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6.2
Hydrogeology of karst

Effect of land use/land cover change on karst hydrogeochemistry: A paired catchment study of Chenqi and Dengzhanhe, Puding, Guizhou, SW China

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INTRODUCTION

Land use and land cover change is an important anthropogenic factor that shows the influence on the surface of the earth. It directly impacts biological diversities, contributes to the local and regional climate changes as well as to global warming, and may cause land degradation by altering ecosystem services and livelihood support systems. The primary objective of this study is to understand how the karst processes and karst hydrogeochemistry respond to different land use and land cover change, which is essential to assessing the karst-related carbon cycle (Yuan, 1997; Liu et al., 2010).

METHODS

Rainfall, spring stage, water temperature, pH and conductivity (EC) in the paired karst spring catchments of Chenqi and Dengzhanhe, which shared the same climatic condition but different land use/land cover changes at Puding, Guizhou Province, SW China (Fig. 1), were monitored by two high resolution multi-parameter auto-recordable instrument of CTDP300 during the hydrological year of September, 2007-September, 2008.

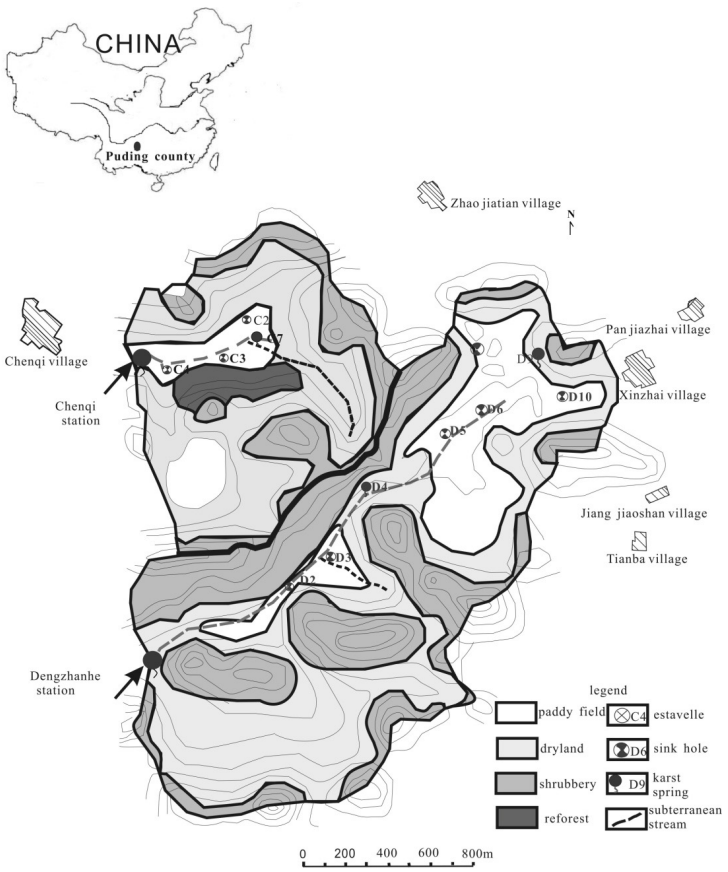

Figure 1. Comparison of distribution of various land use types between Chenqi and Dengzhanhe spring catchments [Modified after Zeng (2009)].

Other monthly hydrogeochemical (Ca^{2+}, Mg^{2+}, Na^{+}, K^{+}, HCO_3^{-}, SO_4^{2-}, Cl^{-}, NO_3^{-}) and carbon isotopic ($\delta^{13}C$) variations in the paired karst catchments during the same hydrological year were also investigated. A thermodynamic model was used to link the continuous data to monthly hydrogeochemical data allowing the calculation of CO_2 partial pressure (pCO_2) and calcite saturation index (SIc) on a continuous basis (Liu et al., 2007).

RESULTS

Marked seasonal variations were found for pH, conductivity, pCO_2, SIc and $\delta^{13}C$ of the two springs (Figs. 2 and 3), indicating that both springs were dynamic and variable systems. However, there were differences in the magnitude of the variations of these features between the two springs. The higher pCO_2 and HCO_3^{-} concentration and lower pH, SI_C and $\delta^{13}C$ in Chenqi Spring than those in Dengzhanhe Spring tend to be related to the difference in land use and land cover change between Chenqi and Dengzhanhe spring catchments: in the Chenqi Spring catchment, there was larger soil cover and the paddy land was located in the discharge area, both of which produced and kept more CO_2 (a major driving agent for the karst processes) and lower $\delta^{13}C$ in the soil-aquifer system, while in the Dengzhanhe Spring catchment area, there was larger bare carbonate rock occurrence and the paddy land was located mainly in the recharge area (Fig. 1).

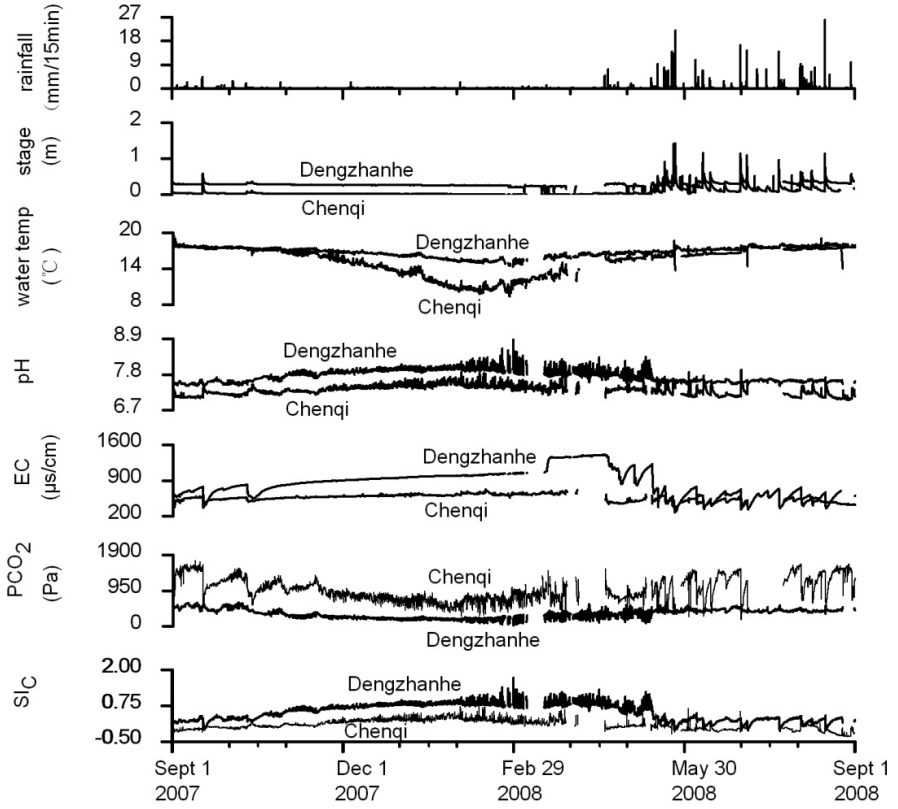

Figure 2. Comparison of continuous hydrochemical variations between Chenqi spring Dengzhanhe spring in relation with rainfall (The discontinuities in the curves are due to human disturbance).

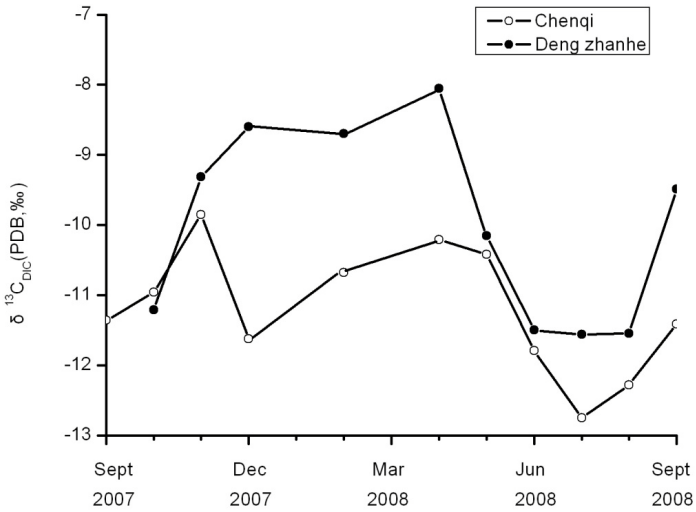

Figure 3. Comparison of seasonal variations of $\delta^{13}C_{DIC}$ between Chenqi and Dengzhanhe springs during the hydrological year period of 2007–2008.

In addition, the pH increased and pCO_2 decreased generally in Chenqi Spring after rainfall, possibly due to more carbonate dissolution in the larger soil cover rich in limestone fragments in the spring catchment, while the pH decreased and pCO_2 increased generally in Dengzhanhe Spring after rainfall (Fig. 4).

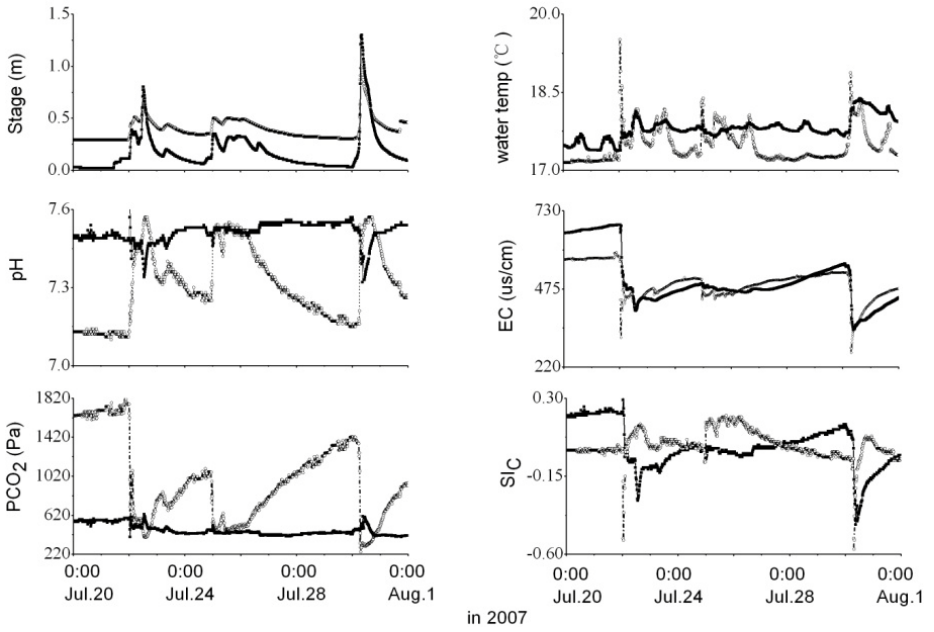

Figure 4. Comparison of storm-scale hydrochemical variations during July 20-Aug.1, 2007 between Chenqi Spring (dotted line) and Dengzhanhe Spring (solid line).

CONCLUSIONS

All these differences show that soil cover played a key important role in the karst processes. In other words, the karst hydrogeochemistry and the karst-related carbon cycle could be regulated effectively by different land use and land cover changes.

Therefore, the karst hydrogeochemical parameters, including pH, conductivity, HCO_3^-, Ca^{2+}, Mg^{2+}, pCO_2, SIc, and $\delta^{13}C_{DIC}$, could serve as good indicators of different land use and land cover changes and the other environmental changes.

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