Spatial Analysis of Ranch in South Texas for Pasture land

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Abstract

Juan De Dios Ranch in south Texas has been used for cattle ranching and hunting for decades. To develop this land and increase productivity, a GIS has been implemented utilizing esri ArcGIS to model the existing terrain and perform spatial analysis determining better areas for specific grass types. Layers of geographic phenomena essential to development are topography, soil types, vegetation index and hydrologic locations for irrigation are analyzed. Overlay analysis of soil, hydrologic, and vegetation layers are compiled to comprise a location of best fit for land development. Data acquired through U.S.G.S., Texas Soil and Water Conservation Board, and Texas Parks and Wildlife Management has been utilized to create a model serving increased productivity and land development.

Introduction

Ranchers and Landowners in South Texas benefit from having deep knowledge of their land; knowledge not only about the spatial attributes of their land but environmental aspects. These environmental aspects include land cover pertaining to vegetation, water, roads, developed areas and soils. Many land owners rely solely on generalized area maps for geographic information regarding their property along with perceptual knowledge of the wildlife and other environmental aspects. Knowledge about one's land can be more fully and accurately acquired through the building of geographic models. The use of geographic information systems (GIS) is becoming widely recognized for modeling these types of systems. A GIS can be used to effectively model individual ranch tracts and determine the most suitable areas for pasture land to increase livestock productivity and wildlife attractant.

To be successful in developing land for these purposes, the proper balance of select vegetation for pasture with native grass species must be maintained. Appropriately stocking a tract of land and continually moving livestock from one pasture to another are vital undertakings in maintaining the balance of select pasture to vegetation which sustains and even promotes the population of wildlife in some cases by ensuring a high quantity of available forage (Texas Parks and Wildlife, 2006).

To ascertain a reasonable quantity estimate for select pasture grass in the Juan De Dios Ranch (JDDR), a GIS model was used for classifying vegetation species within the rangeland surroundings, determine hydrography, and topography. After understanding the diversity of vegetation along with other environmental elements in the model, it is hypothesized that the GIS model will facilitate the determination of the most suitable areas for pasture grass and optimize management of livestock and development

Study Site

Juan De Dios Ranch is approximately 1,800 acres of land located in the county of Zapata (fig.1), Texas out of Porcion 41. The Porcion, being an original Spanish land grant is a long strip of land that lies generally perpendicular to the Rio Grand River (fig.2). The topography of the tract ranges from flat to gently rolling and includes several artificial water reservoirs. The land has been left in a natural state where native grasses and weeds occupy much of the area except for small area well locations and a hunters camp ground. These native grasses and some weeds are essential to the habitat and food supply for wildlife such as South Texas White-Tailed Deer, White-Winged Dove, and Quail. JDDR supports an average of 50 head of cattle that are moved from one pasture to another to allow pasture recovery. The climate is considered to be subtropical-sub humid, average yearly rainfall is 19.53 inches and monthly rainfall averages range from 0.7 to 3.65 inches (ZCCC, 2005). During times of low rainfall averages, grasses become very dry and low in nutrients requiring more grazing pasture to support livestock. This phenomenon is included in the analysis where water reservoirs and ground water well locations are added to the model.

Fig. 1

Fig. 2

Methods

The method used for determining suitability for pasture land is overlay analysis. Through overlay analysis, spatial features on different layers are overlaid and combined from logical conditions. The intersect procedure is used for processing two coverages where only the area that is included in the input coverage that also lies in the intersect coverage will be passed to the output coverage (Yue-Hong, 1997). Layers included in the spatial analysis were color infrared imagery, digital elevation model, and ground reference point coordinates. Soil type was not included as a variable in this study since it is constant throughout the study area and may be taken into consideration after the results of this study for purposes of selecting the type of pasture grass to be planted.

As a base for the intersect coverage, a series of United States Geologic Survey (USGS) standard digital orthophoto quarter-quadrangles (DOQQ) s in color infrared were used. These DOQQ s were flown in 2004, two years before this study, so data pertaining to vegetation, hydrography, and topography are still relevant since there have not been any significant changes to the terrain. The DOQQ s have a 1 meter ground resolution and are in the Universal Transverse Mercator (UTM) projection based on the North American Datum of 1983 (NAD83) Zone 14N which establishes a spatial reference for the GIS.

The color infrared DOQQ s allowed for the determination and classification of vegetation varieties through the use of ground reference points for implementing a supervised classification of the study site after mosaicking and taking a subset of three images that encompass the JDDR. There are three stages in implementing a supervised image classification, the training stage where land cover types and their spectral attributes are identified, the classification stage categorizing each pixel into a class, and the output stage (Thomas, Kiefer, 1994). The identification of clusters of various land cover types and their geographic location within the study site was the training stage of the three stage process (fig. 3). Using ERDAS IMAGINE 8.7 to implement the image classification, an area of interest was selected for each land cover type using the non parametric (feature space) region grow method. The process applied a four pixel neighborhood method for searching pixels and values ranging from 10 to 25 were used for specifying the spectral Euclidean distance depending on the ground cover type being categorized. A new image file was created in the output stage after a resampling of the original color infrared image (fig. 4). After analyzing the classified image, polygons were used to generalize land cover such as grass fields, roads, bare ground, water, weeds, and tree canopy as well as to convert the data from raster to vector for overlay analysis (fig. 5).

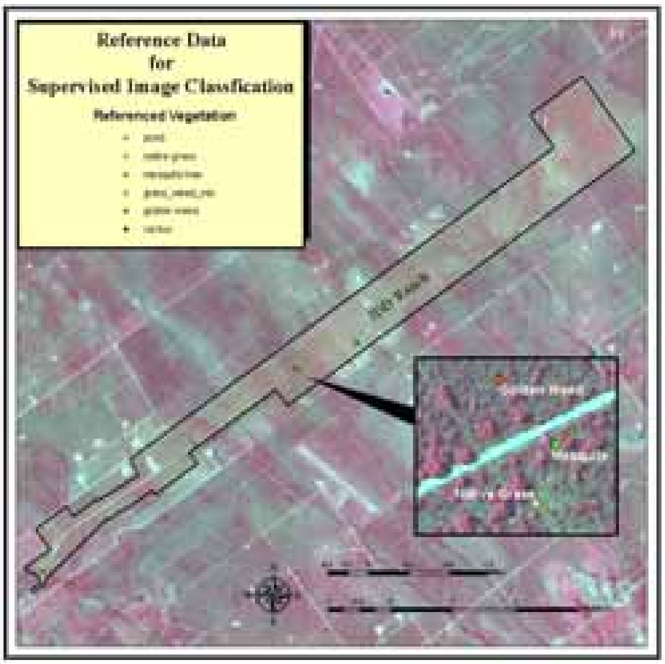

Fig. 3

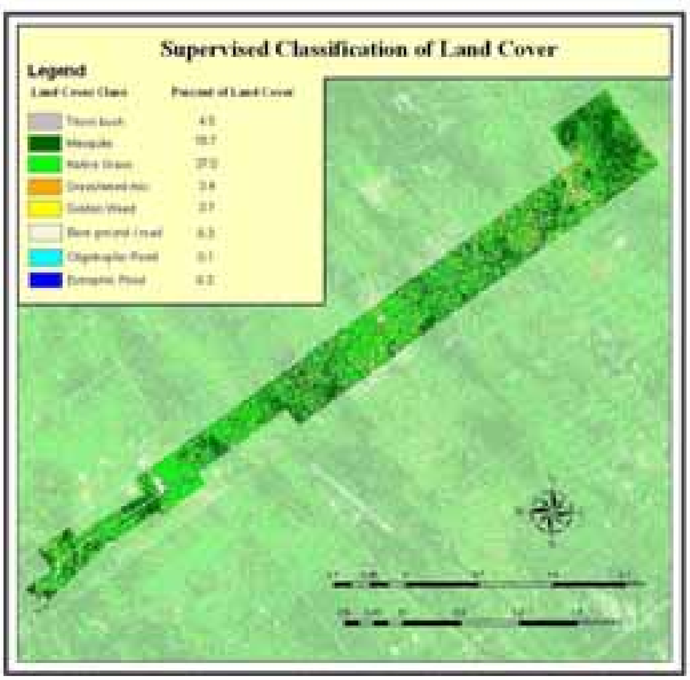

Fig. 4

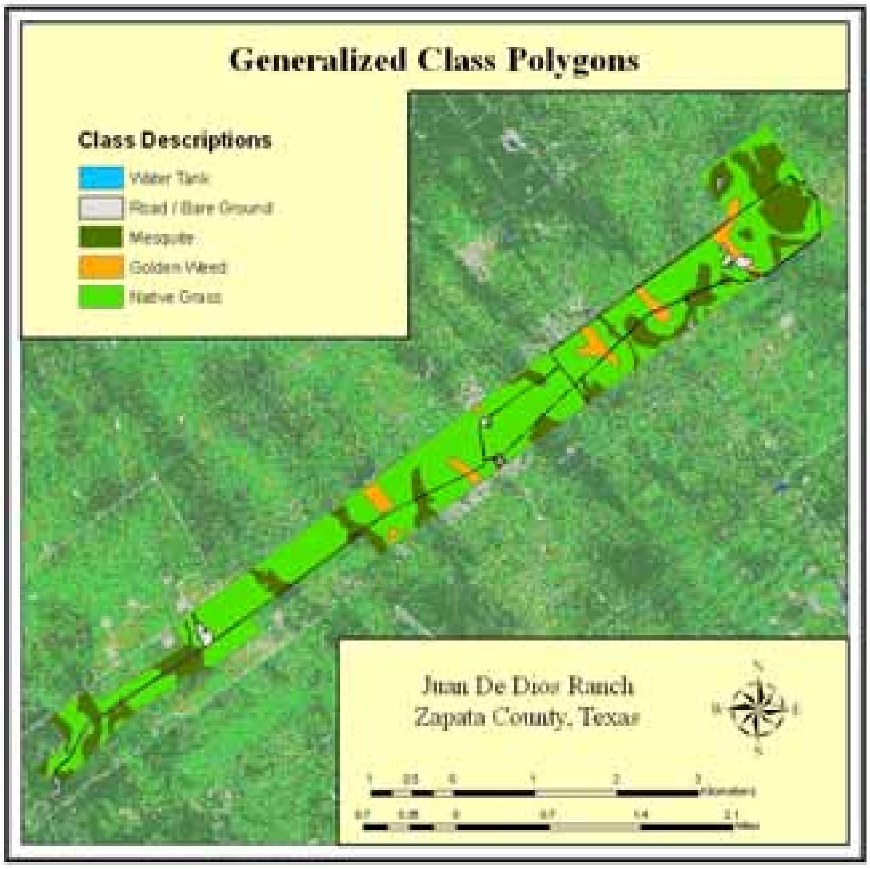

Fig. 5

Another dataset added to the GIS was a digital elevation model (DEM) which was used to generate hillshade, contours and determine areas with greater runoff amounts. These attributes are typically derived from a DEM for use in a GIS (Yamada et al, 2005). The DEM was acquired through the USGS National Elevation Dataset (NED) in the same horizontal datum of NAD 83 but uses NAVD88 for elevation values in meters. The hillshade layer was generated with ESRI ArcView 9.1 using an azimuth value of 225 and altitude of 60 to emphasize the valleys of the terrain which were required to determine runoff areas. A contour map was also generated using the DEM to further emphasize valleys and stream areas (fig. 6). Using the hillshade and contour layers, vector data was added to represent areas of greater runoff amounts.

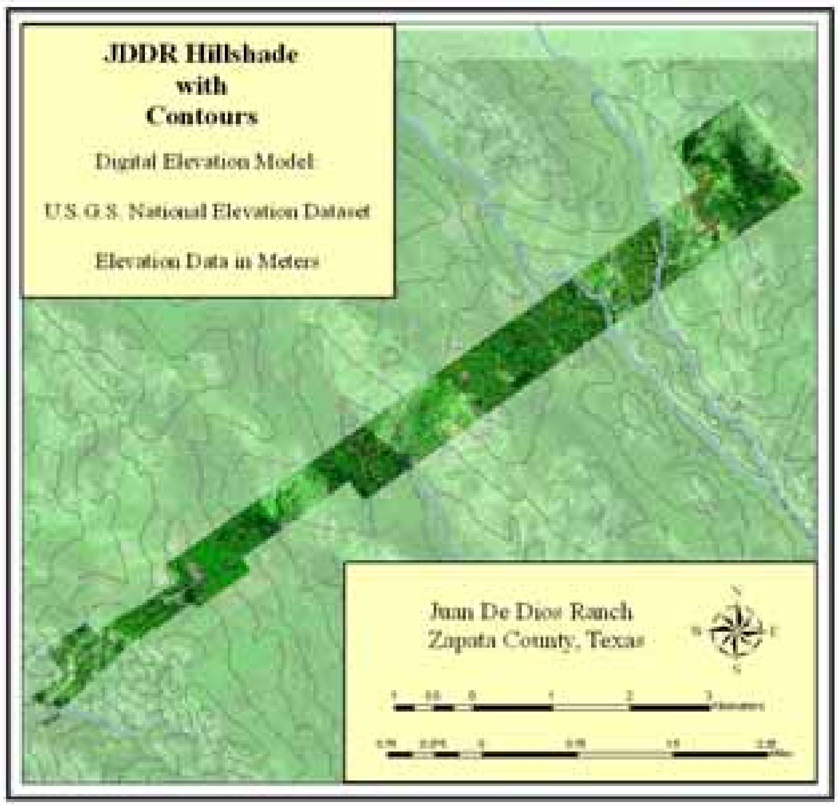

Fig. 6

Results

When combining all vector data generated from the classified image and the DEM, buffer zones were generated (fig. 7) creating overlaps of suitable areas and non-suitable areas for select pasture grass. Suitable areas were those surrounding hydrographic regions such as artificial water tanks and areas of greater runoff. Non-suitable areas were those surrounding tree canopies and infrastructure such as roads, gas well locations and gas pipelines. Suitable sites that resulted in areas surrounding artificial water tanks amounted to approximately 70 acres of land which could be irrigated from stored rain water or ground water. The total approximate area for suitable sites excluding those that fell within infrastructure and tree canopy buffer zones amounted to approximately 130 acres (fig. 8).

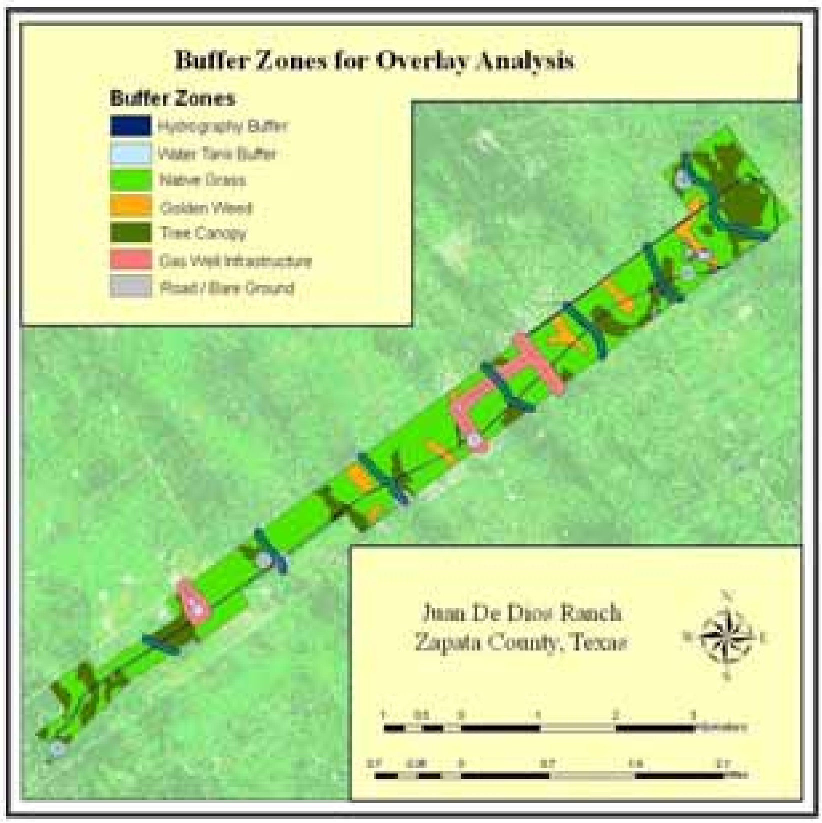

Fig. 7

Discussion

The suitable areas in the study site are positioned such that any select pasture grass to be grown should thrive being in close proximity to irrigation water and/or water from runoff even in months of low rainfall intensities or drought. The 130 acre area is a low percentage of developable land relative to the area of the entire tract. As a pilot project, however, this amount is reasonable as issues of cost of development and environmental impact should be taken into consideration. The various specious of wildlife that exist forage on grass, but prefer forbs (weeds) and/or browse (twigs, shoots, and leaves) and cannot sustain solely on grass if their primary forage disappear. The balance of select pasture grass to native vegetation must be maintained (Texas Parks and Wildlife, 2005)

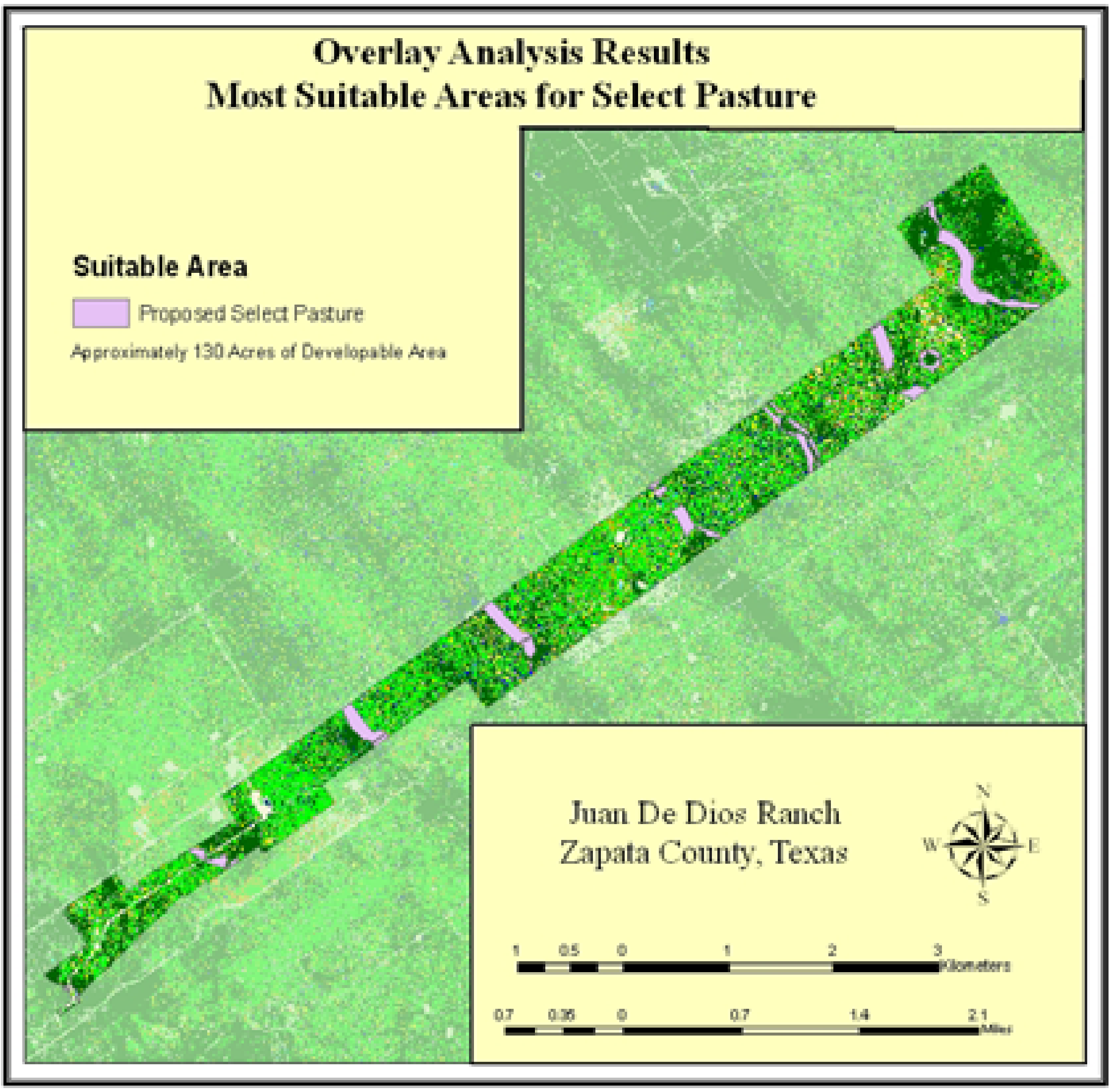
Overlay Analysis Results
Most Suitable Areas for Select Pasture
Suitable Area
Proposed Select Pasture
Approximately 130 Acres of Developable Area
Juan De Dios Ranch
Zapata County, Texas
N
W
E
S
1
0.5
0
1
2
3
Kilometers
0.7
0.35
0
0.7
1.4
2.1
Miles

Fig. 8

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