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Soil Degradation Status in China

Muhammad Wajid, Yannong Xiao

Department of plant pathology, College of Plant Sciences, Huazhong Agricultural University, 430070 P.R. China

*Corresponding Author's Email Address: hafizwajid.agri@gmail.com

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ABSTRACT

Soil degradation can be described as either erosion or salinization, depending on the type of soil and the degree of depletion of organic matter in the soil. A fundamental understanding of soil degradation is that its expressions are as diverse as its causes. China has an area of arable land that is more than 40% degraded, which represents a major problem. There are a number of direct and indirect consequences of soil degradation in China that are reviewed in this paper. As a consequence of soil degradation, nutrient content in soil is lost, salinity increases, acidification increases, and desertification occurs. The importance of soil resources will only increase in the future as the world's population increases to around eight billion. By 2020, the global population will be one-third higher than in 1995, yet food and fiber demand will increase by even greater proportions than in 1995, despite growing incomes, a more diverse diet, and rapid urbanization. As a result of the loss of soil layers that contain organic matter and nutrients, there will be a reduction in the amount of land that can be used for agriculture and a decrease in the amount of land that will produce crops, since the soil will be less fertile and less capable of retaining moisture. In China, the amount of arable land that has been degraded exceeds 40%. As a result of soil degradation, several negative impacts are observed and measured, such as soil nutrient loss, salinization, acidification, and desertification, among others.

Keywords: : Degradation, nutrient, population, eight billion, urbanization, arable land, China.

INTRODUCTION: Soil is essential to life on Earth. The future we want depends on sustainable development. The soil significantly impacts climate regulation in addition to food and water security (McBratney *et al*., 2014). This paper aims to examine the state of the soil, the services it provides, and threats that threaten it from fulfilling these roles. An assessment of several threats to soil function is provided in the paper, including erosion, compaction, acidification, contamination, sealing, salinization, waterlogging, and nutrient imbalance (deficiency or excess of nutrients) (Montanarella *et al*., 2016).

As incomes rise, diets diversify, and urbanization accelerates, the demand for food and fiber will increase even more. Population growth and agriculture will put great pressure on land resources if this demand is met. There has already been a significant impact on food production in the developing world due to long-term declines in soil productivity (Gomiero, 2016). Approximately 8.7 billion hectares of land are used by humans worldwide. Even though there are over 3.2 billion hectares of arable land available, less than half of them are farmed. There are about 1.7 billion hectares of potentially arable land and most of the nonarable land is used for pasture, forests, and woodlands. According to recent studies conducted globally, soil quality has remained relatively stable on three-quarters of agricultural land for more than a century. Although the pace of degradation has increased over the last 50 years, the problem is widespread. In developing countries, productivity has declined on about 16 percent of cropland and pasture, and in forests and forests in Central America, especially in Africa. It has been estimated that 20 percent of agricultural land in Africa is seriously degraded, as well as a large percentage of agricultural land in Central America. Approximately 20 percent of the area of agricultural land in Africa and 11 percent of the area of agricultural land in Asia has been severely degraded, according to estimates (Scherr, 1999).

China's agriculture sector is one of its most important economic sectors. Its agricultural sector contributed 7.9% to the Gross Domestic Product in 2017, involving 35% of its labor force. The Chinese agricultural sector is one of the most productive in the world. The amount of agricultural land per capita in China has remained stable at 0.21 hectares per person since the 1980s, about half the amount worldwide (Fukase and Martin, 2014). China produces 20 % of the world's cereals and feeds 18% of its population by cultivating 13.4% of the world's land. The cost of such high productivity is, however, high. Due to the extensive use of fertilizers, this increase has only been possible. There are more than four times as many kilograms of nitrogen fertilizer applied per hectare in China as there are in the rest of the world. There has been a degradation of soil as a result of this. There are more than 40% of China's land area has been affected by erosion, which is one of the biggest problems in the world when it comes to soil degradation. Most of the erosion occurs in the mountainous regions of central China (Rao *et al*., 2015). It is important to note that soil degradation has a number of consequences. The degradation of the soil causes a lesser amount of land to be usable for agriculture and a decrease in land productivity as a result of the decrease in soil fertility and moisture-holding capacity. This is due to the loss of the organic matter and nutrients found in the surface soil layers. Furthermore, soil salinization, acidification, and desertification are direct consequences (Rao *et al*., 2015). People's livelihoods, the environment, and land productivity are all negatively affected by land degradation. A land degradation event is estimated to cost CNY 540 billion each year in direct economic costs and CNY 200 billion in indirect costs which in some cases can exceed 100 times the direct costs. The purpose of this essay is to explore the consequences and solutions of soil degradation.

OBJECTIVES: The objectives of this study were as follows: (1) To identify the soil degradation status. (2) To identify the causes of soil degradation. (3) To identify the impacts of soil degradation.

Soil erosion: In general, soil erosion occurs when wind, water, or tillage rapidly removes topsoil from the surface. A major cause of water erosion on agricultural land is when runoff or drop impact entrains soil particles, causing clearly defined channels called rills or gullies. Dry, loose, bare soil can be eroded by the wind when it is exposed to strong winds. By creeping along the ground or saltating (bouncing) across the surface, larger particles are deposited near the field boundary during wind erosion events. It is only when tillage implements move soil particles directly downslope that soil particles are redistributed within fields. Erosive processes are primarily responsible for soil degradation. An erosion process removes the layer of soil that is most nutrient-dense and organic matter-dense (Oldeman, 1997). Therefore, soil fertility, structure, and water retention can all be compromised. The rate at which soil erosion occurs is often unsustainable, and its impact is global. According to the European Commission (Hickey, 2000) soil erosion rates on tilled, arable lands are usually 3-40 times higher than the annual upper limit of 1.4 tons/ha. There is 70% of degraded farmland in Sub-Saharan Africa because of erosion. It appears that the U.S. loses soil ten times faster than it regenerates, whereas China and India lose soil 30-40 times faster, according to a meta-analysis by Pimentel (Verheijen *et al*., 2009).

Soil degradation is not a theoretical problem, according to the Food and Agriculture Organization. During (Giller *et al*., 2011) study, he observed that degraded soils in Zimbabwe had a lower response to fertilizers as they had deficiencies of calcium, zinc, nickel, and potassium. From 2006 to 2015. (Diao and Sarpong, 2007) estimates that land degradation in Ghana will result in a loss of approximately $4.2 billion in agricultural income as a result of soil erosion, as a result of land degradation. Erosion has contributed to the deterioration of yields in India, China, Iran, Israel, Jordan, Lebanon, and Pakistan by a factor of 20%. It is estimated that the cost of lost production due to salinity in the world amounts to $11 billion per year. Last but not least. (Pimentel, 2006) found that soil erosion is responsible for $37.6 billion in productivity losses each year in the United States, and the total worldwide is likely to be close to $400 billion.

Soil salinization: The concentration of soluble salts in saline soil is high enough to influence plant growth. A problem arises when sodium accumulates in the root zone and causes salinity, which interferes with plant growth. Plant growth is further affected by excessive salt in transpiration streams, which damage the root cells and prevent them from absorbing water from the ground. Salt specificity or ion excess is known as this phenomenon (Li *et al*., 2016). Different factors can contribute to soil salinization. There are several reasons why soils are salinized, including physical and chemical weathering as well as transport from groundwater, geological deposits, or parent material. Furthermore, salts can accumulate if the soil is submerged in seawater for a short period of time, or if underlying minerals, such as carbonate minerals and/or feldspars, are present (Salama *et al*., 1999). A coastal zone may also accumulate salts due to wind and air. Rainwater can carry salt to the ground after north-westerly winds carry it over long distances. Inland winds can also carry salt in the form of spindrift. Global warming is also responsible for soil salinization. The warming and drier climate in north and northeast China are contributing to soil salinization. The most common conditions for salinized land are a high groundwater table and a high evaporation rate. Evaporation and insufficient rainfall can lead to saline soils during arid periods. As a result of waterlogging, salt can also become dissolved and transported to the surface of a semi-arid region when rain falls. Following the evaporation of water, salt remains on the surface (Mao *et al*., 2002).

In addition to containing salts, irrigation water also evaporates leaving behind salts in the soil (river or groundwater). Additionally, paddy rice fields irrigated by continuous flooding suffer secondary salinization due to impeded drainage. One million hectares of Xinjiang's oasis basin are salinized, which represents 33.4% of the region's total agricultural land. Research indicates that salinity is increasing in the region. Approximately one-third of China's arable lands are salinized. The growth of crops in farmlands can be severely affected by soil salt ions exceeding 8 grams per kilogram (Zhaoyong *et al*., 2014).

Soil acidification: The pH of the soil is an important indicator of plant growth. In general, crops thrive in soils that are slightly acidic (pH value lower than 7) or neutral (pH value 7). It is possible for plant growth to be slowed down by diseases and pests when the pH of the soil decreases. Water nearby can also be polluted by toxic metals when conditions are highly acidic. Additionally, soil acidification increases the accumulation of heavy metals in food crops (Hvistendahl, 2010). A national soil survey conducted in the early 1980s determined the pH values of top soils. There was a significant change in soil acidity between 1980 and 2000. Compared to other agricultural systems, both cropping systems have received high fertilizer inputs since the 1980s, especially cash crops like greenhouse vegetables.

There has been a greater drop in pH in cash crops (0.3 to 0.8) than in cereals (0.13) in all other soil groups. The pH value of some soils growing high-input cash crops dropped by 0.8 over two decades, reaching a pH value of 5.07 in some places. The process of acidification takes at least 100 years when soil is left under natural conditions. Some areas have already experienced a 30-50% decrease in crop production due to acidification (Gilbert, 2010). Based on the results of (Hou *et al*., 2012)'s study in Foshan, 90% of the soil samples had a pH of 4.5, and only 8% had a pH between 4.5 and 5.5. Between 1979 and 1984, 80% of soil samples had a pH between 4.5 and 5.5 (figure 1).

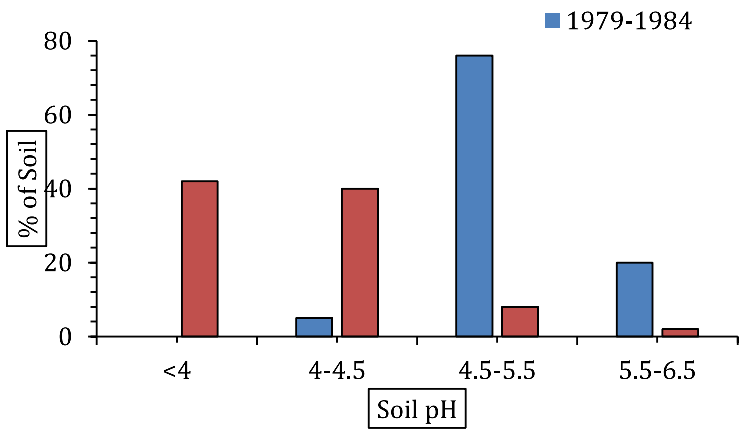

Figure 1: A comparison of the pH of natural soils in Foshan (Guangdong Province) between 1977-1984 and 2008-2009.

Desertification: China's ecological development is threatened most by land desertification, according to the deputy head of the State Forestry Administration, Yongli Zhang. A total of 261 million acres of Chinese soil have been converted to deserts in the past few decades, according to Zhang. The country's mainland is covered by 528 counties spread across 18 provinces, autonomous regions, and municipalities, occupying approximately 27.2% of its land mass (Delang, 2017). In addition to the natural factors that contribute to desertification, there are also man-made factors that play a role in it. Desertification in China has been caused by a number of natural factors, including wind erosion, water erosion, and freeze-thaw erosion. In total, 183.2 million hectares have been desertified, 25.52 million hectares have been desertified, and 36.35 million hectares have been desertified (Figure 2). The provinces of Xinjiang, Inner Mongolia, Tibet, Gansu, and Qinghai represent a substantial portion of China's certified lands, with 80% of its certified lands located in those provinces.

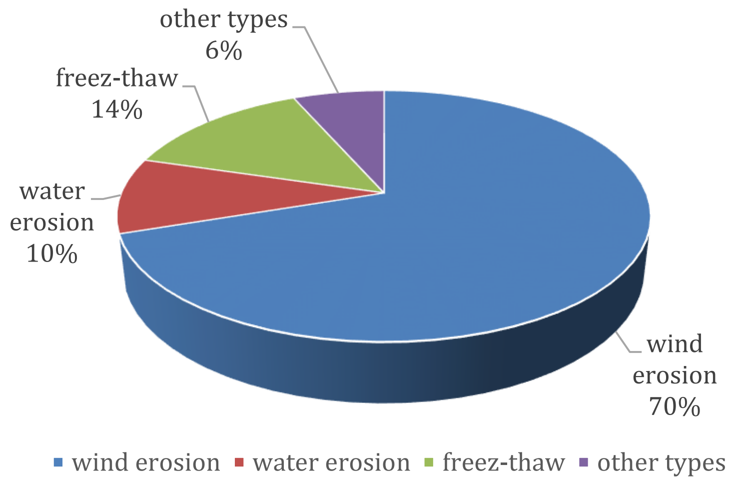

Figure 2: Different types of desertification and their distribution.

Dust and sandstorms: Overgrazing by livestock, excessive farming, excessive water usage, and climate change have all contributed to the degrading or desertification of more than a quarter of China's land area. Among the country's top ecological concerns is desertification, according to the State Forestry Administration. Because of climate change, this problem will only worsen (Delang, 2017). There are two main areas in China where dust events occur. Along with the Gobi Desert, wadis, and alluvial fans, the Hexi Corridor and Inner Mongolia Plateau also face climate change. It is estimated that the Gobi Desert destroys 360,000 hectares of fertile grassland in China and Mongolia every year. China's north-eastern region is the second largest source of dust, after the Taklimakan Desert and the Inner Mongolia Plateau. It is common for Inner Mongolia to experience sandstorms during the spring, especially during the month of April. They have far-reaching consequences despite their impacts on the dry land. Dust and sandstorm hit 72 counties and four provinces on 5 May 1993, affecting 12 million people. Approximately 40 million hectares were affected, resulting in 100 deaths and thousands of livestock losses (Liu and Diamond, 2005). Furthermore, damage to the ground vegetation has deteriorated the environment along with the continuous drought in winter and spring. In addition to damaging the environment, dust storms have a negative impact on health. The effects of SO2 and/or NO2 exposure have been shown to significantly increase respiratory and cardiovascular hospitalizations following dust events (Pan and Liu, 2011).

Floods and landslides: A total of 7.3 million hectares of farmland are irrigated by the Yellow River, also known as Huang He in China. The Yellow River basin is home to more than 400 million people, who are dependent upon the river for their sustenance. Throughout most of its course, the Yellow River moves slowly and sluggishly. As well as being one of the wildest and most destructive rivers in the world, it is also one of the most beautiful. Thousands of floods have killed millions of people since the river's course changed 26 times during the period of 602 B.C. These disasters are the result of soil erosion generating large amounts of silt. Sediment discharged by the Yellow River is three times greater than that of the Mississippi River. Some people consider it the world's muddiest river. There are 1.5 billion tons of sediment washing into the Yellow River every year, causing the water to appear chocolate milky in colour. Sediments, most of which are carried downstream to the Yellow Sea, are deposited in river beds, raising the river's level (Liu *et al*., 2014). In addition to intensifying peak river flows, the water running off hills also erodes riverbanks, which increases the risk of natural landslides. Additionally, farmers are unable to utilize soil on the land as more soil is washed into the river. Rainfall and earthquakes are the main causes of landslides. Among the many reasons for the high

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number of landslides in China are tree cutting, farming, and construction activities that cause the instability of mountain slopes (Huang and Li, 2011).

Accumulation of silt in dams: Over half of the world's large reservoirs have been built by the Chinese since 1950. They are used primarily for hydroelectric power production. A dam serves as a barrier between rivers and reservoirs. Silt in rivers settles behind dams when it reaches a reservoir. Silt accumulation is directly related to the amount of sediment carried by a river. The dam gradually loses its ability to store water and to generate electricity as sediment builds up at the bottom of the reservoir (Gao *et al*., 2018). Through the construction of the Three Gorges Dam, it was designed specifically to control sedimentation along the Yangtze River in China. The sediment backlog should be eliminated over a period of 100-150 years by properly scheduling discharges under a carefully planned discharge program. The dam still blocks two-thirds of the sediments coming behind it each year, according to a report published in 2013. Upstream in Chongqing, engineers believe that sedimentation in the Yangtze River could start causing problems by the 2020s due to sedimentation in the Yangtze River. The sediment accumulation in Chongqing could lead to flooding and shipping problems much earlier, according to geologist Fan Xiao from Sichuan Province (Wang and Shen, 2014). It is possible to increase the efficiency of dams by flushing out the silt. One of the dams featuring these types of facilities is the Xiao langdi Dam in China, which is the second biggest behind the Three Gorges Dam. Floods are controlled, silt is reduced, electricity is produced, and irrigation is facilitated with the dam. In addition to storing silt, the earthen dam prevents the Yellow River from rising by dumping 1.6 billion tons of silt into it annually. During the rainy season, the reservoir acts as a flood buffer by holding water. Irrigation is done with water during the dry season. Furthermore, three specialized holes are used to flush out the accumulated silt during the dry season. Silt from the dam's reservoir is released every year in the amount of 30 million tons. By using this method, river beds in the lower reaches of a river are typically lowered by 2 meters. There is only enough water to be stored until 2020 in the reservoir of the Xiao langdi Dam. Once that point has been reached, the reservoir can no longer be flushed out with water, causing the river levels to rise once again (Delang, 2017).

CONCLUSION: salinification, and desertification, which cause nutrients to be lost and crop yields to be reduced significantly due to soil degradation. Deserts and mountainous regions in the north and west are affected by soil degradation, which increases floods and landslides as well as lowers agricultural and livestock income. Moreover, food prices may increase beyond socially acceptable levels if grain and livestock output is reduced. As far as extent, intensity, socioeconomic impact, and number of affected people are concerned, China has the most severe land degradation problems. The Chinese agricultural sector is critical to the country's economy and the livelihoods of its citizens despite having only 7.2% of the world's cultivated land. The rapid growth and urbanization of the country have resulted in 5.392 million km2 of land becoming degraded as a result of excessive human activity and natural factors. Only 14 percent of China's total land area is suitable for agriculture, with only 1.3 million square kilometers of suitable land. A large proportion of the total cultivated land is degraded, thereby reducing the economic benefits of agricultural production and food security. Degradation of cultivated land will also reduce the potential land productivity, resulting in more inputs such as fertilizer and irrigation water, thereby increasing production costs. The conversion of land also leads to structural changes in land use and succession patterns, which will affect the quality and suitability of the land. In order to ensure the long-term sustainability of the agricultural economy, sustainable land management measures are necessary. It is most common for the north and west of the country to have arid climates, with mountainous areas experiencing soil degradation, especially in the north. Additionally, it is also responsible for causing dust storms, floods, and dam silt to accumulate across the nation as well.

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