

摘要

本研究採用系統動態軟體—Vensim 為模擬工具，模擬高雄縣美濃鎮及湖內鄉之廢汙水隨著灌排系統進入農田後，對於灌溉水汙染、農地土壤汙染、地下水汙染及回歸水水質影響河川水質作分析，並探討在「深水灌溉」、「灌排分離+下水道系統」、「農田休耕」、「農田輪作」等環境因素下，回歸水、灌溉水及河川水質之影響。

在施行深水灌溉時，美濃平均每月約增加五萬噸地下水；湖內則平均每月約增加一萬噸地下水。

而灌排分離加下水道系統，即廢汙水不進入灌溉圳路，美濃農田回歸水最終流到旗山溪，發現水質改善，甚至在一月 BOD 濃度可以從原本約 2.4 mg/L 降至約 1.5 mg/L；至於湖內鄉因為灌溉水質非常差，其改善成效不彰，僅重金屬鉛濃度因為灌排分離有稍稍改善。

在以「自然淨化法」概念下的休耕農田當溼地情況下，因為處理之水量相對於河川很少，所以對河川水質沒有多大成效。

以農田輪作進行模擬，植物吸收土壤重金屬，使累積量趨於緩和，湖內鄉農地重金屬濃度平均每月約減少 0.0025 mg/kg，但仍然有逐年增加趨勢。以 Vensim 為本研究之模擬工具，看出水量水質及農地重金屬隨時間的變化趨勢，同時分析眾多參數的互相影響行為，從變化趨勢發現深水灌溉的可行性，及灌排分離後水質較明顯的改善。

Abstract

The effect of quality of irrigation water on the overall quality of surface water bodies has raised significant concerns in Taiwan. In this study, quantity and quality of water bodies of Meilon and Hunai Townships was simulated with the system dynamic simulation software, Vensim®, to investigate the interaction between polluted irrigation water and other water bodies and farm land. The water bodies analyzed included the return flow, streams, and groundwater. Four scenarios were selected for simulation in order to evaluate possible schemes to reduce the pollution loading in the return flow and, thus, the streams. These scenarios are: “deep-impounding irrigation”, “irrigation and discharge separation”, “farm fallow”, and “crop rotation”.

Under the “deep-water irrigation” scenario groundwater discharge in Meilon and Hunai increased 5 million tons and 1 million tons over the 100 months period simulated, respectively. In the “irrigation and discharge separation” scenario, return flow does not flow into irrigation channel and, thus, into farm lands again. Under this scenario, BOD concentration decreased from 2.4 mg/L to 1.5 mg/L decreases to 1.5mg/L even in January. Because of irrigation water in Hunai was heavily contaminated, the strategy to separate irrigation and discharge water did not show significant improvement. Nevertheless, the concentration of lead in the water bodies and the soil decreased. On the other hand, since the quantity of irrigation water treated by the temporary wetland converted from farmland had been so small, water quality in the water bodies was hardly noticed. Finally, when the crop rotation scheme was used as a way to conserve water, plants were used to uptake heavy metal from the soil of the farm land. As a result, the accumulation rate of heavy metal in the soil was reduced. For example, the total monthly accumulation of heavy metals in the soil of Hunai was reduced approximately 0.0025 mg/kg.

The results of this study demonstrate that system dynamic analysis is capable of modeling various scenarios with complex management schemes. It was found that the “deep-impounding irrigation” and “separation of irrigation and discharge” are strategies that can significantly increase groundwater recharge and improve discharge water quality, respectively.