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Review Article

Soil Pollution: The Hidden Threat to Food Security in Iran

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2. Keywords

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1. Abstract

Achieving global food security through the production of sufficient food materials for the growing world population needs the soil quality to be enhanced or at least, maintained at the presence level. Soil pollution is one of the most important soil degradation pathways that indirectly reduce the food safety and food security. Source identification of the soil pollutants may provide useful information to stop their transferring to human food chain. This paper discusses the effects of human activities on the concentration of hazardous pollutants in the soils and plants in different regions of Iran.

3. Introduction

The world population is estimated to reach to 9 billion by 2050 and feeding this population will be the greatest global challenge in next decades [1]. At least, a 60% increase in global food production is needed to meet the demanded food materials by all world population [2]. According to [3], "food security exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food, which meets their dietary needs and food preferences for an active and healthy life". Food security has four dimensions: (1) food production and availability through agronomic management of soil resources; (2) stability of food production and availability at all times; (3) food access through economic and physical capacity of households or communities; and, (4) food safety and utilization through nutritious and biological quality [4]. Food insecurity occurs when there is insufficiency in any of the aforementioned components.

As the basic component of food security, food production through agronomic management of soil resources is becoming a crucial issue among the land managers. Soil is considered as a fundamental production factor that directly or indirectly produces about 95% of global agricultural products [5]. Therefore, maintaining soil quality is a prerequisite to achieve to the sustainable production of food materials at the present level. At the next step, the before-mentioned necessary increase in food production must be obtained by agricultural intensification of cropland already under cultivation or finding new lands suitable for crop farming [6].

3.1. Current status of soil resowurces in Iran

Iran is located in the Northern Hemisphere, between 25° and 40° N and 44° to 63° E. and covers a total area of about 1648000 square kilometer. Iran is a mostly arid or semi-arid country, with a subtropical climate along the Caspian coast. The average annual precipitation is 252 mm (one-third of the world's average precipitation), and this is under conditions in which 179 mm or 71 percent of rainfall is directly evaporated. Due to the arid climate and topographical conditions, most of the soils in Iran are less-developed soils, mainly classified as Aridisols and Entisols. Rangeland and forest covers about 84 and 12.5 million hectares of the lands in Iran and just less than 10 percent of the total area of the country is occupied by dry or irrigated farming [7]. **Table 1** shows the main farming systems in Iran.

Table 1: Main farming systems in Iran (Emadodin et al. [17]).

Farming system	Area (million hectares)	% of total arable land	Production (million tons)
Irrigated	6.2	41.34	56.1
Rainfed	6.2	41.36	8.4
Horticulture	2.6	17.3	13.4
Total	15	100	77.8

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3.2. Declining food security by soil degradation

Soil degradation is defined as the measurable loss or reduction of the current or potential capability of soils to produce plant materials of desired quantity and quality [8]. Therefore, soil degradation may be caused by different physical, chemical or biological process through natural or human-made events. Main soil degradation processes and their potential threats to food security are depicted in **Figure 1**.

Figure 1: Main soil degradation processes and their potential threats to food security.

Among the mentioned processes of soil degradation, the physical types are the most known processes which have been studied many times. Water erosion has been reported as the main driver of soil degradation [9]. This is due to the fact that the consequences of soil physical degradation directly affect the net yield and also can be easily seen by field observations. On the contrary, there is no field evidence as the result of most of soil chemical degradation processes. For example, many crops may have a good yield at the severely polluted soils; whereas they transfer the dangerous pollutants from the soil to human food chain.

3.3. Soil degradation by pollutants

Soil pollution is the accumulation of a substance, native or introduced, in soil at a level harmful for the growth and health of organisms, including microorganisms, plants, and animals [10].Rock weathering is the most important natural source of pollutants; whereas a wide range of human activities, including industrial, agricultural and urban activities, may result in soil pollution [11]. Excessive accumulation of different organic or mineral pollutants in the soil may lead to a significant decline in soil quality and finally decrease the quality and quantity of the crops grown on these soils [12]. Moreover, taking the pollutants up by natural or cultivated plants may facilitate their transferring through the human food chain [13]. However, identification the vital role of the soil in this scenario seems to be necessary to maintain the quality of final food products in order to achieve to food safety and food security.

Heavy metals are the most dangerous, non-degradable pollutants which may enter into the soil by the natural processes, like rock weathering and more commonly, by a vast range of human activities, such as industrial and agricultural practices [10]. Their transferring from the polluted soils to the edible parts of grown crops may provide them a big chance to enter into the human body, where their elevated concentrations may even result in some deadly diseases [11]. It is obvious that at this rate, food safety in target society is significantly declined by the existence of these harmful agents in food materials.

3.4. Industrial activities

Commensurate with the rapid growth of industry and technological development, accumulation of different organic or inorganic pollutants in fertile layers of the soil is becoming a crucial environmental challenge in Iran. Metal processing factories are responsible for the accumulation of pollutants, specifically heavy metals, in the soil and agricultural crops thorough the different regions of the country [14,15] . Found that cadmium (Cd) concentration in wheat grains of 19 sampled plants from the total of 65 analysed plants, grown on the polluted soils around a zinc processing factory in northwest Iran, was higher than the maximum permissible concentration of 0.2 mg kg^{-1} proposed by FAO/WHO [16]. **Figure 2** shows that wheat crop is cultivated in polluted soils near the tailing dump of Zanjan Zinc Town, northwest Iran. It should be noted that wheat crop is the most important cereal in Iran, including 35 % of the food grain production [17].

Figure 2: A Rainfed wheat field located on the polluted soils just behind the tailing dump of Zanjan Zinc Town, northwest Iran.

It has been reported that elevated concentration of zinc (Zn), lead (Pb), Cd and copper in agricultural soils of Isfahan industrial region, Central Iran, may be originated from the non-metallic, textile, chemical, food, electronic and pharmaceutical plants [18,19]. Reported that the concentration of Cd, Pb, and Arsenic (As) in some parts of cultivated wheat (*Triticumaestivum L.*), corn (*Zea Maize*), and tomato (*Solanum lycopersicum*) in the agricultural lands of an industrial area, Razavi Khorasan province, Northeast Iran, were above the international standards. Mining activities is considered as another important source of heavy metals in Iranian soils [20,21].

3.5. Urban activities

The rapid and discordant urban development over the last several decades in Iran has been reported as one of the most important threats to food safety and human health [18,22]. Found that the distribution of heavy metals, especially Pb, in urban soils of some cities in Isfahan Province in Central Iran, is controlled by traffic. It is also observed that polycyclic aromatic hydrocarbons (PAHs) levels in Isfahan urban soils are highly carcinogenic [23]. The spread of urbanization and industrial activities in recent decades in Mashhad City located in Northeast Iran, has been reported as the controlling factor of soil pollution by Pb and Zn [24,25]. Concluded that due to the industrial effluents sewage sludge, vehicular emissions, industrial waste and atmospheric deposition, the amounts of Pb, Cd and chromium (Cr)in some vegetables grown locally in the suburban of Isfahan city were higher than the acceptable levels recommended by WHO/FAO [16].

3.6. Agricultural practices

There is limited access to supplies of clean water for agricultural purposes in Iran due to the widespread water scarcity. Therefore, raw wastewater is directly used for irrigation in some regions of the country, resulting in some environmental problems. It has been reported that application of untreated wastewater in Shiraz area, Southwest Iran, resulted in significant increase of soil Pb and nickel (Ni) concentration and transferring the hazardous amounts of these pollutants to grown wheat crop [26]. Moreover, it was observed that grown vegetables (spinach and lettuce) in Shiraz area were polluted by Cd due to its high availability in topsoil causing a hazard quotient > 1[27]. Found that the concentration of Ni and Pb in soils of Tehran region, Central-North Iran, exceeded the toxicity limit due to the irrigation by municipal sewage [28] reported that the elevated heavy metals concentration (especially Pb) in grown wheat and rice crop in suburban soils of Isfahan region, Central Iran, may cause a serious health risk for the inhabitants.

4. Conclusion

Unlike the physical types of soil degradation, chemical soil degradation through the concentration of organic or inorganic pollutants in the fertile layers of agricultural soils generally has neither significant field evidence nor sensible decrease in final food production. Nevertheless, compared with other soil degradation types, soil pollution may lead to more deleterious effects on food security through the transferring of hazardous materials to human food chain. Fast-growing industrial activities in different regions of Iran, along with the uncontrolled agricultural practices and also the rapid and discordant urban development over the last several decades may be listed as the main human-induced scenarios of soil pollution in the country. Wheat crop, as the most important cereal in Iran, has a considerable ability to take the pollutants up from the soil and forward them to human body.

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