Hillslope anatomy and geomorphic processes at Target kopje of Masvingo City, Zimbabwe

By

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Abstract

Every land surface regardless of origin, depositional or erosional processes, is composed of one or more slope units. There is a linkage between slope form and geomorphic processes. Data for this study was collected through measurements and observations. The slope units on the hillslopes of Target Kopje experience different geomorphic processes and these to a large extent depend on slope gradient, orientation, surface cover and length. It emerged from this study that there are five slope units on the hillslopes of Target Kopje. The slope units are crests, the convex slope, the transportational middleslope, the footslope and the toeslope. To illustrate the slope units found on the hillsopes of Target Kopje the photograph as well as the diagram of the profile of the hillslopes is provided. There are different slope processes (erosional and depositional) on the slope units of the Kopje. The processes differ with the nature of the slope unit.

1. Introduction

Slope can refer to the angle of inclination of the ground surface, expressed in degrees or refers to the inclined surface itself. To avoid confusion in this paper, the term hillslope is used to refer to the inclined surface and the term slope angle, slope gradient, or simply slope to its inclination. On a given hillslope, the slope angle can show continuous horizontal and vertical variation. At the same time the slopes can vary from simple miniature size e.g. a river bank to complex ones such as those of the side of a mountain range. In order to effectively describe the complex land surface, it necessary to convert visual impressions and real dimensions of the components of the landscape into categories. A hillslope unit is one such category. A hillslope is a series of basic units that describe changes in slope, curvature and processes along a hillslope profile (Goudie, 1995). It is therefore a morphological sequence consisting of a particular combination of hillslope units. Hillslope units form a geomorphic catena, which is a sequence of linked slope units (Speight 1974; Scheidegger 1986). A slope's shape is governed by its internal structure and external processes, such as slope wash, creep and other mechanisms of sediment transport.

2. Study area

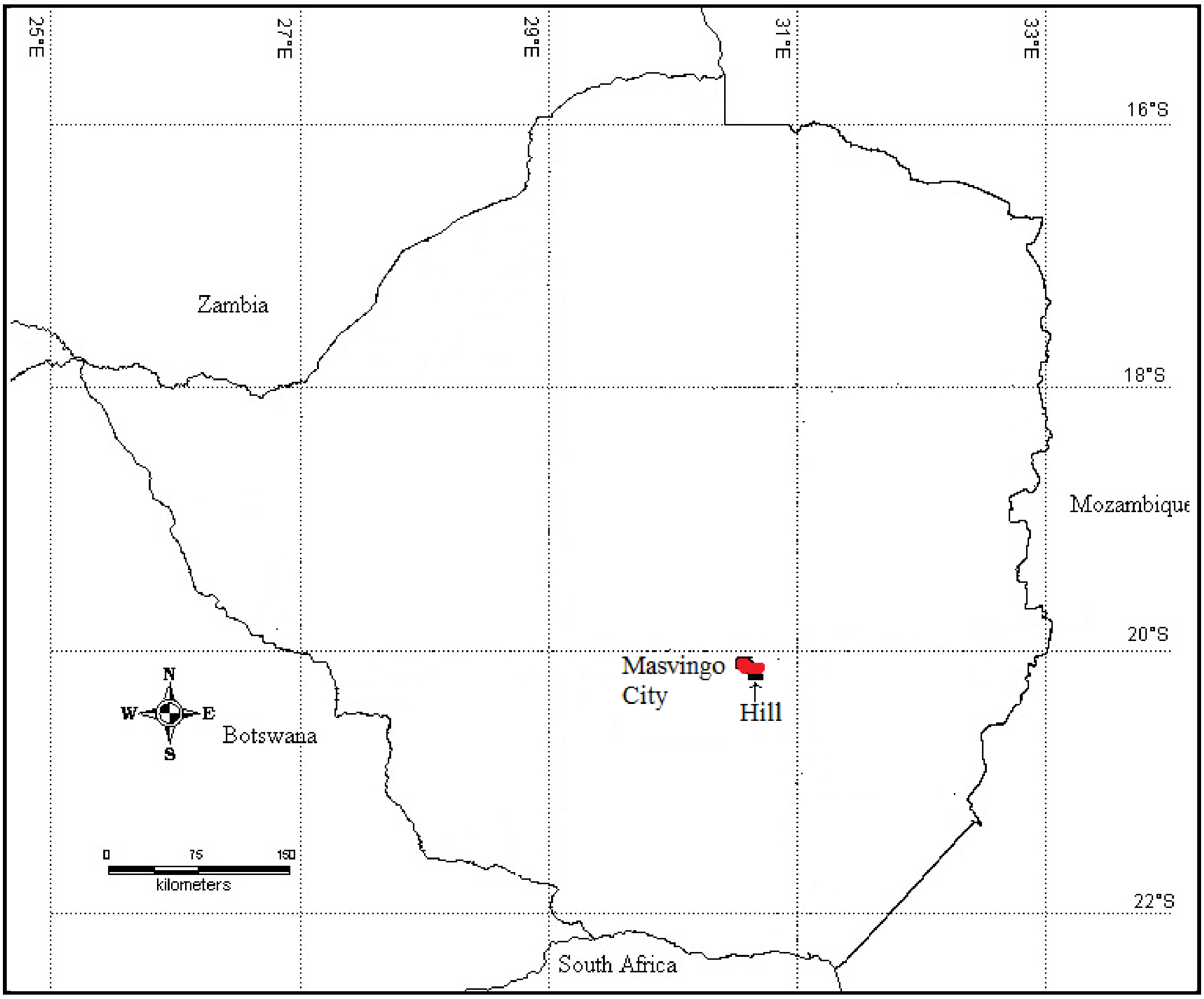

Figure 1: Location of Target Kopje Hill in Masvingo City, Zimbabwe (Source: Adapted from Musanga, 2009)

Masvingo city is located in the southern part of Zimbabwe. It is situated in a region which is generally dry with rainfall of 650mm per annum and below. The city is the provincial capital of Masvingo province and is the oldest urban area in Zimbabwe. The map (Figure 1) shows the location of Masvingo city in Zimbabwe as well as the location of Target Kopje, a hill in the city. Target Kopje, the area under study is situated along the southern fringes of the Zimbabwean central watershed. According to Lister (1987), the region is correlated with the post-African surface. The African erosion cycle commenced with the disruption of Gondwana, while the ensuing post-African cycle of erosion was initiated by the late Palaeogene uplift along the line of the modern central watershed (Moore *et al*., 2009: 65). This led to rejuvenation in the river network system and consequently removal of the deeply weathered saprolite. The post-African surface is thus an etch surface, with the characteristic plain and inselberg topography marking the weathering base of the African erosion event.

3. Methods and materials

To determine hillslope anatomy, slope angles were supposed to be measured. Topographic maps are available on the area under study and could have been used in the determination of such angles. Such maps are, however, insufficiently accurate for slope gradient determination; even where photogrammetric contours give improved accuracy, the number of contours is often too small to yield a detailed picture of a profile, with information on breaks and changes of slope or microrelief. Data for the analysis of the hillslope anatomy and associated geomorphic processes were obtained through the observation and measurement techniques. The Abney level, linen tape and ranging poles method was used in this study. The method was convenient because it gave the required accuracy. It was also rapid to use and needed only one observer. The materials that were required were Abney level, linen tape and ranging poles.

4. Results and discussion

Though observations and measurements, it emerged that the hillslopes on Target Kopje generally exhibited five slope units which are the crests, the convex slope, the transportational middleslope, the footslope and the toeslope. The photograph (Figure 2) shows the nature of slope units from a three dimensional perspective. As far as gradients are concerned, they vary from 0 to 5° on the crests. On the transportational middleslopes, they get up 40°. On the footslopes they ranged from 4 to 8°. Finally, the toeslopes are generally level. Human interferences on the natural processes of slope development are evidenced by constructed water tank (marked A in Figure 2) and the vegetation removal on the hillslopes.

Figure 2: Slope units on Target Kopje (Source: Field data, 28-11-2015)

The five slope units are also shown on the hillslope profile from either side of the kopje in Figure 3. A hillslope profile is a line on a land surface linking a crest on a drainage divide and a base on a drainage line, following a maximum gradient path that runs perpendicular to the contours (Goudie, 1994). The slope units on the hillslope profiles were recorded directly in the field. The profile measurements were done to angle measurements of ± 1° and height measurements of ±0.2m. The slope units, as depicted in in Figure 3 are crest, convex, middleslope, footslope and toeslope.

Different slope processes tend to dominate the various slope units along the catena. On the crest, processes associated with lateral and vertical subsurface water movement are predominant. On the convex slope segment, soil creep and rain splash erosion are dominant. There was also evidence of isolated cases of rapid mass wasting and subsurface movement of soil water accompanied by rockfall, slide. Straight (middleslope) elements receive a large amount of material from upslope by mass wasting processes (including flow, slump, and slide), surface wash, and subsurface water movement.

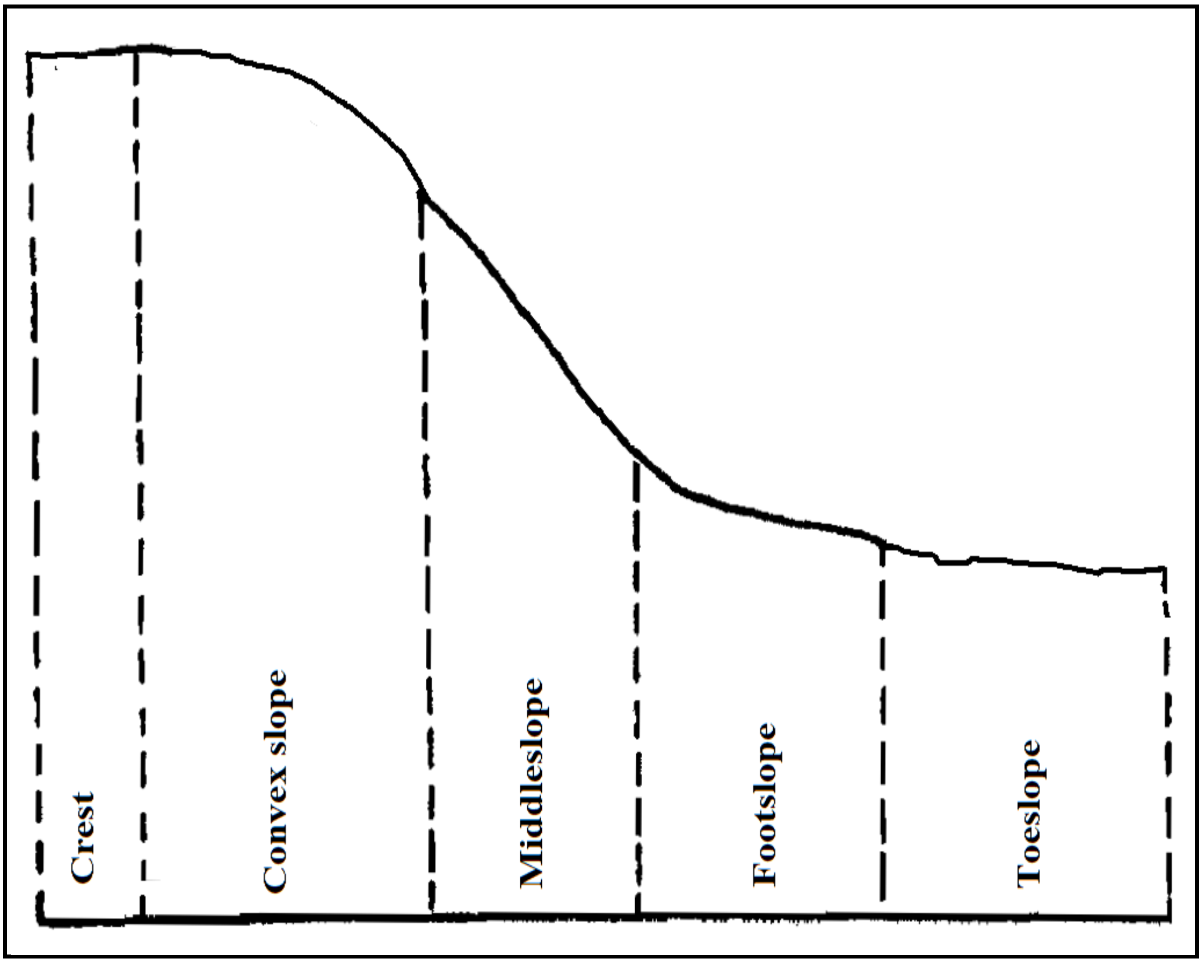

Figure 3: Profile of slope units on either side of Target Kopje (Source: Field data, 27-11-2015)

The dominant process at this segment is transportation of material by creep, slide, slump and flows especially during the wet season. On the footslope and the toeslope, which are the concave slope elements, are commonly sites of transport and deposition. They are at the base of the hillslope profile. Waste material moving down the hillside through mass wasting and surface and subsurface water action comes to rest and generally it is not removed. At the toeslope, in particular, deposition of colluvial and alluvial material is predominant but at the footslope, both transportation and deposition are active processes.

Hillslope processes occurring on the slope units of Target Kopje are subjected to human interference. The water tank on top of the hill implies that the Kopje is not only subjected to natural processes but also to human action. A huge body of evidence indicates that humans are a potent denudational force (Huggett, 2007; Brooks, 2011; Goudie, 2013 and Grace, 2005). Humans have removed the vegetation and have also destabilised the slopes during the construction and maintenance of the City water tank. The overall effect of such human interference is accelerated slope erosional processes.

5. Conclusion

A hillslope profile consists of slope units, which may be slope segments (with a roughly constant gradient) or slope elements (with a roughly constant curvature). The hillslope profiles at the target kopje hill studied comprised of five slope units. The slope units are crest, convex, middleslope, footslope and toeslope. These elements (units) form a geomorphic catena. Different geomorphic processes dominate different slope elements along the catena at Target Kopje. Landform elements are basic units of the two dimensional land surface. Properties such as slope angle, slope curvature, and aspect define the slope elements (units). Land-surface form is also the basis of landform classification schemes. Geomorphic processes that transport material over and through the hillslopes at Target Kopje include rainflow, leaching, throughwash, creep, dry ravel, mass wasting, and mixing by organisms (bioturbation). Transport-limited processes, such as creep and rainsplash are more dominant than supply-limited processes, such as solute leaching and debris avalanching on the hillslopes of Target Kopje. Human activities also alter hillslope processes. This is evident in the erosion of soil-mantled hillslopes caused by water tank construction, road building and agricultural practices on the lower part of the hillslopes. The movement of people, animals, and vehicles along trails also cause soil erosion.

6. References

Brooks, S. (2011) *Geomorphological processes.* London. University of London

Goudie, A. S. (ed.) (1994) *Geomorphological Techniques*. London and New York. Routledge

Goudie, A. S. (1995) *The Changing Earth: Rates of Geomorphological Processes*. Oxford. Blackwell Science

Goudie, A. S. (2013). *The Human Impact on the Natural Environment.* Wiley & Sons. West Sussex

Grace, J. (2005) 'Humans and environmental change' in Holden, J. (ed.) An *Introduction to Physical Geography and the Environment.* Harlow. Pearson Education Limited

Huggett, R. J. (2007). *Fundamentals of geomorphology.* New York. Routledge.

Lister, L.A. (1987). The erosion surfaces of Zimbabwe. *Zimbabwe Geological Survey.* Bulletin **90**: 1-174.

Moore, A. E,. Cotterill F. P. D,. Broderick. T. and Plowes. D, (2009). Landscape evolution in Zimbabwe From the permian to present, with implications for kimberlite prospecting. *South African Journal of Geology.* 112: 65-88

Musanga, L. (2009) *Zimbabwe: Geography Today*. Harare: Zimbabwe Education Books.

Scheidegger, A. E. (1986) The catena principle in geomorphology. *Zeitschrift für Geomorphologie.* 30: 257–73.

Speight, J. G. (1974) A parametric approach to landform regions. In Brown, E. H. and Waters, R. S. (eds) *Progress in Geomorphology: Papers in Honour of David L. Linton* (Institute of British Geographers Special Publication No. 7) pp. 213–30.