Appendix 3.6: Models - Cultural Heritage

Morgan-Morgan-Finney (MMF) Model

Organisation: NSRI

Date: 2001 (revised), 1984 (original)

Objectives

- To predict annual soil loss by water
- To provide a stronger physical base than Universal Soil Loss Equation whilst retaining its simplicity
- To encompass recent advances in the understanding of erosion processes
- To bring together the results of research by geomorphologists and agricultural engineers
- To incorporate the effects of soil conservation practices

Methodology

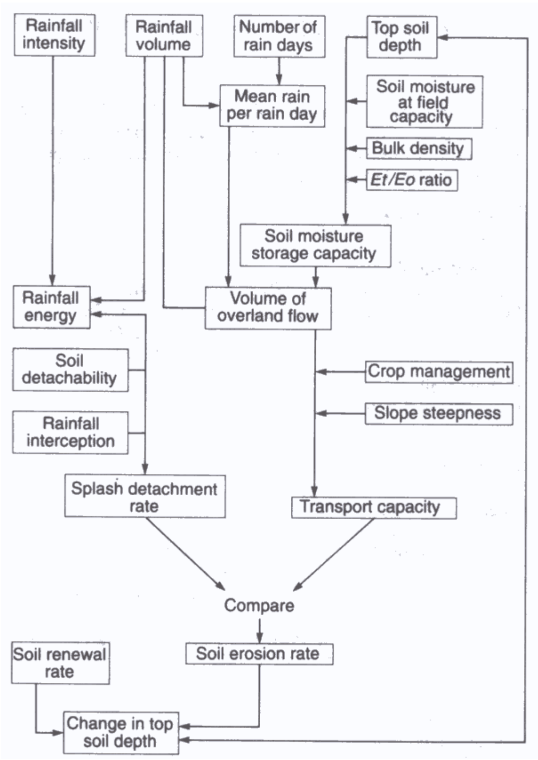

Figure 3.6.1: Flow diagram for the Morgan-Morgan-Finney Method (Source: Morgan, 1986)

The MMF model separates the process of soil erosion into 2 phases: the water phase and the sediment phase. The water phase uses soil mass and volume of runoff to predict the detachment of soil particles by rainsplash and the sediment phase determines the transport capacity of runoff (Figure 3.6.1). The model then assigns the lower of the 2 values as the annual rate of soil loss, therefore identifying whether detachment or transport is the limiting factor. The model cannot be used for predicting sediment yield from drainage basins or soil loss from individual storms. Good information on rainfall and soils is required for successful prediction.

Input requirements

- landuse
- rain days
- bulk density of the top soil layer
- soil detachability index
- actual/ potential evaporation
- average annual rainfall
- soil moisture content
- depth to slowly impermeable layer
- minimum soil depth
- series
- slope
- texture

Results

The model was implemented for both the Eden (Figure 3.6.2) and the Tern (Figure 3.6.3) catchments. As the Macaulay Institute had it own erosion model (see next section), the Morgan-Morgan-Finney model was not implemented for the Lossie catchment.

Literature references

Besler, H. (1987) Slope properties, slope processes and soil erosion risk in the tropical rain forest of Kalimantan Timur (Indonesian Borneo). Earth Surface Processes and Landforms, 12, 195-204.

Coppin, N.J. & Richards, I.G. (1990) Use of Vegetation in Civil Engineering. London: CIRIA/Butterworths.

De Jong, S.M., Paracchini, M.L., Bertolo, F., Folving, S., Megier, J. & De Roo, A.P.J. (1999) Regional assessment of soil erosion using the distributed model SEMMED and remotely sensed data. Catena, 37, 291-308.

De Jong, S.M. & Riezebos, H.T. (1992) Assessment of erosion risk using multitemporal remote sensing data and an empirical erosion model. Department of Physical Geography, University of Utrecht.

Morgan, R.P.C. (1985) The impact of recreation on mountain soils: towards a predictive model for soil erosion. In: Bayfield, N.G. & Barrow, G.D., (Eds.) The Ecological Impacts of Outdoor Recreation on Mountain Areas in Europe and North America. Rural Ecology Research Group Report, 9, 112-121.

Morgan, R.P.C. (2001) A simple approach to soil loss prediction: a revised Morgan-Morgan-Finney model, Catena, 305-322.

Shrestha, D.P. (1997) Assessment of soil erosion in the Nepalese Himalaya: a case study in Likhu Khola Valley, Middle Mountain Region. Land Husbandry, 2 (1), 59-80.

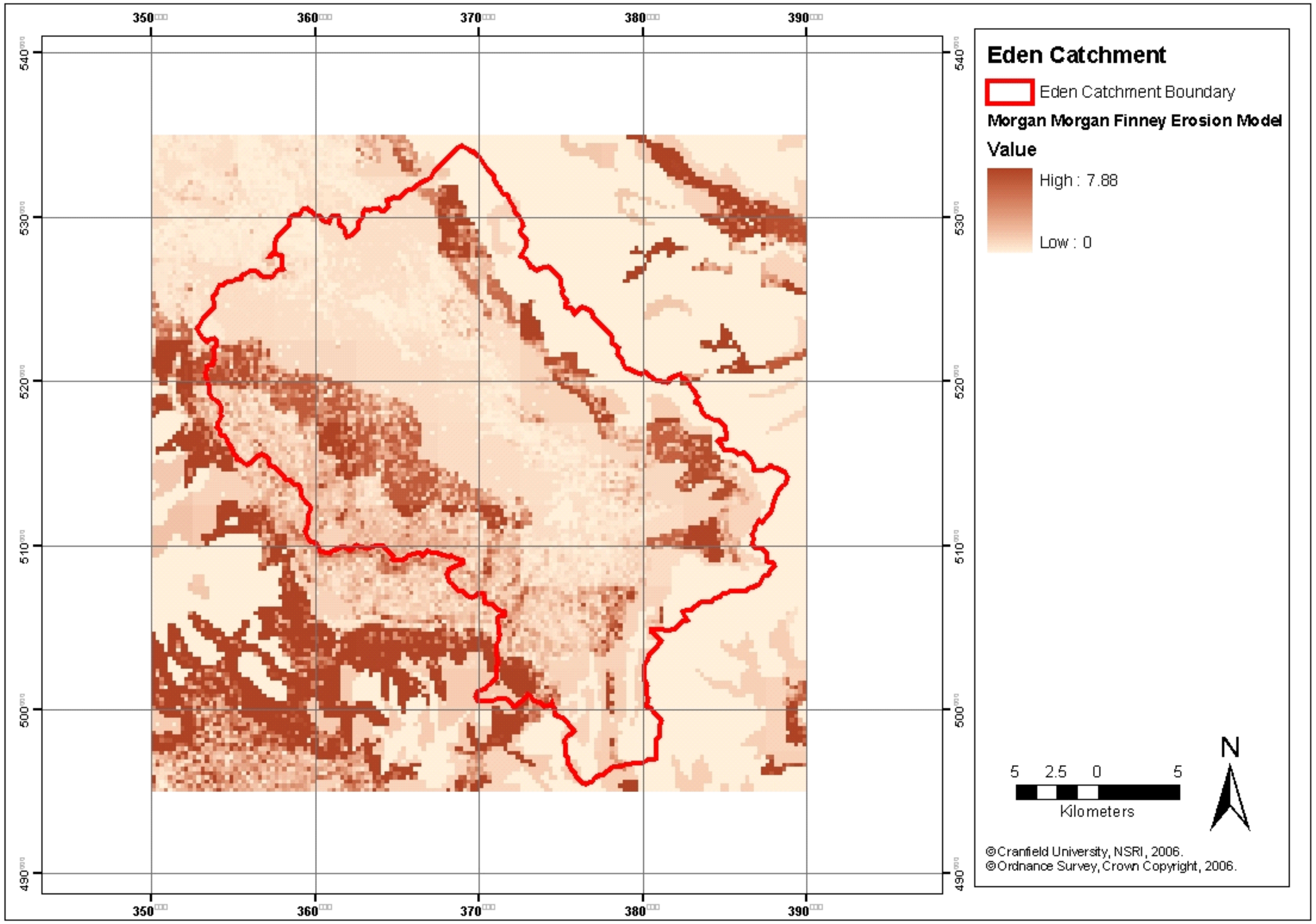

Figure 3.6.2: Morgan-Morgan Finney erosion model for the Eden catchment

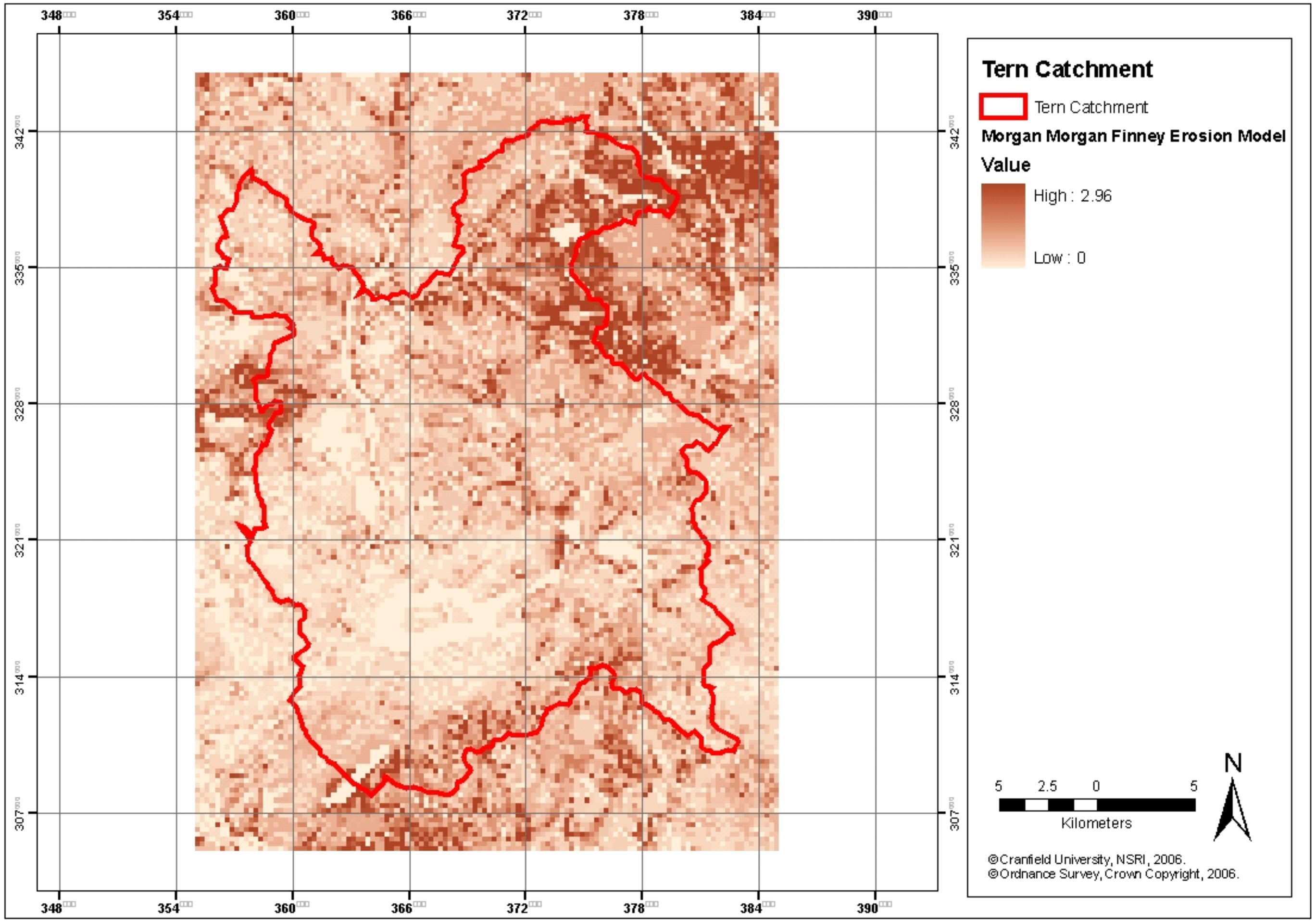

Figure3.6.3: Morgan-Morgan Finney erosion model for the Tern catchment

Inherent Geomorphological Risk of Soil Erosion by Overland Flow in Scotland

Organisation: Macaulay Institute

Date: 2002

Objectives

- To determine the inherent geomorphological stability of the Scottish soil resource using the following assumptions:

    1. all soils are assessed on the basis that they are free of vegetation;
    2. only erosion related to surface runoff or overland flow is considered (i.e. wind erosion or other forms of mass movement are excluded);
    3. no consideration is made of the dynamic factors affecting erosion (i.e. management practices or occurrence of triggering events like rainfall).

Methodology

The classification is based on a set of decision rules that define the erosion risk categories. The rules operate via a two-step procedure. The first step defines the erosive power of the overland flow, based upon a calculation of slope angle from a 50m resolution digital elevation model, and an estimate of standard percentage runoff derived from the Hydrology of Soil Types classification (Boorman et al., 1995) (Table 3.6.1). The six classes of erosive power are then passed forward to the second step where they ere combined with soil surface texture to define the erodibility classes. Table 2 shows the classification for mineral soils. Due to the distinctive nature of organic soils, these were classified separately (Table 3.6.1).

Table 1. The erosive power of overland flow

Percentage Runoff	Slope Categories (degrees)					
	<2	2-4.9	5-9.9	10-17.9	18-30	>30
<20	a	b	c	d	d	slopes unstable
20-40	b	c	d	e	f	
>40	c	d	e	f	g	

Table 2. Erodibility classes for mineral soils

Soil texture	Erosive power						
	a	b	c	d	e	f	g
Fine	1	2	3	4	5	6	7
Medium	2	Low	4	Moderate	6	High	8
Coarse	3	4	5	6	7	8	9

Table 3. Erodibility classes for soils with organic surface layers

Organic surface layer	Erosive power						
	a	b	c	d	e	f	g
Peaty or humus topsoil	I	Low	III	IV	Moderate	VI	VII
Organic soils (Peats)				High	VIII		

Table 3.6.1: Classification for mineral soils

Input requirements

- Standard percentage runoff (derived from HOST classification)
- Slope
- Presence/absence of organic horizon
- Soil surface texture (for mineral horizons)

Results

The model was implemented for the Eden (Figure 3.6.4), Tern (Figure 3.6.5) and Lossie (Figure 3.6.6) catchments.

Literature references

Lilly, A., Birnie, R.V., Hudson, G. and Horne, P.L. (2002) The inherent geomorphological risk of soil erosion by overland flow in Scotland. Scottish Natural Heritage, Survey and Monitoring Report No183.

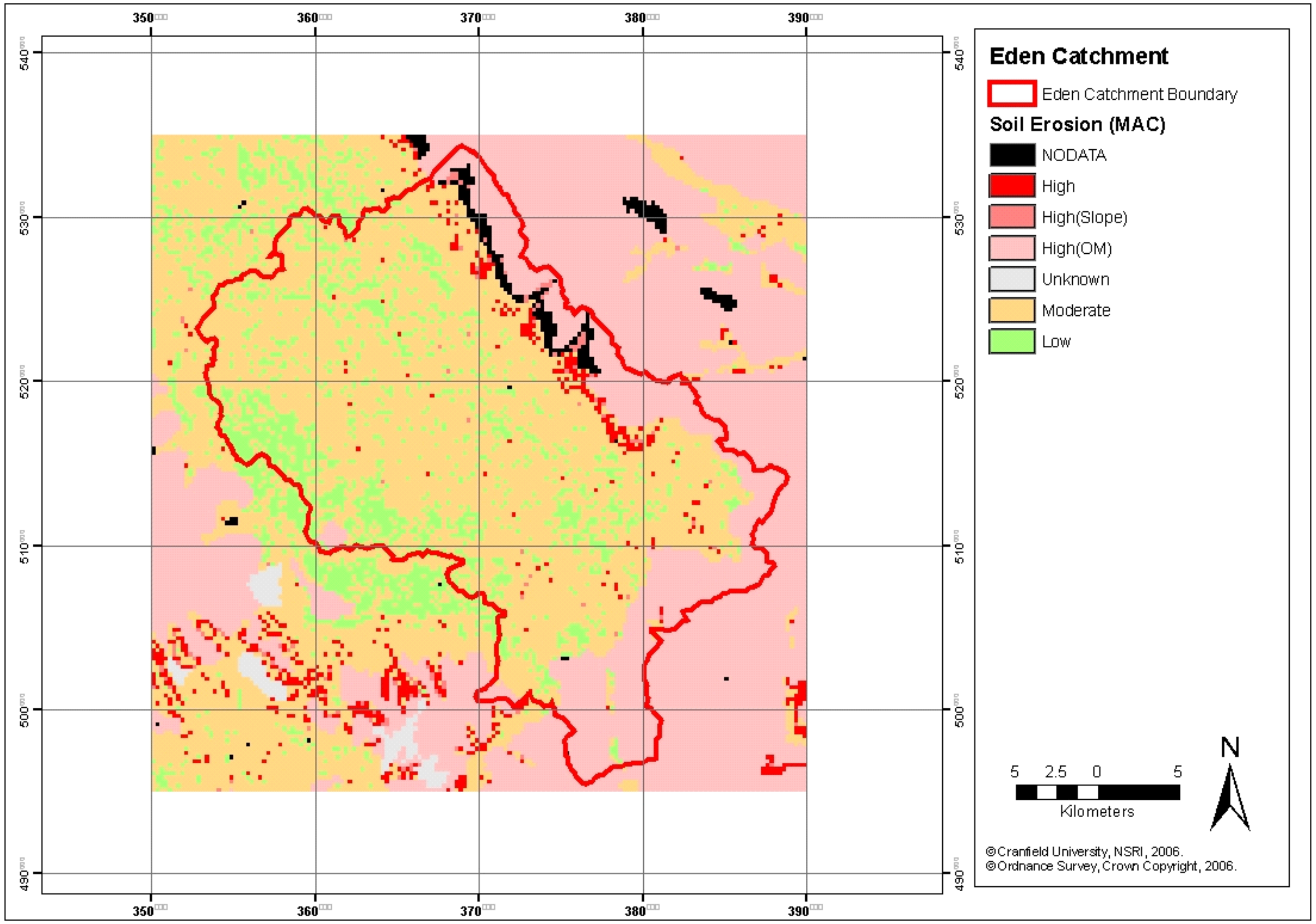

Figure3.6.4: Soil Erosion model for the Eden catchment

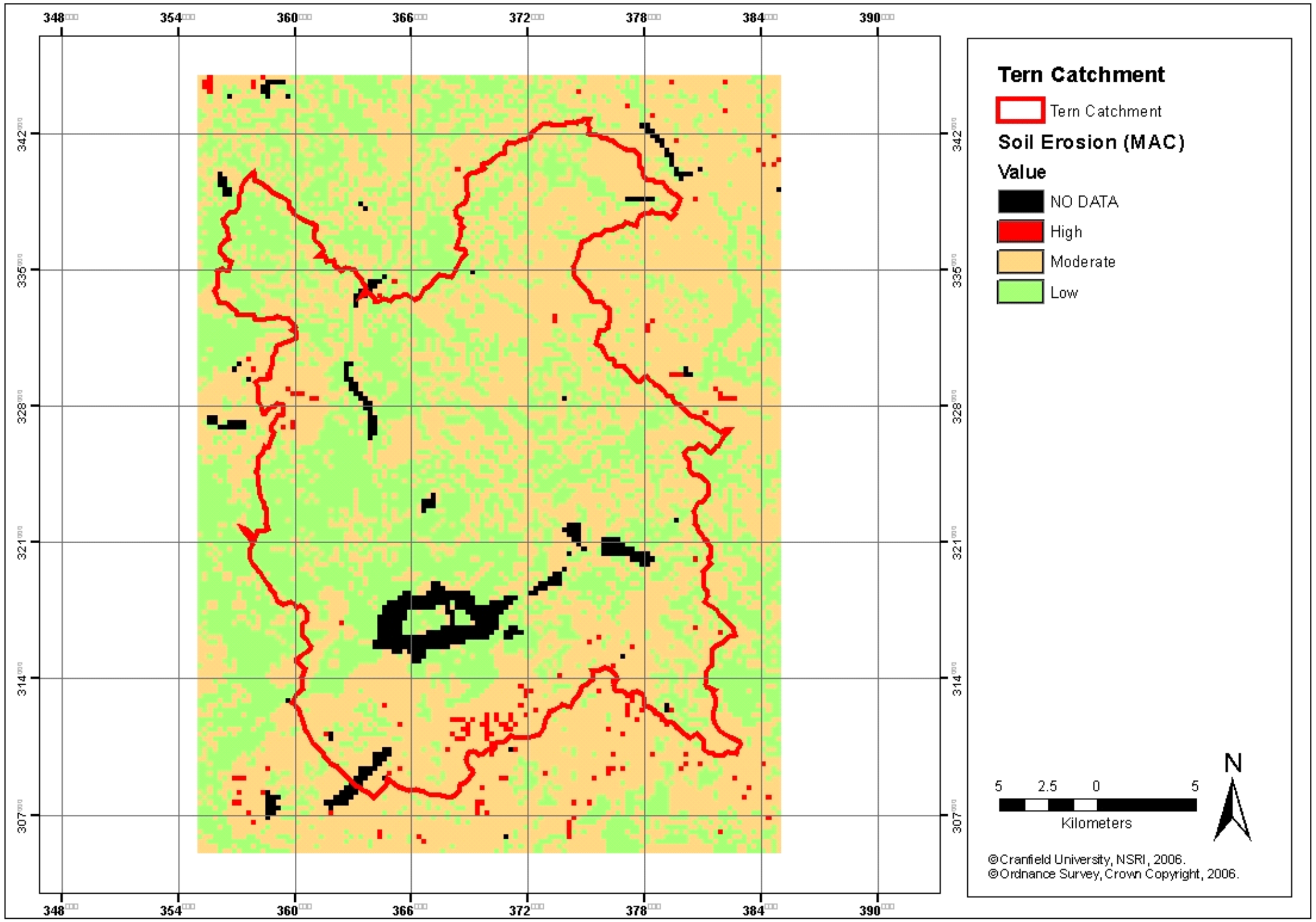

Figure3.6.5: Soil Erosion model for the Tern catchment

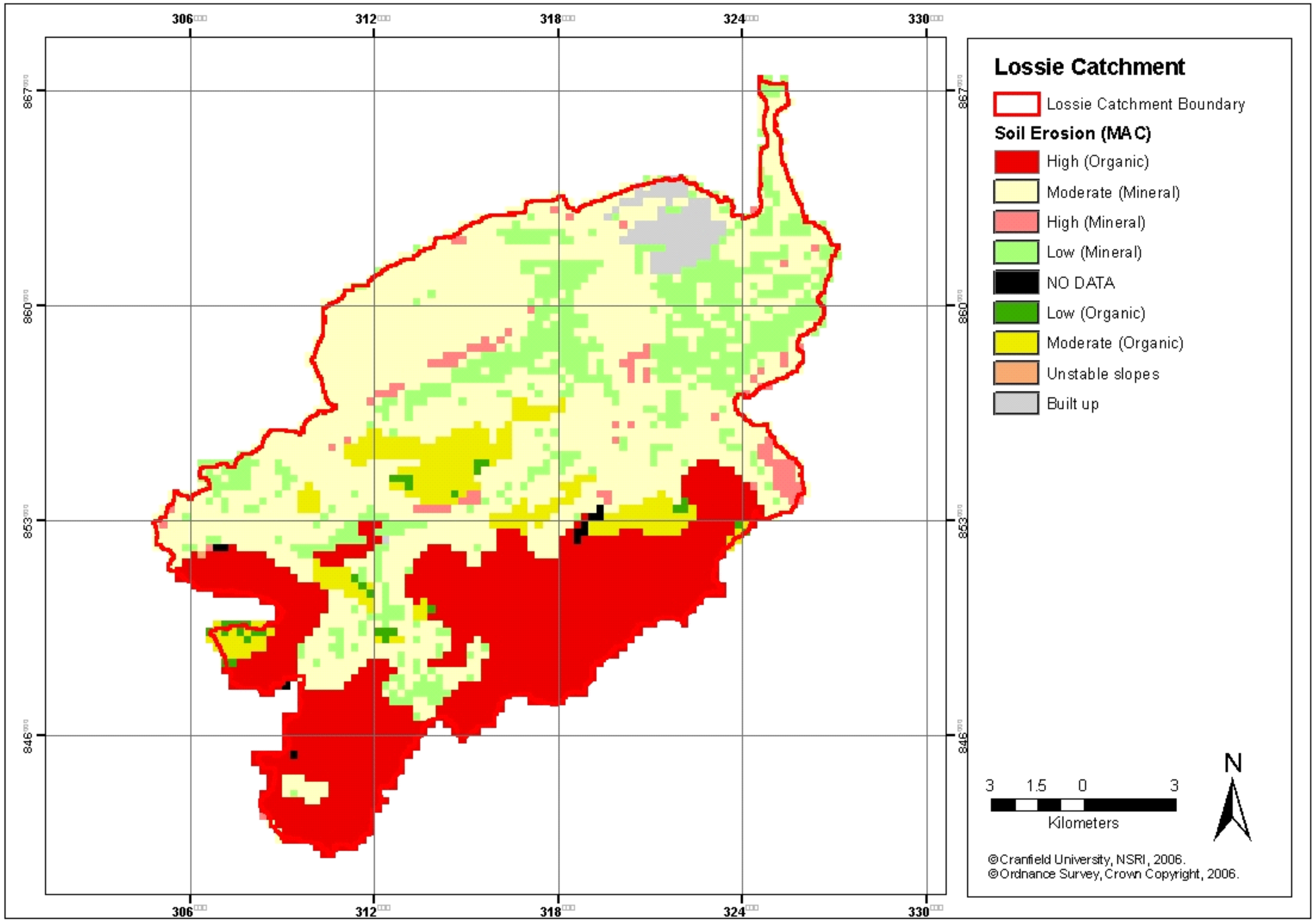

Figure3.6.6: Soil Erosion model for the Lossie catchment