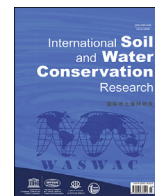




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Editorial

New sciences & technologies in soil conservation and eco-sustainability

ABSTRACT

Keywords:

Development
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Soil conservation is necessary to achieve a sustainable world because soils play a crucial role in the Earth's system. At the same time, the applicable and precise methods are vital to obtaining credible data in soil studies. A collection of 10 articles have been organized to focus on the new technologies regarding soil conservation and eco-sustainability and the results related to the novel approaches. The articles put effort into the innovative works of field investigations, field experiments, model experiments, and numerical simulations. Pivotal questions baffling soil scientists have been clarified and solved, and many valuable insights have been aroused.

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1. Tutorial

Soil is a critical element in the Earth's system, controlling hydrological, biological, erosional, and geochemical cycles. Moreover, the soils are a vital resource for food and fiber production that sustains human societies. Given the actual threats due to the intensification of climate change and anthropogenic landscapes fragmentation, it is necessary to adopt soil conservation strategies for a sustainable world. This collection of articles aims to provide new advances and research in experimental, theoretical and applied soil conservation and eco-sustainability. The 10 research articles cover the following topics (Table 1): (1) Theory and practice of soil conservation experiments, (2) measurement technologies and instruments for soil loss, (3) modeling and decision support tools for watershed regulation, (4) hazardous substances and detection techniques, and (5) validations and applications of remote sensing to eroded areas.

2. Theory and practice

2.1. Field investigation

Two papers discussed the role of soil conservation based on field investigations. The article of Chen et al. (A in Table 1) aimed to compare the root tensile strength, root morphologies, and root fiber contents and quantify their differences among different plant species. Three root systems of terrace hedgerow plant species were sampled to detect root morphologies and fiber contents at different slope positions on a representative hillslope in the karst trough valley. Results showed that root diameter is the main factor affecting root tensile properties. Except for *V. villosa*, the classic power root tensile strength-root diameter function, ultimate tensile force-

root diameter function, and Young's modulus-root diameter function were obtained. The linear function was obtained between maximum root elongation and root diameter for each studied species. The relationships between root tensile properties and fiber contents were plant-species-specific. The effects of slope positions on root tensile properties also depended on plant species. Thus, plant species were the most fundamental factor impacting the root tensile properties. The results may deepen the understanding of the terrace hedgerow functions in controlling soil erosion. Liu et al. (B in Table 1) clarified the mechanisms governing soil-water content dynamics in soil profiles. Here a field investigation was conducted in Dalaoling National Forest Park, China. Using Spearman's rank correlation and wavelet coherence analysis methods, this study analyzed the similarity in soil profile dynamics and factors governing the dynamics under three vegetation types at different time scales and in different seasons. The results revealed significant similarity in the soil-water content, decreasing with the increment in soil depth. The average soil-water content among surface and deep soil layers varied with the time scale, which was in the order of monthly (58.6%) > weekly (42.8%) > daily (21.8%). These results help to elucidate soil water transport processes and to improve the prediction accuracy of soil hydrological processes.

2.2. Model or field experiment

Half of the published papers were devoted to field or model experiments. Based on a field experiment on the vegetated hillslope plots and bare hillslope plots, Guo et al. (C in Table 1) quantified the influence of revegetation on erosion caused by concentrated runoff in extreme rainstorms. The result implied that the ability of vegetation to reduce erosion was more significant than its ability

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Table 1
Articles collected in the special issue.

Index	Authors, title	Links
A	Chen et al. Root tensile strength of terrace hedgerow plants.	https://doi.org/10.1016/j.iswcr.2022.01.008
B	Liu et al. Influence of vegetation type and topographic position on volumetric soil water content dynamics and similarity among surface and deep soil layers.	https://doi.org/10.1016/j.iswcr.2022.07.002
C	Guo et al. Runoff- and erosion-reducing effects of vegetation on the loess hillslopes of China under concentrated flow.	https://doi.org/10.1016/j.iswcr.2022.03.007
D	Lucas-Borja et al. Exploring the factors influencing the hydrological response of soil after low and high-severity fires with post-fire mulching in Mediterranean forests.	https://doi.org/10.1016/j.iswcr.2022.08.002
E	Ma et al. Overland flow resistance and its components for slope surfaces covered with gravel and grass.	https://doi.org/10.1016/j.iswcr.2021.08.003
F	Chen et al. Variations in the disintegration rate of physical crusts induced by artificial rainfall in different alcohol concentrations.	https://doi.org/10.1016/j.iswcr.2022.03.006
G	Li et al. Determination of rill erodibility and critical shear stress of saturated purple soil slopes.	https://doi.org/10.1016/j.iswcr.2021.04.013
H	Mauri et al. Multi-temporal modeling of road-induced overland flow alterations in a terraced landscape characterized by shallow landslides.	https://doi.org/10.1016/j.iswcr.2021.07.004
I	Tian et al. Soil erosion assessment by RUSLE with improved P factor and its validation: Case study on mountainous and hilly areas of Hubei Province, China.	https://doi.org/10.1016/j.iswcr.2021.04.007
J	Yuan et al. Effects of a check dam system on the runoff generation and concentration processes of a catchment on the Loess Plateau.	https://doi.org/10.1016/j.iswcr.2021.06.007

to reduce runoff. Both the rate of runoff reduced by grass and rate of erosion reduced by grass decreased as the inflow rate increased, and the former decreased as the hillslope gradient increased. There were no apparent differences in the latter between hillslope gradients. Vegetation could reduce the ability of the concentrated flow to carry and transport sediment and increase the energy consumption of the concentrated flow in response to hydraulic resistance. Vegetation also significantly reduced the degree of rill development. The degree of rill dissection on the vegetated slope was lower than that on the bare slope. This study provides a reference for the ecological environment and vegetation restoration on loess hillslopes. Using the data from a field experiment, Lucas-Borja et al. (D in Table 1) tried to clearly understand the surface runoff and erosion rates altered by wildfires. This study carried out a combined analysis of the hydrological response of soil and its driving factors in burned forests of Central-Eastern Spain. The results illustrated that the wildfire increased many-fold the runoff and erosion rates. The mulching reduced the hydrological response of the burned soils, particularly for the first two-three rainfalls after the fire. The increase in runoff and erosion after the wildfire was associated with the removal of the vegetation cover, soil water repellency, and ash left by the fire; the changes in water infiltration played a minor role in runoff and erosion. These results help better understand the relations between fire's hydrological effects on one side and the main soil properties and cover on the other.

Ma et al. (E in Table 1) provided important information on the resistance components of a composite slope land based on a model experiment. In this study, the smooth and sand-bed surfaces covered with different gravel and grass under five slope gradients were subjected to inflows to investigate the hydraulic resistance and validate the sum law of resistance components. The results showed that the overland flow mainly belonged to transition or turbulent and supercritical flow regimes with $150 < Re < 2050$ and $0.4 < Fr < 6.9$. The flow discharge had a more significant influence on flow resistance than gravel or grass cover, and the impact of flow discharge was weakened with the increasing bed slopes. The total resistance was generally more significant than the sum of resistance components, and an additional positive resistance existed for the composite surfaces. The additional resistance accounted for 37.4%, 4.2%, and 16.6% of the total resistance for the sand surfaces covered with gravel, grass, and both, respectively. These results may be referred to as the design of soil and water

conservation measures in rocky and mountainous areas. Chen et al. (F in Table 1) conducted a quantitative study on the disintegration processes of the physical crust controlling soil surface erosion. Here, a model experiment with simulated rainfall was undertaken to study the disintegration rate of physical crusts. The results showed that the physical crusts were immersed for 200 s at different alcohol concentrations to delay the disintegration process to obtain the disintegration rate. The content of organic matter and the sand percentage in the structural and sedimentary crusts decreased with increasing rainfall duration, while the bulk density, silt, and clay percentages increased. Due to the lower disintegration rate, the structural crust had a lower erosion resistance than the sedimentary crust. The study revealed the erosion resistance mechanism of physical crusts. Using a model experiment, Li et al. (G in Table 1) compared the soil erodibility and critical shear stress of saturated purple soil slopes with those of unsaturated purple soil slopes. The results illustrated that there were no significant differences in the soil erodibilities of the saturated purple soil and those of the unsaturated purple soil at the different slope gradients ranging from 5° to 20° . The critical shear stresses slightly varied with the slope gradients. The saturated purple soil was relatively significantly more susceptible to erosion. The results of this study help explain the rill erosion process of saturated purple soil slopes. Further studies are necessary to quantify erodibility and critical shear stress for other soil types.

2.3. Numerical simulation

Three papers focused on simulation calculation, where data from experimental, monitoring, or investigating studies are used to validate the calculating results. Based on the data from field monitoring, Mauri et al. (H in Table 1) modeled multi-temporal overland flow dynamics in a shallow landslides-prone terraced landscape (northern Italy). This study combined Remotely Piloted Aircraft Systems and photogrammetric techniques to elaborate multi-temporal high-resolution Digital Elevation Models. Hydrological analyses of water flow's depth alterations due to the road presence were carried out adopting the SIMulated Water Erosion model, focusing on different scenarios considering the presence of the road and assuming its absence through a specific DEM smoothing procedure. Results proved that the role of the road in water flows changed in the two observed shallow landslides,

with respective maximum water depth values equal to 0.18 m and 0.14 m. On the contrary, no-road simulations with water depth values around 0 m showed that relevant changes would be avoided in water flow paths toward the collapsed surfaces. This work highlights the advantage of multi-temporal topographical analysis to better understand the road-induced overland flow alteration in a terraced agricultural area. Tian et al. (I in Table 1) improved the RUSLE by considering the quantitative impacts of different soil conservation measures on the P factor value. The applicability of the improved RUSLE was validated against monitoring data concerning long-term (2000–2015) soil erosion obtained from 96 runoff plots in typical mountainous and hilly areas of central China. Based on the erosion monitoring data of 2018 and 2019, the root mean square error of the result calculated with the improved RUSLE was 28.0% smaller than that by the original RUSLE with a decrement of 19.6%–24.0% in the average P factor values, indicating that the improved RUSLE significantly enhanced the modeling accuracy of soil erosion. Relatively low P-factor values appeared for farmlands with tillage measures ($P < 0.53$), grasslands with engineering measures ($P < 0.23$), woodlands with biological measures ($P < 0.28$), and other land use types with biological measures ($P < 0.51$). The measurements verified the applicability of the improved RUSLE in typical mountainous and hilly areas of Hubei Province, China, and the arrangements of SWC measures of this area were proposed. Yuan et al. (J in Table 1) examined the watershed hydrologic process modulated by the check dam system in a typical catchment of the Loess Plateau. By simulating scenarios with various numbers of check dams using a distributed physically-based hydrological model, the effects of the number of check dams on runoff generation and concentration were analyzed for the study catchment. The results showed that the presence of check dams reduced the peak discharge and the flood volume and extended the flood duration; the reduction effect on peak discharge was the most significant among the three factors. The system of check dams substantially decreased the runoff coefficient, and the runoff coefficient reduction rate was more significant for rainstorms with shorter return periods than for rainstorms with longer return periods. The check dams increased the capacity of the catchment to regulate and store floods, extended the average runoff concentration time in the catchment, and flattened the instantaneous unit hydrograph. This study revealed the influence of the check dam system on the watershed hydrological process under heavy rain-storm conditions on the Loess Plateau of China.

3. Conclusions

In this special issue, nearly a hundred soil scientists, including the authors, reviewers, and editors, narrate new advances in soil conservation and eco-sustainability. Ten research articles are

published based on the innovative works of field investigations, field experiments, model experiments, and numerical simulations. These works solved several pivotal questions baffling soil scientists and they generated valuable insights on possible new soil conservation strategies supporting a more resilient environment to address global environmental changes.

Declaration of competing interest

The authors declare no conflict of interest.

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