TEXAS TERROIR: GIS CHARACTERIZATION OF THE TEXAS HIGH PLAINS AVA

E.W. Hellman[1,2], E.A. Takow[3], M.D. Tchakerian[3], and R.N. Coulson[3]
[1]Texas A&M University, AgriLife Research and Extension Center, 1102 East FM 1294, Lubbock, TX 79403 USA
ewhellman@ag.tamu.edu
[2]Department of Plant and Soil Science, Texas Tech University
[3]Knowledge Engineering Laboratory, Texas A&M University, College Station, TX 77843 USA
etakow@tamu.edu

ABSTRACT

The Texas High Plains AVA is one of eight officially recognized wine regions in Texas, established in 1993. Six local wineries, including the second-largest in Texas, are supported by approximately 50 vineyards, which are also major suppliers of grapes to Texas wineries outside the region. The distinctive characteristics of the Texas High Plains AVA have contributed to the region's reputation for producing medal-winning red wines with excellent color and good tannins, primarily from Cabernet Sauvignon and Merlot. The large region (3.6 million ha) is known for its semi-arid climate with hot summers and mild winters, and very deep, well-drained soils. However, little detailed information is available on the spatial variability of growing conditions within the region. The Texas AVA GIS was constructed with datasets describing soils, elevation, topography, and climatic variables of significance to grape production for all 8 winegrowing regions in the state. Growing degree-days (GDD) and ripening period mean temperature (RPMT) in the Texas High Plains AVA decrease from southeast to northwest as elevation increases. The range of GDD is 2028 to 2653. RPMT ranges from 23.8-26.7^{o}C in August and 19.9-22.6^{o}C in September. Precipitation ranges from 41.4-63.7 cm, increasing from west to east. High solar radiation contributes to vine fruitfulness and color development in red wine grapes. Vineyards are predominantly planted on the reddish-brown, deep fine sandy loam and sandy clay loam soils (Amarillo, Patricia, and the related Brownfield series). Patricia soils predominate in the southern portion of the AVA; Amarillo is overall more common and found primarily in central areas of the region. An interactive website was created for public access to the GIS - the Winegrowing Regions of Texas [txwineregions.tamu.edu]. Such data will be critical for vineyard site selection and matching grape cultivars to site as the region's wine industry continues to expand and experiment with warm-climate cultivars.

KEYWORDS: grapes – wine – terroir – GIS - Texas

INTRODUCTION

An American Viticultural Area (AVA) is a "delimited grape growing region distinguishable by geographical features", which is the officially recognized wine appellation system of the U.S. The Texas High Plains AVA, established in 1993, is a new winegrowing region; the first vineyards were planted in the mid-1970's and a small winery opened soon thereafter. At present, there are approximately 280 bearing hectares of vineyards in the region (National Agricultural Statistics Service, 2009) and more than 80 non-bearing hectares of newly planted vines,

reflecting the recent growth in the Texas wine industry. The region is home to 6 wineries, including the second-largest in Texas, and vineyards here have become a major grape supplier to wineries throughout Texas. Prominent grape cultivars in the region are Cabernet Sauvignon, Chardonnay, and Merlot (National Agricultural Statistics Service, 2009), as well as Muscat blanc. Recent plantings demonstrate new interest in Tempranillo, Viognier, Mourvedre, Grenache, Vermentino, and other cultivars anticipated to have good adaption to the region.

Because winegrowing is relatively new on the Texas High Plains, little has been published on the growing conditions of this region. Thorough understanding of winegrowing conditions is critical for selection of vineyard sites, varieties, and rootstocks (Jones, Hellman, 2003). The objective of this research was to construct a geographic information system (GIS) to characterize the spatial distribution of key viticultural attributes of the 8 Texas AVAs; the Texas High Plains AVA is described in this paper.

MATERIALS AND METHODS

Construction of the GIS system is reported in detail elsewhere (Takow, 2008). Climatic data were obtained from Daymet [daymet.org], a climatic database produced from a model that generates daily surfaces of temperature, precipitation, humidity, and radiation over large regions of the entire United States (Thornton et al., 1997). The model utilizes digital elevation models and daily observations from an eighteen year daily data set (1980-1997) to produce climatic variables. The State Soil Geographic (STATSGO) data base was the source of soils data, which consists of georeferenced map data and associated tables of attribute data (Soil Conservation Service, 1994). Map units in STATSGO are a combination of geographically associated phases of soil series. Elevation data were obtained from the National Elevation Dataset [seamless.usgs.gov], and topographic categorization was carried out using 10 meter digital elevation models (DEM) to determine areas of higher elevation and to calculate hill shade values.

RESULTS AND DISCUSSION

The Texas AVA GIS was constructed with datasets describing climatic variables of significance to grape production, soils, elevation, and topography for all 8 winegrowing regions in the state. An interactive website was created for public access to the GIS - the Winegrowing Regions of Texas [txwineregions.tamu.edu].

The Texas High Plains AVA (centroid: 33.8N, 102.2W) is located within the southernmost extension of the vast Great Plains physiographic province of the central United States. It is the second largest AVA in Texas, containing 3.6 million hectares in the western part of the state (Fig. 1). The western boundary of the Texas High Plains AVA is the Texas-New Mexico border, where elevation reaches its highest point at about 1,250 m in the northwest portion of the AVA. The plateau gently slopes down to the southeast where the eastern border of the AVA follows the 914 m elevation contour line.

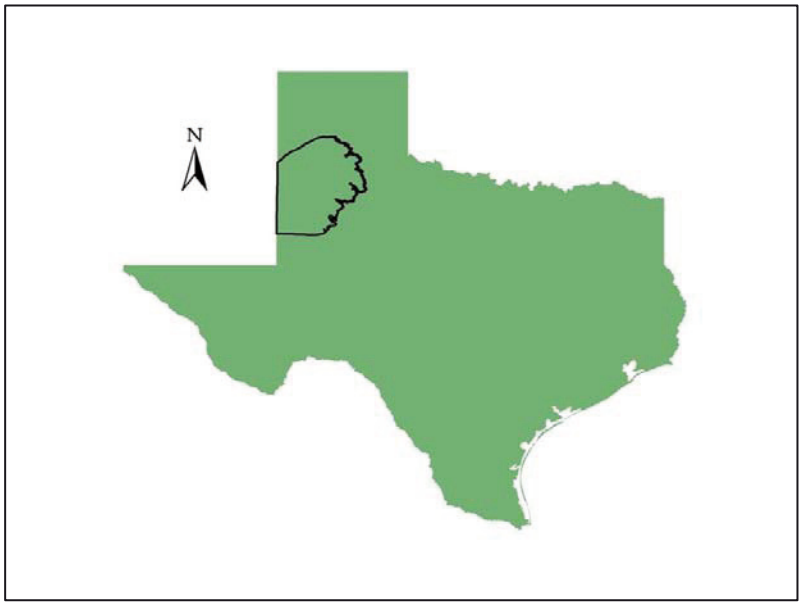

Figure 1. Location of the Texas High Plains AVA within the State of Texas, USA.

Climate. The climate of the Texas High Plains is semi-arid, with hot summers and mild winters. The majority of the region receives an average annual precipitation of about 48.2 cm; the range throughout the AVA is 41.4 to 63.7 cm, increasing from west to east. Cumulative growing degree days (April-October, 10 ^{o}C base) correspond generally to elevation change in the region, with the lowest degree day accumulations experienced in the northwest corner of the AVA, averaging 2028^{o}C, and the highest in the southeast region, 2653 ^{o}C (Fig. 2). Grape ripening period mean temperature ranges from 23.8 to 26.7^{o}C in August and 19.9 to 22.6 ^{o}C in September. Nighttime minimum temperatures range from 16.7-19.4^{o}C in August and from 12.2-15.6^{o}C in September. Solar radiation in the region is high, averaging 20.1 MJ m-2 day-1 for the April-October growing season. Radiation is at its highest during the flower initiation period (May-June) at 22.8 MJ m-2 day-1, and 19.6 MJ m-2 day-1 occurs during fruit ripening (July-September).

Temperatures generally decrease with increasing elevation from southeast to northwest. January is the coldest month; average daily temperature ranges from 2.1 to 5.4^{o}C and minimum temperatures are -5.6 to -2.2^{o}C. Freeze injury to grapevines occurs sporadically, usually in association with a rapid drop in temperature while vines are in early stages of cold acclimation in late autumn or deacclimation in late winter. The region experiences from 1 to 6 days of frost in April, presenting a risk of frost damage particularly to grape cultivars with early budburst.

Climatic conditions of the Texas High Plains are conducive to high quality grape production; although the region is considered a warm climate based on degree-days, temperatures become favorably moderate at night during the fruit ripening period due to the high elevation and low relative humidity. Good fruit color development is attained and vine fruitfulness is high, which are attributable to abundant sunlight and possibly an enhanced ratio of red to far red light

wavelengths reflected from red soils (Gladstones, 1992). Relatively low annual precipitation enables grapevine vigor management through irrigation practices. Low rainfall and low relative humidity also provide an environment conducive to few fungal diseases of grapes.

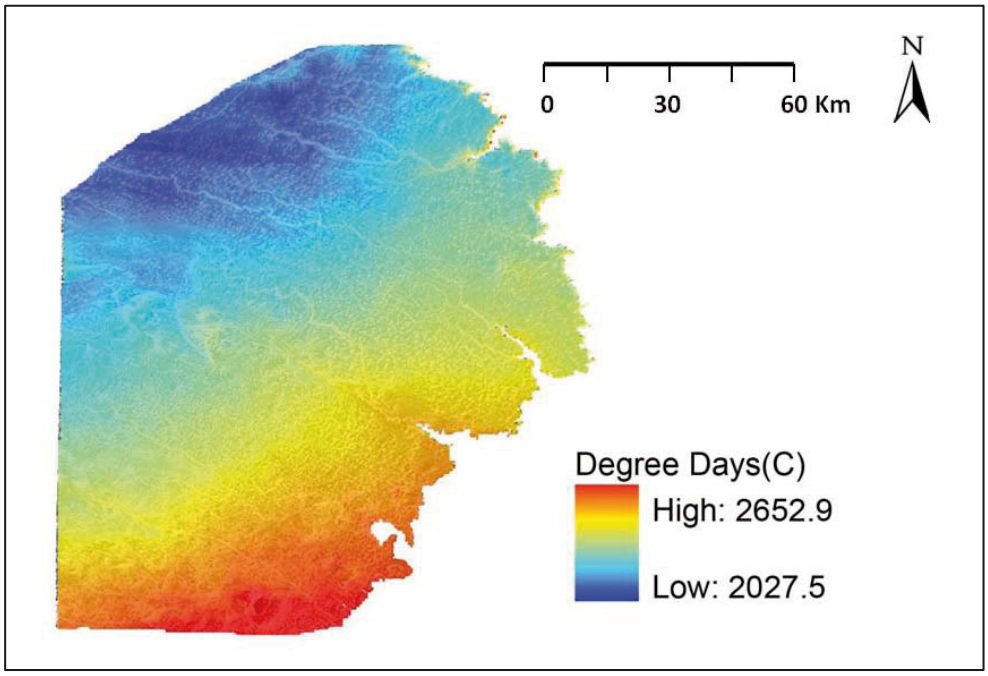

Figure 2. Spatial distribution of accumulated growing season degree days within the Texas High Plains AVA.

Climatic conditions of the Texas High Plains are conducive to high quality grape production; although the region is considered a warm climate based on degree-days, temperatures become favorably moderate at night during the fruit ripening period due to the high elevation and low relative humidity. Good fruit color development is attained and vine fruitfulness is high, which are attributable to abundant sunlight and possibly an enhanced ratio of red to far red light wavelengths reflected from red soils (Gladstones, 1992). Relatively low annual precipitation enables grapevine vigor management through irrigation practices. Low rainfall and low relative humidity also provide an environment conducive to few fungal diseases of grapes.

Soils. The region is characterized by very deep (>150cm), well-developed soils with accumulations of calcium carbonate in the subsoil and clay increasing with depth. Soil texture generally becomes increasing finer from southwest to northeast (Fig. 3). The Texas High Plains contains 31 soil associations, five of which comprise 75% of the acreage in the region: Pullman-Randall-Lofton (22.8%), Amarillo-Acuff-Olton (19.5%), Patricia-Amarillo-Gomez (15.5%), Olton-Acuff-Amarillo (9.5%), and Pullman-Olton-Randall (7.7%). Pullman, Randall and Lofton soils have clayey subsoil horizons with shrink-swell potential and are not commonly planted to grapes. Amarillo, Acuff and Olton are loamy soils; of these, the Amarillo series of fine sandy loam and sandy clay loam soils is preferred for vineyards because of lower organic matter and

fertility. The Patricia series comprises loamy fine sand and sandy clay loam soils that are very well suited to grape production.

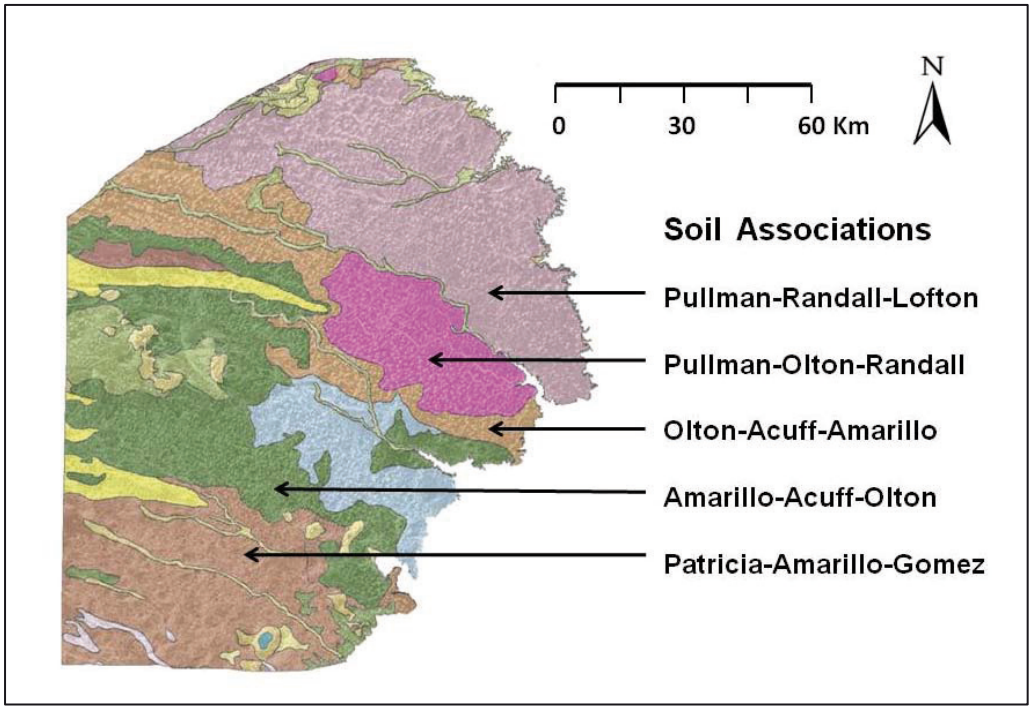

Figure 3. Spatial distribution of soil associations within the Texas High Plains AVA.

The Amarillo-Acuff-Olton association covers nearly 700,000 ha, primarily in the west-central portion of the AVA. It comprises deep soils with sandy loam texture from 0 to 30 cm depth, transitioning into sandy clay loam from 30 to 200 cm. The saturated hydraulic conductivity in the upper 30 cm averages about 8.5 cm/hr; within the sandy clay loam it is approximately 3.2 cm/hr. Soil pH increases with depth; the sandy loam portion is approximately 7.3, while the sandy clay loam ranges from 7.9 to 8.1. Available water capacity at depths of 0-100, 100-150, and 150-250 cm is 15, 22, and 28 cm, respectively.

The Patricia-Amarillo-Gomez association predominates in the southern portion of the AVA. These deep soils have a texture of sand from 0-40 cm depth and sandy clay loam from 40-200 cm. Hydraulic conductivity within the sand is rapid (21-24 cm/hr), and slower in the sandy clay loam, from 3.5 to 6.5 cm/hr. The pH ranges from 7.2 to 7.8, increasing with depth, and available water capacity is 12, 19, and 26 cm at depths of 0-100, 100-150, and 150-250 cm respectively.

Vineyards in the Texas High Plains are predominantly planted on the reddish-brown, deep fine sandy loam and sandy clay loam soils (Amarillo, Patricia, and similar series such as Brownfield) for their combination of good internal drainage and subsoil with enough clay for adequate water-holding capacity. Favorable soil water characteristics, low annual rainfall (see below), and low

to moderate soil fertility enables viticulturists to manage grapevine vigor through irrigation practices, which is an important tool for optimizing canopy microclimate for fruit quality.

CONCLUSIONS

Development of the Texas AVA GIS has enabled a detailed spatial characterization of the Texas High Plains AVA. Vast areas of suitable soils and climate offer the potential for large-scale expansion of vineyards in the region and use of the GIS will facilitate selection of vineyard sites and grape cultivars.

BIBLIOGRAPHY

Gladstones, J., 1992. Viticulture and Environment. Winetitles. Adelaide.

Jones, G.V., and Hellman, E.W., 2003. Site Assessment. In: Oregon Viticulture. Hellman, E.W., ed. Oregon State University Press. Corvallis. pp 44-50.

National Agricultural Statistics Service. 2009. Texas Grape Production and Variety. U.S. Department of Agriculture, PR-114-09. Austin.

Soil Conservation Service. 1994. State Soil Geographic (STATSGO) data base for Texas. U.S. Department of Agriculture, Soil Conservation Service, Fort Worth.

Takow, E. A., 2008. Utility of the American viticultural areas of Texas (AVATXIS) information system as a tool in the characterization of the Texas wine regions. MS thesis. Texas A&M University. College Station.

Thornton, P.E., Running, S.W., and White, M.A., 1997. Generating surfaces of daily meteorology variables over large regions of complex terrain. Journal of Hydrology, 190:214-251.