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MAPPING SOIL ORGANIC MATTER CONTENT IN FLOODPLAINS USING A DIGITAL SOIL DATABASE AND GIS TECHNIQUES: A CASE STUDY WITH A TOPOGRAPHIC FACTOR IN NORTHEAST KANSAS

Sunyurp Park*

Abstract

Soil organic matter (SOM) content and other physical soil properties were extracted from a digital soil database, the Soil Survey Geographic (SSURGO) database, to map the amount of SOM and determine its relationship with topographic positions in floodplain areas along a river basin in Douglas County, Kansas. In the floodplains, results showed that slope and SOM content had a significant negative relationship. Soils near river channels were deep and nearly level, and they had the greatest SOM content in the floodplain areas. For the whole county, SOM content was influenced primarily by soil depth and percent SOM by weight. Among different slope areas, soils on mid-range slopes (10-15%) and ridgetops had the highest SOM content because they had relatively high percent SOM content by weight and very deep soils, respectively. SOM content was also significantly variable among different land cover types. Forest/woodland had significantly higher SOM content than others, followed by cropland, grassland, and urban areas.

1. INTRODUCTION

Natural floods provide essential ecosystem services, keeping riparian ecosystems healthy and productive, and creating floodplains by fluvial aggradation or lateral stream planation. Individual floods leave overbank deposits over older sand and gravel point-bar deposits and create nearly level landscape, which is mostly used for agricultural land. Floodplains are usually very fertile since its nutrients are renewed periodically by fresh deposition (Muller and Oberlander 1984). Floodplain deposits provide an important food source for aquatic life and

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* Department of Geography, University of Kansas

mineral soils required for woody-plant establishment (Gill 1973; Yarie et al. 1998). Since floodplain soils have high organic matter content, they are also important potential sinks for soil organic carbon storage (Wigginton et al. 2000). Despite the important roles of floodplains as a nutrient source, a soil carbon sink, and wildlife habitat (Fredrickson 1978; Lowrance et al. 1984; Ramankutty and Foley 1998), there are few studies that estimate and map the amounts of soil organic matter (SOM) in floodplain areas. Especially, grassland soils are believed an important component for SOM dynamics (IPCC 1990). Knowing that floodplain lands are used for a variety of land uses, and SOM content varies spatially, estimation and mapping of SOM content is important for resource management of floodplains areas.

The distribution of SOM content is usually related with topographic factors (Dunn and Stearns 1987; Brunet and Astin 1997). Determining a relationship between SOM content and topographic factors is a critical element for understanding the dynamics of SOM in the environment. Microtopography, topographic position/relief, and erosion can affect thickness, density of the A horizon and eventually change SOM content (Kachanoski et al. 1985; Moulin et al. 1994; Gregorich et al. 1998; Bergstrom et al. 2001). It is well documented that one of the main contributing factors to soil-carbon storage is land use/land cover (LULC) (Sarmiento and Wofsy 1999; Houghton et al. 1999; Caspersen et al. 2000; Garten and Ashwood 2001). Since the conversion of prairie lands to agricultural fields has been made rapidly in the central Midwestern U.S.A. since the mid 1800s, the relationship between SOM content and LULC is also important for modeling SOM dynamics (Ramankutty and Foley 1999). There is no publication about rapid SOM mapping in floodplains in this region. Using the georeferenced spatial soil database and remotely sensed data, soil characteristics can be effectively incorporated into and analyzed by Geographical Information Systems (GIS). The purpose of this study is to map the amounts of SOM in floodplains, and determine their relationship with topographic factors and land use/land cover types in northeastern Kansas.

2. STUDY AREA AND MATERIALS

1) Study Area

The study area is Douglas County, Kansas, which is in the northeastern part of the state and has a mid-continental temperate climate (Figure 1). The county receives an average of 900 mm of precipitation per year with 70% falling during the growing season (April through September). The average annual temperature for Douglas County is 13℃ with a mean low monthly temperature of -2℃ in January and a high of 26℃ in July. The county has undulating topography with elevations ranging from 237 to 365 meters. Farming is one of the dominating landscape features in the county, and 47 percent of the acreage is cultivated. Corn, grain sorghum, soybeans, wheat, and alfalfa are the principal crops. The native (warm season, C_4 photosynthetic pathway) and non-native native (cool season, C_3, photosynthetic pathway) grasslands cover 41% of the county, which has a total area of 122,766 ha (Whistler et al. 1995). The dominant warm-season grasses in clude big bluestem (Andropogon gerardii Vitman.), little bluestem (Andropogon scoparius Michx.), Indiangrass (Sorghastrum nutans), and switchgrass (Panicum virgatum L.). The dominant non-native grasses are smooth brome (Bromus inermis Leyss.), tall fescue (Festuca arundinacea Schreb.), Kentucky bluegrass (Poa pratensis L.), and orchard grass (Dactylis glomerata L.) (Guo et al. 2000). The remaining land cover types in the county in their respective order of dominance include forest/woodland (12%), urban area (3%), and water (3%) (USDA 1977; Whistler et al. 1995; Egbert et al. 2001).

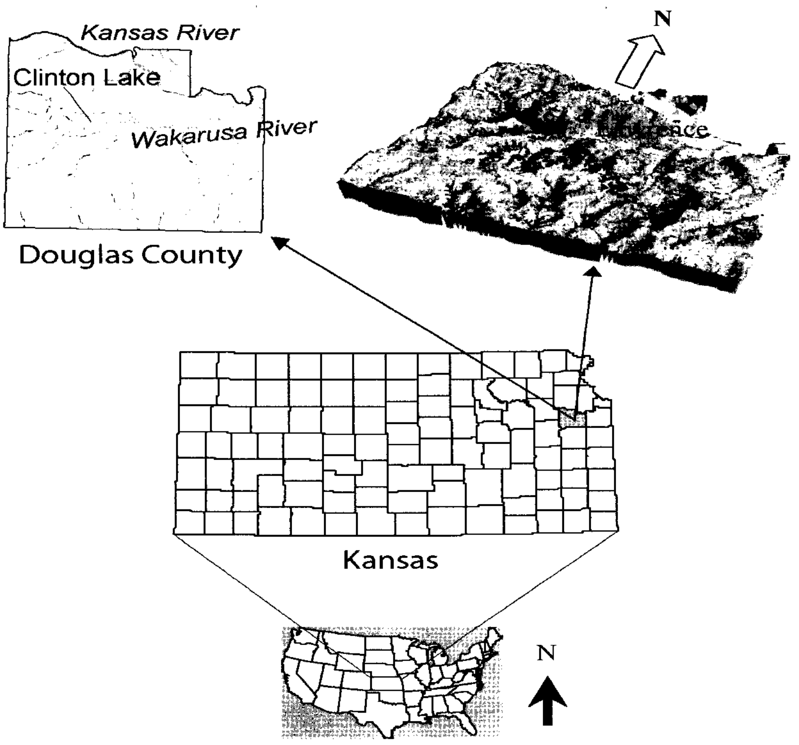


Figure 1. Study area. Major hydrological features are superimposed on the county boundary map of Douglas County (a), and land cover map is draped over digital elevation model for the county, creating a better view of three-dimensional landscape (b).

2) Soil Database

A digital soil database, known as the Soil Survey Geographic (SSURGO) database, is a valuable source for soil mapping and soil-property extraction (Nellis et al. 1996; Wu et al. 1997; Wu et al. 2001). The U.S. Department of Agriculture' s (USDA) Natural Resources Conservation Service (NRCS) collects, stores, maintains, and distributes the database (USDA 1995). The SSURGO database contains detailed information about soil properties and is designed primarily for farm and ranch, landowner, township, or county natural resource planning and management. The SSURGO database for Kansas has been converted to a digital format (Arc/Info coverages) and is available at no charge from the Kansas Data Access Support Center (DASC) of the Kansas Geological Survey at the University of Kansas (http://gisdasc.kgs.ku.edu).

The SSURGO database consists of geo-referenced spatial data, attribute data, and metadata. The spatial data are spatial objects expressed as polygons, lines, and nodes, whose coordinates represent real locations on the eart h' s surface. The attribute data contain both estimated and measured data on the physical/chemical soil properties and soil interpretations for engineering, water management, recreation, agronomic, woodland, range, and wildlife uses of soils. Metadata, or data about data, describe the content, quality, condition, history, and other characteristics of the data.

The fundamental graphic feature in STATSGO is the map unit (Figure 2). Each map unit is designed as a separate polygon and represents an area dominated by one to three soil components. Each soil component has up to six layers (soil horizons). Soil

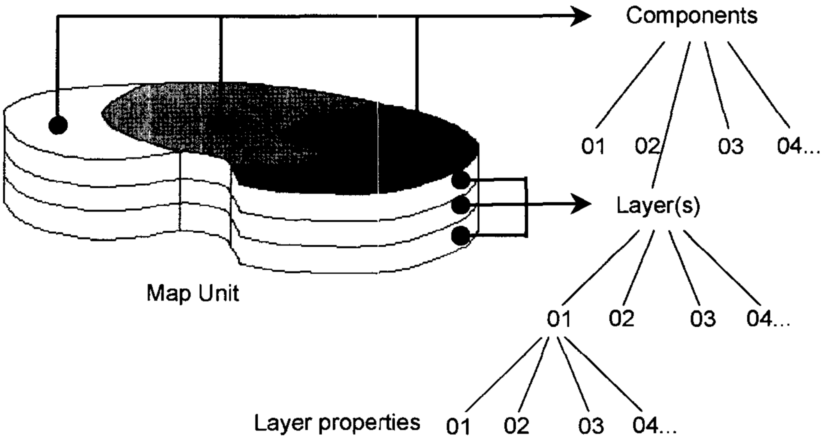


Figure 2. SSURGO map unit. Each map unit can have multiple components and each component can have multiple layers. Individual soil properties are associated with unique map unit identifier (MUID). The analysis begins from lowest level (layers) and integrated back to the highest level (map unit) (USDA 1977).

maps in the SSURGO database are made using field methods. Surveyors observe soils along delineation boundaries and determine map unit composition by field traverses and transects. Aerial photographs are interpreted and used as the field map base. Line segments are digitized from USGS 7.5-minute topographic quadrangles or the 1:12,000 or 1:24,000 orthophotoquads as the mapping bases, which meet the National Map Accuracy Standards (USDA 1995).

In addition to physical and chemical properties, the database also includes flood frequency data. The data categorize the frequency of annual flooding that is likely to occur during the year. It has three levels; frequent (>50% chance of flooding), occasional (5 to 50% chance of flooding), and rare (0 to 5% chance of flooding). These categorical data was extracted from the SSURGO data, and converted into a raster image for comparison with other datasets (Figure 3-c).

3) Maps and Satellite Imagery

To delineate floodplains as accurately as possible, several data sources were used, including a land use/land cover map, digital elevation model (DEM), Landsat Thematic Mapper (TM) imagery, and a topographic map. These data were projected to Universal Transverse Mercator (UTM) coordinates, and compared with each other using ERDAS Imagine, an image processing software program. The descriptions of these datasets are as follows.

Land use/land cover map (LULC). A recently updated land cover map for Kansas was used. The Kansas Applied Remote Sensing (KARS) Program at the University of Kansas recently finished a mapping project, the Gap Analysis Program (GAP), for natural vegetation classification using Landsat TM imagery and ancillary data. The original classification was conducted with 41 vegetation-alliance level classes (Stewart et al. 2000; Kansas Applied Remote Sensing Program 2002). From this detailed map, a generalized map was created at the Anderson level I, which includes grassland, cropland, forest/woodland, water, and urban areas (Figure3-a). This land use and land cover classification system was devised by the US Geological Survey in the mid-1970s for use with remote sensor data (Anderson et al. 1976). The Anderson system includes four different levels of information (level I to IV). This multilevel system has been devised because different degrees of detail can be obtained from different aerial and space images with various image resolutions. Level I was originally designed for low to moderate resolution satellite data such as Landsat imagery (Lillesand and Kiefer 2000). One characteristic of the system is that classification categories in each level must aggregate into the categories in the next higher level. The overall accuracy of the map used for this study is 89% (Egbert et al. 2001).

Digital Elevation Model (DEM). Three DEM files were obtained from Kansas

Geological Survey to cover entire Douglas County. The product consists of a regular array of elevations referenced on the geographic coordinate system. The unit of coverage is a 30-by-30 minute block. The three coverages with a USGS-DEM format were converted to ERDAS Imagine images with 30-meter resolution and put together to make a single image (Figure3-b).

Landsat TM imagery. Multi-temporal TM images (path/row = 27/33) were obtained from the archive of the KARS Program. The data acquisition dates are April 21, July 21, and October 25, 2001, and each image included bands 3, 4, 5, and 7. Multiple-date images provide better differentiation between

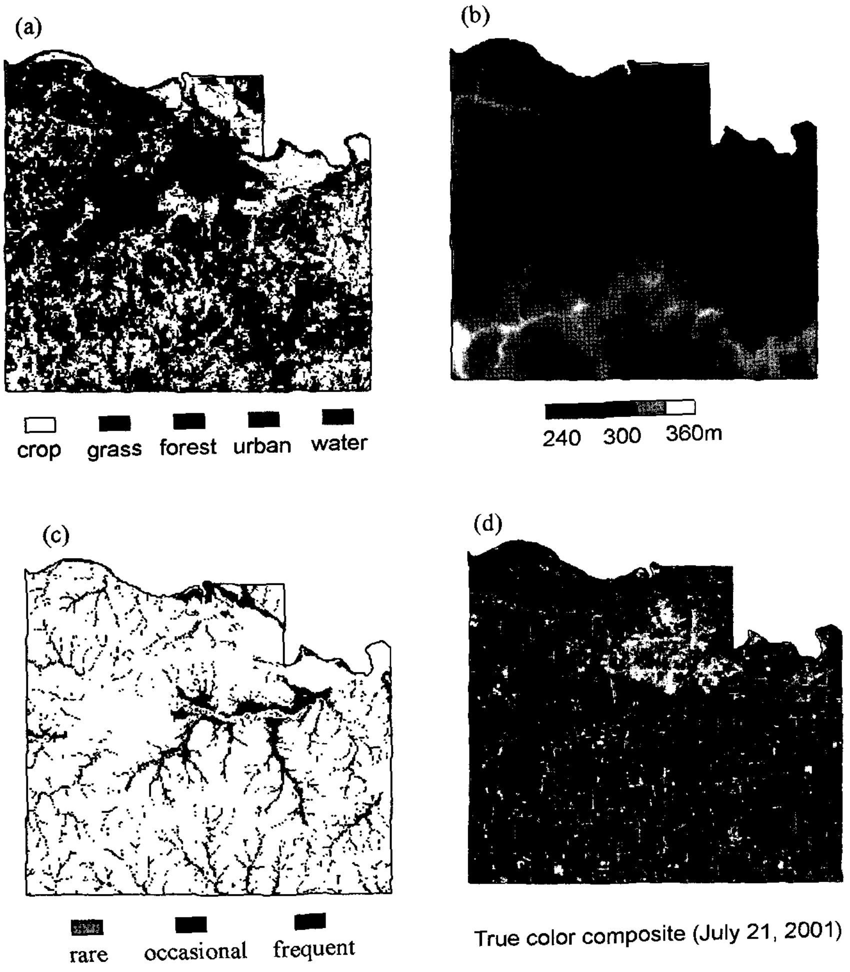


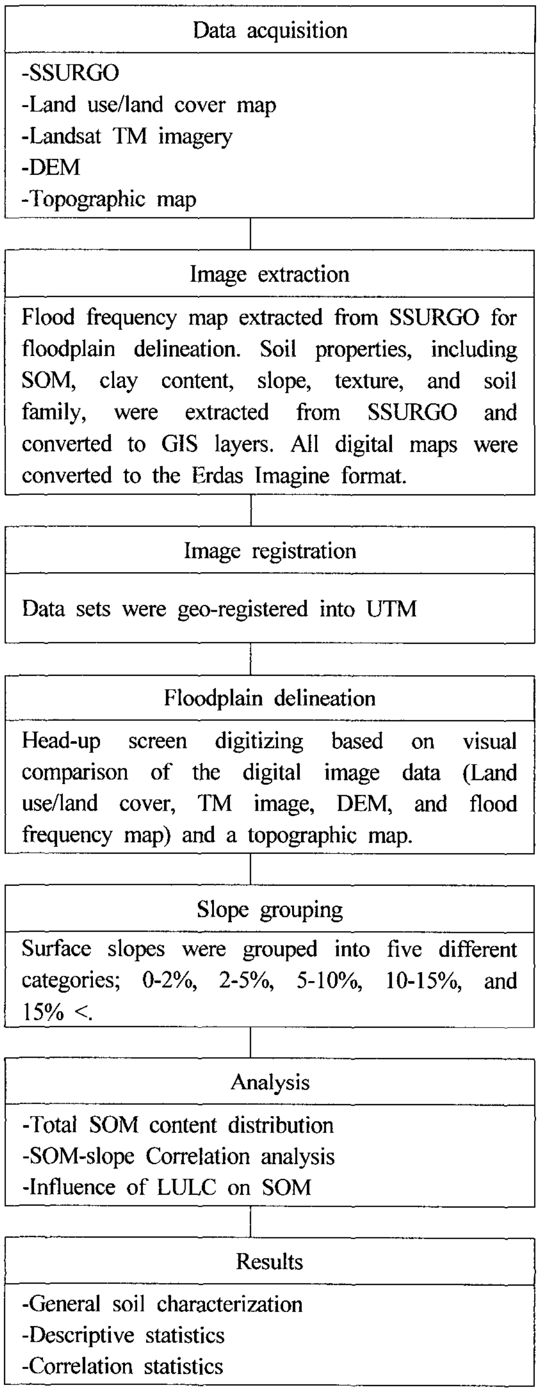
Figure 3. Four data sources that were used for floodplain delineation-Anderson level I land cover map (a), digital elevation model (DEM) (b), flood frequency map (c), and Landsat Thematic Mapper imagery (d).

ground objects, especially vegetation, compared to single-date images because multiple dates increase the likelihood of sensing the differences among vegetation types. The Optimal index factor (OIF) described by Jensen (1996) was used to select the least inter-correlated bands with greatest variance. It is based on the amount of total variance and correlation within and between various band combinations. Bands 3, 4, 5, and 7 were selected because they were consistently ranked as having the highest OIF values. Figure3-d shows the true color composite image (bands 1, 2, and 3) from imagery acquired on July 21, 2001.

Topographic map. The 1:100,000-scale metric topographic map of Douglas County, Kansas was also used (USGS 1981). Elevation contour lines were examined in detail and compared to the other images for floodplain identification. It has contour intervals of 10 meters and supplementary 5-meter intervals.

3. METHODOLOGY

Various soil attributes, including SOM, soil depth, area, soil bulk density, clay content, slope, texture, and soil family, were extracted from the SSURGO to calculate total SOM content and describe general characteristics of each map unit. Then, the impacts of surface slope and LULC on total SOM content were evaluated. The flow of the study is briefly shown in Figure 4.



Data acquisition

-SSURGO
-Land use/land cover map
-Landsat TM imagery
-DEM
-Topographic map

Image extraction

Flood frequency map extracted from SSURGO for floodplain delineation. Soil properties, including SOM, clay content, slope, texture, and soil family, were extracted from SSURGO and converted to GIS layers. All digital maps were converted to the Erdas Imagine format.

Image registration

Data sets were geo-registered into UTM

Floodplain delineation

Head-up screen digitizing based on visual comparison of the digital image data (Land use/land cover, TM image, DEM, and flood frequency map) and a topographic map.

Slope grouping

Surface slopes were grouped into five different categories; 0-2%, 2-5%, 5-10%, 10-15%, and 15% <.

Analysis

-Total SOM content distribution
-SOM-slope Correlation analysis
-Influence of LULC on SOM

Results

-General soil characterization
-Descriptive statistics
-Correlation statistics

Figure 4. Data preparation, image extraction, and analysis procedures in the study.

1) Soil Property Extraction

A hierarchical relationship between a map unit, components, soil layers, and soil attributes is shown in Figure 2. Because of this one-to-many relationship, analyses must begin at the lowest level in the schema. Since each component has several layers, each soil property of interest has to be calculated in each layer, and then integrated over multiple layers to create a value for that soil component. Once soil property values of each component in a map unit are computed, a weighted average of these values is obtained for that map unit by multiplying the component values by their proportions in the map unit. Attribute data in the SSURGO database were analyzed using the Microsoft Access, a database management software package. After soil property values were calculated for each map unit in the database, these values were added to the polygon attribute table of their spatial data based on their map unit identification. Since the initial spatial data (Arc/Info coverage) format was a vector, the spatial data layers for each soil property were converted to a raster format for further image analyses.

To compute the total amount of SOM for the soil whole column of a map unit, SOM expressed in percent by weight, soil bulk density, and soil depth for each map unit were extracted from the SSURGO database and rasterized with a spatial resolution of 30 meters. Since soil bulk density is expressed in grams per cubic centimeter and soil depth is in centimeters, the amount of SOM in each image pixel is computed using a following formula:

$$\text{Total SOM (g)} = \text{SOM (\%)} \times \text{Soil depth (cm)} \times \text{Area (m}^2\text{)} \times \text{Soil bulk density (g/cm}^3\text{)}$$

Other properties, such as soil texture, clay content, slope, and soil class, were also analyzed to determine general soil characteristics in the study area.

2) Floodplain Delineation

For SOM calculation in floodplains, the delineation of floodplains of the study area was needed. With reference to the topographic map, all the digital data were carefully examined at a time on screen using the ERDAS Imagine software program. Since all the images were projected onto UTM coordinates, head-up screen digitizing was performed for the delineation after they were geometrically linked to each other for effective visual comparison.

The overall extent of floodplains was generally depicted on the topographic map with its flat characteristic. The distribution of floodplains is represented well by the land use/land cover map because most floodplain areas are used as agricultural land. The decision of floodplain boundary lines was supervised by Landsat TM imagery, which provided an aerial view of the landscape features. DEM data were considered helpful in separating floodplain zones from upland areas from a terrain elevation perspective. DEM data were also helpful in creating smoothed curvy floodplain boundary lines along contour lines when the maps and the Landsat TM image did not correspond to each other very well. Input data also included a flood frequency map because it was assumed that frequently- or occasionally-flooded areas should be categorized into floodplain areas. Each of these data sets is shown in Figure 3.

3) Topographic Factors

Geochemical dynamics of soils is controlled by interactions among landscape characteristics, such as topographic factors (Hook and Burke 2000; Phillips et al. 2001). Since the distribution of SOM is closely related with topographic positions, surface slope and elevation are believed to be important control factors for SOM content across the landscape. To determine the influences of slope on the SOM content within floodplain areas, a correlation between the two elements was computed. Since each soil property was calculated by map unit, correlation analysis was performed at the map-unit level. The SOM content of the floodplains was also compared to that of other topographic positions, including slope segments with different slope angles and ridgetops outside the floodplains. Ridgetops were defined as areas with slope gradients less than 2% and elevations of 330 meters or higher, which is the highest elevation range in the study area. Slope areas were categorized into four levels; 2-5%, 5-10%, 10-15% and >15%. These slopes were identified only where they were higher in elevation than floodplains to separate them from floodplain areas.

4) Land use/land cover (LULC) relations

Land cover mapping became a crucial tool for better estimation of carbon pools since land use/land cover is a determinant component contributing to SOM content (Moraes et al. 1998). The exchange of nutrients and energy flow between vegetation and soil contributes to chemical and physical properties of the soil through SOM interface (Swift et al. 1979). Therefore, different ranges of SOM content may be found in different LULC types. SOM variation is particularly expected in floodplain systems because floodplains is known as one of many active physiographic areas where plant developments are most obvious (Clements 1916). Moreover, SOM concentration in the surface layer of soil is influenced by agricultural management practices (Martel and Paul 1974; Monreal et al. 1997; Dick et al. 1998; Rasmussen et al. 1998; Post and Kwon 2000). This study also aimed to determine if there was any variation in SOM content among different land cover types in the floodplains. A land use/land cover map based on the Anderson level I classification scheme was used to determine the relationship. The SOM content in each land cover type was calculated and compared to each other.

4. RESULTS AND DISCUSSION

1) General soil characteristics

To describe the overall soil characteristics of Douglas County and floodplains within the county, five soil attributes, including SOM content, clay, slope, texture, and soil family, were extracted from the SSURGO (Table 1). The floodplain areas had a narrower range of SOM content but a higher mean value (SOM=1.18%) compared to the entire county (SOM=1.05%). The ranges of percent clay were similar to each other, but the floodplains had a slightly greater mean value. It is not surprising to have a significantly lower slope for the floodplains (1.3%) compared to the county as a whole (5.2%). The floodplains had well-drained to very poorly-drained soils, which were deep and nearly level, on bottom lands (USDA 1977). Silty clay loam, silty clay, and silt loam were among the most dominating textures in the study area. Five major soil family types were found in the county, and all of them belonged to Mollisols. Mollisols are characterized by their soft layers and dark colors due to abundant humus. They are extensively distributed in the North American Great Plains and intermontane plateaus (Steila and Pond 1989). Most of the soil families found in the county fell on the 'Argiudolls' great group, which is moist soil with argillic horizons. On floodplains, three soil family

Table 1. A comparison of soil properties between entire Douglas County and Wakarusa floodplain areas.

	Douglas County			Floodplains		
	Min	Max	Mean	Min	Max	Mean
OM (%)	0.16	4.70	1.05	0.30	2.40	1.18
Clay (%)	6.6	48.4	34.5	7.1	48.4	36.7
Slope (%)	0.5	25.5	5.2	0.5	12.5	1.3
Texture	Silty clay loam (53.9%) Silt loam (23.4%)			Silty clay (42.7%) Silt loam (36.8%)		
Soil Family	Fine, smectitic, mesic Aquertic Argiudolls (18.6%), Fine, smectitic, mesic Typic Argiudolls (12.9%), Fine, smectitic, thermic Abruptic Argiaquolls (11.2%), Fine-loamy, mixed, superactive, mesic Typic Argiudolls (12.5%), Loamy, mixed, superactive, mesic, shallow Typic Hapludolls (17.1%)			Fine, smectitic, mesic Vertic Endoaquolls (45.9%), Fine-silty, mixed, mesic Pachic Argiudolls (13.4%), Fine-silty, mixed, superactive, mesic Fluventic Hapludolls (20.1%)		

types were dominating, and the 'Aquolls' suborder group occupied 45.9% of the floodplain area. This soil is periodically saturated with water during the year, and has characteristics associated with wetness.

2) Floodplain delineation and SOM content

A land-cover map and satellite imagery were very helpful in delineating floodplains since most of the floodplains is agricultural areas or floodplain-forest/woodland areas. The DEM image showed that elevations of the floodplain boundaries ranged from 243 to 255 meters above the sea level. The elevation of the floodplain boundaries in the western part of Wakarusa River was 255 meters, and it decreased to 243 meters in the eastern part of the river. This reflects the topographic characteristic of the study area, where elevations gradually increase from east to west (Sophocleous 1998). The flood frequency map was valuable in delineating floodplain boundaries when the DEM data and land cover data did not agree well. Virtually, all of the flooding areas were categorized as 'occasional' in the flood frequency map. If image pixels of the DEM and land cover maps were confusing to classify but fell on 'occasional' flooding areas, these pixels were included in floodplains. The total delineated area of Wakarusa floodplains was 4488.8 hectares (Figure 5).

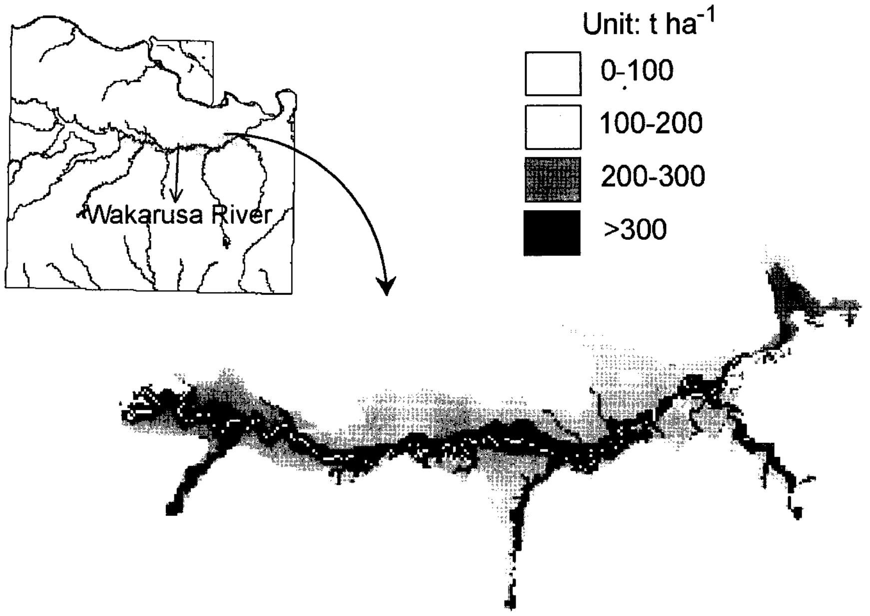


Figure 5. The floodplain areas along Wakarusa River are delineated. They included 35 different soil map units. In the map of SOM content, each map unit was categorized into one of the four SOM levels.

Table 2. Soil organic matter content for Wakarusa floodplains and Douglas County.

	Area (%)	Soil Organic Matter				
		Minimum	Maximum	Mean	S.D.*	Total amount
Douglas County	122,950.7 ha (100%)	31.4 (t ha-1)	941.9 (t ha-1)	157.9 (t ha-1)	109.2 (t ha-1)	18,577,673.7 tons (100%)
Floodplains (Wakarusa)	4,488.8 ha (3.7%)	31.4 (t ha-1)	450.6 (t ha-1)	257.8 (t ha-1)	140.0 (t ha-1)	1,110,543.5 tons (6%)

*Standard deviation.

In the floodplains along Wakarusa river, 35 different map units were found. SOM content varied from map unit to map unit in the floodplain zone, ranging from 31.4 to 450.6 t ha-1. This range is much greater than that of non-floodplain soils surveyed in Douglas County. Soil property data collected by the Kansas Applied Remote Sensing (KARS) Program at the University of Kansas showed that SOM ranged from 12.4 to 112 t ha-1 (unpublished internal data). These data underestimated the total SOM of soil columns because they were calculated based on topsoil sampled to a depth of 15cm. Even after taking into account this underestimation, the SOM levels were significantly lower than those of the floodplains given that most SOM is concentrated on topsoils. Although the floodplain zone occupies only 3.7% of the county land, it contains 6% of the total SOM of the county, which counts 1,110,543.5 tons (Table 2). Compared to the mean of the entire county, the floodplains had 1.6 times as high SOM concentration as the mean value of the county (257.8/157.9 t ha-1). This SOM level often doubles SOM levels in other areas. For example, Pennock and van Kessel (1997) observed that SOM content ranged from 112 to 145 t ha-1 in silty clay soils of grassland and forest in Saskatchewan, Canada. The lower range of the SOM content in the upper central plains may be due to low metabolism and particle size fractions. In forested floodplains of Savanah river, South Carolina, Wigginton et al. (2000) found that carbon seemed to be accruing preferentially in silt-clay and microaggregate fraction. The mean clay content of floodplains of the study area was 37%, and this fraction is higher than the soils in Saskatchewan, which ranged from 12% to 35%. Due to the high fertility of floodplains, it is not surprising to have high SOM content in other floodplain areas. Wigginton et al. (2000) also observed that total organic matter across the floodplain chronosequence ranged from 150 to 560 t ha-1 to 0.7 m depth.

3) Topographic factors

In the floodplains, SOM content had a

negative relationship with slopes, having a Pearson's correlation coefficient of r= -0.536 (significant at the 0.05 level). Floodplain soils, especially those close to river channels, were deep and nearly level. The surface soils were usually 56 cm thick and slopes were 0 to 2%. Soils farther from the river channels were less thick with 9 inches in depth and also had 0 to 2% slopes. Soils even farther than these areas were as thick as 16 inches, and their slopes generally ranged from 1 to 5% (USDA 1977). Soils close to the river channels are believed more frequently flooded and provided with nutrients compared to those away from the river. Therefore, these deep, flat soils are likely to have higher SOM content than shallow, steep peripheral soils in the floodplains.

However, slopes were not a determining factor outside the floodplain areas in the county. Figure 6 shows that SOM content increased with topographic gradients up to 15%, dramatically decreased on the steepest slopes (>15%), and increased again on ridgetops. The SOM content seems to have a close relationship with soil depth as shown in Figure 7. But, there was one exception in 10-15% slope areas. Although soil depth in this group was very shallow (59 cm), its total SOM amount was greater than the other slopes. One reason for this result can be found in its higher percent SOM content by weight compared to the other slope areas. The percent SOM content of soils with 10-15% slopes was 2.0% whereas that of the other slopes ranged from 0.5 to 1.5%. Therefore, the amount of SOM (t ha-1) in the study area was influenced by slope, soil depth, and percent SOM by weight.

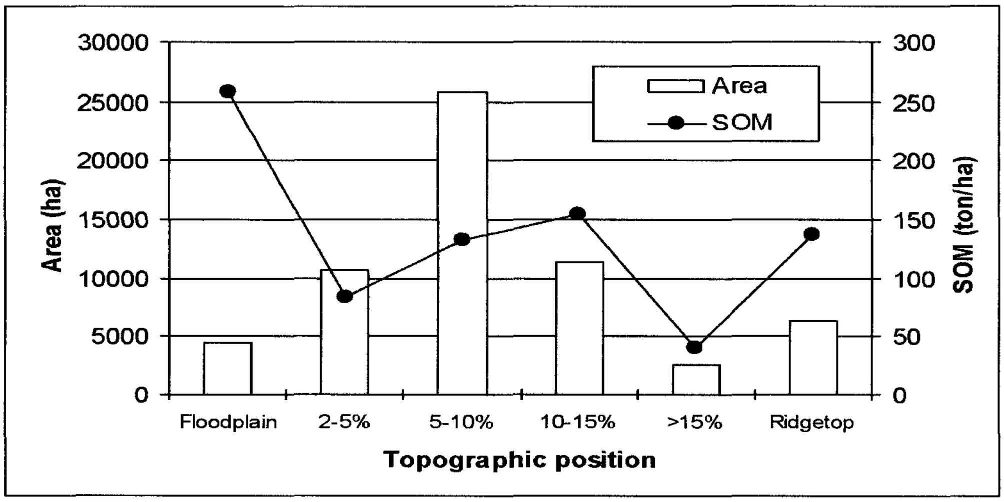


Figure 6. Land area of floodplains, different slopes, and ridgetops, and SOM content for each topographic position in the study area.

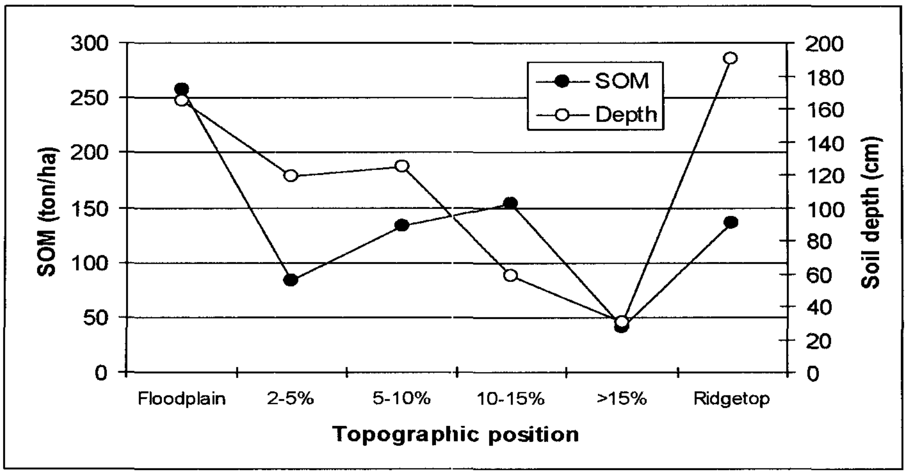


Figure 7. Comparison of SOM content and soil depth in different topographic positions.

4) Influences of LULC

Five land cover types were identified in the floodplains: grassland, cropland, forest/woodland, urban area, and water. As shown in Table 2, significant variations of SOM content were found among the five land cover types. Forest/woodland had significantly greater SOM content (316 t ha-1) than the other land cover types. This is due to extensively developed organic horizons of forest/woodland stands. Cropland had lower SOM content than forest/woodland, but it contained more than 55% of the total SOM in Douglas County because of its 56% land area of the county. Cropland had greater SOM content than grassland. This result agrees with a previous study conducted in southwestern Kansas (Unpublished data), where cropland had greater SOM content than grassland in six southwestern counties. However, woodland had lower SOM content than cropland in their study area. This is probably because woodland in southwestern Kansas is not developed as much as in northeastern Kansas, where Douglas County is located, due to a dry southwestern climate.

Relationships between SOM and land use/land cover have valuable implications for soil organic carbon dynamics. Land use changes from forests or grasslands to agricultural land have been known for one of the main causes of carbon loss from terrestrial ecosystems (Houghton et al. 1999; Caspersen et al. 2000). Since land use changes can be effectively determined over large areas by remote sensing and GIS techniques (Price et al. 1997; Egbert et al. 1998; Egbert et al. 2002), SOM mapping coupled with land use types in floodplains can be useful for terrestrial carbon-dynamics modeling in the agricultural landscape.

5. CONCLUSIONS

A digital soil database, remote sensing data, and DEM were effectively incorporated into Geographical information Systems (GIS) to map the amount of SOM in floodplain areas and to determine how the SOM content changed with different topographic positions and land use/land cover types. Results showed that the elevation of the floodplain boundaries along Wakarusa River ranged from 243 to 255 meters, and it rose from east to west. Different types of geospatial data, such as DEM, Landsat TM imagery, a land use/land cover map, flood frequency data, and a topographic map, were helpful in delineating the floodplain boundaries.

Statistical analysis showed that slope and SOM content had a significant relationship in the floodplains. Deep, flat floodplain soils near river channels had the highest SOM content across the floodplain areas. For the county as a whole, SOM content was influenced primarily by soil depth and percent SOM by weight. Among slope areas that had the highest SOM content levels were mid-range slopes (10-15%) and ridgetop areas.

Significant variations of SOM content were also found among five different land cover types. Forest/woodland had the highest SOM content followed by cropland, grassland, and urban areas. Knowing that most floodplain areas have high SOM contents and land cover types and their transformation are one of the most important forces for soil carbon dynamics, a relationship between the amount of SOM and LULC types in floodplains may contribute to terrestrial carbon-dynamics modeling. Future studies may include other factors, such as different crop practices, land use history, and microclimate, for better understanding of SOM distribution throughout the landscape. Other topographic factors also need to be analyzed in the future. Shapes of slopes and slope facing would be important factors for SOM content since mass movements on slopes and vegetation distribution in different facings may be important causes for SOM variations.

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