Title of Proposal: Determining Effects of Brush Clearing on Deep Drainage Using Soil Chloride; A Feasibility Study For South Texas Rangelands

Statement of Critical Regional Water Problems:

Aquifer depletion is of major concern when considering water as a resource in many regions of Texas. There is a need to understand the possibility of using land management as a tool to increase groundwater recharge. It is not entirely known whether the clearing of vegetation will enhance groundwater recharge, however this study may provide some insight into this.

Nature, Scope, and Objectives of the Research:

Introduction

Recharge is affected by both vegetation water uptake (i.e. evapotranspiration) and soil permeability. In this study we will account for differences due to soil permeability and manipulate vegetation cover in order to determine the direct effect of vegetation on recharge. Percolation rates through the soil have a direct affect on deep drainage rates and recharge of the groundwater. Water that is available to plants within the rooting zone for long periods, due to reduced percolation, will fail to provide significant recharge and in some cases, where brush density is high and the soil prevents water movement, recharge will be zero. During large volume, episodic rainfall events, water will be readily available in the upper soil profile for vegetation to access and in most cases will also find its way through to below the rooting zone. In sandy loam soils, like those of the study area and where impermeable layers, such as caliche, are intermittent or non-existent, deep drainage is increased and will help replenish the groundwater.

However, there may be important negative consequences. Deep drainage increases groundwater recharge and base flow in streams and normally the effects are considered positive, however there is evidence that mobilization of salts stored in the soil due to increased leaching could be potentially harmful elsewhere in the landscape. Also, excessive deep drainage is a loss of water that could be used for pastures and crops. We don't know whether brush clearing produces water savings or if the "salvaged" water is used for increased grass production.

An improved understanding of deep drainage is needed to better inform soil water balance modeling, which in turn can be used to measure likely impacts of changing land use on groundwater recharge and quality. Using chloride mass-balance methods to measure deep drainage are a useful tool as they are fairly cost effective for examining large number of sites with standard soil sampling equipment and can make use of existing data and archived samples. Chloride is considered an environmental tracer (Scanlon 1994), being applied on the surface by precipitation.

The study area is located approximately 3 miles (KM) east of Cotulla, TX in La Salle County on Private land – Northcut Ranch. The vegetation is predominantly mesquite, pricklypear, and buffalograss with blackbrush, broomweed and curlymesquite common.

The soil classifications of the area have been described by the Soil Conservation Service (1994) as Brystal-Duval-Webb Series, which consist of very deep, well-drained, sandy loam soils on uplands with slopes of 0-5 percent. The soils are generally moderately to slowly permeable with loamy or clayey subsoils. Caliche layers exist in these soils and will play an important role in inhibiting deep drainage. In our study area, the caliche layers are discontinuous and relatively thin.

The local climate is semi-arid. Total annual precipitation is 21.85 inches and of this, about 14 inches usually falls between April and September. Average daily temperatures range from 55 degrees in winter (44 degrees at night) to 97 degrees in summer (85 degrees at night). The untreated study area has been lightly grazed for a period of at least 15 years.

Root plowing is a common method for improving forage for livestock and its use affects soils to a depth of approximately 50 cm. The brush is then piled and burned.

Objectives

The objectives for this study are to obtain preliminary estimates of soil chloride levels and electrical conductivity in order to provide necessary information to plan a future extensive study. We hope to find differences in deep drainage between vegetation treatments. Something that may emerge from the data is the relationship and/or affects between chloride accumulation and the position and thickness of the caliche layer, thereby helping to quantify any affect on water movement that this layer might have.

Experimental design

There are 3 sites within the study area, each with 4 treatments; a control (not cleared), 3 months, 5 years and 15 years since vegetation removal. This strategy reveals a "Chronosequence" where, assuming soil, climate and geology are uniform over the site, the difference in deep drainage rates between vegetation treatments (and therefore time since clearing) will be observed. For this preliminary study, 4 profiles will be sampled at each of 2 treatments (the control and the 15 years treatment) for 2 of the sites (total of 16 profiles).

Soils will be described and characterized especially for texture and structure. Any caliche layers will also be documented. Each of the soil profiles will be sampled in 10cm intervals at 13 different depths to a total depth of 3 meters. Samples will be tested for soil chloride and electrical conductivity.

Scope

This study is the beginning of a new phase for an ongoing project funded by the Wintergarden Groundwater Conservation District. These TWRI funds will be used for preliminary analyses to assess the feasibility for using chloride mass balance to detect cumulative changes in recharge due to vegetation over time intervals of up to 15 years. The data that we gain from this will enhance and provide vital insights that will guide the remainder of our project.

Expected Outcomes:

We expect to be able to determine rates of deep drainage, using the chloride mass balance data, to see if clearing of vegetation over a period of 15 years will increase groundwater recharge. Any affects of impermeable layers, such as caliche, should be evident in the data.

Citations

Scanlon, B. R. 1994. Water and heat fluxes in desert soils - 1. Field studies. *Water Resources Research* 30:709-717.

Gabriel, W. J., D. Arriaga and J. W. Stevens. 1994. Soil Survey of La Salle County, Texas. USDA Soil Conservation Service 183p.