ISSN: 2688-8645

Spatial and Temporal Variability of Soil Moisture in the Loess Plateau

Lu Zhang[1, 2, 3, 4, 5, a], Lei Shi[1, 2, 3, 4, 5]

[1]Shaanxi Provincial Land Engineering Construction Group, Co., Ltd, Xi'an, 710075, China

[2]Institute of Land Engineering and Technology, Shaanxi Provincial Land Engineering Construction Group Co., Ltd.. Xi'an, 710021, China

[3]Key Laboratory of Degraded and Unused Land Consolidation Engineering, the ministry of Natural Resources, Xi'an, 710021, China

[4]Shaanxi Engineering Research Center of Land Consolidation

[5]Land Engineering Technology Innovation Center, Ministry of Natural Resources

[a]luluqiaofeng@126.com

Abstract

The soil moisture in the Loess Plateau has obvious temporal and spatial variation characteristics, and the soil is prone to dry layers in the dry season and the peak season of crop growth, which affects the growth of plants and the sustainable development of the local soil. Focusing on solving the problem of local soil moisture imbalance, this paper reviews the temporal and spatial variability of soil moisture in the Loess Plateau, and points out the direction for the control measures to improve the soil moisture status in this region.

Keywords

Season; Soil profile; Space-time variability.

1. Introduction

The spatial and temporal differences of soil moisture are the result of the joint action of various environmental factors on multiple scales. The influence of these factors on the temporal and spatial heterogeneity of soil moisture shows a significant temporal and spatial variation law. The spatial heterogeneity of soil moisture is the site of Scale (slope), slope scale (slope position and relative height) and watershed scale (land use and rainfall) and other multi-scale environmental factors. The spatial variation and distribution pattern of shallow soil moisture are mainly affected by factors such as topography, precipitation, and land use patterns and structures. Studies by She Dongli et al. found that during humid and moderately humid periods, land use was the main factor affecting the variation of soil moisture (except for the surface layer). The variation pattern of soil moisture during drought period is mainly affected by soil properties. Slope aspect, slope, and slope position are important influencing factors of soil moisture distribution at the slope scale. Microtopography has a significant impact on soil moisture content. The order of soil moisture for each microtopography on sunny slopes is collapse>cut ditch bottom>gentle platform>shallow ditch bottom > Undisturbed slope > Steep ridge (Sun et al, 2005; Zhao et al, 2010). Huang Yilong et al. studied the seasonal and vertical changes of soil water content in different precipitation years among various species. The seasonal changes of soil water content of various species in sparsely flooded years showed a concave curve, and the seasonal changes of soil water content of various species in normal precipitation years showed a W-shaped curve.. The soil moisture in the Loess Plateau has significant regional and micro-regional differentiation characteristics, and the spatial distribution of soil moisture determines the spatial distribution of vegetation types and growth conditions in the region (Hu et al, 2004).

2. Variation Trends at Different Scales

2.1. Seasonal Variation of Soil Moisture

Since the soil moisture content in the Loess Plateau is mainly compensated by rainfall, the soil moisture also undergoes corresponding seasonal changes due to the influence of rainfall. The measurements of Dong University et al. in the Weibei dry plateau show that the seasonal dynamics of soil moisture in bare soil can be divided into four stages: the dry-wet alternation stage in spring, the moisture storage stage in the rainy season, the upward evaporation stage after rain, and the slow evaporation stage in winter.. In general, the soil moisture dynamics of crops in the growing period can be divided into three periods: soil moisture consumption in late spring and early summer, soil moisture accumulation in late summer and early autumn, and soil moisture consumption in late autumn and early winter. The annual seasonal dynamics of soil moisture in woodland in the gully area of the Loess Plateau can be divided into four stages: the relatively stable period of soil moisture at the beginning of growth, the period of intense soil moisture consumption in the middle of growth, the compensation period of soil moisture recovery in the middle of growth, and the slow evaporation of soil moisture at the end of growth (easy and easy to use). Bright, 2009). Li Kaiyuan et al. divided the seasonal changes of soil moisture into four stages: slow evaporation in spring, water storage and moisture increase in summer, strong evaporation loss in autumn, and relative stability in winter. High-low seasonal variation. In conclusion, the temporal variation characteristics of soil moisture on the Loess Plateau show that the land use type and slope aspect have a greater impact on soil moisture in dry years, while the effects are weakened in wet years.

2.2. Moisture Change of Soil Profile

In the same geographical location, the distribution of soil moisture is affected by slope, slope aspect, slope position, vegetation type, vegetation density and biomass, and exhibits certain spatial variability characteristics. According to Li Yushan's research, the soil layer of the Loess Plateau is generally 50-100 m, the groundwater is buried deep, and there is no possibility of upward recharge, so precipitation has become the only source of soil moisture in this area. Under the combined effect of drought and biological utilization, precipitation The infiltration generally does not exceed 3m, which is basically the same as the activity range of plant roots. However, in woodlands and perennial grasslands, a low-humidity layer often forms at a certain depth in the soil of the Loess Plateau, and even a "soil dry layer" appears, and the soil water content is close to the withering coefficient. It causes great harm to the productivity of forest and grass. It can be seen that the water cycle of the Loess Plateau is a relatively simple process of precipitation infiltration and upward evaporation. At the same time, due to the combined action of precipitation, evaporation and plant utilization in the Loess Plateau, soil moisture is The distribution also shows a certain level of hierarchy. Wang Mengben et al. divided the soil profile into three layers: active layer, sub-active layer, and relatively stable layer; Dong Daxue et al. divided the soil profile into two layers: active layer (0-80cm) and relatively stable layer (80-200cm). level. In recent years, Fu Bojie et al. studied the spatial distribution of soil moisture on hilly slopes in the central loess region, established a mathematical model of the spatial distribution of soil moisture on slopes, and believed that soil moisture on slopes was mainly affected by slope and slope position (Fu et al, 2001). Mu Xingmin discussed the soil and water resources of dry land in the loess region, and proposed the zonal and non-zonal concepts of soil and water resources in the loess region (Mu, 1999). It is related to the concept of stable natural flora, and the concept of soil moisture zone of the Loess Plateau needs to be confirmed by further research.

The regional distribution of soil water and its available water on the Loess Plateau has a similar pattern, that is, the north is low and the south is high, with a mosaic structure, especially in the area south of Yan'an, which is obviously affected by local small topography and microclimate, and the soil water content is high. The spatial distribution of the soil water area is consistent with the condition of the underlying surface area. The area where the soil quality water content is lower than 5.5%, has entered the typical grassland area because it is close to the local soil withered humidity. The groundwater level on the Loess Plateau is less than 60 m deep and does not participate in the local SPAC water cycle. Therefore, the vertical distribution of soil water in the Loess Plateau is only represented by the infiltration and redistribution of precipitation or runoff in the soil body. The soil profile moisture distribution curve , this water profile distribution structure is likely to cause the consequence that the deep soil water storage is overutilized by plants and difficult to compensate.

The soil moisture of natural grassland in the Loess Plateau has similar distribution characteristics in the vertical direction, generally in the soil layer above 70 cm from the surface, due to the strong influence of changes in hydrothermal conditions, the soil moisture content shows great fluctuations with precipitation. In the soil layer below 70 cm, the soil water content basically shows a gradually increasing trend. Therefore, from the soil layer 70 cm from the surface, the distribution of soil water in the natural grassland of the Loess Plateau in the vertical direction can be divided into two levels: 70 The rapidly variable layer above cm and the accumulation layer below 70 cm. Regarding the research on the water distribution characteristics of soil profiles in the loess area, Han Shifeng (bare land), Liu Zengwen et al. (artificial pine forest land), Li Kairong et al. (artificial locust forest land), Wu Xuedong et al. (Sadawang artificial grassland), Wang Mengben et al. (artificial caragana Forests) have been researched, all of which are analyzed from the perspective of water activity characteristics. Generally, the vertical profile of the Loess Plateau is divided into four layers according to the water use situation: rapidly variable layer, active layer, sub-active layer, and relatively stable layer.

2.3. Spatial Variation of Regional Soil Moisture

Since the soil moisture in the Loess Plateau is mainly compensated by precipitation, the level change of soil moisture in this area is basically consistent with the regional change of precipitation, gradually decreasing from southeast to northwest, and there are 4 vegetations, namely forest, forest steppe, typical steppe and desert steppe. Although there are obvious regional changes in soil water content in the horizontal direction, in a specific area, due to the influence of the environmental microclimate, there are regular changes in the vertical direction. Generally speaking, in the valleys and slopes The moisture condition at the foot is better than that of the ditch slope, the top of the slope and the Liangmao, and the condition of the shady slope is better than that of the sunny slope. In a word, in the Loess Plateau region, due to the transitional geographical location, severe climate change, and terrain complexity, it exhibits unique water ecological conditions, and the resulting plant productivity levels are also very different. Vegetation construction is the only way for the improvement and sustainable development of the ecological environment of the Loess Plateau.

3. Conclusion

The soil moisture in the Loess Plateau varies with time and space, and has obvious spatial and temporal characteristics. Seasonal changes are affected by precipitation, and the changes are obvious; the moisture changes of soil profiles are affected by precipitation, topography, climate and other factors, and the changes are dramatic; regional soil moisture changes also have obvious regional characteristics due to different geographical conditions.

ISSN: 2688-8645

References

[1] L.J. Hu, M.A. Shao, W.Z. Yang. Spatial differentiation of soil moisture in the Loess Plateau and its relationship with forest and grass layout, Grassage Science, vol. 13(2004), 4-20.

[2] Z.F. Sun, X.P. Zhang, H.F. Liu, et al. Study on the distribution law of soil moisture at slope scale in the loess area of western Shanxi, Soil Bulletin, vol. 6(2005), 846-849.

[3] H. Zhao, Q.K. Zhu, W. Qin, et al. Study on soil moisture characteristics of microtopography on arid sunny slopes in the Loess Plateau, Bulletin of Soil and Water Conservation, vol. 3(2010), 64-68.

[4] X.M. Mu. The zonality and non-zonality of soil water resources in dry loess, Soil Journal, vol. 36(1999), 237-244.

[5] B.J. Fu, Z.J. Yang, Y.L. Wang. Mathematical Model of Spatial Distribution of Soil Moisture on Slopes in Loess Hilly and Gully Regions, Science in China (Series D), vol. 31(2001), 185-191.