Chapter 3

GIS-Assisted Modelling of Soil Erosion in a South African Catchment: Evaluating the USLE and SLEMSA Approach

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Additional information is available at the end of the chapter

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1. Introduction

Soil erosion – the detachment and transportation of particles from soil aggregates by erosive agents (Stocking, 1984) – is regarded as one of South Africa's most significant environmental problems (Meadows, 2003). In South Africa, roughly 6 million households derive all or some of their income from agriculture (South African Department of Agriculture, 2007). Roughly 25 % of the population is directly dependant on agriculture, an activity that utilises about 80% of the total surface area of the country (Lutchmaih, 1999). The implications of high soil erosion rates are reflected in agricultural costs as well as social welfare costs where the decline in soil productivity causes the migration of the workers to urban areas. For a developing country, such as South Africa, these social impacts further burden the national economy.

Crucial in combating the scourge of soil erosion in South Africa is to estimate amounts and rates of soil loss in the country at various levels of scale. This will facilitate the initiation of regional land-use and management planning strategies, and the application of appropriate conservation and management practices at various scales of development. Studies on soil erosion in South Africa have been summarised by Garland, Hoffman & Todd (1999); annual soil loss estimates for the whole country range from 363 million tonnes (Midgley, 1952), to 233 million tonnes (Schwartz & Pullen, 1966) and to 100-150 million tonnes (Rooseboom, 1976). These overall national figures are based on the sediment yield of main rivers in South Africa. While indicating the importance of soil erosion on a national level these figures are unhelpful in drafting local or regional plans to combat erosion. Conservation strategies are conventionally planned on the scale of river catchments; at this scale the complete erosion process is included while it is still possible to spatially pinpoint actual control measures.

Geographical Information Systems (GIS) provide a much-favoured tool in regional soil erosion studies in South Africa (Le Roux et al., 2007). Such tools facilitate the upscaling of plot-scale soil loss predictions to a catchment or bigger scale.

In this paper we apply GIS technology to estimate soil loss rates per land use type in a quaternary catchment using two common approaches that generate rapid soil erosion assessment results at a low cost: the Universal Soil Loss Equation (USLE) and the Soil Loss Estimator for Southern Africa (SLEMSA). The objective of our research is to critically compare these popular approaches and discuss potential ways of improving their application. This paper starts with a concise introduction to the study site and then discusses how soil erosion is described in the USLE and SLEMSA approaches. Specific attention is paid to the way the various constituting factors are made operational. Subsequently the resulting soli loss estimates are described and their relation with the underlying factors is analysed. In a final concluding section the main results are highlighted and their implications for other applications of these approaches are discussed.

2. Study site and methodology

As study site we selected a catchment in the KwaZulu-Natal province of South Africa. The catchment is situated between latitudes 29º 30' 36'' S and 29º 52' 48'' S and longitudes 29º 8' 24'' E and 29º 5' 24'' E and has a surface area of approximately 341 km^2 (Figure 1). The altitude of the catchment ranges from 1160 m a.s.l from the Wagendrift Dam, at the outlet of the catchment, to 2080 m at the Giant’s Castle nature reserve at the western corner of the catchment. The topography is characterised by deeply incised valleys and steep slopes mainly covered by grassland. The catchment is located in a sub-humid environment and receives an annual average rainfall of 932mm. Rainfall is concentrated in the summer months (November - March) with the winter months (May – August) receiving as little as 10mm of rainfall per month. The most notable water body in the catchment is the Bushman’s River that drains into the Wagendrift Dam at the outlet of the catchment.

Grassland covers over 80% of the catchment with the remainder consisting mainly of forest plantations and thicket and scrubland. A small percentage (4,3%) of the catchment consists of small-scale subsistence, and large-scale commercial agricultural settlements. The commercial settlements comprise of six holdings in the catchment. The small-scale settlements, where subsistence agriculture is practiced, are numerous and sporadic. The commercial farmers focus mainly on dairy production, while subsistence agriculture, practiced by approximately 5000 families, is based mainly on the food grains of maize and sorghum. The geology of the catchment is characterised mainly by dark-grey (often carbonaceous) shale, siltstone and fine and medium to coarse-grained sandstone (Turner, 2000). There is a great diversity of fauna and flora in the catchment as well as several national parks, the most notable being the Wagendrift nature reserve and the Giant’s Castle nature reserve.

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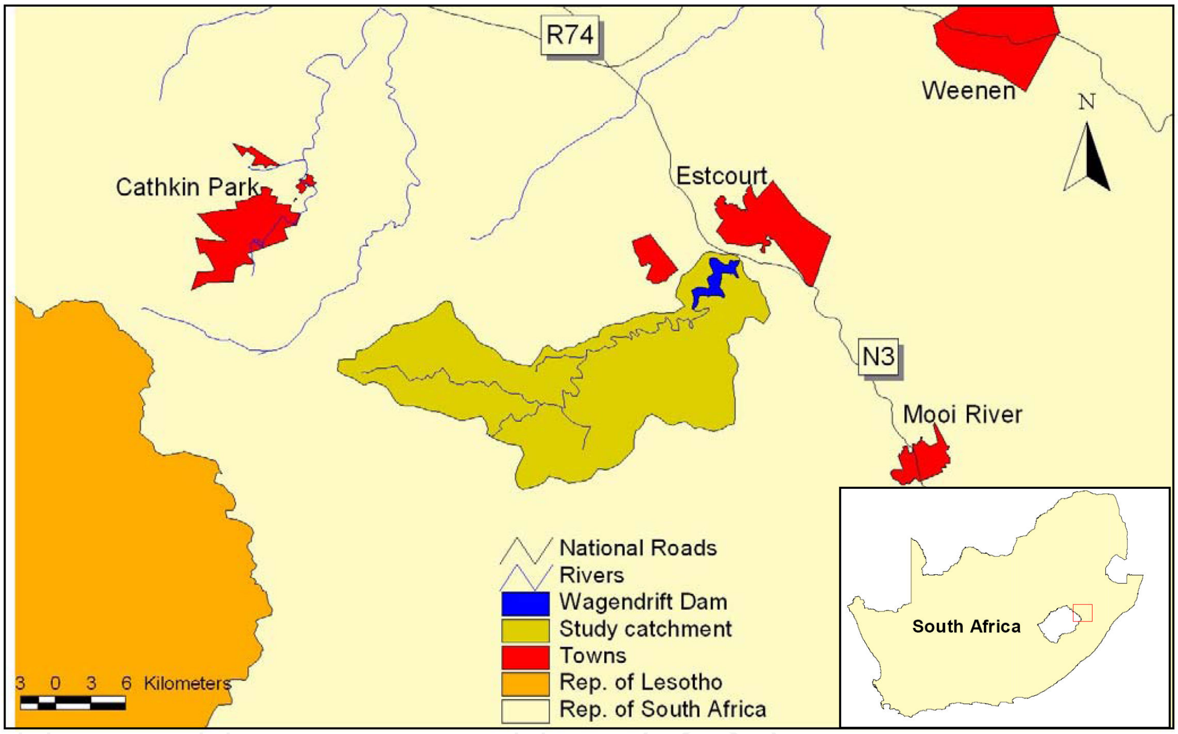

Figure 1. Location of the study catchment area in KwaZulu-Natal, South Africa

2.1. Governing equations

The USLE was developed in 1965 by the Agricultural Research Service (ARS) scientists Wischmeier and Smith to predict long time average soil losses in run-off from specific field areas in specified cropping and management systems (Wischmeier & Smith, 1978). The USLE disaggregates the erosion process into 6 factors that were each determined based on the analyses of more than 11 000 plot-years of research data from 47 locations in 24 states in the United States. Notwithstanding its initial north American focus, this approach or its revised successor (RUSLE, see Renard et al., 1991) has been applied in many studies around the world including a particularly interesting study that estimates sediment yield in the past 6000 years in the Meuse catchment area (Ward et al., 2009). The basic equation follows:

$$A = R \, x \, K \, x \, LS \, x \, C \, x \, P \tag{1}$$

Where:

A = Mean annual soil loss (t ha^{-1} yr^{-1})

R = Rainfall and runoff erosivity index (J $mm.m^{-2}$ h^{-1})

K = Soil erodibility factor (t J^{-1} mm^{-1})

LS = Slope and length of slope factor

C = Cropping – Management factor

P = Erosion control factor practice

The SLEMSA model was developed by Elwell (1977) in Zimbabwe to estimate the long-term mean annual soil loss from sheet erosion on arable land (Bonda et al., 1999). SLEMSA was developed on the basis of the USLE and is an attempt to adapt the USLE model to an African environment. It is a relatively widely used soil loss model in African environments (Elwell & Stocking, 1982), and should be seen as a modelling technique or framework, rather than mechanistic descriptions of the erosion system (Smith, 1999). The SLEMSA model divides the soil erosion environment into four physical systems: crop, climate, soil and topography. The SLEMSA equation is represented schematically as follows:

$$Z = K \, x \, C \, x \, X \tag{2}$$

Where:

Z = Mean annual soil loss from the land (t ha^{-1} yr^{-1})

K = Erodibility factor (t ha^{-1} yr^{-1})

C = Crop factor

X = Topographic factor

2.2. Calculating the USLE factor values

GIS is used to calculate the individual USLE factor grids that, upon multiplication, provide the total potential soil loss within the catchment. A short description of the assumptions and calculations related to the creation of the factor grids is provided below. For a more comprehensive explanation of the methodology see Breetzke (2004).

2.2.1. Rainfall erosivity (R) factor

Cubic surface trend analysis was used to create a Mean Annual Precipitation (MAP) isohyetal grid of the site, based on an average of 30 years of annual rainfall data. The rainfall-erosivity grid was obtained by assigning a regional specific formula based on a rainfall-erosivity relationship developed by the Department of Agriculture and Water Supply (1984) to the MAP grid. The equation is based on computed erosion index values (EI_{30}) for a rainfall station located within the site and is shown below. The erosion index, EI_{30}, for a given storm is a product of the kinetic energy of the falling raindrops and its maximum 30-minute intensity (Engel, 2002):

$$R = 0.63P - 153.72 \tag{3}$$

Where:

P = mean annual precipitation grid (in mm)

2.2.2. Soil erodibility (K) factor

The erodibility factor was calculated according to the nomograph method outlined in Wischmeier & Smith (1978) and shown mathematically below. Basic data for estimating soil erodibility were obtained by collecting 120 samples from test sites representative of the major soil-mapping units in the catchment. The erodibility was calculated as:

$$K = \left(2.1 * 10^{-4} * \left(12 - OM\right) * M^{1.14} + 3.25\left(s - 2\right) + 2.5\left(p - 3\right)\right) / 759 \tag{4}$$

Where:

K = erodibility factor (in ton/MJ/mm)

OM = organic matter content (%)

M = texture product

s = structure class

p = permeability class.

A fine particle analysis was conducted to obtain the percentage sand, silt, clay and organic matter for each test site. These values were used to obtain a soil erodibility value per test site. The K factors generated for each test site were subsequently used as a variable for the erodibility grid map composed using the Inverse Distance Weighting (IDW) interpolator. This grid map was summarised to create a table containing mean K values per soil type in the catchment, and a grid created with the mean K values as the variable.

2.2.3. Topographic (LS) factor

The topographic factor consists of two sub-factors: a slope gradient factor and a slope length factor. A DEM was built through digitising the contours of a 1:50 000 topographic map of the study site. The slope length and slope gradient factors (shown below) were calculated using the filled DEM and entered into the equation below to produce the topographic factor grid, following:

$$LS = \left(L/22\right)^{0.5}\left(0.065 + 0.045S + 0.0065S^2\right) \quad (5)$$

Where:

$L = (x/22.13)^m$, in which x is length of slope (in m), m is 0.5 if the slope is >5 %, 0.4 if between 3 and 5 %, 0.3 if between 1 and 3 percent and 0.2 if below 1and L is the slope length factor;

$S = (0.43 + 0.30\ s + 0.043\ s^2)/6.613$, where s is the gradient (%), and S is the slope gradient factor.

2.2.4. Crop management (C) factor

Land use types in the site were assigned C factor values based on their percentage canopy cover, fall height and ground cover. These values are determined using Thompson's (1996) classification, aerial photo analysis, information from studies conducted within southern Africa on specific crops and land cover types, (e.g. McPhee & Smithen, 1984) and field observation of the catchment. In this way mimicking similar research (e.g. Donald, 1997), in determining appropriate C factor values for a South African catchment in which little local data is available.

2.2.5. Erosion control practice (P) factor

Information on the support practices or P factor values in the site (e.g. contour intervals, terracing, burning) was collected through field observation. Field examination of the land cover-mapping units revealed the only form of erosion control being practiced in the site was contour tillage on land under temporary cultivation. According to McPhee and Smithen (1984) a support practice factor value of 0.6 should be assigned to land cover under this control practice and the remainder of the site is assigned the P factor value of 1, indicating no physical evidence of erosion control in these areas.

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2.3. Calculating the SLEMSA factor values

GIS is used to calculate the individual SLEMSA factor grids that, upon multiplication, provide the total potential soil loss within the catchment. A short description of the assumptions and calculations related to the creation of the factor grids is provided below. For a more comprehensive explanation of the methodology see Breetzke (2004).

2.3.1. Erodibility (K) factor

The erodibility factor of SLEMSA is determined using the exponential relationship (Morgan, 1995):

$$lnK = blnE + a \tag{6}$$

Where:

E represents the kinetic energy of raindrops as they strike the soil or vegetation, in J/m^2 (Schultze, 1979); and

a and b are functions of the soil erodibility factor (F).

Schultze (1979) calculated a rainfall intensity and kinetic energy equation for the region which is shown below and used to calculate the kinetic energy of the raindrops, E:

$$E = 15{,}16MAP - 1517.67\ J.\ m^{-2}annum^{-1} \tag{7}$$

Where:

MAP equals mean annual precipitation (in mm)

The erodibility (F) of the soil is governed by its soil texture and soil type. Using the results of the particle size analysis and governed by the United States Department of Agriculture (USDA) textural triangle, the texture of 120 soil samples at test sites was determined. An individual soil erodibility value (F) was subsequently assigned to each test site according to the specifications provided by Elwell (1978). An erodibility value per test site was derived and used as a variable for the erodibility grid map composed using the IDW interpolator. This grid map was summarised to create a table containing the mean K values per soil type in the catchment, and a grid created with the mean K values as the variable.

2.3.2. Slope length (X) factor

The slope length factor consists of two sub-factors: a slope gradient factor and a slope length factor. The slope length and slope gradient factors are calculated using the filled DEM and entered into the equation below to produce the slope length factor grid.

$$X = \sqrt{\left(L * \left(0.76 + 0.53 * S + 0.076 * S^2\right) / 25.65\right)} \tag{8}$$

Where:

X = topographic ratio

L = slope length, in metres (m)

S = slope steepness, in percent (%)

2.3.3. Crop (C) factor

The crop factor (C) is based on a Zimbabwean model originally developed for grassland by Elwell and Stocking (1976). A summary of the factor is shown below:

$$C = e^{(-0.06i)} \text{when } i < 50\% \tag{9}$$

and

$$C = \left(2,3 - 0,01i\right) / 30 \text{ when } i > 50\% \tag{10}$$

Where:

C = the ratio of soil loss from a crop having an interception value of i, compared to the soil loss from bare fallow;

i = percentage rainfall energy intercepted by the crop

The average percentage cover values for the land cover types were adapted from Schultze's (1979) index. Validation of these observations was provided through research done by Elwell (1977) and Edwards (1967).

3. Soil loss estimates

The erosion potential according to the USLE and SLEMSA models is shown in Figures 2 and 3 respectively. Soil loss rates are classified into five categories ranging from very low, where soil loss rates range between 0–1 $t^{-1}.ha^{-1}.yr^{-1}$, to very high where soil loss rates exceed 25 $t^{-1}.ha^{-1}.yr^{-1}$. Table 1 indicates the soil loss rate per land use type in the site. Soil loss rates were classified according to land use types as this allows for an effective subdivision of each soil model's input parameters thus providing useful insight into the components that contribute to the calculated soil loss rates. This knowledge can further aid planners in determining effective soil conservation strategies at the regional level. The basic conclusion drawn of Table 1 is that USLE and SLEMSA provide an average rate per hectare ($t.ha^{-1}.yr^{-1}$) of differing magnitude. Large differences are indicated per land use type where SLEMSA greatly exceeds the USLE models' mean annual rates on the of unmanaged grassland, thicket and scrubland, and indigenous forest land use types, while on the cultivated land use types, the USLE mean annual rates provide higher estimates.

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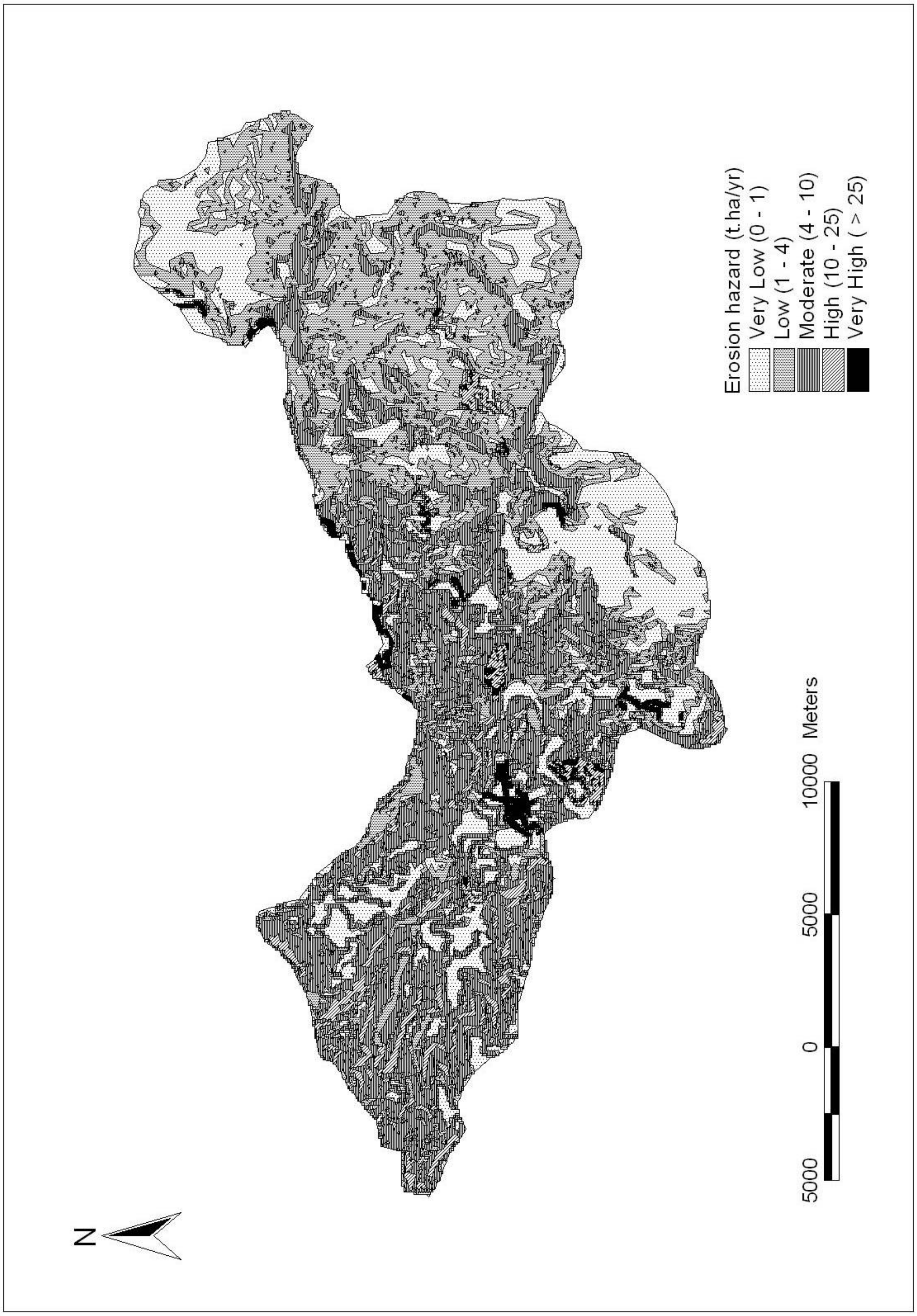

Figure 2. USLE soil erosion hazard in the study catchment

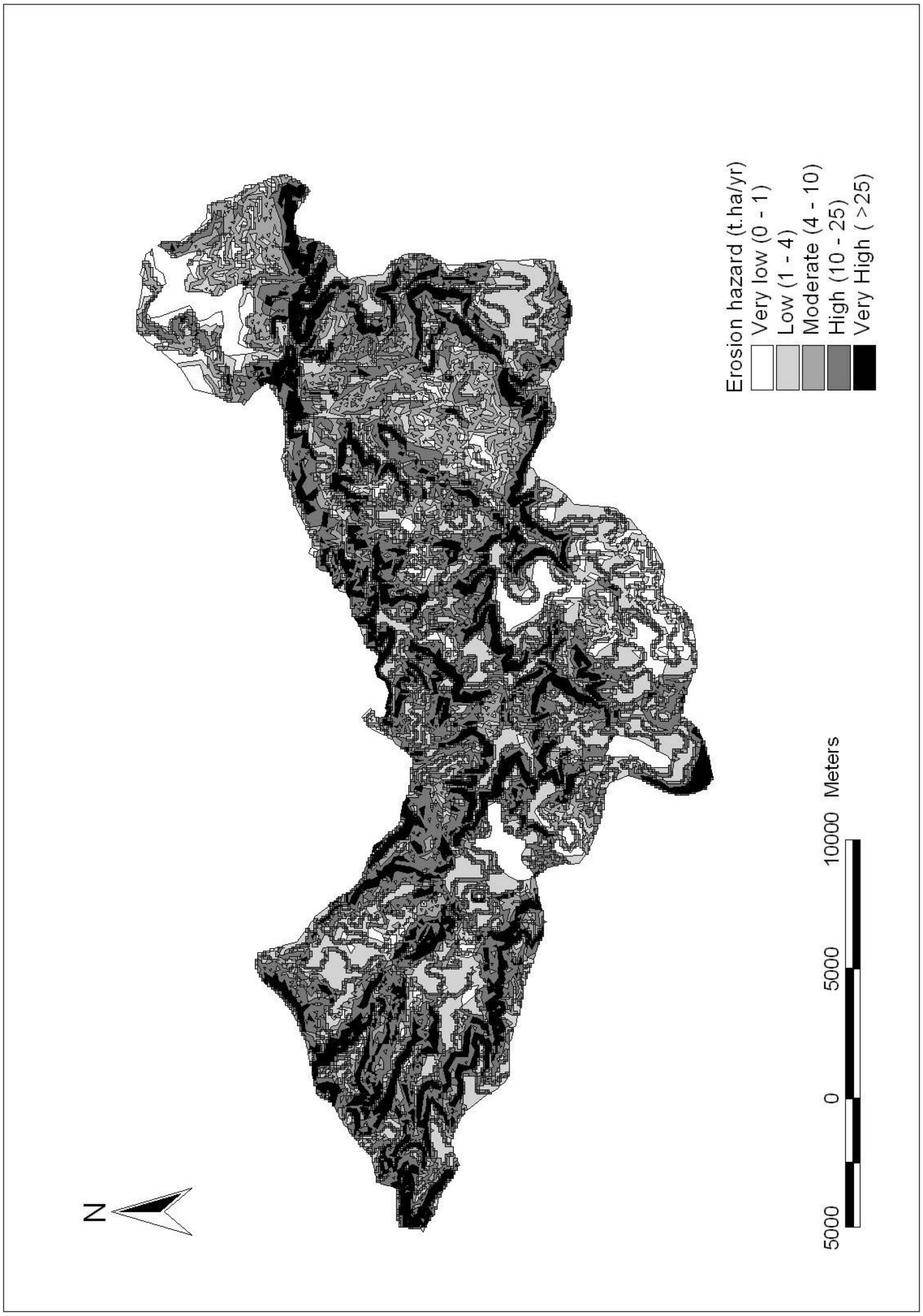

Figure 3. SLEMSA soil erosion hazard in the study catchment

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Land-use type[1]	Area (km^2)	Coverage (%)	Soil loss approach ($t.ha^{-1}.yr^{-1}$)	
			USLE	SLEMSA
Grassland (unmanaged)[2]	278.2	81.5	4.1	15.6
Forest plantations[3]	18.7	5.5	0.6	2.8
Thicket and scrubland[4]	16.4	4.8	1.5	13.6
Cultivated: TCD [5]	6.3	1.9	8.5	2.4
Cultivated: TSD[6]	5.8	1.7	16.2	5.4
Residential land[7]	5.6	1.6	8.6	3.1
Waterbodies[8]	5.6	1.6	-	-
Cultivated: TCI[9]	2.2	0.7	13.3	2.8
Indigenous Forest[10]	1.5	0.4	2.1	30.8
Grassland (managed)[11]	1.1	0.3	0.6	4.3
Average rate per hectare ($t.ha^{-1}.yr^{-1}$)			4.11	13.88

Table 1. Estimated mean annual soil loss per land use type

Notes:

1. Land cover types are in accordance with the land classification of the CSIR's – Satellite Application Centre of South Africa (CSIR-SAC, 2001).
2. Essentially indigenous species, growing under natural or semi-natural conditions.
3. All areas of systematically planted, man-managed tree resources, composed of primarily exotic species (including hybrids).
4. Areas of densely interlaced trees and shrub species (often forming an impenetrable community).
5. TCD: temporary commercial dryland: Large, uniform, mechanised, well-managed field units under temporary crops with lack of major irrigation schemes.
6. TSD: temporary subsistence dryland: Small field units in close proximity to rural population centres. Typically crops produced for individual or local (i.e. village) markets. Low level of mechanisation. Low-level mechanisation.
7. Areas in which people reside on a permanent or near-permanent basis.
8. Areas of (generally permanent) *open water*.
9. TCI: temporary commercial irrigated: Large, uniform, mechanised, well managed field units under temporary crops using major irrigation schemes.
10. Planted grassland, containing either indigenous or exotic species, growing under man-managed conditions for grazing, hay or turf production or recreation (e.g. golf courses)

3.1. USLE soil loss per factor

Overlaying the USLE erosion map on the grids of rainfall erosivity, soil erodibility, slope and length of slope, and crop management factors provides information on those land use types associated with high soil loss rates. A statistical comparison of mean factor rates of USLE and predicted soil loss values is provided in Table 2.

In general, the mean soil loss rate per land use type correlates most significantly with the mean crop management factor values. The cultivated land use types in the catchment had typically the highest mean crop management factor values which are indicative of the low percentage canopy cover, fall height and ground cover of the cultivated land. Such low ground cover values are typically found on cultivated land in South Africa where the national ground cover of cultivated land rarely exceeds 40% (Thompson, 1996). The canopy cover in the catchment, although affected by the current growth phase of the crop, rarely exceeded 50% as the crops are temporary (i.e. annuals) and are harvested at the completion of the growing season but remain idle until replanted, therefore prone to severe erosion in heavy rainfall events. The fallow period of crops by subsistence farmers in rural KwaZulu-Natal is extensive and coincides with rainfall peaks, particularly in the summer months. The canopy cover of forestland in the catchment (i.e. indigenous forest and forest plantations) on the other hand is continuous. It comprises mostly of evergreen trees beneath which the vegetation is multi-layered (Bredenkamp *et al*., 1996).

The emphasis that USLE places on the ground and canopy cover explains the low soil loss rates of forestland in the USLE approach when compared to the SLEMSA estimates that rather consider the percentage rainfall energy that is intercepted by the crop than on the percentage canopy cover, fall height and ground cover.

Land use type	Mean factor rate					Soil loss
	R	*K*	*LS*	*C*	*P*	(t. h^{-1} yr^{-1})
Grassland (unmanaged)	629	0.016	10.5	0.040	1.0	4.1
Forest plantations	650	0.015	6.1	0.006	0.6	0.6
Thicket and scrubland	586	0.017	16.6	0.008	0.6	1.5
Cultivated: TCD	557	0.016	4.0	0.421	1.0	8.5
Cultivated: TSD	739	0.017	8.4	0.170	1.0	16.2
Built-up – residential	753	0.014	6.3	0.130	1.0	8.7
Water bodies	-	-	-	-	-	-
Cultivated: TCI	493	0.019	4.1	0.673		13.3
Indigenous forest	764	0.015	25.0	0.006	1.0	2.1
Grassland (managed)	479	0.016	7.2	0.008	1.0	0.6

Table 2. Comparison of mean factor rates of USLE and mean predicted soil loss values per land use type

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3.2. SLEMSA soil loss per factor

Overlaying the SLEMSA erosion map on the grids of topographic, erodibility and crop factors provide information on those land use types associated with a high soil loss rates. A statistical comparison of the mean factor rates of SLEMSA and predicted soil loss values is shown in Table 3. In general, the mean soil loss rate per land use type correlates most significantly with the topographic factor values and indicates the strong influence of the topographic factor plays in determining soil loss estimations in SLEMSA. In general, erosion rates were low on gradual slopes (e.g. cultivated land and forest plantations) with mean soil loss rates less than 2,5 t. h^{-1} yr^{-1} predicted. Erosion rates were typically high on steep slopes (e.g. thicket and scrubland, and indigenous forest) with mean soil loss rates greater than 30 t. h^{-1} yr^{-1} predicted.

Land use type	**Mean factor rate**			**Soil loss**
	K	***C***	***X***	**(t. h^{-1} yr^{-1})**
Grassland (unmanaged)	29.8	0.12	4.3	15.6
Forest plantations	30.8	0.05	1.9	2.8
Thicket and scrubland	28.8	0.05	9.2	13.6
Cultivated: TCD	29.6	0.06	1.3	2.4
Cultivated: TSD	30.7	0.05	3.2	5.4
Built-up – residential	32.8	0.04	2.2	3.1
Water bodies	-	-	-	-
Cultivated: TCI	27.8	0.06	1.4	2.8
Indigenous forest	29.9	0.05	20.8	30.8
Grassland (managed)	32.9	0.06	2.1	4.3

Table 3. Comparison of mean factor rates of SLEMSA and mean predicted soil loss values per land use type

A further subdivision of the topographic factor of SLEMSA into slope degree, slope gradient (S) and slope length (L), Table 4, indicates that slope gradient, in particular, is the over-riding factor in explaining the high soil loss rates attributed to certain land use types. The mean slope length attributed to each land use type remains relatively consistent throughout the site, while the slope gradient is highest on those land use types with similarly high-predicted erosion rates. A point supported by Hudson (1987) who found that soil loss estimations using SLEMSA in mountainous terrain in South Africa were very sensitive to variations in slope steepness, while le Roux et al (2004) established that SLEMSA predicts excessive high soil losses on steep slopes and regions with high rainfall, while conducting a catchment scale studying using SLEMSA in Mauritius. In general, the slope length of the land use types are too small to bring about a concentrated flow and the effect of the slope gradients on the input parameters within SLEMSA is significant as it is the predominant factor that influences the erosion rates.

Land use type	Mean factor rate		
	Slope (°)	***Slope factor S***	***Slope length L***
Grassland (unmanaged)	0.07	137.5	3.0
Forest plantations	0.07	23.4	2.7
Thicket and scrubland	0.07	75.3	3.3
Cultivated: TCD	0.07	20.9	2.2
Cultivated: TSD	0.07	53.3	2.7
Built-up – residential	0.07	26.0	2.6
Water bodies	-	-	-
Cultivated: TCI	0.07	17.1	2.5
Indigenous forest	0.30	130.9	3.3
Grassland (managed)	0.07	6.1	2.8

Table 4. Comparison of slope related mean factor rates and mean predicted SLEMSA soil loss values per land use type

4. Discussion and conclusion

An accurate validation of the soil loss rates obtained is challenging, as there is a dearth of empirical investigations covering soil loss in South Africa and no calculated soil loss data from run-off plots in the catchment. It is beyond the scope of the study to develop a set of field data to assess the accuracy of each model but rather the focus is confined to qualitatively contrasting the soil loss rates obtained for each model and elaborating on causal influences within each model that play a significant role in eliciting the varying soil loss rates obtained.

The strikingly different results illustrated pose the question whether or not the use of USLE or SLEMSA for erosion modelling at a catchment scale is valid. The selection of both soil loss models to a mountainous quaternary catchment in South Africa must raise questions of applicability. Numerous studies have been conducted investigating the use of USLE in South African conditions, most notably, Donald (1997), McPhee & Smithen (1984) and Crosby, McPhee & Smithen (1983), these researchers propose that USLE could be applied to South African conditions provided input data for local conditions could be developed. Site-specific correct parameters however, have not been determined for both models in South Africa and neither model has been comprehensively tested and calibrated to determine its practicality in a South African environment. Yet the majority of soil erosion prediction research conducted in South Africa has been done using the USLE, Revised Universal Soil Loss Equation (RUSLE) and SLEMSA models (Smith, 1999). The USLE (e.g. Smith *et al*., 2000) and SLEMSA (e.g. Schulze, 1979; Hudson, 1987) have, however, been applied on catchment scales elsewhere and these studies demonstrate that the models are capable of adequately predicting

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soil loss under different land use, despite being applied to conditions beyond the original database (Le Roux *et al*., 2004).

The spatial scales with which these models have been applied in practice are not the spatial scale for which they have been conceived. The mismatch between the small spatial and temporal scales of data collection and model conceptualisation, and the large spatial and temporal scales of most intended uses of models (Renschler & Harbor, 2002) is a major challenge in soil erosion modelling, which has become even more important with the increasing use of models linked to GIS. The problem with spatial scale and erosion modelling is two fold – on the one hand by estimating potential soil loss at a catchment scale the spatial error in the application is propagated. Jetten et al (1999) states the reason being that at a catchment scale the input maps are often created from a limited amount of field data and with a lot of assumptions and therefore highly subjective; there are also many methods of interpolation that are equally valid but give different results. He concludes that all these problems mean that there is a greater opportunity for concatenation and amplification of any errors and uncertainties in the input data within the model. On the other hand however GIS is able to model catchment-scale applications and treat heterogeneous catchments of varying size to produce regional results for a catchment-scale conservation strategy.

4.1. Future developments

The USLE and SLEMSA soil loss models were used to estimate soil loss rates in a quaternary catchment in the KwaZulu-Natal province of South Africa. The mean annual soil loss is estimated approximately at 4.11 $t.ha^{-1}.yr^{-1}$ by the USLE and 13.88 $t.ha^{-1}.yr^{-1}$ by SLEMSA. The SLEMSA rates greatly exceed the USLE rates on the unmanaged grassland, thicket and scrubland, and indigenous forest land use types, while on the cultivated land use types, the USLE mean annual rates provide higher estimates. Overlaying the USLE and SLEMSA erosion maps on the respective factor grids provided an insight into factors that played a significant role in eliciting the varying soil loss rates obtained. For the USLE, the crop management factor provided the most significant influence in determining high soil loss rates, whereas in SLEMSA the topographic factor was the predominant factor that influenced the erosion rates per land use type. Our analysis shows that SLEMSA is very sensitive to variations in slope steepness whereas the effects of crop and canopy cover within USLE are the strongest determinants of high erosion potential.

The USLE and SLEMSA factor calculations and resulting local soil loss estimates need to be validated by measuring erosion from run-off plots or applying a correction for inter-catchment deposition by means of a Sediment Delivery Ratio (SDR). To date such validation work is lacking (Le Roux et al., 2007). Developing effective regional values for land use types and soils within each soil erosion assessment should occur as uncertainty regarding the allocation of crop factor and soil erodibility values within a study can have a significant impact on the results produced, particularly within a South African context. The focus on the variable results obtained should however be shifted towards what models are best suited for each spatial application, the problem for developing countries, where data is scarce and unreliable, is that they do not have a choice in the selection of a model for determining erosion potential simply because of a lack of data resources. Both the methodology and results obtained through the paper pose the question whether or not such a study can stand up to scientific scrutiny, the answer is provided in the lack of the realistic alternatives for soil loss estimation in South Africa. For the foreseeable future, the USLE and SLEMSA as well as the methodology employed still have a role to play.

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