# APPENDIX A:

# MAPS OF FACTORS INFLUENCING SHEET-RILL EROSION AT A NATIONAL SCALE

The annual erosivity map shows an east to west gradient over SA with low (100-300 MJ.mm/ha.hr.yr) erosivity values over the dry western parts of the country and high (20 000-40 000 MJ.mm/ha.hr.yr) erosivity values over the eastern parts of the country (see Figure 1). Over the southwestern Cape erosivity values are lower than over the summer rainfall areas where similar annual rainfall occurs. Therefore, the model correctly compensated for lower rainfall intensities over the winter rainfall areas and higher intensities over the summer rainfall areas. While winter rainfall produced by frontal activity is of a more general and light nature, thunderstorms associated with convection during summer produce higher rainfall intensities. The highest erosivity values occur along the escarpment, especially northward, where the influence of tropical low pressure systems from time to time cause heavy rainfall and very high daily rainfall totals. Erosivity values calculated over mountainous areas are two to three times higher than those previously calculated by Smithen and Schulze (1982). This is the result of more stations used as well as the inverse distance weight method of interpolation that better compensates for topographical influences.

Figure 2 indicate that high to very high soil erodibility values in range of 0.022 - 0.046 t/ha/(MJ.mm/ha.hr) are found in a number of regions in SA, some of the most prominent being in the southern Free State, as well as the northern and southern regions of the Eastern Cape. In terms of texture, soils with high clay content usually have low k-factor values because they are generally resistant to detachment with strong cohesion between the clay particles (e.g. Shortlands along the Lebombo mountain range). Soils with a high permeability prevent runoff and erosion, and therefore generally have low K-factor values (e.g. coarse sandy soils of the Kalahari Desert). In terms of structure, transported sediment and unconsolidated soil with a Neocutanic horizon, usually have high K-factor values because they are easily detached and transported by overland flow (e.g. transported colluvial and alluvial sediments of the Mtata River in the Eastern Cape) (Tooth *et al*., 2000). Orthic topsoils often have high k-factor values due to a weak structure caused by wetness or waterlogging (e.g. Kroonstad Katspruit form). Soils with an E-horizon are also weakly structured or structureless and erodible due to periodic saturation with water and *in situ* removal of colloidal cementing matter including clay, iron oxides and organic matter (e.g. Fernwood near Humansdorp) (MacVicar *et al*., 1977). The removal of colloidal matter is also the reason why soils with a clear transition from overlying horizons are erodible (e.g. Swartland form near Stanger) (Fey, 2010). In many cases soils have an abrupt transition between the topsoil and the subsoil with respect to texture, structure and consistence (e.g. Sterkspruit Duplex soils). These soils are highly erodible due to a permeable horizon overlying abruptly a less permeable one, causing water to infiltrate and saturate the top layer where it moves in a predominantly lateral direction as subsurface flow (MacVicar *et al.*, 1977). Finally, in terms of soil depth, deep soils usually have low K-factor values because they have higher water-holding capacities and are able to absorb larger rainfall amounts before overland flow is generated, whereas shallow soils with minimal development and lithic contact on steep slopes have high K-factor values (e.g. Mispah and Glenrosa soil forms between Douglas and Vryburg in the Northern Cape) (Samadi *et al.*, 2005).

The LS-factor map is shown in Figure 3. Results illustrate that high LS-factor values follow the topography, especially in the escarpment. Long steep slopes, a common feature in the KwaZulu-Natal Drakensberg, render the land extremely susceptible to erosion (Schulze, 1979). Other areas of pronounced relief include large tracts of the former Transkei and Waterberg Plateau. It is worth mentioning here that not all these areas are necessarily affected by high erosion rates. Some areas have a high potential erosion risk but a low actual erosion risk due to good vegetation cover and/or stable soils. The problem is that (R)USLE based studies tend to overestimate erosion rates in areas with steep terrain (e.g. along the escarpment in SA), especially since (R)USLE was developed in the US where LS features very prominently and is considered to be a dominant factor (Laker, 2004).

The C-factor map is illustrated in Figure 4. The C-factor map indicates that the highest C values are ascribed to the western and northern arid parts of SA (0.6). The eastern marginal zone of SA (approximately 42 million ha) positioned between the interior plateau and coast (0 – 1200 m a.s.l.) has the lowest C-values (0.003). Low C-values (good cover) in the eastern marginal zone are essential to compensate for the high potential erosion risk and it is recognised that there is a huge difference between actual and potential soil erosion for this region.

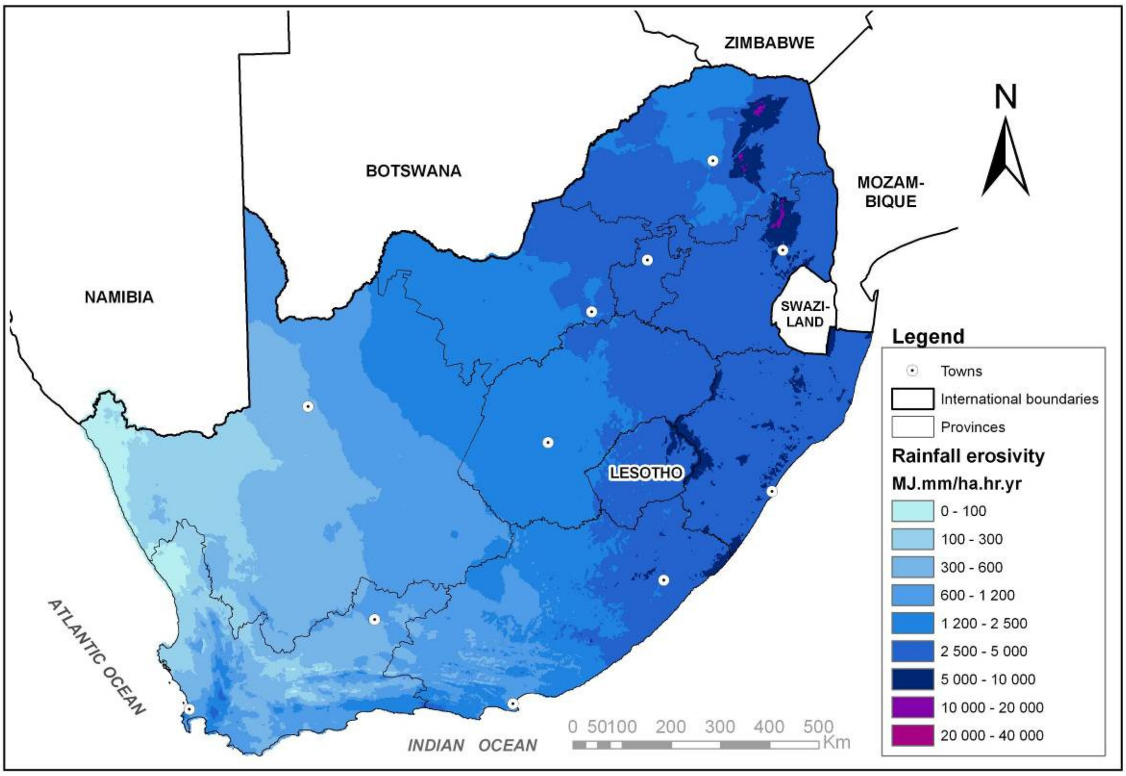


**Figure 1: Rainfall erosivity factor (R) map of South Africa.**

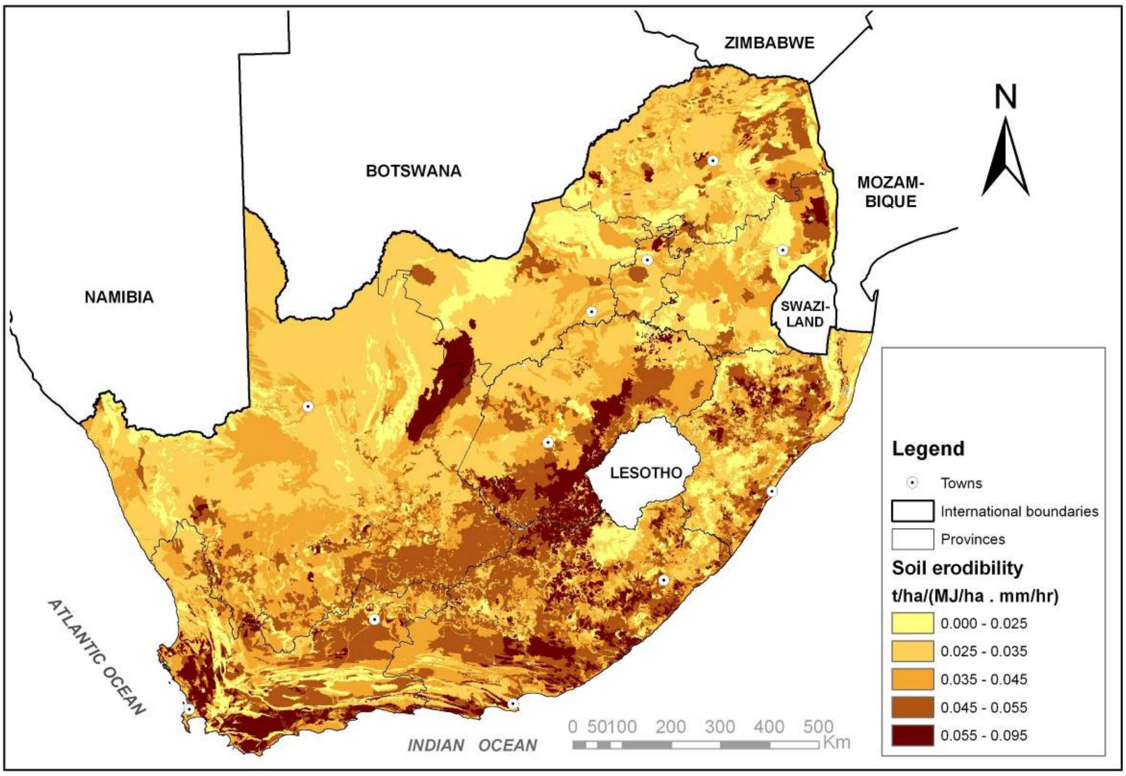


**Figure 2: Soil erodibility factor (K) map of South Africa.**

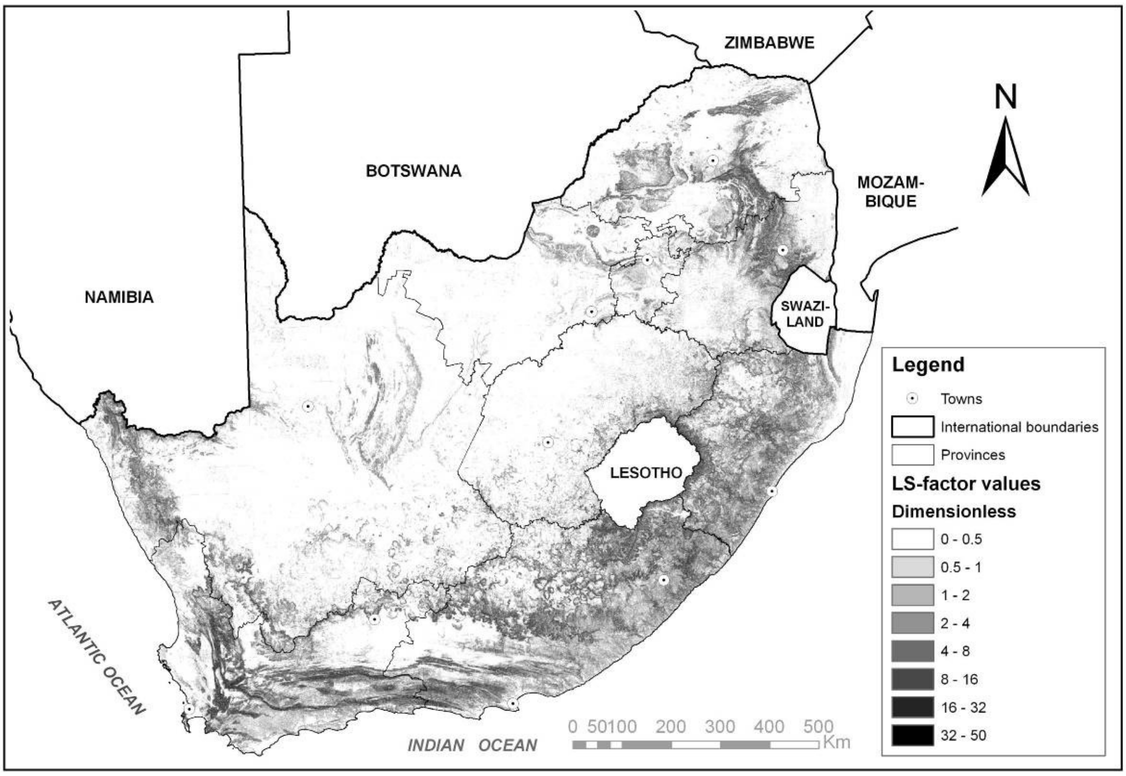


**Figure 3:** **Topography factor (LS) map of South Africa.**

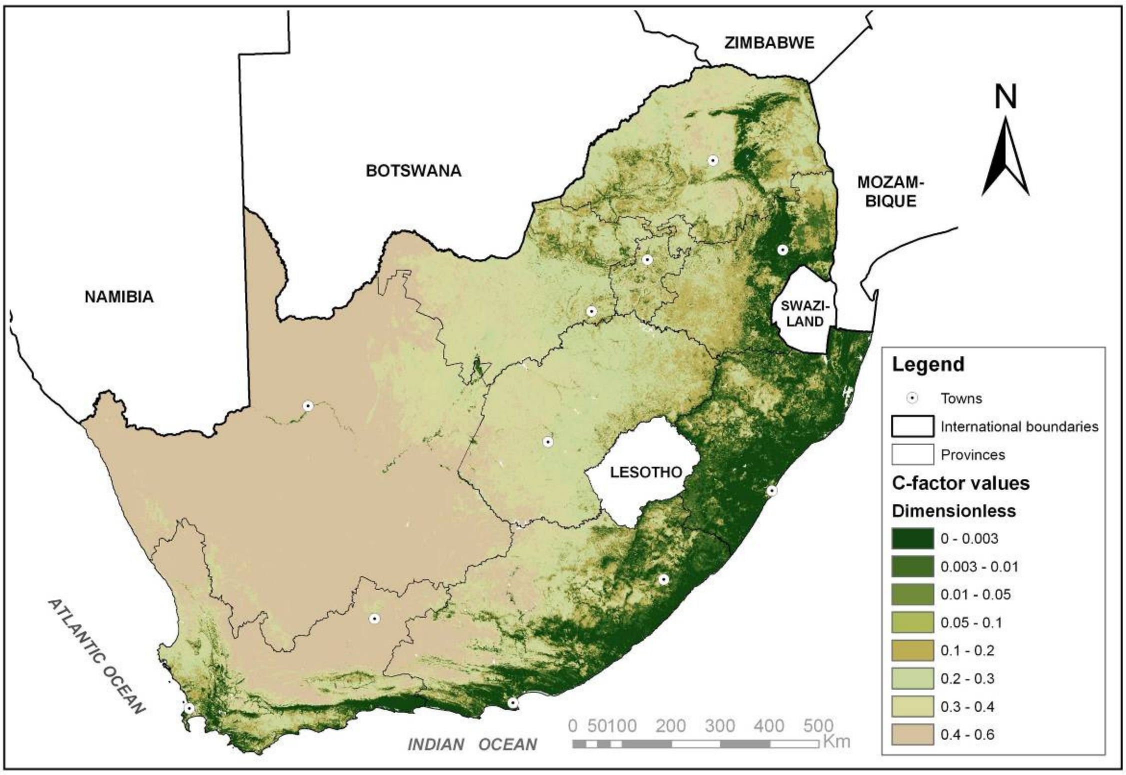


**Figure 4:** **Cover factor map of South Africa.**

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# APPENDIX B:

# MAPS OF FACTORS USED TO DETERMINE AREAS SUSCEPTIBLE TO GULLY EROSION

Geology, land type, soil erodibility and soil depth class layers are illustrated in Figure 5a-d respectively. The Tarkastad and Molteno Formations in the central part of the catchment are ranked as class 5, as well as the soils derived there from. Since gully development also depends on the availability of deep soils, it is not surprising that relatively large fractions of deep soils are affected by gully erosion, especially where footslopes and valleys are filled with erodible soils derived from mudstones. As mentioned in Case Study *ii* of Section 3, the soils from these Formations are associated with duplex soils that are highly erodible (class 5) with widespread gully erosion evident.

Figure 6a-e respectively illustrates slope, contributing area, the wetness and sediment transport capacity indices, as well as terrain unit class layers. Gullies are prominent on gentle footslopes in concave zones of saturation along drainage paths with large contributing areas. As mentioned above, gully formation is favoured in these areas because the critical drainage area needed for gully initiation increases as slope decreases (Poesen *et al.*, 2003), representing zones of saturation with high surface soil water along drainage paths where the contributing area is high and slope is low.

Figure 7a-b respectively illustrates vegetation cover and land use indices. Gullies are mainly located in areas with poor vegetation cover and in cultivated areas and degraded grassland. As mentioned above, gully formation is favoured in these areas because cultivated areas and degraded grassland represent areas where the soil is frequently disturbed and gully development is favoured. Field observations indicate that a relatively large portion of the cultivated and grassland areas in the catchment is affected by gully erosion due to livestock disturbance, including overgrazing and trampling along cattle tracks.

Figure 8 illustrates areas that are intrinsically susceptible to gully erosion, yet are vegetated and gully-free (estimated at approximately 7 260 ha). The identification of currently vegetated or gully-free areas susceptible to continuous and/or discontinuous gully development was also achieved (estimated at approximately 560 and 6 700 ha, respectively). Appropriate strategies need to be designed for these susceptible areas in order to protect the current vegetation cover. This approach proved to be relatively simple, realistic and practical, and it can be applied or expanded to other areas of SA at a regional scale; thereby providing a tool to help with the implementation of plans for soil conservation and sustainable management (Kheir *et al*., 2007).

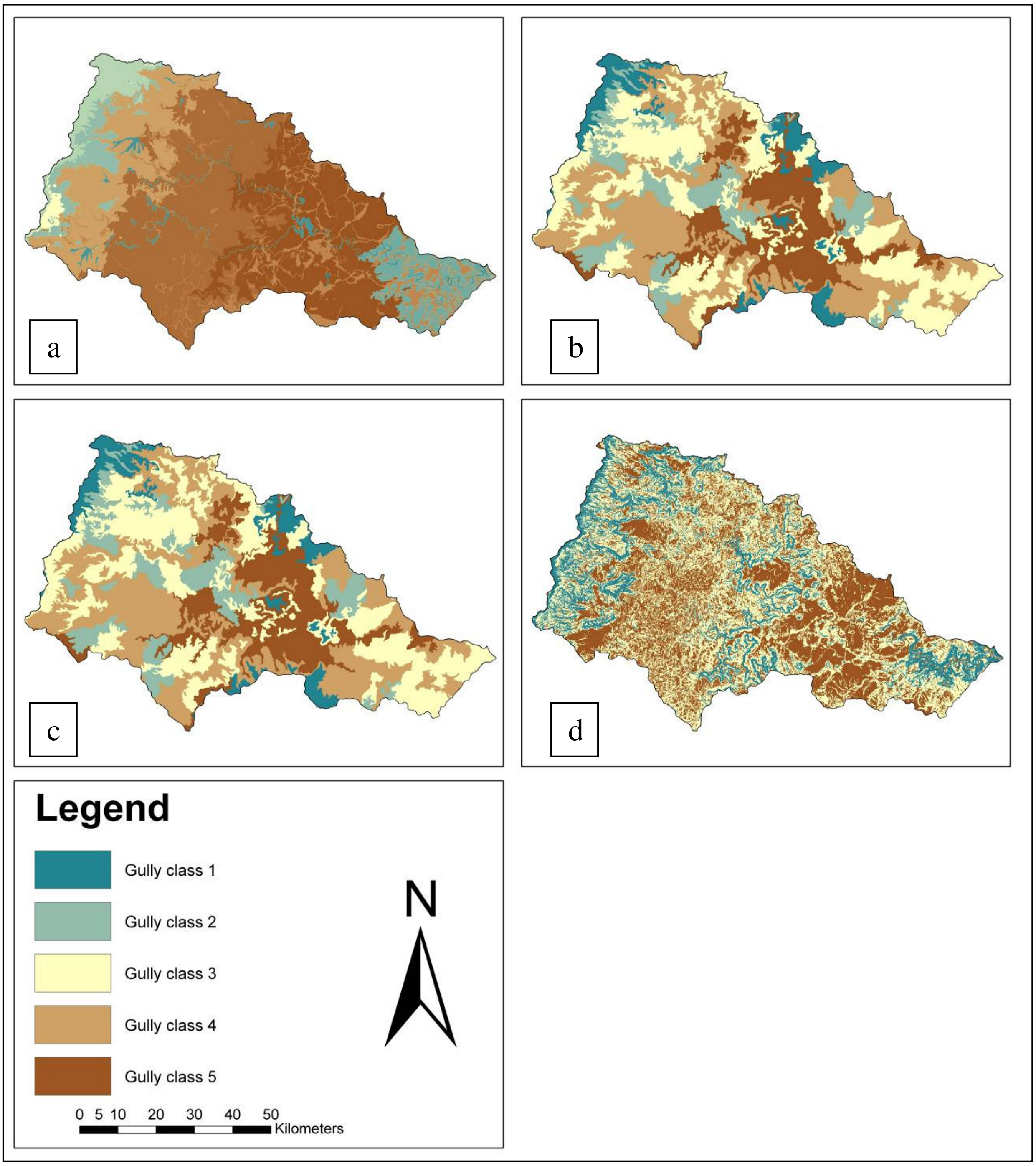


**Figure 5: Lithological and pedological gully class layers including (a) geology, (b) land type, (c) soil erodibility and (d) soil depth.**

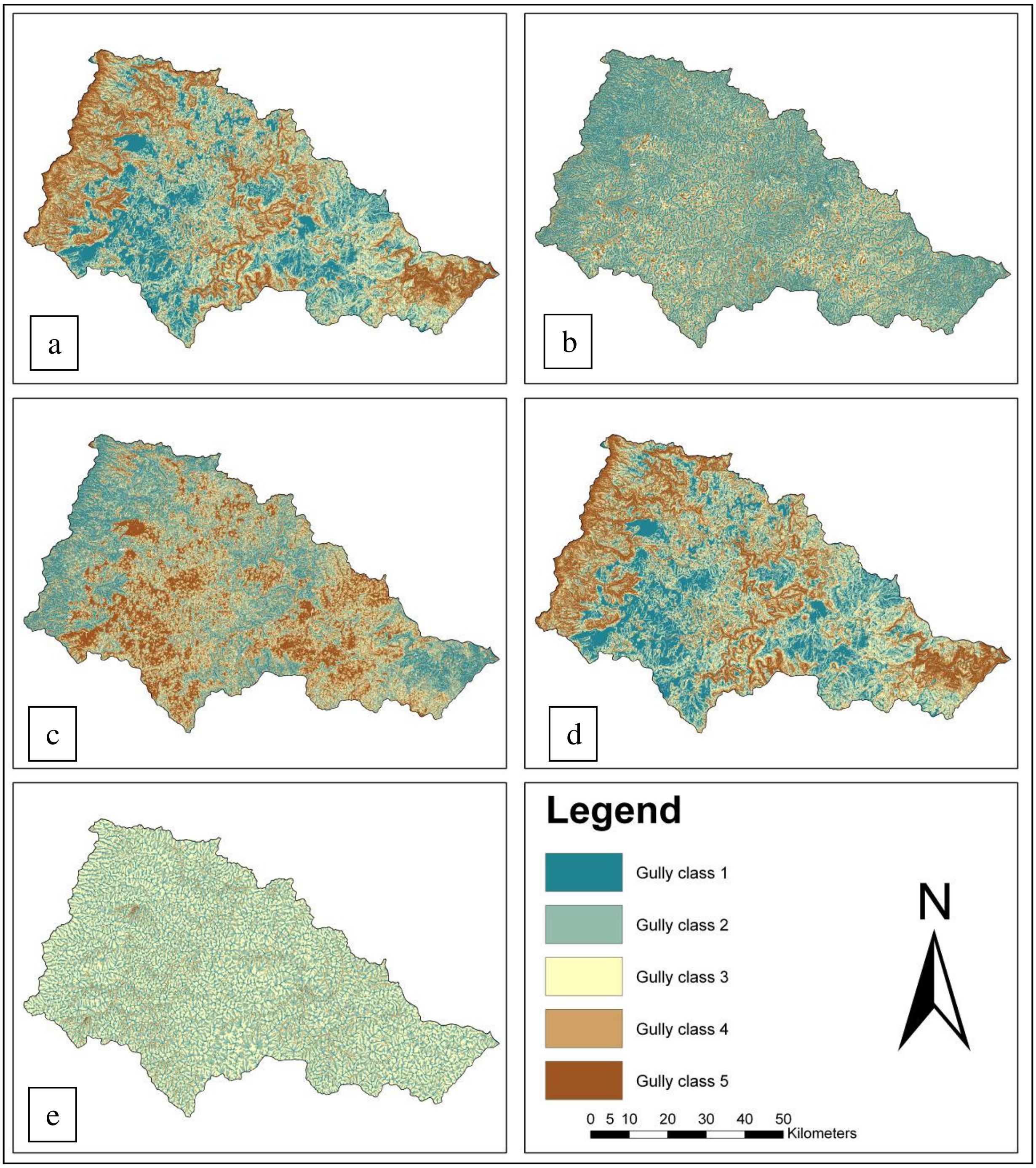


**Figure 6:** **Topographical gully class layers including (a) slope, (b) contributing area, (c) wetness and (d) sediment transport capacity indices, as well as (e) terrain units.**

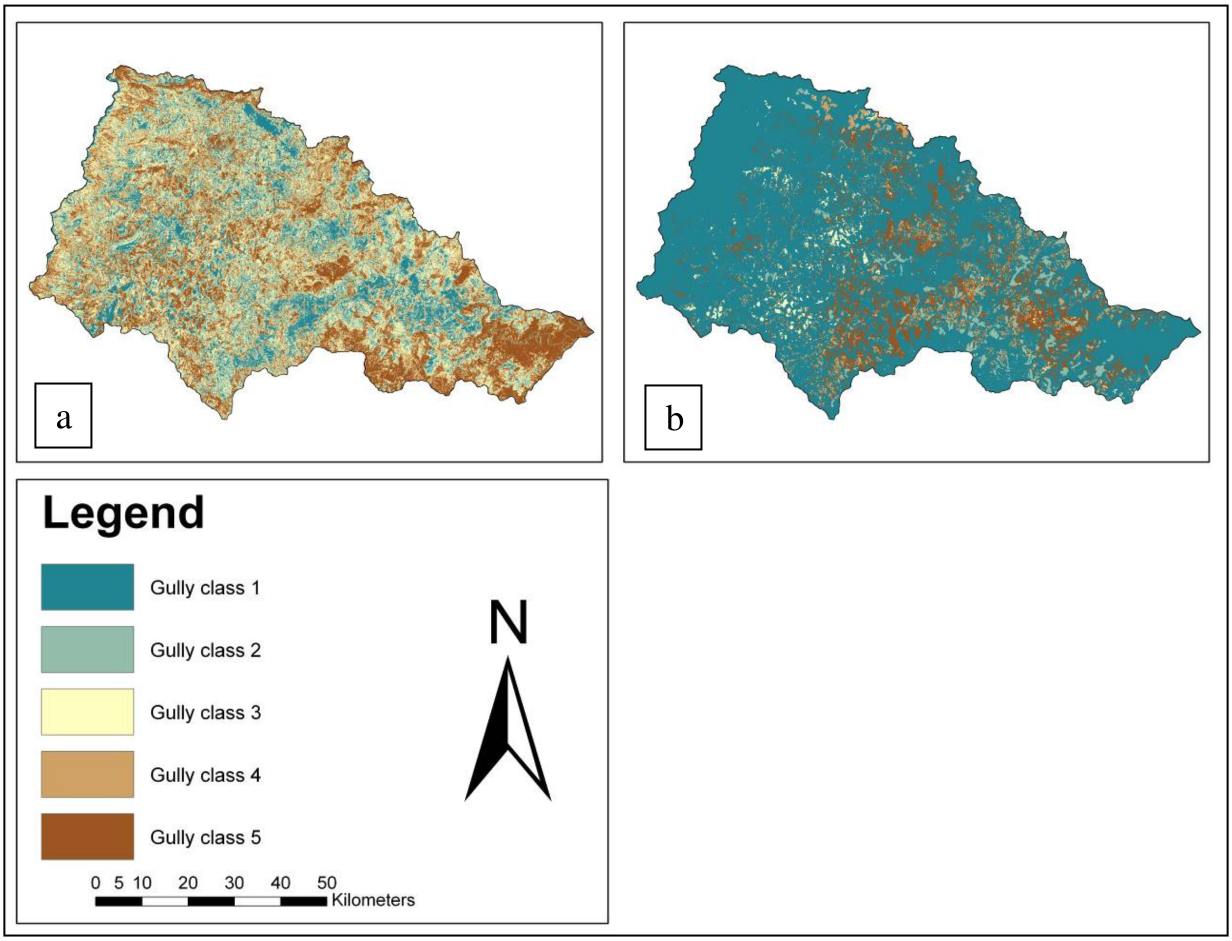


**Figure 7:** **(a) Vegetation and (b) land cover gully class layers.**

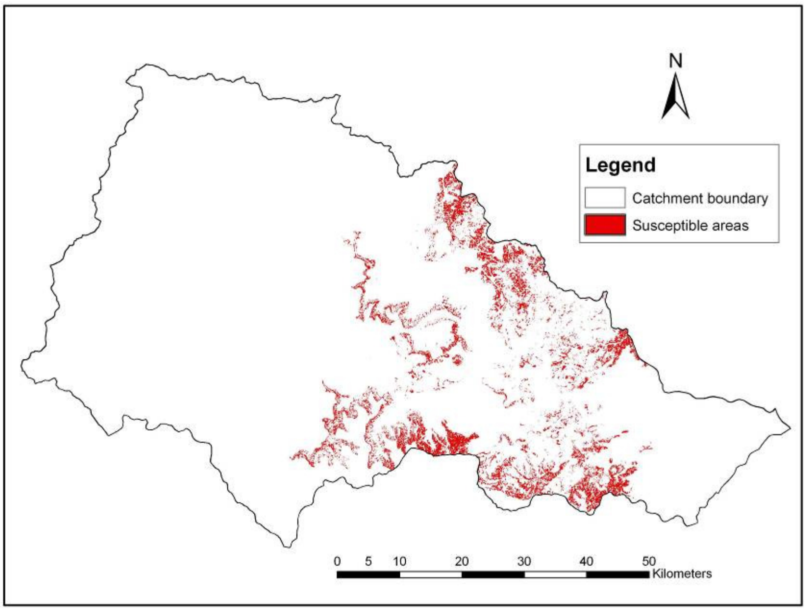


**Figure 8:** **Areas that are intrinsically susceptible to gully erosion, yet are vegetated and gully-free.**

## References

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