Application of Self-Organizing Maps for Seasonal and Spatial Classification of the Unconfined Groundwater Hydrogeochemical Factors in the Red River Delta, Vietnam

Thuy Thanh Nguyen, Tokyo Metropolitan University, Tokyo, Japan
Akira Kawamura, Tokyo Metropolitan University, Tokyo, Japan
Naoko Nakagawa, Tokyo Metropolitan University, Tokyo, Japan
Hideo Amaguchi, Tokyo Metropolitan University, Tokyo, Japan

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Introduction

The Red River Delta (RRD) is the second largest delta and one of the most densely populated regions in Vietnam. In the RRD, all its residents depend entirely on groundwater for their domestic water supply. Until recently, very few studies have been carried out to examine the RRD's groundwater-related issues, especially hydrogeochemical characteristics.

Recently, the Self-Organizing Maps (SOMs), an unsupervised Artificial Neural Network, has been widely used as a powerful and effective data analysis tool in the exploration of data properties in many research fields [1]. However, SOM utility in classification of groundwater hydrogeochemitry is rare. This study is the first attempt to apply SOM for investigation of the seasonal and spatial hydrogeochemical characteristic of the unconfined aquifer groundwater in the RRD, Vietnam.

Data used and Methodology

In this study, the groundwater chemistry dataset used in the analysis is composed of 8 major dissolved ions (i.e. Ca^{2+}, Mg^{2+}, Na^{+}, K^{+}, HCO_3^{-}, Cl^{-}, SO_4^{2-} and CO_3^{2-}) that are collected from 47 unconfined groundwater monitoring wells within the study area. SOM, developed by Kohonen [2], can project high-dimensional, complex target data onto two-dimensional regularly-arranged units in proportion to the degree of similarity. In this study, the objective of the SOM application is to classify the unconfined groundwater hydrogeochemical factors in the RRD.

Results

Figure 1a) shows that the groundwater chemistry monitoring data was classified into five clusters. Clusters-1 and 5 are typical of low salinity groundwater type, in which the vast majority of groundwater samples are distributed in the upstream area of the RRD. Clusters-2, 3 and 4 represent the high salinity groundwater type, in which almost all of samples are found in both middle-stream and downstream areas. Changes in the clusters from the dry to rainy seasons were detected in more than 20% of the samples, which were mostly located in the downstream area of the delta, as shown in Figure 1 b). By the systematic application of SOM, it was possible to classify the hydrogeochemical aspect into a number of characteristic patterns with exclusively distinguishable groundwater types. Therefore, SOM was found to be a very effective tool for interpretation of groundwater chemistry.

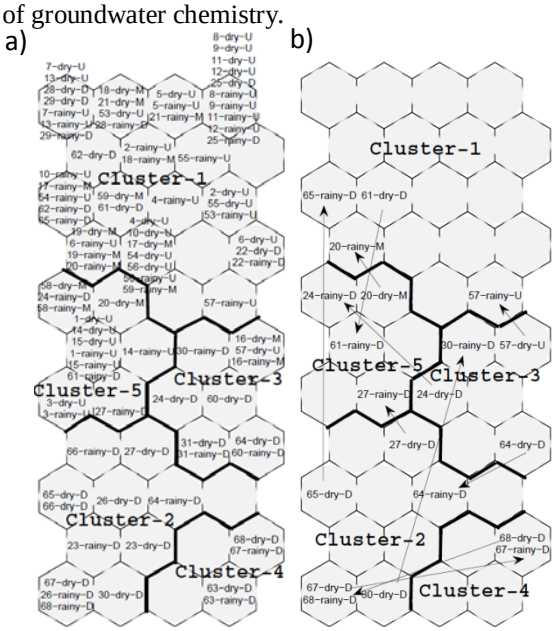

Figure 1: a) Pattern classification map of the five clusters by SOM; b) The changes in clusters from the dry to rainy season. Numbers represent the name of sampling wells. The last characters U, M, D mean upstream, middle-stream, and downstream areas.

References

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