

中文摘要

土地利用變遷與氣候、自然與人為環境、土壤條件、水文條件、生態系統的互動關係是土地資源永續發展相關研究極力探討的議題；此外，土地利用變遷對景觀生態衝擊評估與管理是都市計畫與景觀生態領域中相當重視的問題，然而在研究方法上仍缺乏一完整的評估機制，足以整合土地利用管制、土地利用變遷驅動力評估、土地利用變遷模擬、景觀生態評估的方法進行評估。

本研究目的在於建構土地利用變遷及景觀生態評估方法，主要是整合土地利用變遷驅動力分析方法、土地利用變遷模擬模式、景觀生態結構評估方法、多變量方法、土地利用管制情境評估等方法。以基隆河中上游流域集水區為方法試驗地區，以1994年土地利用為基礎，以1999年土地利用進行模式驗證，之後擬定六個土地利用管制情境，並模擬2000至2020年土地利用，進行土地利用變遷驅動力分析、景觀生態指數評選、景觀生態結構評估及差異性分析、土地利用面積比例與景觀生態指數相關性分析、土地利用管制政策情境評估，以及都市與非都市地區景觀生態結構指數敏感性分析等。

土地利用變遷驅動力分析結果發現土地所有權、土壤沖蝕指數K值、高程、坡度、土壤深度、與道路距離、與建築距離等七項變數是影響基隆河流域各種土地利用分佈與變遷的主要因子。土地利用管制策略與土地利用變遷模擬結果發現整體的模擬準確率Kappa值為61.9%，林地模擬的準確率高達93.7%、建成地為70.3%，水體為69.5%，草地為25%、農地為18.5%。

景觀生態結構指數評選結果顯示，邊長密度指數(ED)、面積權重形狀指數(AWMSI)、平均鄰近指數(MPI)等三個指標不適用於基隆河流域景觀生態結構評估。都市與非都市地區景觀生態結構指數敏感性分析結果顯示，整體土地利用的總邊長(TE)與散列並置指數(IJI)、農地的平均嵌塊體面積指數(MPS)、平均形狀指數(MSI)應用於都市與非都市景觀生態結構比較時敏感度較差。

景觀生態結構與差異性分析結果發現，土地使用分區、農地釋出政策或兩者同時作用下，導致各土地利用產生不同的景觀結構，農地釋出政策造成的景觀生態結構差異性比土地使用分區還顯著，而農地釋出與土地使用分區政策同時作用下，對於各土地利用的鑲嵌度產生的差異性影響最顯著。此外，兩政策在都市與非都市地區造成的景觀生態結構差異性，兩地區有顯著的不同。土地利用面積比例與景觀生態指數相關性分析結果發現，建成地與農地的面積變化對於指數值的改變與林地、草地所造成的變化完全相反。

土地利用管制情境評估結果顯示，相較於1999年的景觀生態結構，實施農地釋出政策及管制飲用水水源水質保護區、保安林地、森林區，有助於整體土地利用、農地景觀結構完整性提昇。整合本研究方法與分析結果，進一步提出土地利用與景觀生態管制計畫架構，並以基隆河中上游流域集水區為例，提出林地、建成地、草地、農地之土地利用與景觀生態管制計畫。

綜合言之，本研究提出的整合性分析方法在不同評估方法銜接、資料整合上

無相斥現象，且能夠有效的進行基隆河流域土地利用變遷與景觀生態結構相關主題的評估，驗證了本研究所提土地利用變遷及景觀生態評估方法之有效性。此外，本研究所建立之方法，完全能夠與國內土地管制法令相銜接，並可將景觀生態觀念整合其中，提昇目前土地利用管制與管理效率。本方法未來可與其他研究領域、研究方法進行縱向與向橫連結，進行跨領域、跨議題之研究。

關鍵詞：土地利用管制、土地利用變遷、景觀生態評估、景觀生態指數、二元羅吉斯迴歸、CLUE-s、變異數分析、基隆河流域

Abstract

Exactly how changes in land use and land cover and climate, human and natural environment, soil, water, or ecological systems are related which is a major research area in sustainable development. Furthermore, exactly how land use change impacts landscape ecology is a key topic in urban planning and landscape ecology. Currently, an integrated method is lacking for assessing the interaction between land use policy, driving force, land use change, and landscape structure.

This study presented a novel approach that combines the logistic regression model, CLUE-s (the Conversion of Land Use and its Effect Small regional extent model) model, landscape metrics, multivariate analysis of variance, and landscape scenario assessment methods. The model was tested on the Keelung river watershed in northern Taiwan. Land use data from 1994 was used to simulate land use change in 1999 via the CLUE-s model, and then was used to test the model accuracy. Subsequently, six land use control scenarios, developed based on zoning and agricultural land release policy, were set and used to simulate land use change from 2000 to 2020 in each scenario. These analyses were then tested, including driving factors of land use change, landscape metrics assessment, differently assessment of landscape structure between six scenarios, relationship analysis of land use area ratio and landscape metrics, scenario assessment, and sensitivity analysis of landscape metrics in urban and non-urban areas.

The test of model accuracy for the land use change model, CLUE-s, demonstrates high accuracy in forest, water and built-up areas, and low accuracy in grass and agricultural areas. Furthermore, landscape metric sensitivity tests performed by the Pearson correlation test, and one and two-way ANOVA reveal that three landscape indices, edge density, area weight mean shape index and mean proximity index, are unsuitable for measuring landscape structure in the study area. Meanwhile, two indices, total edge and interspersed and Juxtaposition index, have difficulty representing overall landscape structure difference and mean patch size, and the mean shape index is insensitive for testing structural differences in agricultural landscapes between urban and suburban areas. The application of binary logistic regression to examine drivers of land use change reveals seven major factors driving land use change in the Keelung river watershed, including land ownership, soil erosion

coefficient, altitude, slope, soil depth, distance to roads, and distance to buildup areas. Difference assessment of landscape structure for different land use control indicated that zoning affects landscape structure change more than agricultural land release policy does. On the other hand, the results of relationship analysis of land use area ratio and landscape metrics reveal a high correlation between the ratio of land use area and landscape metrics. Scenario assessment finds that agricultural land release policy and controlled land development in protected water resource areas and forest areas improves landscape structure by making it more integrated.

Finally, this investigation demonstrates that the land use change and landscape ecological assessment models are effective for simulating land use change and landscape structure assessment in the Keelung river watershed. Furthermore, this model has high potential to be linked with land use control policy to reduce land use control problems in Taiwan. In the future, the model can be combined with the climate simulation model, hydrological modeling, and other models to research the land use change problem in detail.

Keywords: Land use policy, Land use change, Landscape ecological assessment, Landscape metrics, CLUE-s, Multivariate analysis of variance, Keelung river watershed.
