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ABSTRACT

A recharge probability model was produced using GIS ArcView. Grids of 200 x 200 meters were generated from these views. A rating scheme was assigned to each layer based on their recharge effectiveness. Individual rated layers were then summed for a cumulative recharge probability per grid unit.

INTRODUCTION

Location

The "Hill Country" in south-central Texas includes an approximately six county area located in the Edwards Plateau. Its rugged beauty has led to many profound changes over time. Recently, the most important of these changes has been rapid population growth as people from nearby cities move into these once rural areas. This population explosion has shifted much of the residential setting from single-family homes on large plots of ranch land to densely populated subdivisions.

The major water source for these counties is the Trinity Aquifer. The objective of this study is to create a methodology for a large-scale study of the area to understand recharge quantities as they relate to precipitation.

GIS MODEL

A GIS model was built to include the following layers as listed in Table 1.

Geology
Land Use
Soil
Vegetation
Faults & Fractures
Streams

Slope

Each data set was used as a theme or shape file in ArcView. A grid size of 0.002 x 0.002 decimal degrees (latitude x longitude) was chosen, which is approximately 200m x 200m, or 660 feet x 660 feet. Each grid in each layer was assigned a value for recharge potential based on a numerical weighting or rating system (Table 1). Spatially corresponding grids were added using the ArcView Spatial Analyst extension to produce a cumulative rating layer. Figure 1 shows an example of a cumulative grid at the top of the page. The final score of a grid was determined by adding the grids directly below it, i.e. 25 + 35 + 0 + 1 + 10 = 71.

Figure 1. Diagram showing GIS grid stacking (Clark, 2000)

The rating systems used were derived from a number of different sources, including the DRASTIC system (Clark, 2000).

Model LayerLayer SubdivisionsRatingGeologyOther Formations0Lower Glen Rose25Land Use Permeable5SoilOakalla-Boerne-Nuvalde5Brackett-Eckrant10Eckrant-Comfort-Tarpley15Doss-Brackett15 VegetationLive Oak-Ashe Juniper Woods3Live Oak-Mesquite-Ashe Juniper Park5Live Oak-Ashe Juniper Park7Faults & FracturesNo Fault Present0Fault Present35StreamsMajor Streams 0Perennial Streams5Ephemeral Streams7SlopeGreater than 18 percent1Greater than 12 to 18 percent3Greater than 6 to 12 percent5Greater than 2 to 6 percent9Less than or equal to 2 percent10

Shaded region indicates rating used for the test scenario, but not included in the final model.

Table 1. GIS Model Rating Code

Geology

The Trinity Aquifer consists of the Cow Creek Limestone, Hensel Sandstone, and the Upper and Lower Glen Rose Formation. The majority of the ground water is produced from the Lower Glen Rose Formation which contains the Lower Glen Rose Aquifer. The primary source of recharge to the Lower Glen Rose Aquifer is by infiltration of precipitation on outcrop (Hammond, 1984), therefore, outcrop location is the one the most important factors in evaluating recharge potential. It is assumed that the Lower Glen Rose receives no recharge from overlying units; therefore the only Lower Glen Rose outcrops would affect recharge to the aquifer. These outcrops were given a value of twenty-five (25).

Land Use

Land-use data were sorted to show only impervious cover. Areas with pervious cover were assigned a value of 5. The low ranking was chosen to correspond qualitatively with the overall rating system based on its minimal impact on recharge.

Soil

Soils were rated based on their ability or inability to contribute to recharge with the higher numbers assigned to the highest recharge potential. Because all of the soil groupings have similar geologic characteristics, the major factors that determine their recharge capability are slope, thickness, and permeability.

Vegetation

There are only three types of vegetation configurations in Kendall County. They are as follows

1. Live Oak-Ashe Juniper Park
2. Live Oak-Ashe Juniper Woods
3. Live Oak-Mesquite-Ashe Juniper Park

The naming system identifies the type and density of vegetation in the area. An arbitrary rating system was devised for vegetation based on type and thickness of vegetation and included in a preliminary layer addition. Park was given a higher rating than woods based on the assumption that open areas would benefit recharge.

Faults and Fractures

Fault and fracture information was digitized from the long fracture traces in Wermund et. al., (1978). The shape file was then converted into a grid. Fault trace lines were given a value of 35 all other areas were given a default area of zero. This rating system was used because areas with faults traces are considerably more permeable than areas without fractures (Clark, 2000).

Streams

Perennial and ephemeral streams constitute the majority of waterways in the study area. Recharge lost by perennial streams between rain events is counteracted by stream flow gain through aquifer discharge. Therefore, perennial streams were assigned a rating of 5 and ephemeral streams were assigned a rating of 7.

Slope

Slope contributes to the amount of time that water remains on the surface. In general, the longer the time that water is retained on the surface, the higher the probability that it will infiltrate into the subsurface (Clark, 2000). Slope data as listed by Dittemore & Hensell (1981) were taken into consideration when values were assigned to the soil types.

a) excluding vegetation

b) including vegetation

Figure 2. Recharge Probability Maps

The cumulative layers generated in this study show a range of recharge probabilities from precipitation for the study area (Figure 2).

CONCLUSIONS

A GIS model was created by examining a series of features which influence recharge. The features were converted to a grid and assigned a rating code based on their recharge effectiveness. These views were then summed. The final GIS model that excluded vegetation had a rating code that ranged from zero to eighty-seven. Figure 2 shows a range of recharge probabilities. In general, the higher values, which indicate the greatest probability for recharge, were found in areas where fractures coincided with the presence of Lower Glen Rose outcrop. The identification of high recharge areas would be useful in assisting in the location of premium areas for enhanced recharge. Future studies should attempt to better quantify vegetation characteristics and adjust the rating scale accordingly for more accurate recharge rates

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