Application and validation of artificial neural network model to groundwater productivity-potential mapping

Lee, Saro

1 Geological Research Division, Korea Institute of Geoscience and Mineral Resources (KIGAM), 124 Gwahang-no Yuseong-gu, Daejeon 305-350, Korea, leesaro@kigam.re.kr

Table 1. Input factors and weights value of each factor.

<table>
<thead>
<tr>
<th>Factor</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ground Elevation</td>
<td>0.041</td>
</tr>
<tr>
<td>Ground Elevation within 300m</td>
<td>0.052</td>
</tr>
<tr>
<td>Forest Density</td>
<td>0.048</td>
</tr>
<tr>
<td>Bedrock Geology</td>
<td>0.041</td>
</tr>
<tr>
<td>Groundwater Depth</td>
<td>0.069</td>
</tr>
<tr>
<td>Groundwater Gradient</td>
<td>0.043</td>
</tr>
<tr>
<td>Hydrogeology</td>
<td>0.043</td>
</tr>
<tr>
<td>Lineament Frequency Density</td>
<td>0.042</td>
</tr>
<tr>
<td>Lineament Length Density</td>
<td>0.047</td>
</tr>
<tr>
<td>Lineament Weighted by its Frequency Density</td>
<td>0.046</td>
</tr>
<tr>
<td>Lineament Weighted by its Length Density</td>
<td>0.045</td>
</tr>
<tr>
<td>Density for Lineament Cross Points</td>
<td>0.043</td>
</tr>
<tr>
<td>River Density</td>
<td>0.041</td>
</tr>
<tr>
<td>River Distance</td>
<td>0.051</td>
</tr>
<tr>
<td>Ground Slope</td>
<td>0.059</td>
</tr>
</tbody>
</table>
This study analysed groundwater productivity-potential using a data-mining classification model such as an artificial neural network (ANN) in a geographic information system (GIS) in Boryeong city, Korea.

The model was based on the relationship between groundwater-productivity data, including specific capacity (SPC) from 72 well locations, and its related hydrogeological factors (Table 1). Data for related factors, including topography, lineament, geology, and forest and soil, were collected and input into a spatial database. The SPC values of < 4.55 m³/d/m, corresponding to a yield of 300 m³/d, were used as criteria for GPP.

The ANN model was used to map groundwater productivity-potential (GPP). In the ANN model, a back-propagation algorithm was applied and the resulting GPP map was created (Figure 1). Finally, the GPP map was validated using area-under-the-curve (AUC) analysis with the well data that had not been used for training the model. The ANN model had accuracies of 83.57%.

To assess the weight (importance) of the factors, the weights were calculated in ANN (Table 1). As a result, “Groundwater Depth”, “Forest Density”, “Ground Slope”, “Ground Elevation within 300 m”, and “Ground Slope” were found to have relatively more weight, whereas “Bedrock Geology”, “Lineament Frequency Density”, and “Soil” had relatively less weight on the GPP maps. These results indicate that the ANN model could be useful for the development of groundwater resources.

Figure 1: Groundwater productivity potential map created using artificial neural network. The index was classified into very high (10%), high (20%), medium (20%), and low (50%) index ranges of the study area.