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Influence on the Movement Law of Soil Water due to Coal Mining

Kui Zhu[1,2], Feng Wang[1], Zhengjie Chen[1], Xinyi Song[1]

1 School of Resources and Geosciences, China University of Mining and Technology, Xuzhou 221116, China
2 Key Laboratory of CBM Resources and Reservoir Formation Process, the Ministry of Education, Xuzhou 221116, China;

Abstract Soil water is the basis of various plants of agriculture to survive, which is the foundation of the national economy. And it is the link between surface water and groundwater in land hydrological process. Otherwise, it is an indispensable component in the process of the water resources formation, transformation and consumption. So, soil water has become one of the important researches in areas meteorology, penology, hydrology, ecology and so on. During the mining process, the changes of underlying surface conditions affect the dynamic movement of soil moisture, which is very different because of the geological condition, landform, climate and the underground water level in different mining area. In this paper, it is classified about the progress of the research on soil water movement in mining area at home and abroad. In addition, the problems are pointed out in the study of variation of soil moisture and the following researches are showed. Furthermore, the migration laws of soil moisture are expounded in different areas, vegetation and land types. At last, the influence is analyzed on soil water supply, drainage and the environment of mining areas because of the variation of soil moisture during coal mining. The study provides the basic theory and technology for the research in vegetation restoration, ecological reconstruction and soil-water conservation in mining area.
Keywords soil water, mining area, underlying surface conditions, movement law

Introduction

Soil moisture is a tie and bridge that connect surface water and groundwater, it is the center of atmospheric water, surface water, soil water, groundwater, plant water "five water" into each other, soil moisture is the source of plant water, and is the source of the survival of terrestrial plants. With the development of human life and production, the demand for water is increasing, and the problem of water shortages is growing, so there is a growing emphasis on the development and use of soil moisture .In recent years, the mining area large-scale of surface subsidence, groundwater levels dropped significantly, reducing the ability of soil drought control, threatening the survival of vegetation, serious damage to the surface environment, these are due to large-scale mining activities, caused mine ecological environment further deterioration. Therefore, the study of the mine soil moisture is urgent.

The research progress of soil moisture theory and method

The study of soil moisture mostly reflect in the revolution of methods, in the early years of scientific research about soil moisture, Morphological Method was widely used by Former Soviet Union, Japanese, Eastern European Countries and etc. However, Energy Method has the incomparable superiority which Morphological Method cannot compared(Hu et al., 2007). Energy Method's viewpoints and research methods started early in Europe and America, such like Darcy's Law,Capillary hypothesis, Infiltration Model which is based on Capillary Theory; in 1931, on the basis of Darcy Law, Richards Equation had been evolved which is suitable for unsaturated flow. As the development of science, Morphological Method had been progressively replaced by Energy Method. After 1980, as computers evolved, the Numerical Simulation Model of Soil Moisture acquired huge development, including the Equilibrium Model of Soil Moisture which could reflect the moisture condition in plant's

roots and the SWATRE Numerical Model which used for calculating the dynamic change of soil moisture.

Chinese scholar have made some further development in soil moisture's research, such as useing the FEM build the Spatial Distribution Prediction Model of Soil Moisture in loess hilly slope, utilizing Fractal theory to study the soil's water holding capacity and the influence of moisture movement in various soil texture, utilizing Statistical Method to study the soil moisture's characteristic of spatial and temporal variation in Chinese southwest hilly slopes. Meanwhile, the research of soil moisture had been evolved from the single discipline to the cross of multidisciplinary, like the research of SPAC System and Macrospore Flow. With application of computers, the research of soil moisture had some further evolution, for instance: introducing FEM and Finite Analytic Method (FAM) to solve the problem about unsaturated flow; in 1993, Zuo Qiang and his partners use CFE, QUD, Improved alternating direction finite element and some other ways effectively to deal with the numerical dispersion and oscillation.

The research progress of soil moisture dynamic change in subsidence area

Mining subsidence is the common geological disaster in diggings, mining break the balance of gestures, which cause the variation in the diggings' soil structural characteristic, porosity and water content, the change of a diggings' environmental geology and hydrogeology will influence the soil moisture in the diggings. In different diggings, their geological conditions, landform and underground water level have a huge diversity; as a result, several aspects should be taken into account in the research of diggings' soil moisture.

Research methods

At present, the methods which used in the soil moisture movement research are few, relating to the diggings, the methods are more limited, there are two main methods for study the digging's soil moisture dynamic change: Stable Isotope Labeling Method and Remote Sensing Monitoring Method.

(1) Stable Isotope Method: This method is also called Isotopic Tracer Method, it's a way to utilize tracer element to trace the progress of the material movement and change. Depend on the hydrogen stable isotope research of a digging's vegetal and environmental moisture, it could draw a conclusion: what is the main source of vegetal moisture and the range of natural vegetation coverage, analyzing the characteristic of stable isotope in different environmental system such like soil, plant and atmosphere, it could reveal the water source of the diggings' typical plants and provide the scientific water source basis for the spontaneous recovery and sustainable development of the diggings plants(Wang et al. 2010).

(2) Remote Sensing Monitoring Method: Remote Sensing Monitoring is a way which is utilizing remote sensing technology to survey atmosphere, ocean and near-surface condition. Depend on remote sensing monitoring and field measurement, by comprehensive analysis, it could reach a conclusion: the soil permeability had been enhanced upon the mine goaf and in the subsidence area, the soil water evaporation is higher than the non-subsidence area (Bian et al. 2009).

Influence factors

The influence of coal mining on soil water which differ from each other, the subsidence of coal mining damage soil water characteristic, influence the physical properties of soil

moisture and result in the loss of soil water content. There are numerous factors which could influence soil moisture, the main factors are following:

(1) Precipitation: Soil water content is influenced by precipitation and especially, the variation of soil water content has an extremely significant effect on plant growth. Normally, the soil water content in subsidence area is lower than non-subsidence area, precipitation is the crucial factor on influence sandy soil moisture dynamics, the soil water content in subsidence area and non-subsidence area has a vertical variation, the difference of soil water content in different parts of the dune do not appeared obviously, the soil water content in subsidence area and non-subsidence area could remain fairly consistent in temporal and spatial variation tendency.

(2) Subsidence cracks: After the subsidence of coal mining, the subsidence area especially in the zone of subsidence cracks: in this part, both the soil water content and soil water retaining capacity are lower than the non-subsidence area, on the loess plateau, soil moisture is the main factor that limited plants growth, the surface soil water moisture is influenced by evaporation heavily, and the substratum is quite the opposite, cause the ground surface fissures in diggings, the digging's soil average water content is lower than other areas which are not diggings(Wang et al. 2013), the lateral loss of the soil moisture had been enlarged is due to the development of subsidence cracks which also enlarge the non-capillary porosity and promote vertical evaporation of soil moisture, and the emergence of scattered surface subsidence enlarge the lateral evaporation of soil moisture(Kuang et al. 2007).

(3) Evaporation: In the numerous factors which could influence the loss of soil moisture, evaporation is a important one, the coal mining's on the Huang huai hai plain are not influence the soil moisture evaporation but the water surface evaporation of hydrops, and in dry seasons, from the edge of the plash to the edge of the collapse basin, the seasonal gentle water's soil evaporation is heavy, with the evaporation, soluble salt in the underground water will move up and bring dissolved salts to the surface and creating a white crustal layer, result in the salinization. For control the loss of soil moisture in subsidence area, there are some processes to do: soil freezing, snow-covered and so on, when soil is freezing, the difference of mass water content between subsidence area and non-subsidence area is in apparent, and slope position, slope aspect, wind, precipitation and temperature decline also have the effect on control the loss of soil moisture(Zang et al. 2009).

(4) The depth of plant roots: The depth of the plant roots is the significant factor to determine the quantity of soil water content(Li et al., 2003). Due to the coal mining, the water table is reduced obviously, but whether it would be influence the soil water content and the phreatic water which can be used by plant is depend on the water table before mining and the depth of plant roots(Bian et al. 2009).

Meanwhile, the condition of soil moisture is also influenced by climate, landform, plant transpiration, soil permeability, phreatic water and other factors.

Ecological restoration and environmental protection

Revegetation and ecological restoration in diggings attracted worldwide attention, also are one of the significant part of degraded ecosystem and restoration ecology and conversation of water and soil in diggings(Santhi et al. 2006), and the best strategy is reduce the damage to the land and accelerate the pace of revegetation as much as possible(Wilson et al., 2005). The variation of diggings' soil moisture is influenced by the type of land and plant.

(1) Ecological restoration: There is an internal connection among the soil moisture physical properties, in a goaf, under the different vegetation patterns, the soil moisture physical properties is closely related with its soil moisture variation and its water holding and draining capacity(Wen et al. 2009), and in the hypaethral reclamation area, for the different vegetation forms, it could be analyzeD the spatio-temporal variation rules depend on the soil water content(Sun et al. 2010), to study the soil moisture and soil structure on different land utilization types is helpful to change soil moisture condition and structure improving soil fertility and revegetation(Zhao et al. 2008), Measure the soil moisture characteristic curve of different land types is study soil water holding and supplying capacity and soil moisture efficiency(Sun et al. 2013).

(2) Environmental protection: Study the characteristic of spatial distribution and dynamic change of soil moisture in mining subsidence area, ascertain the influence of mining subsidence on the soil water content(Zhao et al. 2010), Study the growth rhythm of artificial plant communities, ecological effects of soil hydrology and its restraining factors on hillock, these have an obvious influence on improving the water-holding capacity, enhancing the infiltration ability of revegetation and improving soil, these have significantly directive meanings on ecological environmental protection of diggings and land reclamation of subsidence area.

Discussion about the dynamic study of diggings' soil moisture

The soil moisture dynamic change is a complex process inside the soil. So the research of soil moisture movement is relatively slow, especially for the research of diggings' soil moisture, though it had been made some advance in recent years, however, the problems in the research and some unworked area still need a further study:

(1) There are many researches come down to the theory of soil moisture, but the practical applied research is relatively lacking. For instance, considering how to interconnect hydrology model with soil moisture dynamic model, the SPAC system provide a convenience for the research of soil moisture, but whether it would be suitable for the study in diggings? And etc;

(2) About the soil moisture dynamic change, there are numerous influential factors, when these factors work together, the studies about how to confirm which one is the main controlling factor, interaction of other factors and the specific influence of fracture development are still lacking;

(3) Remote sensing technology and isotopic tracing technology had already played their role in the research of diggings' soil moisture. But, using stable isotope as the tracer had been restricted because its lower sensitivity and higher price; remote sensing technology could indirectly assess the soil moisture by some indexes like vegetation index, brightness, temperature and so on, so finally it need the measured data of soil moisture to regress and invert. How to get rid of the dependence of measured data and merely depend on remote sensing data to acquire the actual percentage of soil moisture is the important target in the future;

(4) Though the soil moisture characteristic of different vegetation types of various land types in different stages of growth had been studied, but the research about how to combine with the plant growth mechanism and analyze the influence from subsidence to soil moisture are still lacking;

(5) Enhancing the long-term monitoring of essential data about surface water environment, groundwater regime, groundwater environment and geological disaster in diggings, improving the monitoring methods, establishing the geographic information system of

environment protection and disaster prevention, providing the authentic reference data to the digging's water environmental management.

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