Assessing Groundwater Vulnerability using DRASTIC: A Review

C. P. Kumar, Former Scientist 'G', National Institute of Hydrology, Roorkee - 247667, India

Abstract

Groundwater is an essential resource for human consumption, irrigation, and industrial uses. However, it is also a finite resource that requires careful management and protection. Groundwater vulnerability assessment is an effective tool for identifying areas at risk of contamination and guiding appropriate management strategies. DRASTIC is one of the widely used methods for assessing groundwater vulnerability. DRASTIC stands for Depth to water, Recharge, Aquifer media, Soil media, Topography, Impact of vadose zone, and Conductivity. This article provides an in-depth review of the DRASTIC method, including its principles, strengths, limitations, and applications. The article also examines the various modifications and improvements made to the method over the years. The review aims to provide groundwater managers and researchers with a comprehensive understanding of DRASTIC and its role in groundwater vulnerability assessment.

Introduction

Groundwater is a vital resource for human consumption, irrigation, and industrial uses. However, it is a finite resource that requires careful management and protection. Groundwater vulnerability assessment is an effective tool for identifying areas at risk of contamination and guiding appropriate management strategies. Several methods are available for assessing groundwater vulnerability, including the DRASTIC method.

The DRASTIC method was developed in the 1980s and has since been widely used for assessing groundwater vulnerability. DRASTIC stands for Depth to water, Recharge, Aquifer media, Soil media, Topography, Impact of vadose zone, and Conductivity. The method uses a combination of seven parameters to determine the vulnerability of groundwater to contamination.

This article provides an in-depth review of the DRASTIC method, including its principles, strengths, limitations, and applications. The article also examines the various modifications and improvements made to the method over the years. The review aims to provide groundwater managers and researchers with a comprehensive understanding of DRASTIC and its role in groundwater vulnerability assessment.

Principles of DRASTIC

The DRASTIC method is based on the principle that the vulnerability of groundwater to contamination is a function of the characteristics of the aquifer and the overlying soil and land use. The method uses seven parameters to assess groundwater vulnerability, each of which is given a weightage based on its importance.

Depth to water: The depth to the water table is an essential parameter in assessing groundwater vulnerability. The closer the water table is to the surface, the more vulnerable

the groundwater is to contamination. The depth to water parameter is given a weightage of 5 in the DRASTIC method.

Recharge: The amount and rate of recharge are critical factors in groundwater vulnerability assessment. The more significant the recharge, the greater the potential for contamination. The recharge parameter is given a weightage of 5 in the DRASTIC method.

Aquifer media: The type of material that makes up the aquifer is an essential parameter in groundwater vulnerability assessment. The more permeable the aquifer, the more vulnerable the groundwater is to contamination. The aquifer media parameter is given a weightage of 5 in the DRASTIC method.

Soil media: The type of soil that overlies the aquifer is also an important parameter in groundwater vulnerability assessment. The more permeable the soil, the more vulnerable the groundwater is to contamination. The soil media parameter is given a weightage of 4 in the DRASTIC method.

Topography: The topography of the area is an important parameter in groundwater vulnerability assessment. Areas with steep slopes are more vulnerable to contamination as contaminants can quickly move downhill. The topography parameter is given a weightage of 3 in the DRASTIC method.

Impact of vadose zone: The vadose zone is the unsaturated zone above the water table. The impact of the vadose zone on groundwater vulnerability is assessed based on factors such as soil type, depth to the water table, and the presence of fractures. The impact of vadose zone parameter is given a weightage of 3 in the DRASTIC method.

Conductivity: The conductivity of the aquifer is a measure of its ability to transmit water. The higher the conductivity, the more vulnerable the groundwater is to contamination. The conductivity parameter is given a weightage of 2 in the DRASTIC method.

The weightage of each parameter is determined based on its importance in groundwater vulnerability assessment. The weightage values are multiplied by the parameter values to obtain a vulnerability index (VI) for each parameter. The VI values are then added together to obtain a final vulnerability index for the area under assessment.

Strengths of DRASTIC

The DRASTIC method has several strengths that make it a popular choice for assessing groundwater vulnerability. Some of these strengths are:

Easy to use: The DRASTIC method is relatively easy to use and requires only basic data such as the depth to water table, soil type, and land use. The simplicity of the method makes it accessible to groundwater managers and researchers with limited resources.

Comprehensive: The DRASTIC method assesses several parameters that influence groundwater vulnerability, including the depth to water, recharge rate, aquifer and soil media, topography, vadose zone impact, and conductivity. The method provides a comprehensive assessment of groundwater vulnerability that accounts for various factors that affect groundwater quality.

Flexibility: The DRASTIC method is flexible and can be adapted to different hydrogeological settings. The method can be modified to include additional parameters or to adjust the weightage values based on the specific conditions of the area under assessment.

Limitations of DRASTIC

The DRASTIC method also has some limitations that need to be considered when using it for groundwater vulnerability assessment. Some of these limitations are:

Lack of specificity: The DRASTIC method provides a general assessment of groundwater vulnerability and does not account for the specific contaminants or sources of contamination in the area under assessment. The method assumes that all contaminants are equally likely to occur in the area, which may not be the case.

Limited data availability: The DRASTIC method requires several data inputs, including depth to water table, soil type, and land use. In some cases, the data may be limited or unavailable, making it difficult to use the method accurately.

Over-reliance on expert judgment: The weightage values assigned to each parameter in the DRASTIC method are based on expert judgment and may not always reflect the actual importance of the parameter in the area under assessment.

Applications of DRASTIC

The DRASTIC method has several applications in groundwater vulnerability assessment, including:

Identification of areas at risk of contamination: The DRASTIC method can be used to identify areas that are most vulnerable to contamination, which can guide the development of appropriate management strategies.

Prioritization of groundwater protection efforts: The DRASTIC method can be used to prioritize groundwater protection efforts, focusing resources on areas that are most vulnerable to contamination.

Evaluation of management strategies: The DRASTIC method can be used to evaluate the effectiveness of management strategies in reducing groundwater vulnerability. The method can be used to monitor changes in vulnerability over time and assess the impact of management practices on groundwater quality.

Modifications and Improvements to DRASTIC

Over the years, several modifications and improvements have been made to the DRASTIC method to address its limitations and improve its accuracy. Some of these modifications and improvements include:

Integration of GIS: Geographic Information Systems (GIS) can be used to integrate the various data inputs required by the DRASTIC method. This can improve the accuracy of the method and make it easier to use.

Incorporation of site-specific parameters: The DRASTIC method can be modified to include site-specific parameters that are not accounted for in the original method. This can improve the accuracy of the method and make it more relevant to the specific conditions of the area under assessment.

Use of machine learning algorithms: Machine learning algorithms can be used to improve the accuracy of the DRASTIC method by identifying patterns and relationships in the data that may not be apparent to human experts.

Development of new vulnerability indices: Several new vulnerability indices have been developed that are based on the DRASTIC method but include additional parameters or modify the weightage values assigned to each parameter.

Conclusion

The DRASTIC method is a widely used approach for assessing groundwater vulnerability to contamination. The method is easy to use, comprehensive, and flexible, making it accessible to groundwater managers and researchers with limited resources. However, the method also has some limitations that need to be considered when using it for groundwater vulnerability assessment. Modifications and improvements to the method have been made over the years to address these limitations and improve its accuracy. The DRASTIC method has several applications in groundwater vulnerability assessment and can be used to identify areas at risk of contamination, prioritize groundwater protection efforts, and evaluate management strategies.