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Editorial

Soil Erosion Modeling and Monitoring

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Soil erosion is one of the most significant factors in the degradation of agricultural land, because it causes soil particles to be displaced, transported and deposited in different places through the actions of water or wind. Together with non-erosive degradations that include, among others, contamination or salinization, these processes deteriorate the quality of the soil. As a result, soil compaction can occur, as can a reduction in its organic matter content, drainage problems, the loss of soil structure, decreased crop yields, the loss of soil nutrients and, finally, the reduction of soil productivity.

Anthropic actions can cause changes in soils and have accelerated erosion rates and diverted nutrient flows. When the use of the soil changes, especially in conditions of great fragility, the region in question will often display a significant tendency toward erosion. Soil erosion, as a primary condition of desertification, has become a subject of public concern and intense research. The necessity for research along these lines is increasingly growing in order to advise on decision making and the design of environmental policies [1]. Thus, soil erosion modeling is becoming more important in the development and implementation of soil conservation and management policies. Inadequate agricultural practices, such as intensive tillage, the removal of vegetation, the excessive use of chemical fertilizers and pesticides or excessive grazing all cause increased rates of soil erosion, the rapid mineralization of organic matter, lower soil fertility, soil, higher CO2 emissions and the loss of biodiversity [2,3].

This Special Issue, titled "Soil Erosion Modeling and Monitoring", as published in *Agriculture*, encompasses contributions from various researchers from different countries, which I will cite in chronological order of publication. Firstly, a work by Egyptian and Spanish researchers is included, which is related to the modeling and evaluation of potential erosion hazards [4]. The authors propose a space-based model that integrates geographic information system (GIS) techniques with the universal soil loss equation (USLE) model and the index of land susceptibility to wind erosion (ILSWE). The evaluation of soil erosion, both water and wind, responds to very complex processes due to its multifactorial influences [5]. According to different authors [6], there are three types of soil erosion models based on the nature of the basic algorithms, namely models based on (i) the physical, (ii) the empirical and (iii) the conceptual. This paper aims to predict, evaluate and quantify erosive hazards with a statistically validated model, comparing its results with the results of the USLE and ILSWE models in promising areas of sustainable agriculture when proper management is applied.

The next work was carried out by Czech researchers, establishing the quality indicators of natural runoff water under culture conditions [7]. When it comes to intensive agriculture, it significantly affects the quality of surface and groundwater. Production practices used in agriculture can often lead to the leakage into water sources of many contaminants, including sediments, pathogens, pesticides and salts. During the runoff process, residues of nitrates, phosphorus and pesticides, as well as their metabolites, are filtered out [8,9]. Soil erosion is intensified by the use of large blocks of soil and monocultures, typical of Central European countries [10]. In the case of potatoes, as these authors indicate, it is

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convenient to cultivate varieties with dense vegetation and high sprouting. The specific mechanical methods for tilling crops have a significant influence on the volume of runoff and the contamination of the waters by nitrates. The researchers of this study recommend designing a new row cultivator as part of a weed control system strategy that allows for reduced herbicide application requirements.

Chinese researchers present new work using near-infrared spectroscopy for the rapid detection of available nitrogen in vermiculite substrates [11]. The rapid development of precision agriculture along with facility agriculture demands fast and accurate detection technology for crop control and management [12,13]. Vermiculite generates a substrate that provides the water and nutrients necessary for plant growth and effectively promotes crop root growth for stable seedling development [14]. It is used for rapid, short-term nitrogen fertilizer supplementation to promote crop growth and ensure yield [15–17]. It is important to be able to quickly detect the available nitrogen content in the substrates in order to avoid its excessive application and ensure a sufficient supply [18]. The authors achieve this through a self-assembled near-infrared spectrometer.

Next, a study carried out by Spanish and North American researchers is included, where the combination of sewage sludge amendments with cyanobacteria inoculation was studied to improve the stability and gain of carbon in soil [19]. The use of organic waste has become an important waste recycling measure in the European circular economy strategy [20] in order to improve or restore the quality of agricultural soil. Due to its high content of organic matter and macro and micronutrients, it is applied as a soil conditioner with the aim of improving and maintaining its quality and stimulating plant growth. The nitrogen contained in the residues is rapidly mineralized, making it available for absorption by plants, stimulating their growth. Sewage sludge also increases total carbon, improving soil aggregation and water holding capacity [21]. However, a wide range of contaminants can persist within it, which can be transferred to the food chain along with the risk of soil salinization [22]. To reduce environmental risks and nutrient losses, new techniques have been implemented with the idea of stabilizing contaminants, using natural or synthetic materials, in combination with the inoculation of microorganisms [23,24]. On the other hand, soil cyanobacteria can grow and survive at high temperatures and under prolonged exposure to drought and ultraviolet radiation. In addition, thanks to their capacity for photosynthesis, they are capable of fixing atmospheric CO_2 and N_2. On the other hand, they secrete exopolysaccharides that, in addition to increasing soil fertility and water retention [25], bind soil particles, increasing their stability and reducing erosion [26]. They are also effective for the remediation of soils affected by salt [27]. Hence the advantages of their combined application with sludge.

In the next study, Spanish and Mexican researchers monitor real time wind deposits in tree crops [28]. In these crops, usually a greater amount of plant remains in the soil, favoring their aggregation. In addition, the loss of soil due to the effect of the wind is reduced as the wind speed decreases in the tree crops, which increases the capture of the transported material [29]. However, the crop reduces the stability of the aggregates in dry soils of medium texture, which favors an increase in the erodible fraction of the soil by the wind [30]. This paper analyzes the total material lost or deposited by the wind in the soil of an orchard, together with the qualitative and semi-quantitative variability of soil minerals transported at different times and from different sources. In addition, the possible effects on the studied crop are evaluated. The application of new devices that allow the monitoring, in real time, of the capture of sediments from different sources is also being tested.

A novel work by Chinese researchers analyzes the breakdown of soil aggregates, with the release and transport of colloidal particles through laboratory column experiments [31]. Soil aggregates influence the transport of water, air and heat in the soil; support the soil structure to resist erosion; and control microbial activity [32]. The decomposition of soil aggregates is closely related to the internal forces of the soil [33]. The interactions between the particles, at a mesoscopic scale, significantly influence a series of physical and chemical characteristics of the soil [34]. The internal forces of the soil influence the movement of water in it through the matrix potential, conditioned by the morphology of the soil pores [35]. Different authors indicate that colloidal size particles contribute more than 80% of the surface charge and the specific surface area of the entire soil [36]. In these terms, a column laboratory experiment for the investigation of the release and transport of particles allows for the control of the variables and the separation of the effect of the electrostatic repulsive force from the total internal forces.

Finally, this Special Issue includes a study carried out by Egyptian and Saudi Arabian researchers related to the dangers caused by heavy metals, using remote sensing and GIS [37]. Due to the scarcity of fresh water, many soils are irrigated with water flowing from mixing stations, which mix fresh water with agricultural drainage water or sometimes with sewage, causing an increase in the concentration of heavy metals. Relying on Landsat ETM+ images and the digital elevation model (DEM), the environmental risks of heavy metals in the study area were evaluated using contamination indices that include the enrichment factor (EF), the contamination load index (PLI) and the potential ecological risk index (PER). The investigation of contamination indices enables the sustainability of agricultural ecosystems and the monitoring of soil quality [38].

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