Paper Number: 387

Assessment of climate impacts on the karst-related carbon sink in SW China using MPD and GIS

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Abstract Riverine carbon fluxes of some catchments in the world have significantly changed due to contemporary climate change and human activities. As a large region with an extensive karstic area of nearly 7.5×10^5 km^2, Southwest (SW) China has experienced dramatic climate changes during recent decades. Although some studies have investigated the karst-related carbon sink in some parts of this region, the importance of climate impacts have not been assessed. This research examined the impacts of recent climate change on the karst-related carbon sink in the SW China for the period 1970-2013, using a modified maximal potential dissolution (MPD) method and GIS. We first analyzed the major determinants of carbonate dissolution at a spatial scale, calculated the total karst-related carbon sink (TCS) and carbon sink fluxes (CSFs) in the SW China karst region with different types of carbonate rocks, and then compared with other methods, and analyzed the causes of CSFs variations under the changed climate conditions. The results show that the TCS in SW China experienced a dramatic change with regional climate, and there was a trend with TCS decreasing by about 19% from 1970s to 2010s. This decrease occurred mostly in Guizhou and Yunnan provinces, which experienced larger decreases in runoff depth in the past 40 years (190 mm and 90 mm, respectively) due to increased air temperature (0.33℃ and 1.04℃, respectively) and decreased precipitation (156 mm and 106 mm, respectively). The mean value of CSFs in SW China, calculated by the modified MPD method, was approximately 9.36 t C km^{-2}a^{-1}. In addition, there were large differences in CSFs among the provinces, attributed to differences in regional climate and to carbonate lithologies. These spatiotemporal changes depended mainly on hydrological variations (i.e., discharge or runoff depth). This work, thus, suggests that the karst-related carbon sink could respond to future climate change quickly, and needs to be considered in the modern global carbon cycle model.