Environment

Natural Vegetation Restoration Is More Beneficial to Soil Surface Carbon Sequestration on Loess Plateau

The Loess Plateau of China is a unique geographical unit characterized by extensive loess distribution, serious soil erosion, low vegetation coverage and high soil carbonate content.

Since the 1950s, the Chinese government has made great efforts to control soil erosion and restore vegetation, including large-scale tree plantation in the 1970s, integrated soil erosion control in the 1980s and 1990s, and the "Grain for Green Project" in the 2000s. Currently, the ecological restoration of the Loess Plateau has produced remarkable achievements: increasing vegetation coverage, decreasing soil erosion and enhanced ecosystem services.

Soil carbon sequestration is a critical index for evaluating the efficiency of ecological restoration. Previous studies have unanimously indicated that ecological restoration can significantly promote soil carbon storage. However, most of these studies were focused on soil organic carbon (SOC), with only a few on soil inorganic carbon (SIC). These studies showed that the mean density and storage of SIC in the 0-100 cm soil layer on the Loess Plateau is more than twice that of the SOC pool and represents 21.66% of the total SIC storage in China. Therefore, the SIC pool of the Loess Plateau may make an important contribution to the national carbon budget. Moreover, natural vegetation restoration and tree plantation are the two most important measures for ecosystem restoration. However, few studies have compared the effects of the two contrasting measures on SOC and SIC sequestration or have further used soil organic and inorganic carbon isotopes to analyze the inherent sequestration mechanism.

Dr. JIN Zhao from the State Key Laboratory of Loess and Quaternary Geology, Institute of Earth Environment and his collaborators examined two neighboring small watersheds on the Loess Plateau with similar topographical and geological backgrounds (Fig.1). Since 1954, natural vegetation restoration has been conducted in one of these watersheds and tree plantation in the other. The watersheds have now formed completely different vegetation landscapes (DZG: grassland; YJG: forestland). Their study aimed to (1) examine the difference in SOC and SIC sequestration between natural vegetation restoration and tree plantation, and (2) identify the inherent mechanism of carbon cycling using soil organic and inorganic carbon isotopes method.

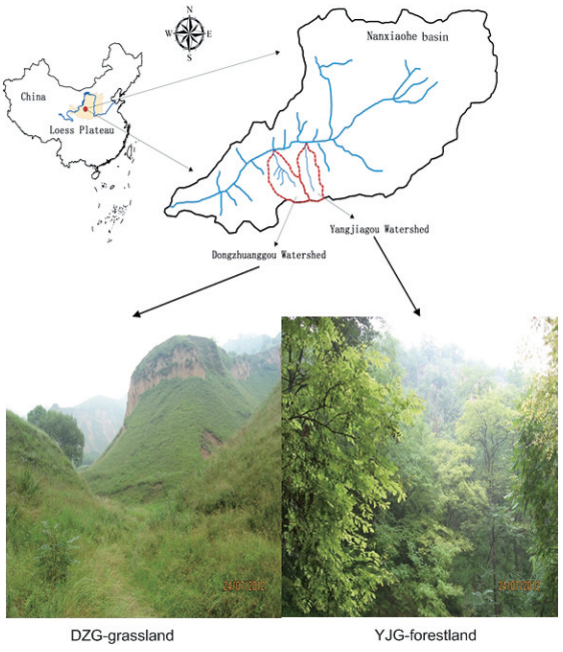

Fig. 1. The location of the study area in Xifeng District, Qingyang City, Gansu Province, including the Dongzhuanggou (DZG) watershed and the Yangjiagou (YJG) watershed.

According to field investigations, the scientists found that SOC storage was higher in the grassland than in the forestland, with a difference of 14.90 Mg ha^{-1}. The vertical changes in the $\delta^{13}C_{SOC}$ value demonstrated that

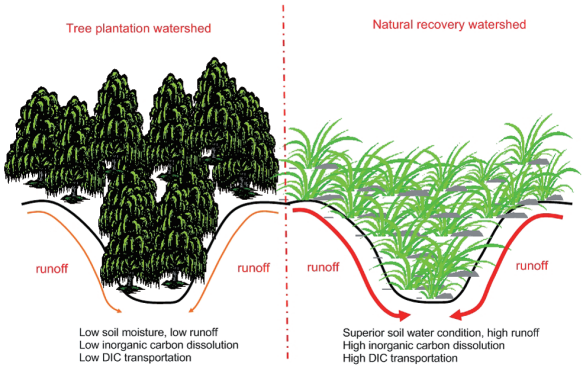

Fig. 2. Difference in runoff and DIC transportation between the tree plantation watershed and the natural vegetation recovery watershed.

the two ecosystems have different mechanisms of soil surface organic carbon accumulation. The SIC storage in the grassland was lower than that in the forestland, with a difference of 38.99 Mg ha^{-1}. The $\delta^{13}C_{SIC}$ values indicated that the grassland generates more secondary carbonate than the forestland and that SIC was most likely transported to the rivers from the grassland as dissolved inorganic carbon (DIC). The biogeochemical characteristics of the grassland were favorable for the formation of bicarbonate (Fig. 2). Thus, more DIC derived from the dissolution of root and microbial respired CO_2 into soil water could have been transported to the rivers through flood runoff.

According to Dr. JIN, further study on the transportation of DIC from the grassland is needed because this process can produce a large potential carbon sink.

Their research was supported by the National Natural Science Foundation of China and the Chinese Academy of Sciences.