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使用類神經網路在洪水推估之研究－以集水區地文特徵為基礎
Flood Estimation Using Artificial Neural Network Based on Physiographic Features of Watersheds

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中文摘要

近年來，類神經網路技術已經成功地應用在集水區降雨逕流的模擬，但是現有的應用架構僅能產生單一集水區適用的流量推估模式，無法進一步用來預測未設流量觀測站集水區的降雨逕流關係，同時也無法評估土地利用變遷所可能造成的水文衝擊。本研究提出一個新的解決方案，透過特徵化與案例化的概念，能夠將集水區地文特徵參數導入類神經網路的學習機制內，使類神經網路模式能夠同時考量地文與水文因子來進行洪水特徵的推估，以突破類神經網路模式現有的應用限制。

本研究使用國內 61 個集水區 292 場水文事件進行實証研究，透過特徵化度量的過程，每個集水區及其發生的水文事件被轉換成一系列特徵參數，並進一步組成特徵化案例庫；地理資訊系統在此過程中扮演了地文特徵度量的重要角色。三層結構的倒傳遞類神經網路以 49 個集水區 243 個案例進行學習，並使用其他案例進行模式驗證，在洪峰流量與洪峰時間二項推論目標上，分別建立了二個集塊型的類神經網路模式雛型。

實証研究結果顯示，以洪峰深度與洪峰發生時間做為推估目標的二個模式雛型，比使用洪峰流量與洪峰稽延做為預測項目的雛型有效，而且洪峰時間推估正確性也比洪峰流量推估來得理想。透過與若干傳統水文模式的評比，本研究建構之模式雛型的正確性，可以達到單位流量歷線模式的水準。經由三項土地利用變遷模擬方案的測試，模式雛型對土地利用變遷可能造成的洪峰流量與洪峰時間變動趨勢之預測，符合水文學的基本原理。總體而言，本研究提出的解決方案確實具有可行性，據以建立的類神經網路模式能夠克服既有限制，廣泛地應用在未設站集水區的洪水推估與土地利用變遷的水文衝擊評估上。

關鍵字：洪水; 集水區; 模式; 類神經網路; 地理資訊系統

Abstract

Although artificial neural networks have been applied successfully on rainfall-runoff modeling in recent years, the current models constructed by using neural network can neither predict the peak flow and the peak time of flood in ungauged watersheds nor evaluate the hydrological impacts of land use changes. This study offers a solution to resolve the limitations of the construction methods that establish current models. It is suggested that based on the concept of event characterization, physiographic features, which have been ignored in current neural network models, can be and should be put into the neural network learning mechanism, and, together with hydrological features, would thus enable the neural network models to remedy the limitations mentioned above .

Four lumped model prototypes of flood estimation are derived from the data of 292 rainfall-runoff events collected from 61 watersheds in various parts of Taiwan, with data from 243 events obtained from 49 watersheds being used to train three-layer structure of back-propagation neural network , and the others for verification. All of the events were characterized as parameters, both hydrological and physiographic, which resulted in a characterizing case-base. In measuring the physiographic features of watersheds, geographic information systems were applied.

Three major findings are located in this study. First, the depth of peak flow and the peak time are more efficient estimation targets than peak flow and lag time. Second, the accuracy of the model prototypes adopted in this study is parallel to that of the unit-hydrograph based models. Third, through the implementation of three simulated scenarios of land use change, estimation of hydrological changes rest upon the model prototypes proposed in this study do conform to the principles of hydrology.

The general conclusion of this study is that, unlike current neural network models which are inapplicable to flood estimation in ungauged watersheds and the evaluation of the impacts of land use change, the model prototypes presented in this study are free from such deficiencies.

Key words：Flood; Watershed; Model; Artificial neural network; Geographic information systems