decrease other vital attributes of quality soils. Desertification, salinization, and overuse and misuse are also problems. Disposal or leakage of chemicals, petroleum products and munitions convert soils into “brown fields” unsafe or unsuitable for agriculture or any other use unless they undergo expensive remediation.

In the Midwest and Great Plains states of the USA, soil erosion has significantly damaged thousands of acres because of the tillage practices used. However, with the advent of no-tillage and other residue conserving farming practices, this degradation is being stemmed. The Himalayas are experiencing rapid deforestation and associated soil erosion. China’s massive loss of soil to water erosion is the highest erosion in the world. In Central and Eastern Europe, farming practices used during the Soviet-era has caused severe compaction of the top soil causing problems with water infiltration and nutrient availability. As in the USA, Western Europe has seen large quantities of prime farmland sacrificed to urban development and highway networks. The Amazon and Sub-Saharan Africa both are experiencing significant losses of soil fertility. The poor soils of the Amazon lose fertility from slash and burn agriculture, which encourages rapid water erosion. The soils of the Sub-Saharan region are being degraded because of intensive use of the soils, and the complete use vegetation and dung which are unavailable to rejuvenate the organic matter and fertility status of the soils. We see widespread petroleum pollution in many areas, but none more prominent than Iraq as a result of the past and current military events. Desertification continues in Africa, and is growing in China, Uzbekistan and Kazakhstan. Salinization is seen in Australia, Iraq and Russia. [9]

If the world is to sustain the productivity of its soils to produce the food, fiber and feed needs of the future, degradation of the soil base must be terminated and rebuilding of quality soils begun. Agricultural practices must be utilized which conserve and protect our remaining productive soil base from loss or misuse. Proven and innovative methods must be used to reclaim the quality of the soil resources, which have been degraded. This requires the building of quality soils by increasing the organic matter of the soil, which in itself will help reclaim soil structure, infiltration, water-holding capacity, soil flora and fauna and a suitable root zone. Soil fertility must be raised or maintained through the appropriate use of legumes, crop residues and natural and/or commercial fertilizers. Only through a concerted effort will the soil resource be conserved, reclaimed and remain as a resource to feed the world’s population.
Reflection upon the Earth’s water and soil resources shows that these resources are intricately linked. While the hydrosphere is very dynamic, the pedosphere is much less so. However, as degradation of soil due to erosion and the associated losses of organic matter, nutrients and chemicals occur a corresponding increase of pollution in the Earth’s waters due to sediment, nutrients and toxics also occurs. Thus to avert this degradation of the Earth’s soil and water resources, the people of the world must not look upon these resources as “the commons”, but all must accept their responsibility to conserve and use their soil and water resources wisely.

REFERENCES

2. Faulkner, E., Ploughman’s Folly, 1947