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Editorial: Soil degradation and restoration in arid and semi-arid regions

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Editorial on the Research Topic
Soil degradation and restoration in arid and semi-arid regions

Soil degradation is one of the huge challenges facing the human society, especially in arid and semi-arid regions (Amundson et al., 2015; Kraamwinkel et al., 2021). Soil degradation will lead to the loss of ecosystem functions, such as the decline in productivity and regulatory functions, the loss of species habitats, *etc.*, causing the environment that was once suitable for living things unsuitable (Nunes et al., 2020; Rillig et al., 2023). Accurately understanding the process and mechanism of soil degradation in arid and semi-arid regions and developing technologies to curb soil degradation are of great significance for scientifically responding to land degradation, restoring and improving degraded lands, enhancing ecosystem wellbeing, and promoting the healthy development of human society.

This Research Topic contains eight articles, mainly involving two categories: soil degradation and degraded soil remediation. In addition, judging from the number of articles in the Research Topic, there is more research focusing on degraded soil remediation (five articles) than soil degradation (three articles). Although the articles in this Research Topic involve wind erosion, water erosion, salinization and other soil degradation types, compared with the more diverse soil degradation, the Research Topic is far from enough to understand the remediation of degraded soils. This Research Topic aims to attract more researchers to pay attention to soil degradation in arid and semi-arid regions and promote the remediation and management of degraded soil.

Process and mechanism of soil degradation

Qi et al. investigated the effect of wind erosion on the surface dust emission of a dry lake in semi-arid grasslands in China. It was found that the surface sediment particles of intermittently dried and permanently dried lakes were mainly <63 μm, but the salt dust particles released from the surface of permanently dried lakes were finer. The concentration of salt dust released from intermittently dry surface is higher than that from permanently dry surface, with the salt ions mainly of Na^+, Cl^-, and SO_4^{2-}. However, the dust flux from intermittently dry surface is only 5%–15% of that from permanently dry land. The study revealed the wind erosion mechanisms of degraded lakes and provided reference data for soil desertification control in grassland areas.

Wang et al. demonstrated the effects of water erosion on the stability of soil aggregates and the loss of organic carbon in different slope shapes in the black soil region of northeast China. There was little difference in the fragmentation of soil aggregates between different slope shapes, and the fragmentation of soil aggregates was caused by the uneven expansion and contraction of clay particles. The soil erodibility of straight slope was lower than that of compound slope and concave slope, largely because soil organic carbon content of straight slope was greater than that of concave slope and compound slope. Soil organic carbon is preferably lost in the erosion of the top soil, resulting in the thinning of the black top soil layer and the decline of cultivated land quality.

Esch and MacDougall explored the retention mechanism of soil N and P in grassland ecosystem through microcosmic experiments. Compared with bare land, grassland can greatly reduce soil N loss, but slightly increase soil P loss. Moreover, most of the soil N loss occurred in the early growing season of grassland, while the soil P loss occurred in the late growing season. The addition of N reduces the loss of soil P obviously, but the addition of P has no effect on the loss of soil N. In addition, the difference in grassland function types had no significant effect on the loss of N and P. The authors concluded that soil nutrient loss in conventional agriculture can be mitigated by reducing N and P additions and changing the time of application.

Process and mechanism of degraded soil remediation

Liu et al. proposed a technique for restoring degraded grassland based on the combination of branch mulching and sheep manure amendment. By combining two readily available and inexpensive resources, sheep manure and caragana branches, soil conditions can be significantly improved by the shelter of tree branches, and further to promote plant growth. Tree branch shelters shade and cool the soil and help maintain high soil water availability. The improvement of soil moisture promotes the conversion of manure nutrients and ultimately promotes the growth of grassland plants. In degraded grassland in northern China, when 60% of the ground is covered by branches, the average soil moisture content can be increased by 5 mm, and the plant yield can be doubled.

In view of the salinization of agricultural soil, Wang et al. took the Yellow River diversion irrigation area in the semi-arid region of northwest China as an example. By comparing the effects of flood irrigation and drip tube on the temporal and spatial distribution of soil water and salt in corn fields, they found that drip irrigation removes excess salt in the root zone through small-area irrigation and slow infiltration in compared with flood irrigation. A desalting zone with plenty water and little salt is formed near the drip head to create a suitable low-salt microenvironment for the normal growth of plants. The use of appropriate drip irrigation can achieve the purpose of water saving and salt control, and effectively enhanced crop productivity.

Sun et al. explored the effect and mechanism of soft rock addition to improve the soil aggregate structure of sandy soil in arid region. It was found that the soft rock addition could change the microstructure of the original sandy soil, which was dominated by a single granular barrier, promote the formation and development of soil, and form soil aggregates with good structural characteristics. Compared with aeolian sandy soil, the iron oxide in composite soil is fixed by combining with organic matter, which enhances the stability and development of soil aggregates, and thus improves the soil structure and productivity.

In response to the low phosphorus availability in calcareous soils in semi-arid regions of China, Lin et al. studied the effects of straw returning on soil phosphatase activity and available nutrients under a corn-wheat planting system. They reported high straw return rates led to a reduction of carbonate concentration by about 50% in 3. 5 years. At the same time, the activity of soil phosphatase was significantly increased. The increase of substrate availability caused by straw returning to field may contribute to the improvement of soil phosphatase activity. The soil nutrition and phosphatase activity of calcareous soil could be improved with a high straw return rate.

Wang et al. research on farmland soil in the Chinese Loess Plateau showed that the application of organic fertilizer and the optimization of planting patterns can effectively improve the soil organic matter, nutrient content and microbial activity of the farmland, thus improving soil quality. After the application of organic fertilizer to the soil, it promoted the propagation of microorganisms and the soil carbon and nitrogen cycles, and increased the accumulation of soil nutrients. Reasonable crop rotation can achieve balanced utilization of soil nutrients and improve soil nutrient status. In dry farmland of the Loess Plateau, wheat and corn rotation combined with organic-inorganic fertilizer is an effective way to improve soil quality.

Author contributions

KW: Writing–original draft. JL: Writing–original draft. ZZ: Writing–review and editing. XZ: Writing–review and editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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