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Spatial Variability Modeling of Soil Erodibility Index in Relation to Some Soil Properties at Field Scale

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Abstract

Soil erosion is a major land degradation issue affecting various facets of human lives. To curtail soil erosion occurrence requires understanding of soil properties and how they influence soil erosion. To this end, the soil erodibility index which gives an indication of the susceptibility of soils to erosion was examined. In particular, we aimed to determine soil erodibility index at field scale and establish relationships that exist between selected soil properties and soil erodibility index. It was hypothesized that for soil erodibility index to vary spatially, then the existing soil properties should have varying spatial structure. Hundred disturbed and 100 undisturbed soil samples were collected from a 7.3 ha gridded area. The samples were analyzed for particle size distribution, bulk density, particle density, organic matter content and porosity. All soil analyses were conducted following standard procedures. Data were analyzed statistically and geostatistically on the basis of semivariograms. Sandy clay loam was the dominant soil texture in the studied field. Results indicate significant negative relationship between sand content, bulk density, particle density and organic matter with soil erodibility index. Silt correlated significantly with a positive relation with soil erodibility. Estimated erodibility for the sampled field ranged from 0.019 t.ha.hr/ha.MJ.mm to 0.055 t.ha.hr/ha.MJ.mm. The order of dominance of erodibility ranges were 0.038-0.042 t.ha.hr/ha.MJ.mm > 0. 036-0.08 t.ha.hr/ha.MJ.mm > 0.032-0.036 t.ha.hr/ha.MJ.mm > 0.019-0.032 t.ha.hr/ha.MJ.mm > 0.042-0.055 t.ha.hr/ha.MJ.mm. Regression analysis revealed silt to be the most significant variable that influences soil erodibility. The best regression of soil properties on soil erodibility index gave an R^2 of 0.90. A comparison of the regression equation with other studies indicated good performance of the equation developed.

Keywords: Soil erodibility; spatial dependency; erosion; semivariograms.

1. Introduction

Land degradation through soil erosion is considered a natural and geologic phenomenon, and one of the most important components of the global geochemical cycle. Soil erosion is identified as one of the key challenges that impacts on diverse sectors of our human existence ranging from the depletion of top nutrient rich soils, lowering agricultural productivity and volume storage depletion of reservoirs through sedimentation (Meadows 2003; Colombo, 2010; Gupta et al., 2010; Wang et al., 2013). Current increases in global demand for food and fresh water with its attendant land use changes exacerbate the menace of soil erosion with substantial consequences on soil and water resources sustainability. Earlier studies on erosion, reported that about 33% of the total arable land of the world were lost to soil erosion and continues to be lost at a rate of 10M ha/yr (Pimental et al,1995). The alarming rate at which soils are being lost calls for remediation measures in order to safeguard against future food and water security threats. Paramount to tackling the soil erosion menace is the need to take into cognizance the spatially distributed pattern and inherent variations caused by different land use management practices and varying soil types. Other factors equally influencing the soil erosion process are rainfall and erosivity index, slope and length factor, cropping management factor and the practice factor and soil erodibility factor (Breetzke et al., 2013). By far, soil erodibility is considered an essential parameter among these factors since it governs the ease with which soils are detached. The erodibility of soils is documented to be more dependent on both the extrinsic and dynamic properties of soil (Torri et al., 1997). Due to the complex nature of erosion processes coupled with anthropogenic factors, it becomes truly essential to have up to date knowledge that is geared towards conservation and management planning strategies. According to Gupta et al. (2010) a thorough understanding of soil properties is required in the consideration of remediation measures for land degradation. Toy et al. (2002) also affirms the need to comprehend soil properties in the wake of ensuring the implementation of management strategies. In view of the above, exploring the relationships that exist between soil properties and how these properties influences the erosion processes through the examination of the erodibility factor becomes essential. To this end, the study had as it objectives to determine soil erodibility index at field scale and establish relationships that exist between selected soil properties and soil erodibility index. It was hypothesized that the existing soil types at the study field had varying spatial structure which influences the spatial variability of soil erodibility index.

2. Materials and Methods

2.1 Study Area

The study was conducted in the Steelpoort subcatchment of the Olifants Basin in South Africa (Figure 1). The subcatchment is located within a semi-arid environment and geographically stretches from latitudes 24.43°- 25.81° S and longitudes 29.73°-30.66° E. The area is characterized by Inter-Tropical Convergence Zone (ITCZ) with temperatures ranging 5°C – 34°C (IWMI, 2008). Rainfall is seasonal in the catchment occurring during the months of October to April with appreciable spatio-temporal variability with coefficient of variation of 24% (Gyamfi et al, 2016). Land uses are documented to include agricultural, urban or built up settlements and grasslands among others (CSIR, 2003). The major soil types in the area are namely; cambic arenosols, orthic acrisols, chromic vertisols and chromic luvisols (FAO, 2002; 2005). It must be reiterated that the steelpoort River is an important source of water for a range of economic activities within the catchment.

2.2 Soil Sampling Strategy and Analysis

Soil samples were collected during the month of October, 2015 using systematic grid sampling approach. An area of 7.3 ha under agricultural utilization was gridded with spacing of 30 m interval. Samples were collected at the nodes of each grid. The grid sample method was employed due to its precision and efficiency with which spatial patterns can be determined (Brus & Heuvelink, 2007; Pennock et al., 2008). In total, 100 disturbed and 100 undisturbed soil samples were collected from the top soil (0-20 cm) using a soil auger and soil core sampler, respectively. The dimensions of the soil core sampler were 10 cm × 10 cm. At each station of sampling, coordinates were taken with a hand held Garmin etrex legend HCx GPS to reference the exact location of the sample. Collected samples were subsequently stored in brown paper bags for onward transfer to the laboratory for analysis. Sampled soils were analyzed for particle size distribution, organic carbon content, bulk density, particle density and porosity. Prior to soil analysis, disturbed samples were oven dried and plant residues were removed. The Bouyoucos hydrometer method of particle size analysis (PSA) as described by Kroetsch and Wang (2008) was used in determining three fractions (sand, silt and clay) of sampled soils. Analysis for bulk density of undisturbed soils followed the procedure outlined by Hao et al. (2008). Determination of soil organic content (SOC) was done using the Walkley-Black method (Walkley & Black, 1934). The organic carbon content obtained using the Walkley-Black method was converted to organic matter content using $\mathrm{OM} = 1.72\mathrm{OC}$ (Brady, 1984;Boyd, 1995; Pansu & Gautheyrou, 2006).

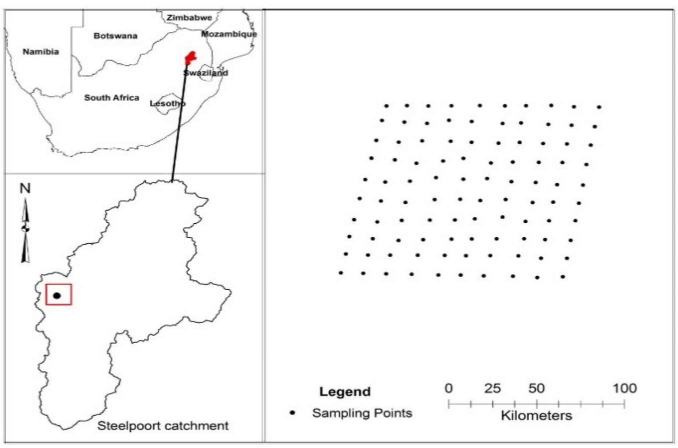

Figure 1. Study location showing soil sampling points

2.3 Soil Erodibility Index Estimation

According to Basson and Di Silvio (2008), the estimation of soil erosion in a semi-arid environment should be based on the Modified Universal Soil Loss Equation (MUSLE) rather than the Universal Soil Loss Equation (USLE). One component of the MUSLE equation, the soil erodibility index which is the subject matter of this study was therefore estimated using measured soil properties following the method outlined by Williams (1995). This approach of soil erodibility index estimation presents advantages of eliminating expensive cost and time involved in direct field measurements. The proposed equation by Williams (1995) is given as;

$$K = f_{csand} \cdot f_{cl-si} \cdot f_{orgc} \cdot f_{hisand} \quad (1)$$

Where; K is erodibility factor (t.ha.hr/ha.MJ.mm), f_{csand} is a factor that gives low soil erodibility factors for soils with high coarse- sand contents and high values for soils with little sand, f_{cl-si} is factor that gives low soil erodibility factors for soils with high clay to silt ratios, f_{orgc} is a factor that reduces soil erodibility for soils with high organic carbon content and f_{hisand} is a factor that reduces soil erodibility for soils with extremely high sand contents.

The individual factors were estimated using the following equations with the measured soil properties as inputs.

$$f_{csand} = \left(0.2 + 0.3exp\left[-0.256m_s.\left(1 - \frac{m_{silt}}{100}\right)\right]\right) \quad (2)$$

$$f_{cl-si} = \left(\frac{m_{silt}}{m_c + m_{silt}}\right)^{0.3} \quad (3)$$

$$f_{orgc} = \left(1 - \frac{0.25.orgC}{orgC + exp[3.72 - 2.95.orgC]}\right) \quad (4)$$

$$f_{hisand} = \left(1 - \frac{0.7.\left(1 - \frac{m_s}{100}\right)}{\left(1 - \frac{m_s}{100}\right) + exp\left[-5.51 + 22.9\left(1 - \frac{m_s}{100}\right)\right]}\right) \quad (5)$$

where m_s is the percent sand content, m_{silt} is the percent silt content, m_c is the percent clay content and orgC is the percent organic carbon content.

2.4 Spatial Variability Modeling of Soil Properties and Erodibility Index

Geostatistical methods employing the use of semivariograms were used in exploring the spatial variability and dependency of both soil properties and erodibility index. Semivariograms give a measure of the relation of data points within a particular variable to each other with respect to distance. The theoritical semivariogram as formulated by Matheron (1963) is given by:

$$\gamma(h) = \frac{1}{2N(h)} \sum_{i=1}^{N(h)} \{Z(x_i) - Z(x_i + h)\}^2 \quad (6)$$

Where; $\gamma(h)$ is semi-variance at lag h, h is distance (lag), x is position in one dimensional space, N(h) is Pairwise Euclidean distance

Ordinary Kriging theoretical semivariograms were fitted to the empirical semivariograms by comparing a set of given models. The choice of the best model was made based on statistical measures of the lowest root mean square error (RMSE), largest Pearsons coefficient of determination (R^2) and lowest residual sum of squares (RSS). From the best fitted theoretical models, the spatial structure of each variable (soil property) was determined using the method described by Cambardella et al. (1994).

2.5 Data Analysis

Results of the soil analysis were presented using descriptive statistics inclusive of mean, median, range, standard deviation, skewness coefficient and coefficient of variation. Pearson's correlation coefficient and multiple regression analysis were used to establish relationships between soil properties and estimated soil erodibility index. SPSS 16.0 and MS excel 2010 were used for the statistical analysis whiles ArcGIS 10.1 was used for the geostatistical analysis and surface creation for soil erodibility index.

3. Results and Discussion

3.1 Descriptive Statistics

To establish the relationship between physical properties of soil and soil erodibility, the sampled soils were analyzed and the summary of the results presented in Table 1. All the examined soil properties were found to be normally distributed based on estimated skewness coefficients ranging from -0.76 for particle density to 0.43 for soil porosity. A dataset is considered to be normally distributed when skewness coefficients are between -1 to 1 (Virgilio et al., 2007; Ortiz et al., 2010). Since all the dataset were normally distributed there was no need for data transformation. The means and medians of the measured parameters were similar with the medians having smaller values than the means. This implies that the measures of central tendency are not dominated by outliers in the distribution. Cambardella et al. (1994) also detected similarities in the mean and median of soil properties and attributed the similarities to the minimal number of outliers found in the soil distribution set. Soil proportions including sand, silt and clay showed wide ranges with mean values of 62.23%, 14.28% and 23.49%, respectively. Conversely, minimal ranges were recorded for soil porosity, organic matter content, bulk density and particle density with corresponding mean values of 42.66 %, 1.91%, 1.47 g/cm^3 and 2.56 g/cm^3.

There were observed variations in the sampled soil properties as indicated by the coefficient of variation. The coefficient of variation values ranged from a minimum of 2.86% to a maximum of 41.80%. As a means of assessing variability, silt was seen to show the highest variation whiles particle density indicated a weak variation. Notably, other properties of the sampled soil inclusive of clay, organic matter content and sand all exhibited some degree of variation with coefficient of variation values of 33.28%, 23.56% and 17.44% respectively. The soil properties with the lowest coefficient of variation were bulk density, particle density and soil porosity.

Table 1. Summary statistics of physical properties of soil

Variable	Descriptive statistics[a]							D.T[b]
	Mean	Median	Min-Max	Range	SD	SC	CV (%)	
Sand (%)	62.23	62.22	37.79-83.05	45.26	10.85	-0.14	17.44	N
Silt (%)	14.28	13.57	1.94-30.80	28.86	5.97	0.40	41.80	N
Clay (%)	23.49	23.74	6.92-40.86	33.94	7.82	0.10	33.28	N
BD (g/cm3)	1.47	1.47	1.31-1.60	0.29	0.07	-0.23	4.86	N
PD (g/cm3)	2.56	2.58	2.39-2.68	0.29	0.07	-0.76	2.86	N
Pores (%)	42.66	42.25	38.85-47.06	8.21	1.59	0.43	3.72	N
OMC (%)	1.91	1.83	0.83-2.77	1.94	0.45	0.06	23.56	N

[a] Min., minimum;Max., maximum; SD., standard deviation; SC., skewness coefficient, CV., coefficient of variation, BD.,bulk density; PD., particle density; OM., organic matter content.

[b] Distribution type, N; normal distribution.

Textural classification using the USDA textural triangle revealed six main soil textures to characterize the sampled field. The textures were namely; sandy clay loam (57%), sandy loam (29%), clay loam (6%), sandy clay (4%), loamy sand (3%) and clay (1%) of sampled soils. Distribution of bulk density, particle density, porosity and organic matter content at the textural class level is presented in Figure 2 using a boxplot. Evidently, bulk density in sandy loam and loamy sand was higher compared to the remaining soil textures. The lowest bulk density values were recorded in sandy clay and clay loam with mean values of 1.49 g/cm^3 and 1.39 g/cm^3 respectively. Particle density follows a similar trend as that discovered for bulk density. Porosity and organic matter content were high in sandy clay with corresponding mean values of 43.87% and 2.20%. Sandy loam had the least pores compared to the remaining soil textures. The lowest organic matter content was found to exist in clay loam. Analysis of particle density, porosity and organic matter content on textural levels indicated the presence of outliers most of which were lower than the limit in the distribution. Yet, further examination of these parameters considering all sampled soil but not on textural classes revealed no outliers. This is perhaps so because there is a wider limit of the distribution when all the soil samples are considered together. In view of this, the detected outliers during the textural class analysis were maintained and used in the ensued geostatistical analysis.

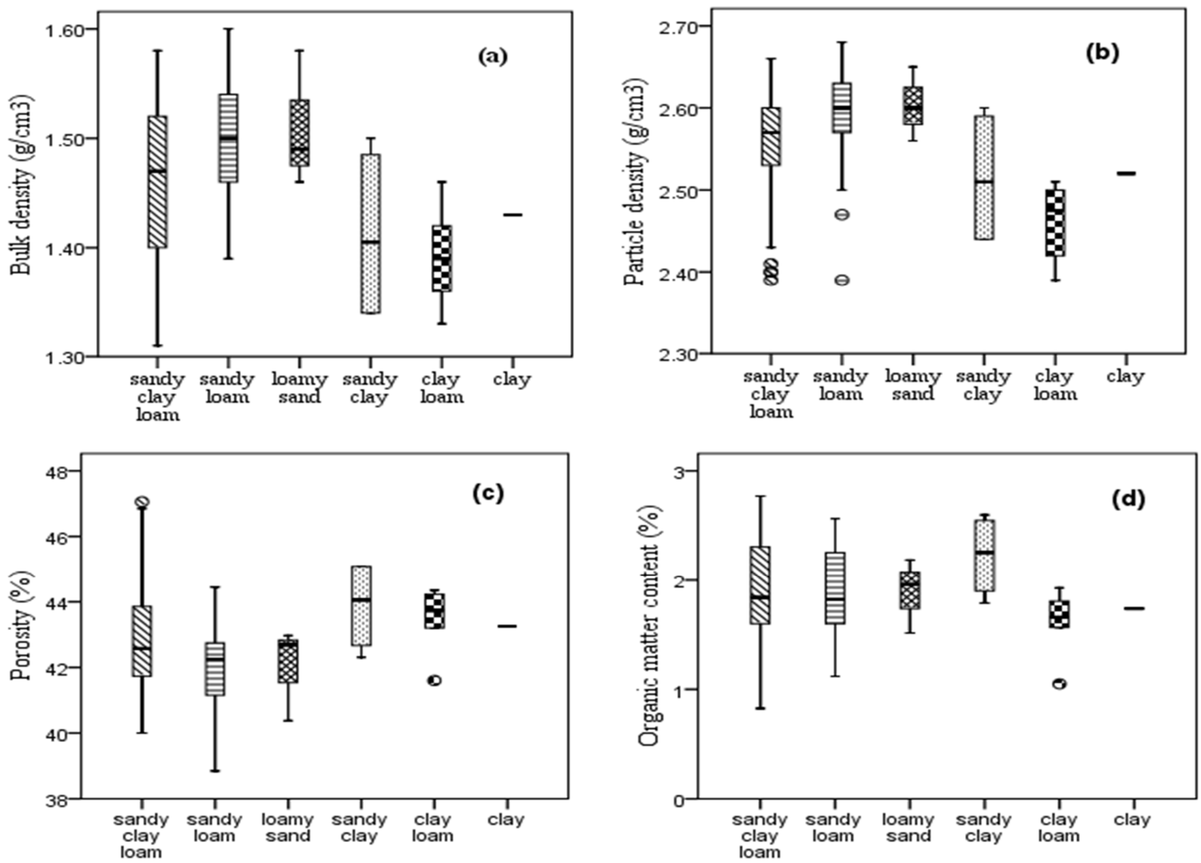

Figure 2. Boxplot of (a) bulk density, (b) particle density, (c) porosity and (d) organic matter content within soil textural classes

3.2 Spatial Analysis of Soil Properties

It was hypothesized that existing soil types at the study field had varying spatial structure which influences the spatial variability of soil erodibility index. To authenticate the veracity of this hypothesis, the spatial distribution and structure of soil properties were investigated by first generating an empirical semivariogram for each of the selected soil properties following which theoretical semivariograms were fitted. An exploration of the soil dataset revealed no trend and anisotropy and hence isotropic semivariograms were fitted. Best fitted isotropic semivariograms were selected based on RMSE, RSS and R^2 (Table 2). With the exception of porosity which was defined by the exponential model, all the other soil parameters including sand, silt, clay, bulk density and organic matter content were defined by the spherical model (Figure 3). From Table 2, it is clear that all the fitted models were able to explain more than 50% of the total variance inherent in the observed data and that the predictions from the model considered to be satisfactory for field predictions of soil properties.

In determining the spatial dependence of soil properties used was made of the nugget/sill ratio as prescribed by Cambardella et al. (1994). This approach of spatial dependency determination has been used by other researchers such as Liu et al. (2014) in the determination of spatial variability of rice yield. The nugget to sill ratio ranged from 45.46 % to 95.60 % putting the soil properties into two major spatial classes of moderate and weak spatial dependency. The three proportions of soil (sand, silt and clay) exhibited weak spatial dependency with nugget/sill range of 93.58% to 95.03 %. Bulk density, organic matter content and porosity constituted the soil properties with moderate spatial dependency with nugget/sill range of 45.46% to 64.50%. The moderately spatially dependent properties may be controlled by intrinsic variation of the soil such as texture and extrinsic factors such as land use activities (Cambardella et al., 1994; Ruth & Lennartz, 2008; Wu et al., 2010; Liu et al., 2013). MacCarthy et al. (2013) also ascribed the low spatial dependency of topsoils to land use and management practices. The spatial dependency determined based on the nugget/sill ratio collaborates the estimates of the coefficient of variation as given in the descriptive statistics section.

Semivariograms (Figure 3) and estimated fitted model parameters (Table 2) revealed most parameters had ranges less than 100 m with the exception of organic matter content and clay which had ranges of 100 m and 190 m respectively. This finding implies samples should be taken at locations not more than 100 m for sand, silt, bulk density, organic matter content and porosity in order to capture the spatial relation between studied properties. For clay, the sampling distances should not exceed 190 m. It thus can be concluded that the spatial structure relations deduced in this work for the studied soil properties are reflective of that on the ground due to the sampling grid distance of 30 m which is far less than the ranges established.

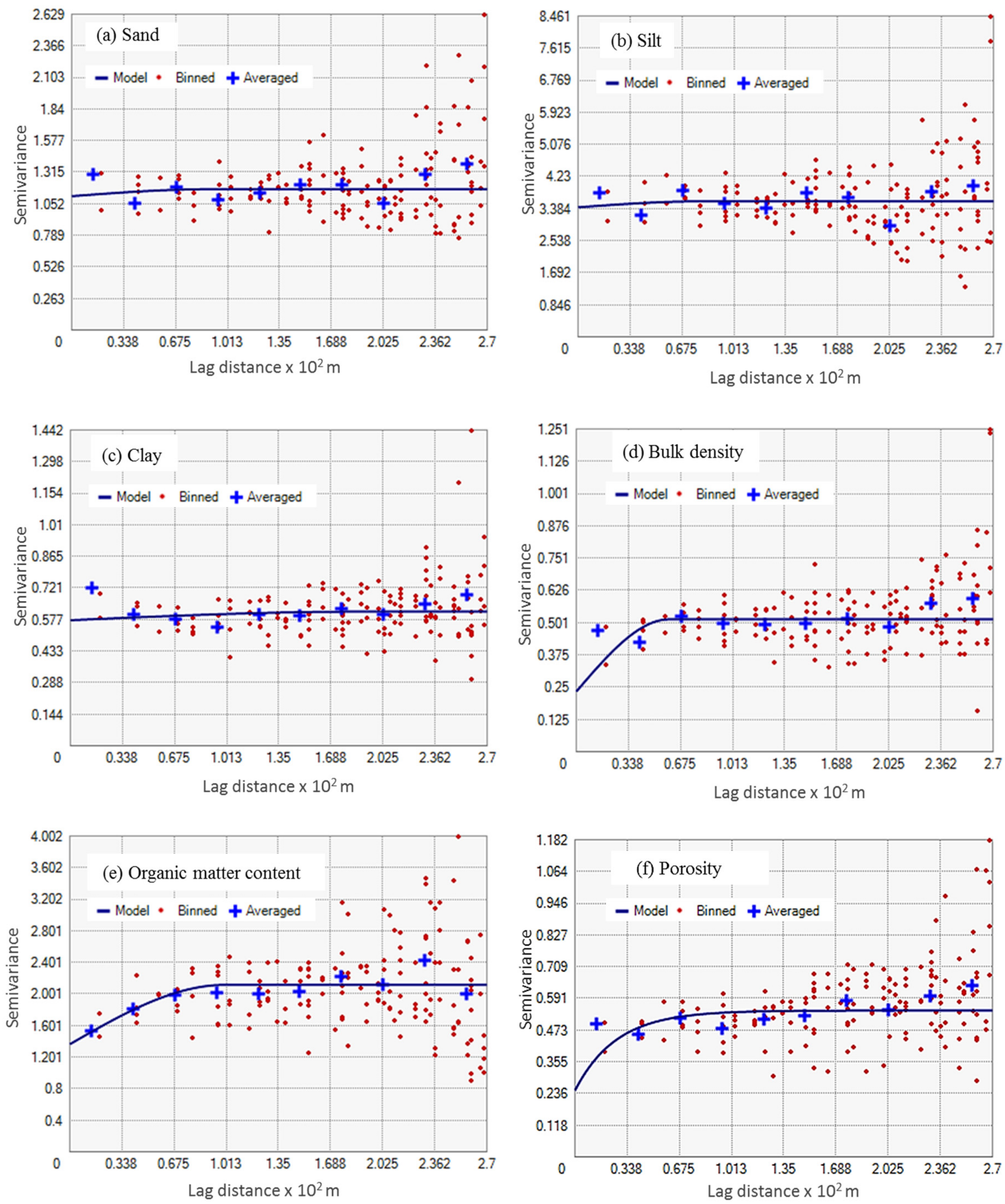

Figure 3. Experimental semivariograms and best fitted models for selected soil properties

Table 2. Parameters of models fitted to experimental variograms of soil properties

Parameter[a]	Model	Semivariance[b] N	Semivariance[b] S	(N/S) %	Range (m)	Class[c]	Diagnostics[d] RMSE	Diagnostics[d] RSS	Diagnostics[d] VE (%)
Sand	Spherical	1.11	1.17	95.03	90	W	7.32	5.37E+03	54.96
Silt	Spherical	3.42	3.58	95.60	80	W	3.93	1.55E+03	56.57
Clay	Spherical	0.57	0.61	93.58	190	W	4.87	2.37E+03	64.51
BD	Spherical	0.23	0.51	45.54	60	M	0.04	0.162	67.91
OMC	Spherical	1.37	2.12	64.50	100	M	0.24	5.72	72.14
Porosity	Exponential	0.25	0.55	45.46	80	M	0.04	0.161	71.25

[a]BD, bulk density; OMC, organic matter content

[b]N, nugget; S, sill; N/S, ratio of nugget to sill.

[c]W, weak spatial dependency; M, moderate spatial dependency.

[d]RMSE, root mean square error; RSS, lowest residual sum of squares; VE, proportion of total variance of observed data explained by model.

3.3 Spatial Distribution of Soil Erodibility Index at Field Scale

The resulting surface for soil erodibility index is shown in Figure 4 with severity of erodibility captured under five classes. The five class erodibility distinction is to allow for easy identification of most vulnerable areas from least vulnerable areas. Soil erodibility index ranged from 0.019 t.ha.hr/ha.MJ.mm to 0.055 t.ha.hr/ha.MJ.mm with a mean of 0.038 t.ha.hr/ha.MJ.mm. The coefficient of variation for erodibility index was 15.79 % and standard deviation of 0.006 t.ha.hr/ha.MJ.mm. Based on the classification used by Le Roux et al. (2006), the studied field was classified as having low to very high soil erodibility. The estimated soil erodibility for the sampled field was well within range of 0.004 to 0.092 t.ha.hr/ha.MJ.mm stipulated by Le Roux et al. (2006) for South Africa. The order of dominance of erodibility ranges were 0.038-0.42 t.ha.hr/ha.MJ.mm > 0. 036-0.08 t.ha.hr/ha.MJ.mm > 0.032-0.036 t.ha.hr/ha.MJ.mm > 0.019-0.032 t.ha.hr/ha.MJ.mm > 0.042-0.055 t.ha.hr/ha.MJ.mm.

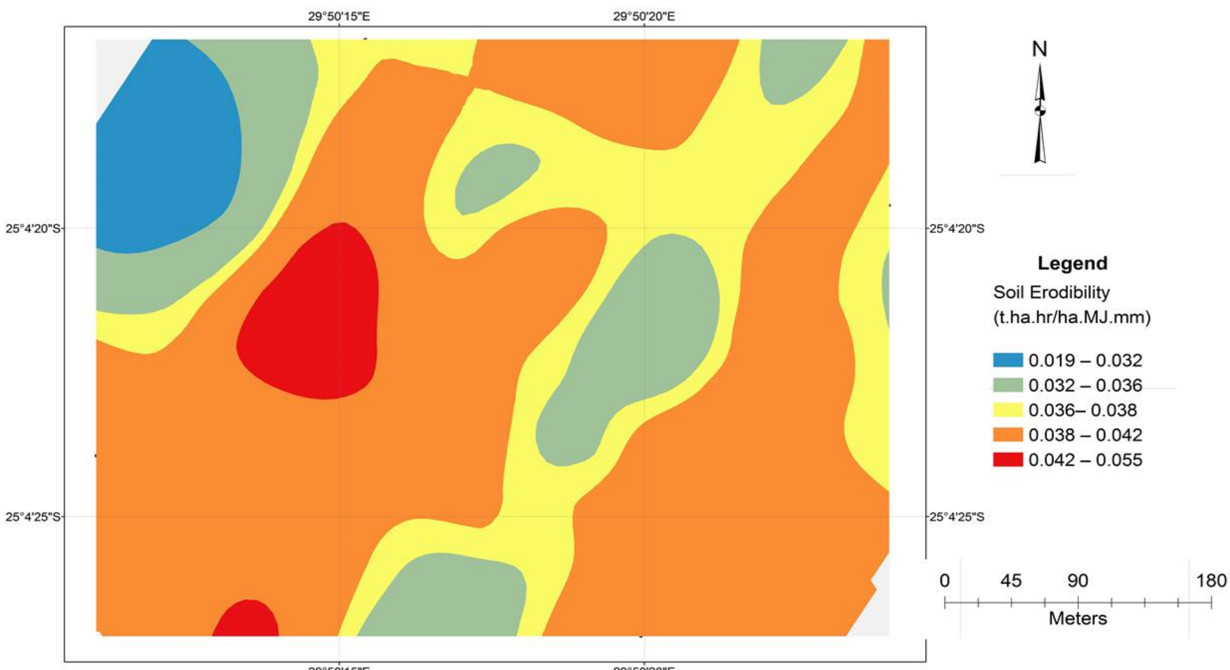

Figure 4. Soil erodibility map for the studied field

3.4 Soil Erodibility Index (K) Correlation with Soil Properties

The characterization of total soil response to a varying number of dynamic soil erosion processes can be achieved using soil erodibility index. These erodibility index are influenced by both intrinsic (e.g. soil texture) and dynamic (e.g. organic matter content) properties of underlying soils (Torri et al., 1997). Here, Pearson's correlation was used to establish the veracity of the relationship existing between soil properties and erodibility factors and the result summarized in Table 3. Results indicate significant negative relationship between sand content, bulk density, particle density and organic matter with soil erodibility index. Soil parameters showing significant positive relationship with soil erodibility were silt content and porosity. Organic matter content is known to increase the stability of soils and subsequently reducing the threat of soils to erosion. The negative relationship between organic matter content and soil erodibility index collaborates the role of organic matter in soil stability. A similar statistically significant relationship was found by Gupta et al. (2010) to exist between organic carbon content (which can be converted to organic matter content) and soil erosion index.

Table 3. Correlation coefficients (Pearson's test) of soil properties and K.

	Sand	Silt	Clay	BD	PD	Porosity	OMC	K_{USLE}
Sand	1							
Silt	-0.713**	1						
Clay	-0.845**	0.226*	1					
BD	0.652**	-0.685**	-0.383**	1				
PD	0.669**	-0.649**	-0.433**	0.866**	1			
Porosity	-0.454**	0.528**	0.228*	-0.860**	-0.490**	1		
OMC	0.005	-0.133	0.095	0.067	0.029	-0.086	1	
K_{USLE}	-0.558**	0.867**	0.113	-0.590**	-0.509**	0.504**	-0.466**	1

**$P < 0.01$; *$P < 0.05$.

A further analysis of the relationship between soil erodibility index and soil parameters was performed using multiple regression analysis and the resulting outcome summarized in Table 4. The analysis revealed sand content alone to account for the 31% of the variation in soil erodibility. Sand and silt together explained approximately 76% of the variation in soil erodibility index. The inclusion of silt increased the variability of soil erodibility index from 31% to 76% indicating the essential role silt plays in the soil erosion process. Wischmeier and Smith (1978) noted similar findings when they ascribed soils with high silt content to be more erodible. Bulk and particle density did not turn to be of much influence on soil erodibility as the addition of these parameters to silt and sand only explained 77% of the variation in soil erodibility. Jointly however, soil parameters inclusive of sand, silt, bulk density, particle density, porosity and organic matter content explained 90% of the variability in soil erodibility index. This finding concurs with previously established facts which alluded to the influential role played by both intrinsic and extrinsic soil properties to the soil erosion processes (Torri et al., 1997).

A study carried out elsewhere indicated bulk density, porosity, water holding capacity, moisture equivalent, silt and sand to account for 59 % of the variation observed in soil erosion index (Gupta et al., 2010). Organic matter content is a crucial dynamic property of soils that ensures soil stability. The exclusion of this property of soil from the regressions developed by Gupta et al., (2010) may have resulted in the low Pearson correlation coefficient recorded for soil erodibility index and soil properties. Mean soil erodibility indexs relatively indicated high values in clay loam, clay and sandy clay loam soils (Figure 5) implying high susceptibility of these soil textures to soil erosion. The low organic matter content and the least pores of these identified soil textures among other factors may account for their high susceptibility to erosion. Diop et al., (2011), also asserts that silts and certain clay textured soils are more susceptible to erosion than other textured soil types. They attributed their reasons to possibly the low infiltration rate, low organic matter content and the lack of soil structure that may be inherent in these soil texture types.

The best regression equation obtained in this study (Equation 6 in Table 4) was compared with findings from other studies (Table 5) whose regression equations were developed using a range of soil properties. It was found out that the regression equation developed in this study with six variables compared well in terms of the coefficient of determination with regression equations developed in other studies using series of explanatory variables. The most significant variable on soil erodibility in this study was silt as compared to clay/OMC, aggregation index, particle size parameter and slope in other studies (Barnett & Rogers, 1966; Wischmeier & Mannering, 1969; Romkens et al., 1977;Young & Mutchler, 1977). The dissimilarities observed in the most significant variable influencing soil erodibility in the study results of others as compared to that in this study could be attributed to land use and underlying soil types of the study locations. Le Roux et al. (2006) also acknowledged the proneness of soils with high silt content to structural breakdown and consequently erosion. From the ongoing discussions, it presupposes that the estimation of soil erodibility depends on varying number of soil properties, here however being more dependent on silt.

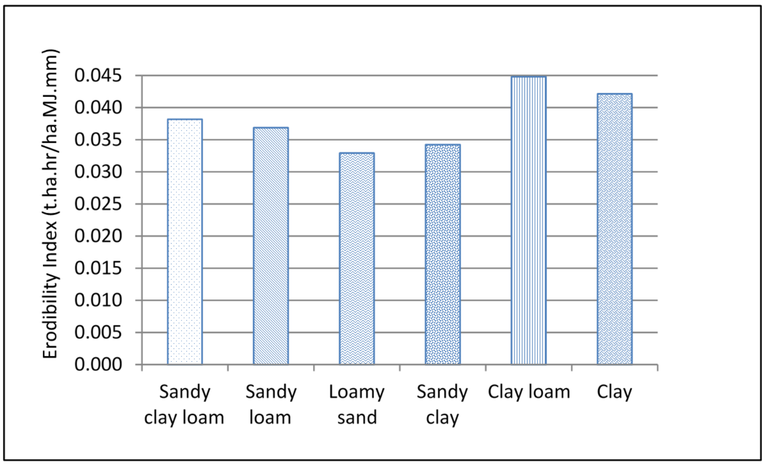

Figure 5. Susceptibility of soil textures to soil erosion

Table 4. Regression analysis of erodibility index (K) in relation to measured soil properties

Eq. No.	Dependent variable	Regression Equation[a]	R^2
1	K	Y= 0.023-0.558Sand	0.312
2	K	Y= 0.151+0.121Sand+0.95Silt	0.758
3	K	Y= 0.184+0.132Sand+0.937Silt-0.035BD	0.759
4	K	Y= 0.026+0.102Sand+0.940Silt-0.167BD+0.178PD	0.766
5	K	Y= 6.584+0.087Sand+0.893Silt-9.097BD+5.383PD-5.114Pores	0.779
6	K	Y= 7.625+0.026Sand+0.795Silt-10.312BD+6.073PD-5.828Pores-0.355OMC	0.90

[a] K, soil erodibility index; BD, bulk density; PD, particle density; OMC, organic matter content.

Table 5. Regression data of K values on soil properties

Study[a]	No. of soils	Variables in regression equation	R^2	Most[b] significant variable	Dominant soil texture
1	17	8	0.87	Slope	Sand
2	7	2	0.95	M	Clay
3	13	5	0.90	Agg.	Loam
4	55	24	0.98	Clay/OMC	Silt loam
This study	100	6	0.90	Silt	Sandy clay loam

[a]1, Barnett and Rogers, 1966; 2, Romkens et al., 1977; 3, Young and Mutchler, 1977; 4, Wischmeier and Mannering, 1969.

[b] M, particle size parameter; Agg., aggregation index; OM, organic matter content

4. Implications of Findings

The high soil erodibility observed in the study area is expected to impact negatively on water resources within the catchment area mainly through sedimentation that may arise from soil erosion. The problem of sedimentation has the tendency to reduce channel capacity of receiving rivers, cause eutrophication as a result of nutrient rich soil deposits and subsequently impact negatively on aquatic life. The cost of treating such waters for domestic water supply and irrigation purposes is expected to be high and perhaps the cost of treatment transferred unto the consumer. From the agricultural perspective, the removal of top rich nutrient soils may result in loss of vital nutrients for plants culminating into low agricultural productivity and turnover.

5. Conclusion

We examined in this study soil erodibility index at field scale and established relations between soil properties and erodibility. Estimated erodibility index for the studied field indicated a greater proportion of the field to be susceptible to erosion with high to very high erodibility index. The predisposition of soil to erosion was found to be significantly dependent on silt content of soil in addition to other soil properties. From the spatial analysis point of view, the spatial variability observed in soil erodibility index can be attributed to the varying spatial structure of studied soil properties. Geostatistical techniques viz-a-viz conventional statistical methods provided a better perspective of the role of soil properties in soil erodibility issues.

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