陽明山溫泉酸排廢水對南磺溪水質與溪流生態之影響

Effect of acid wastewater from Yangmingshan hot springs on water quality and stream ecology of Southern Sulfur creek

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摘　要

陽明山溫泉開發帶來大量酸排廢水，除破壞南磺溪的水生態系，更影響到關渡平原的灌溉用水。本研究調查溪流受到溫泉酸性廢排水後的水質、重金屬變化及溪流生態物種等變化，針對未受污染河段、受污染河段設定了為期一年的生態物種及水質調查採樣。

結果顯示，行義路溫泉區及陽明山中山樓等酸排水影響了南磺溪水質，pH 值有明顯酸化現象(pH 4.9－6.9)，導電度及水溫亦明顯偏高。溫泉排水酸度高（硫酸鹽類），明顯對下游流域水質造成嚴重劣化；同時，水質偏酸加速河床岩石中重金屬溶出，排水下游多處測得重金屬（例如：鋅、鉛、鋁、砷及鉻等）濃度明顯高於排水上游處。此外，酸排廢水也造成水生物種組成之改變，流域常見的魚蝦貝消失殆盡，只剩下高耐受度的水棲昆蟲(如搖蚊科)與紅蟲可發現。本研究比較汙染河道的硫酸鹽濃度(260±136 mg SO_4^{2-} L^{-1})，發現未受污染的八仙圳灌溉渠道的三倍(84±41 mg SO_4^{2-} L^{-1})，更與主河道上游未受污染松溪有七倍(37±19 mg SO_4^{2-} L^{-1})的差距。

為避免利用單一指標來評估溪流生態系統的誤差率，本研究採用多項物種生態指標進行評估與分析南磺溪流域。調查發現香農多樣性與辛普森多樣性指標對於受污染河段皆顯示為低於 1.0 的重度汙染狀態；而無污染的上游松溪與八仙圳，兩指數皆維持在約 1.8-2.1 的優良水體狀態。針對溪流的水棲昆蟲採用科級生物指標(FBI)及綜合各種物種生態指標評估(ASPT)，顯示結果為嚴重污染等級。綜整各種物種生態指標，發現溫泉酸性排廢水不只對溪流水質產生影響，同時嚴重危害水生態物種生存。適用於高汙染流域，分析數值與實際受污染流域水質評估的狀況最為接近。

關鍵詞：地熱溫泉、灌溉水質、營養鹽、溪流生態系統，物種生態指標

Abstract

The development of Yangmingshan hot springs brings a large amount of acid drainage wastewater. The wastewater not only destroys the water ecosystem of Southern Sulfur Creek, but also affects the irrigation water of Guandu Plain. This study investigated the changes of water quality, heavy metals, and stream ecological species after the streams were drained by hot spring acid waste over a year.

The results showed that the water quality of Southern Sulfur Creek near Xing-yi Road and Zhongshan Tower in Yangmingshan was affected by the acid drainage, the pH value was significantly acidified (pH 4.9–6.9), and the conductivity and water temperature were also significantly higher. Hot spring wastewater with high sulfates concentraion seriously deteriorates the water quality of the downstream basin. At the same time, the acidity of the water quality accelerates the dissolution of heavy metals in the river bed rocks, and heavy metals (such as zinc, lead, aluminum, arsenic and the concentration of chromium, etc.) is significantly higher than that in the upstream of the drainage. The change in composition, the common fish, shrimp and shellfish in the watershed disappeared, and only highly tolerant aquatic insects (such as Chironomidae) and red worms could be found. This study compared the sulfate concentration (260 ± 136 mg $SO4^{2-}L^{-1}$) of the polluted river channel and found that the uncontaminated Baxianzhen irrigation channel was three times higher (84 ± 41 mg $SO4^{2-}L^{-1}$), and more closely related to the upper reaches of the main channel. Uncontaminated Pine Creek had a seven-fold (37±19 mg $SO4^{2-}L^{-1}$) .

In order to avoid using a single indicator to evaluate the error rate of the stream ecosystem, this study uses different species ecological indicators to evaluate and analyze the Southern Sulfur Creek. The survey found that Shannon's diversity and Simpson's diversity indicators both showed a heavily polluted state of less than 1.0 for the polluted river section; while the unpolluted upstream Song-xi and Baxianzhen, both indices were maintained at about 1.8-2.1 for excellent water bodies state. For the aquatic insects in the stream, the family-level biological indicators (FBI) and the comprehensive assessment of various species ecological indicators (ASPT) were used, and the results showed that the pollution level was serious. Comprehensively integrating the ecological indicators of various species, it is found that the acidic hot spring wastewater not only affects the water quality of the stream, but also seriously endangers the survival of aquatic ecological species. It is suitable for highly polluted watersheds, and the analysis value is closest to the actual water quality assessment of polluted watersheds.

Keywords: Geothermal spring, Irrigation water quality, River ecosystem, Species ecological indicator