The phenomenon of soil erosion

Environment, Earth

‘ The nation that destroys its soil destroys itself’- Franklin D. Roosevelt

This essay will analyze the phenomenon called soil erosion which is one of the more devastating factors that contribute to soil degradation. It will discuss how deforestation and the use of agricultural methods are prime causes of accelerated erosion. Soil erosion has many effects on the soil and other aspects of the environment. The essay will also examine the on-site effects that erosion has on the soil and establish the different methods that have been used to prevent and protect the soil. Soil degradation is the long term decline of the soil’s productivity and its environment moderating capacity. It is the decline in soil quality and the decrease of quality traits of the soil in relation to specific functions of value to human (Lal, R. 2001: 519). Soil degradation is not something new as it has been around since the emergence of settled agriculture. In ancient times soil degradation caused the downfall of several prosperous ancient civilizations. In the Indus Valley the Harrappan and Kalibangan cultures are civilizations that were wiped out by soil degradation. In the Mediterranean region, the Mesipatamian and Lyndian Kingdoms were also affected by soil degradation (Lal, R. 2001: 519).

Due to the extreme increase in population, soil degradation has become a dangerous phenomenon for living organism of the 20th century as there has been large amounts soil that has been destroyed in a short time period (Lal, R. 2001: 519). Soil erosion is the most dangerous factor that contributes to the soil degradation. Soil erosion is a natural geomorphologic process that occurs on the land surface of Earth. (Middleton, 2013: 319). Soil erosion takes place in the form of wind and water erosion. However human activity has accelerated erosion by creating a platform where wind and water erosion

can have a massive impact on the fertile soil on Earth. Soil erosion have many variations which are both natural and societal, however all these factors contribute to the occurrence of erosion and the rate at which it progresses. Soil is predominantly eroded by the forces of water or wind acting on the soil surface, and on steep slopes by mass movement. However there are other factors such as animals and humans that contribute and accelerate soil erosion (Middleton, 2013: 320).

Water erosion is the most common type of erosion. It is generally known as surface wash or sheet erosion. Water erosion occurs both by the action of raindrops, which remove soil particles on impact and move them by splashing and run off, which transports material either in sheet flow or in concentrated flows which form rills or gullies. (Middleton, 2013: 320). Wind erosion moves soil particles by one of three processes depending on the size and mass of the particles. The largest particles move along the surface by the process of surface creep; sand-sized particles usually bounce along within a few metres of the surface in a turbulent flow of air by saltation; and finer dust particles are transported high above the surface in suspension. Mass movement may also occur in slopes, principally by land sliding and various forms of flow. This depends on the amount of moisture in soil profile. (Middleton, 2013: 320).

It is important to note that both water and wind erosion cannot function on their own, for soil erosion to take place, all the factors that contribute to erosion need to be considered. Middleton groups these factors into two groups, erosivity factors and erodibility factors. Erosivity factors have to do

with rainfall factors and runoff factors while the erodibility factors have to do with soil factors, such as vegetation, topography and land use. When and where soil occurs is determined by the mutual interaction of the erosivity of the eroding agent and the erodibility of the soil surface. These variables of erosivity and erodibility change through time and space, at changing rates and different scales, so that the relationship between the variables is in a constant state of instability. (Middleton, 2013: 321).

As discussed above, soil erosion is a natural geomorphological process and the scale of human impact on global erosion systems is so influential that human society is now considered to be more effective at moving sediment than the sum of all other natural processes operating on the surface of the planet. (Middleton, 2013: 324). There is widespread agreement that the prime causes of accelerated soil erosion are deforestation and agricultural practices. Deforestation is the clearing of the land and forests to estalish large scale commercial forestry, road construction and urbanization (Olderman, 1992: 24). Deforestation removes the protection from raindrop impact offered to soil by the tree canopy, and reduces the high permeability humus cover of forest floors, a permeability that is enhanced by the many macro pores produced by tree roots (Middleton, 2013: 328).

Wind and water erosion have many effect on the environment. These effects can be described as on-site effects and off-site effects. The on-site effects deal with the damage that has been caused on the soil by soil erosion. Loss of topsoil through water erosion is the most common type of soil degradation. This occurs in almost every country, under a great variety of

climate and physical conditions and land use. The topsoil is normally rich in nutrients therefore a reasonable large amount of nutrients is lost together with the topsoil. This process may further lead to an impoverishment of the soil (Middleton, 2013: 325). Loss of topsoil itself is often preceded by compaction or crusting. Compaction and crusting will make tillage more costly, impede or delay seedling emergence, and lead to a decrease in water infiltration capacity, causing in its turn a higher surface run-off, which may lead to significant water erosion both of which may hinder germination and the establishment of seedlings, whole exposure of hardpans and duricrusts presents a barrier to root penetration (Middleton, 2013: 325).

The most common outcomes of this are rill and gully formation. A rill is a small channel engraved on the surface of a land which looks like a water stream. A gully is a relatively deep, vertical channel recently formed within a valley where no distinct channel existed before. The establishment of a gully is a highly developed stage of rill erosion where surface channels have been eroded to the point where they cannot be smoothened over by normal tillage operations (Abdulfatai et al, 2014: 125). The eating away of valuable soil is well known and dramatic in many countries due to the fast opening of gullies. However it is still difficult to have control of active gullies and total recovery of topsoil is almost unattainable. Other effects that water erosion may cause are riverbank destruction and mass movements also known as landslides (Olderman et al, 1991: 12).

These are extremely dangerous especially when human activity is nearby. The sliding of rocks at the Champions Peak is an example of how dangerous

landslides can be. Terrain deformation by wind erosion is less widespread than loss of top soil. It is defined as the uneven displacement of soil material by wind action and leads to deflations hallows and dunes. Terrain deformation by wind erosion can be considered as an intense form of loss of topsoil and it usually occurs in combination (Olderman et al, 1991: 12). Deposition of soil within a field may also result in the demise of plants and seedling and due to the loss of soil, roots may be exposed. Sand blasting by wind eroded material can both damage plants and break down soil clods, resulting in the impoverishing of soil structure and rendering soil more erodible (Olderman et al, 1991: 12).

Soil erosion also has a long term effect in the soil productivity. The top layer of the soil profile, the A horizon, is where most biological activity takes place and where most organic material is located. Hence depletion of the A horizon preferentially removes organic material, soil nutrients, including fertilizers and even seeds, and can reduce the capacity of the soil for holding water and nutrients (Middleton, 2013: 328). Since soil is such a vital natural resource, using it sustainably involves employing methods to reduce accelerated erosion. One of the many methods used to conserve soil is maintaining a sufficient vegetative cover on a soil. This is sometimes referred to as the ‘ cardian rule’ for erosion control. One of the oldest of agronomic measures designed to reduce soil erosion is to rotate the location of crops by shifting cultivation, in which an area of forest is cleared and cultivated for a year or two and then allowed to revert to scrub or secondary forest. An essentially similar method involves rotating crops grown in rows

with cover crops such as grasses or legumes grown on the same field every other year. (Middleton, 2013: 334).

Mulching is the practice of assembling some lingering crop material, such as leaves, stalks and roots, on or near the surface of the soil. It is successful in reducing erosion and in reducing the loss of water from fields by decreasing evaporation. The mulch is not only an effective method for soil and water conservation; the lingering crop material helps fertilize the soil by decomposition and attracts termites that burrow into the soil, breaking up the crust and increasing soil porosity ad permeability (Middleton, 2013: 334). Most soil management techniques are concerned with different methods of soil tillage, an essential management technique that provides a suitable seed bed for plant growth and helps to control weeds. However, different types of soil respond in different ways to tillage operations and a range of methods has been developed to reduce erosion effects. Strip or zone tillage leaves protective strips of untilled land between seed rows, requiring weed control on the protective strips (Middleton, 2013: 335)

There are other ways were soil conservation plans can be made. Mechanical methods, which are normally used in conjunction with agronomic measures, include such techniques as the building of terraces and the creation of protective barriers against wind, such as windbreaks.(Middleton, 2013: 335). Terracing is a very ancient soil conservation technique, dating back up to 5000 years in Yemen. They are commonly built on steep slopes and effectively transform them by creating a series of horizontal soil strips along the slope contours. The function of terraces is to intercept runoff and

diminish its flow to a non-erosive velocity. Terraces also function to conserve water. If well maintained, terraces are very effective but they are costly to construct and their physical dimensions act as a restriction on the use of mechanized agriculture (Middleton, 2013: 335).

There are other methods used to play the same role as terraces. In some environments, check dams are constructed in a similar way to control gully erosion. The dam obstructs the flow of water generated by rainfall, causing the downfall of sediment, which helps to build up soil and encourages the stagnated water to soak into the alluvial fill of soil. A small check dam might then support a single fruit tree, for example. Larger dams may allow a cereal crop to be planted in a small field. (Middleton, 2013: 335)

Windbreaks perform the same sort of function against wind erosion. They reduce wind velocity by lowering its erodibility and encourage the deposition of material that is already entrained. Fence or walls placed at right angles to erosive winds serve this purpose. However windbreaks may also be formed from living plants such as trees or bushes in which case they are known as shelter belts. In some farms you will notice tall trees that are built next to crops acting as a guard against strong wind velocity. There are abundant benefits to crops that are associated with the establishment of windbreak. These include increased soil and air temperatures, reduced pest and disease problems, and an extended growing season in sheltered areas and windbreaks built with living plants can produce lingering materials that can be used for mulching. (Middleton, 2013: 335)