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SWEAP
A computer program for water erosion assessment applied to SOTER

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ABSTRACT

This report discusses a computer program for the assessment of water erosion hazard applied to SOTER. Some of the main characteristics of this program, entitled SWEAP (**SO**TER **W**ater **E**rosion **A**ssessment **P**rogram), are:

- Two alternative erosion assessment models, based on SLEMSA and USLE, can be selected.
- The program uses a "time step" of 1 month. Seasonal dynamics of crop cover and rainfall erosivity are accounted for.
- Soil erodibilities for the SLEMSA model are provided by "F ratings", tabulated in dependence of type of soil development and texture class, with modifiers for conservation practices, internal drainage, sensitivity to capping, abrupt horizon boundaries, shallow soils and salinity. The USLE module employs Wischmeier & Smith's "K-nomograph".
- Optionally, crop factors (C) can be read directly from file, or calculated from relationships between C and leaf area and ground cover.
- Crop residue management is taken into account by adjustment of the crop protection factor. Crop residues are assumed to decay exponentially with time after harvest.
- A simple agro-ecological zoning module is built into the program to calculate potential growing periods when needed.
- A user-friendly, menu-oriented interface to assess erosion risk under different land use systems or scenario's.
- Conversion tables are stored in external ASCII files that can easily be adapted as circumstances for individual users require.

Results must be interpreted in terms of abstract "erosion hazard units" (EHU's), rather than as quantified estimates of potential soil loss.
The program is subject to discussion, and improvement. The main problem for its application (like any program of its kind) is the procurement of appropriate parameter values to be used in transfer functions and conversion tables, and to define their range of validity.

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Chapter 1

INTRODUCTION

SOTER is a methodology for a World **SO**ils and **TER**rain digital data base at a scale of 1:1 million (Van Engelen and Wen, 1993).
One of the main advantages of storing soil and terrain information in a digital data base, rather than as conventional multiple purpose maps, is that tailor-made thematic maps can be derived on request, using the data base as a basic source. The derivation of water erosion risk maps is one important application.
Shields and Coote (1989) proposed the use of SOTER with the Universal Soil Loss Equation (USLE; Wischmeier and Smith, 1978), because it is the best known and most extensively applied method for estimation of soil losses. Rademacher (1991) suggested that also other relatively simple erosion models can be applied to SOTER. He indicated as most promising, besides USLE, the Soil Loss Estimation Model for Southern Africa (SLEMSA; Elwell and Stocking, 1982; Stocking *et al.*, 1988). The latter model claims better applicability in tropical conditions.
Two practical problems for the application of these models to SOTER were encountered: (1) Some of the input data needed to feed the models (e.g. K values and Rain erosivity for USLE) are not contained in most natural resource inventories, and were therefore not included in the SOTER database; (2) The file and data manipulations that had to be executed were rather complicated. Therefore the use of only GIS and DBM software is not practical, especially if the consequences of different management scenarios for erosion hazards are to be modelled, and the results presented as thematic maps.
The first problem can be tackled by an approximation with transfer functions that relate missing data with SOTER data in the form of mathematical relations or conversion tables. The second problem can be solved by linking transfer functions and the SOTER data base with a user friendly software.

The primary objective of this report is to introduce SWEAP, a computer program that facilitates the use of the SOTER data base for erosion hazard risk prediction.
A secondary objective is to present the outlines of an automatically accessible database of transfer functions and conversion tables that relate parameters that are relevant for erosion assessment to conditions of soil, terrain, climate, land use and vegetation.

Chapter 2

SWEAP AND ITS APPLICATION

The SOTER water erosion assessment program is composed of two subsystems: (1) a user interface or menu, and (2) the actual model. SWEAP is supposed to be linked with the SOTER database, i.e. a comprehensive set of digitized map units and their attribute data. For a general description of SOTER and its methodology refer to Van Engelen and Wen (1993).

The SWEAP menu system acts as an interface between user and model: it enables the user to "inform" the model of the:

- location of the **input** file from which data will be retrieved
- name of the **output** file to which results are to be sent
- erosion hazard assessment **model** that is to be used
- (hypothetical) situation of Vegetation/Land use/Management (or **scenario**) for which the erosion assessment is to be made.

The menu part has been set up in such a way that (a) options for different scenarios can easily be adapted or extended without need for additional programming, and (b) any novice to SWEAP will find his way through the program intuitively. The menu system was written in Turbo Pascal 6.0 (Borland).

Currently, the model subsystem comprises two erosion risk assessment models: the Universal Soil Loss Equation (USLE), and the Soil Loss Estimation Model for Southern Africa (SLEMSA). Both models were adapted to the abilities and limitations of the SOTER database.
The model subsystem of version 1.4 of SWEAP was written in FORTRAN77 (Microsoft, V5.0). This version was intended to be used with SOTER data compiled according to the 4th edition of the Procedures manual. A new version of SWEAP was required to:

- be able to use SOTER data compiled according to the 5th edition of the Procedures manual.
- correct a number of faults in the former version
- implement some of the algorithms used by the program more efficiently
- enable a more efficient memory management by the program

Version 1.5 of the model subsystem of SWEAP was written in C (Borland C++, version 3.1). It consists of a number of modules, each of which has a well defined function, and with a well defined interface. This facilitates subsequent updating, even by third parties.
Technical details of the menu system and the input and output of the program are included in the program listings. A discussion of the merits and limitations of the models used falls beyond the scope of this paper[1]. In the following paragraphs those parts of the program that are relevant for understanding the implementation of USLE and SLEMSA in SWEAP are described.

2.1 USLE

[1] Those interested are referred to e.g. Roose (1980), Hudson (1980), Meyer (1981), Lal (1990).

USLE, the Universal Soil Loss Equation (Wischmeier *et al.*, 1958; Wischmeier and Smith, 1978), is the best known and most frequently used soil erosion model. The USLE has been developed to estimate interrill soil losses over extended time periods. The simple, empirical equation has been developed from regression analyses of 10.000 plot years of data from natural runoff plots and plots under artificial rainfall simulators in the USA, east of the rocky mountains. Therefore, the validity of the USLE outside this part of the USA can be called into question (de Roo, 1994). Further limitations are that the equation does not estimate deposition, sediment yield, channel erosion, or gully erosion. The model is not accurate for a single storm event (Foster, 1982).
The basic equation of the model is:

$$A = R * K * LS * C * P \tag{2.1}$$

where

- *A* The computed soil loss per unit area, here expressed in $tons.ha^{-1}.yr^{-1}$.
- *R* The rainfall and runoff factor, expressed in rainfall erosion index units (ru).
- *K* The soil erodibility factor, i.e. the (long term average) rate of soil loss per erosion index unit for a specified soil as measured on a unit plot. The latter is defined as a plot with a length of 22.13 m and a uniform slope of 9%, continuously in clean-tilled fallow. K is expressed in $tons.ha^{-1}.yr^{-1}.ru^{-1}$
- *LS* The slope length and steepness factor, which is the ratio of soil lost from the field under consideration to that from the USLE standard plot, assuming all other factors constant. Wischmeier and Smith (1978) account for slope length (L) and angle (S) factors separately. However, as their L factor is co-determined by the slope angle it is more appropriate to present both factors as a single combined LS factor.
- *C* The cover and management factor, which is 0 for complete protection of the soil (no erosion can occur) and 1 for a clean-tilled fallow.
- *P* The erosion control practice factor.

The USLE was intentionally designed for erosion assessment at farm field level. At larger scales like SOTER, uniform slopes hardly occur and some places will be eroded whereas others will receive sediments. Therefore it is better to interpret *A* as an abstract indication of erosion hazard, expressed in erosion hazard units (EHU's), as proposed by Stocking *et al.*, (1988), rather than as quantified estimates of soil loss in $tons.ha^{-1}.yr^{-1}$.

Several of the components of USLE change on a seasonal basis, notably R and C. This is generally accounted for by first calculating annual weighted averages and subsequently multiplying the averages (e.g. Wischmeier and Smith, 1978; Kassam *et al.*, 1991).
A better result can be obtained however by first multiplying the factors for smaller periods, hence calculating A for shorter time intervals, and then integrating the results in order to obtain an annual figure. This involves more calculations, but this is an insignificant problem for (even simple personal) computers. For the purposes of SWEAP a time step *i* of one month seems appropriate.

Hence USLE was rewritten as:

$$A = \sum_{i=1,12} R_i * K * LS * C_i * P \tag{2.2}$$

2.1.1 The R factor

According to Wischmeier and Smith (1978) the best way to estimate the rainfall and runoff factor (R) is by summing the EI_{30} values (i.e. the kinetic energy of the maximum 30 minute intensity of rainstorms) per year and calculating an average value based on at least 22 years of observation. Erosivity due to snow melt should be estimated separately.
Most available rainfall records do not allow such detailed calculations and the SOTER data base only contains monthly averages. Several approximations have been developed that estimate R from such rough data; some of which were reviewed by Bergsma (1981) and Lal (1990).
SWEAP offers four different methods to approximate the value of R:

1. The method developed by **Bols** (1978) for Indonesia:

$$R_{Bols,i} = a * P_i^b * D_i^c * P_{\max,i}^d \tag{2.3}$$

where

$R_{Bols,i}$	The approximate R factor for month *i*.
P_i	Average precipitation in month *i* (mm).
D_i	Number of rainy days in month *i*.
$P_{\max,i}$	Maximum 24h rainfall in month *i* (mm).
a,b,c,d	Site specific empirical constants.

2. The modified **Fournier** index (Arnoldus, 1980), applied on a monthly basis:

$$F_{m,i} = \frac{P_i^2}{P_{ann}} \tag{2.4a}$$

$$R_{Arnoldus,i} = a + b * F_m \tag{2.4b}$$

where

$R_{Arnoldus,i}$	The approximate R factor for month *i*.
F_m	The modified Fournier index for month *i*.
P_i	Average rainfall in month *i* (mm).
P_{ann}	Annual rainfall (mm)
a,b	Site specific empirical constants.

Table 1 Indicative values for coefficients c and d of equation 2.5 (Source: Hargreaves, 1981)

Country	c	d
Albania	121	1.70
Argentina	109	1.52
Austria	26	2.01
Bangladesh	241	1.29
Brazil	146	1.27
Belgium	24	2.63
Bulgaria	7	2.22
Canada	18	1.97
Chad	46	1.49
Congo Republic	82	1.45
Czechoslovakia	19	1.93
Dahomey	95	1.31
Denmark	31	1.78
Ecuador	-14	2.17
Dominican Republic	74	2.16
France	16	2.38
Germany	16	2.12
Ghana	21	1.96
Greece	19	2.25
Hungary	48	1.71
Iceland	16	2.21
India	155	1.73
Ireland	-6	1.97
Italy	43	2.11
Ivory Coast	94	1.69
Japan	97	1.69
Korea	-35	3.04
Malagasy	95	2.19
Mali	78	1.50
Mauritius	5	2.22
Mexico	112	1.87

Country	c	d
Mozambique	16	2.75
Netherlands	-2	2.31
New Zealand	91	1.59
Niger	-70	2.39
Nigeria	112	1.28
Norway	-11	2.51
Pakistan	71	2.08
Phillipines	40	2.11
Portugal	18	2.70
Romania	43	1.70
Senegal	-2	1.61
Sierra Leone	-21	1.75
South Africa	109	1.50
Spain	5	2.96
Sri Lanka	158	1.79
Sudan	131	1.11
Sweden	13	2.13
Switzerland	74	1.75
Taiwan	-43	3.21
Tanzania	91	1.57
Thailand	159	1.17
Togo	113	1.32
Turkey	27	2.25
Uganda	136	1.13
United Kingdom	-23	2.47
United States	76	1.75
Upper Volta	28	1.71
Uruguay	-178	5.13
Yugoslavia	13	2.12
Zambia	129	1.26

3. A combination of the methods of **Ateshian** (1974) and **Hargreaves** (1981). Ateshian relates R to the expected maximum 6-hour rainfall with a 2-year return period. Hargreaves relates mean monthly rainfall to rainfall for return period T and duration t. Combined these methods yield equation 2.5 (Shields and Coote, 1989):

$$R_{Athesian,i}=0.417*(11.9+0.162*(c+d*P_i))^{2.17} \qquad (2.5)$$

where

$R_{Athesian,i}$	The estimated R factor for month *i*.
c, d	Site specific parameters. Indicative values for c and d are given in Table 1.
P_i	Average rainfall in month *i* (mm).

4. A **linear** relation:

$$R=a+b*P \qquad (2.6)$$

Table 2 gives examples of equations that use the methods described above. The best method for a given situation depends on the availability of experimental data, and the local circumstances. There is probably not a single "best" approximation that can be applied to all situations.

SWEAP allows definition of the parameters for the equations in file *'CONSWEAP.CNF'*. For snowmelt only linear relations are considered. Parameters for rainfall and snowmelt erosivity must be given separately. SWEAP assumes that all precipitation in months with average temperature less than 0°C is snow. Snowmelt takes place in the first month when average temperature reaches a value >0°C.

Note that, if one of the regression equations of Table 2 is used, the intercept must be divided by 12 to convert the value from an annual to a monthly basis.

Table 2 Regression equations relating R or EI_{30} to readily available rainfall distribution parameters.

Equation	r	n	Area of application	Source
$\log(R_{ann}) = -1.52 + 1.93 * \log(F_m)$	0.91	177	USA and West Africa	Arnoldus, 1980
$R_{ann} = -1.52 + 4.17 * F_m$	0.89	177	,,	,,
$R_{ann} = -420 + 6.86 * F_m$	0.89	102	Eastern USA	,,
$\log(R_{ann}) = -1.91 + 2.23 * \log(F_m)$	0.86	47	Western USA	,,
$R_{ann} = -143 + 4.79 * F_m$	0.83	47	,,	,,
$R_{ann} = -3 + 0.66 * F_m$	0.80	15	Northwest USA	,,
$R_{ann} = -416 + 5.44 * F_m$	0.83	14	West-Africa.	,,
$R_{Bols,i} = 0.1112 * P_i^{1.21} * D_i^{-0.47} * P_{m}^{0.}$	0.99	564	Indonesia	Bols, 1978
$\log(EI_{30,ann}) = -6.0 + 3.0 * \log(F_m)$	0.36	37	North & South America	Shields & Coote, 1988
$EI_{30,ann} = -5053 + 5.88 * F_m$	0.33	37	,,	,,
$EI_{30,ann} = -1545 + 2.63 \sum_{i=1,12} R_{Atl}$	0.54	37	,,	,,
$EI_{30,ann} = -1042 + 1.28 \sum_{i=1,12} R_{Bo}$	0.63	37	,,	,,
$EI_{30,ann} = 160 + 0.27 * P$	0.99	3(?)	Belgium	Bolline *et al.*, 1980
$EI_{30,i} = 2.8 + 0.42 * P$	0.89	(?)	East Java	Utomo & Mahmud, 1984
$R_{snow} = 0.1 * P$	-	-	Northwest USA, snow melt	McCool *et al.*, 1982
$R = (0.5 \pm 0.05) * P$	-	-	Tropics, general	Roose, 1980
note: subscript *i* for monthly estimates, subscript ***ann*** for annual estimates				

2.1.2 The K factor

SWEAP calculates the K factor in the Universal Soil Loss Equation according to the equation of Wischmeier and Smith, (1978), for the "soil-erodibility nomograph":

$$100*K=2.241*\left[2.1*10^{-4}*(SILT+VFSA)^{1.14}*(12-OM)+3.25*(b-2)+2.5*(C-3)\right] \qquad (2.7)$$

with

$$OM=\frac{CARB}{0.6} \qquad (2.7a)$$

Where,

SILT+VFSA	the weight% of silt plus very fine sand. Both values are obtained from the SOTER data input file.
OM	Organic matter content as estimated by equation 2.7a.
CARB	The organic carbon content of the fine earth fraction, provided by the SOTER data input file.
b	the soil structure code, which is obtained as a function of structure form (STFO), structure size (STSI) and structure grade (STGR), all provided by the SOTER data base. The function b=f(STFO,STSI,STGR) is given in tabulated form, in file STRUCT.CNT (c.f. section 3.3.2);
c	the profile-permeability class, which is obtained as a function of the internal drainage class (IDRN) provided by the SOTER database. The function is given in tabulated form in file IDRAIN.CNT (c.f. section 3.3.2).

The constant factor 2.241 converts US-ton.acre^{-1} to metric ton.ha^{-1}.

The value of K determined with equation 2.7 is corrected for the protective effect of coarse fragments, stones and/or rocks at the soil surface according to an equation that was derived from a nomograph developed by the US Soil Conservation Service (1980):

$$F_{coar}=1.026-0.025*COAR+2.534*10^{-4}*COAR^{2}-1.026*10^{-6}*COAR^{3} \qquad (2.8)$$

Where

F_{coar}	the correction factor, to be multiplied with the uncorrected K value.
COAR	the maximum of (1) coarse fragments in the first layer or (2) percentage of the terrain surface covered with stones and/or rocks.

The present version of SWEAP does not account for temporal K variability, i.e. K is considered constant throughout the year.

2.1.3 The LS factor

Several methods have been developed to estimate the LS factor from slope length and gradient. The differences between these methods only become appreciable for very gentle or very steep slopes (i.e. less than 1% or more than 20%).
SWEAP uses the equations proposed by Mutchler and Murphree (1981). These equations practically yield the same results as the ones provided by Wischmeier and Smith, but require less program statements and do not have discontinuities:

$$L=\left(\frac{SLEN}{22.13}\right)^{m} \tag{2.9a}$$

$$S=65.41*\sin^2(a)+4.56*\sin(a)+0.065 \tag{2.9b}$$

$$m=1.2*(\sin^2(a))^{\frac{1}{3}} \tag{2.9c}$$

$$\sin(a)=\sin\left(\tan^{-1}\left(\frac{SLOP}{100}\right)\right) \tag{2.9d}$$

$$LS=L*S \tag{2.9e}$$

where

SLEN	the slope length (metres).
SLOP	the slope gradient (percent).

Both values are provided by the SOTER data input file.

TEXTBOX 1

A growing season is defined as any period of at least three consecutive months with an average temperature of more than $T_{cr,av}$, a minimum temperature of more than $T_{cr,min}$ and the ratio between actual and potential evapotranspiration exceeding a critical value $R_{Eac,Epot}$. SWEAP calculates potential evapotranspiration according to the method of Penman or Thornthwaite (optional). If Penman is selected the program first checks whether potential evapotranspiration according to Penman (PETP) is provided by the climate file. If not, then the SOTER climate characteristics TMIN, TMAX, RADI, SUNH, VAPP and WIND (cf. paragraph 3.1) are used to calculate PETP according to Frère and Popov (1979). If data on RADI (radiation) are not available then the program calculates RADI from SUNH (hours of sunshine) according to the method of Prescott (1940):

$$\mathrm{RADI} = \mathrm{OUTRAD}\cdot(A+B\cdot\mathrm{SUNH}/\mathrm{DL}) \qquad \text{(eq.1)}$$

where OUTRAD is the extraterrestrial irradiation ($MJ.m^{-2}.day^{-1}$), DL is the daylength (hours), and *A* and *B* are empirical constants (dimensionless).

OUTRAD and DL are calculated from latidude and time of the year. $T_{cr,av}$, $T_{cr,min}$, $R_{Eac,Epot}$, *A*, *B* and the method for calculating potential evapotranspiration must be specified in file *'CONSWEAP.CNF'* (cf. paragraph 3.3.3). Most countries have at least one meteorological station that can provide representative values for *A* and *B*. Indicative values used by FAO (Frère and Popov, 1979) are: A=0.18, B=0.55 for cold and temperate zones; A=0.25, B=0.45 for dry tropical zones; and A=0.29, B=0.42 for humid tropical zones.
If data on VAPP are not available they will be calculated by

$$\mathrm{VAPP} = \mathrm{SVAP}\cdot(\mathrm{HUMI}/100) \qquad \text{(eq.2)}$$

where HUMI is the relative air humidity (percent), and SVAP is the saturated vapour pressure (mbar). HUMI is input from the SOTER data input file (cf. paragraph 3.1). SVAP is calculated from average temperature and altitude above mean sea level, according to Goudriaan (1977).

Moisture availability is calculated according to a simple water balance model:

$$H_i = H_{i-1}+\mathrm{RAIN}_i-\mathrm{Epot}_i \qquad \text{(eq.3)}$$

Where H_i and H_{i-1} are the available water (mm) at month *i* and month *i*-1 respectively; $RAIN_i$ is the precipitation in month *i* (mm), and $E_{pot,i}$ is the potential evapotranspiration (mm) in the same month.
H_i is a value in the range 0 - STORGCAP. SWEAP assumes a storage capacity of 1 mm per cm depth from the topsoil to the maximum rooting depth (RDEP) or, if RDEP > 120cm, 120mm.

If the land use type involves the application of irrigation then water availability is assumed not to be a restrictive growing factor. The first month of each calculated growing season is assumed to be the month of planting, whereas the last month is assumed to be the month of harvesting. The number of growing seasons per year is assumed to be the number of crops planted per year.

2.1.4 The C factor

C_i, the cover factor for month *i*, is calculated as follows:

1. Check whether land use and/or vegetation data have been provided by the user (through the menu system) or by the SOTER database (through the SOTER data input file). If landuse is 'annual crops', then planting and harvesting dates must have been specified by the user, or the program must have been ordered to calculate potential growing season(s) from geographical latitude, elevation and monthly climate characteristics, according to the method described in Textbox 1.

2. For perennial crops and natural vegetation read C from file *'PERENN.TAB'* or file *'VEGETAT.TAB'*, or read the percentage ground cover (V) and calculate C from a tabulated relation with V in file *'INTRCPT.CNT'* (cf. paragraph 3.3.2).
   For annual crops get the crop coefficients for the month of planting ($C_{1,crop}$), the first month after planting ($C_{2,crop}$) and consecutive months ($C_{3,crop}$). The $C_{i,crop}$ factors can be obtained directly from file *'ANNCROP.TAB'*, or calculated from leaf area index and crop geometry, according to the method described in Textbox 2.

3. If the type of land use is permanent (e.g. perennial crops, livestock, forestry) or if the land is covered with natural vegetation, then C_i is assumed to be constant and equal to C during the entire year.
   If the type of land use is annual crops, then C_i is calculated as the product of $C_{1,crop}$, $C_{2,crop}$, or $C_{3,crop}$ with $C_{resid,i}$, the C factor for residues from a previous crop in month *i*. The calculation of C_{resid} from the cover of crop residues (V_{resid}) is explained in textbox 3.

Indicative values for length of growing period (LGP, days), maximum leaf area index (L_{max}, $m^2.m^{-2}$), *k*, and percentage groundcover of crop residues in relation to maximum ground cover of living standing crop (percentage V_{resid}) are given in Table 3. Relations between percentage ground cover and C factor for several types of cover are given in Table 4.

2.1.5 The P factor

The P factor is extracted from file *'PTAB.CNT'* in dependence of the user-specified type of erosion control factor (c.f. paragraph 3.3.2). The P factor is assumed to be constant throughout the year.

TEXTBOX 2

To estimate the factors $C_{1,crop}$, $C_{2,crop}$ and $C_{3,crop}$, the program first calculates the percentage ground cover according to Kassam et al., 1991 [analogous with an equation for light interception (Montheith, 1969)]:

$$V_{crop} = 100 \cdot (1 - e^{-kL}) \qquad \text{(eq.1)}$$

where

V_{crop}	percentage crop ground cover,
k	a constant based on crop geometry,
L	Leaf area index ($m^2.m^{-2}$)

V_{crop} is transformed to a C factor by means of a tabulated relationship that is provided by file *'INTRCPT.CNT'*.
L_{max}, the leaf area index of the crop at full development, crop geometry factor k, and a reference to a column in *'INTRCPT.CNT'* are extracted from file *'ANNCROP.TAB'* (cf. paragraph 3.3.1). SWEAP assumes a value of $L = 0.1*L_{max}$ for the calculation of $C_{1,crop}$, $L = 0.6*L_{max}$ for $C_{2,crop}$, and $L = L_{max}$ for $C_{3,crop}$. When more than one crop is grown at the same time, and on the same plot (e.g. intercropping), then SWEAP imposes an upper limit for total L of 6.0. In these cases (eq.1) is applied to the lumped value of L.

TEXTBOX 3

The C factor for residuals of annual crops left after harvest (C_{resid}) is calculated as follows:

1. Consider the cover of residuals V_{resid}, expressed as a percentage.
   The maximum uncorrected value of V_{resid} (only economic crop organs removed, residuals left standing or evenly spread on the field), is extracted from file *'ANNCROP.TAB'*, as a percentage of the maximum crop cover $V_{crop,max}$. The latter is calculated according to eq.1 in Textbox 2, with $L = L_{max}$. If k or L_{max} are not available, then $V_{crop,max}$ is estimated with $100 \cdot (1-C_{3,crop})$.
2. Correct V_{resid} for residual treatment (e.g. burning, incorporation etc.) by multiplication with a factor that is extracted from file 'RESIDC.TAB' (cf. paragraph 3.3.1). Residual treatment may occur in the month of harvesting, or in the month of planting or sowing a new crop.
3. Crop residuals are assumed to decay with a constant factor 0.825 per month. This implies that hypothetically 90% of the effective cover breaks down over one year.
4. Transform V_{resid} to C_{resid} by means of a tabulated relation between percentage cover and relative soil loss, extracted from file *'INTRCPT.CNT'* (cf. paragraph 3.3.2).

Table 3 Indicative values of length of growing period (LGP, days), maximum leaf area index (L_{max}, $m^2.m^{-2}$), *k*, and percentage groundcover of crop residues, in relation to maximum ground cover of standing crop ($\%V_{resid}$). Derived from Kassam *et al.*, 1991.

Crop	LGP	L_{max}	*k*	V_{resid} (%)
Barley	105 - 175	4.0-5.0	0.7	90
Cassava	> 240	3.0	1.0	95
Cotton	170	3.0	1.0	95
Cowpea	90	3.0	0.85	85
Green gram	70 - 90	2.5-3.0	0.85	85
Groundnut	90	3.0	0.85	85
Maize	80 - 150	2.5-4.0	0.7	95
Oats	105 - 175	4.0-5.0	0.7	90
Pearl millet	70 - 90	3.0-4.0	0.6	90
Phaseolus bean	> 105	3.5-4.0	0.85	90
Pigeon pea	> 140	4.0	0.45	90
Rice	90 - 130	3.5-5.0	0.6	85
Sorghum	80 - 150	2.5-4.0	0.6	90
Soybean	120 - 150	4.0	0.45	80
Sugarcane	> 270	5.0	0.70	99
Sweet potato	120 - 150	3.5-4.5	0.85	90
Wheat	105 - 175	4.0-5.0	0.7	90
White potato	100 - 150	3.0-5.0	0.85	95

Table 4 Relationships between percentage ground cover and C factor for several types of cover.
Sources: (1) Kassam *et al.*, 1991; (2) Stocking *et al.*, 1988.

%	pasture, low perennials and mulch (1)	Tree and shrub canopies of different heights (no undergrowth)				Humid forest with litter layer > 50mm	annual crops	
		4m	2m	1m	0.5m		(1)	(2)
0	1.0	1.0	1.0	1.0	1.0		1.0	1.0
10	0.55	0.97	0.95	0.93	0.92		1.0	0.55
20	0.30	0.95	0.90	0.86	0.83	0.009	1.0	0.30
30	0.17	0.92	0.85	0.79	0.75		1.0	0.17
40	0.09	0.89	0.80	0.72	0.66		0.86	0.09
50	0.050	0.87	0.75	0.65	0.58	0.003	0.72	0.060
60	0.027	0.84	0.70	0.58	0.50		0.58	0.056
70	0.015	0.81	0.65	0.51	0.41	0.001	0.44	0.053
80	0.008	0.78	0.60	0.44	0.33		0.30	0.050
90	0.005	0.76	0.55	0.37	0.24		0.16	0.047
100	0.002	0.73	0.50	0.30	0.16	0.0001	0.02	0.043

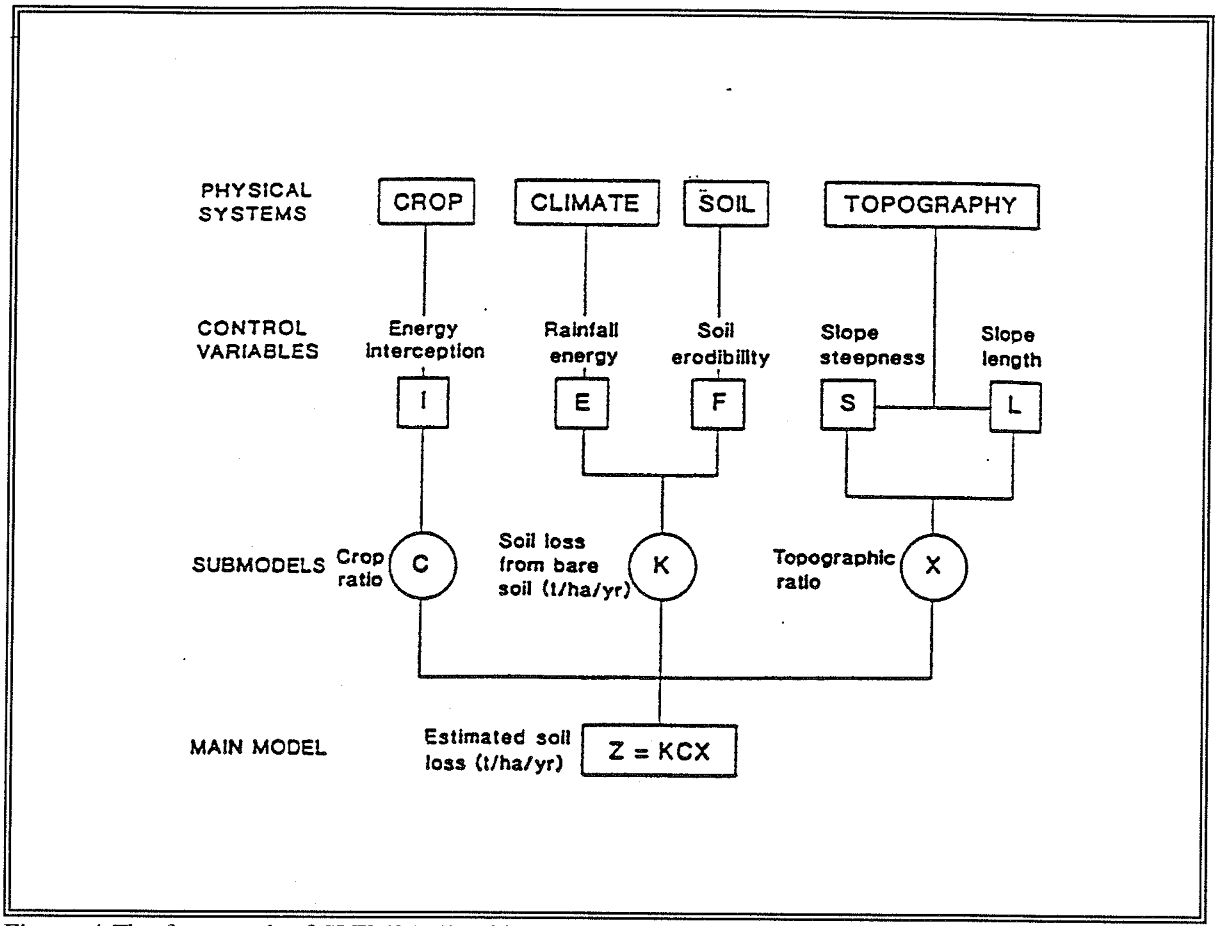

Figure 4 The framework of SLEMSA (Stocking et al., 1988)

2.2 SLEMSA

SLEMSA, the Soil Loss Estimation Model for Southern Africa (Elwell and Stocking, 1982; Stocking *et al.*, 1988) has been developed as an alternative for the USLE in this region. The topography submodel of the original equation is an adaption of the slope factor expression of the USLE using slope gradient and slope length. Furthermore, SLEMSA uses seasonal rainfall energy, a soil erodibility factor and the percentage rainfall energy intercepted by crop. The limitation of SLEMSA is that the equation is developed using only data from Zimbabwe. Also, soil erodibility and crop data are given for soils and crops in this region only.
The basic equation of the model is:

$$Z = K * C * X \tag{2.10}$$

where

- Z The estimated soil loss ($t.ha^{-1}yr^{-1}$);
- K Mean annual soil loss ($t.ha^{-1}yr^{-1}$) from a standard weed-free bare fallow field plot (with a length of 30m and a slope gradient of 4.5%)
- C The crop ratio, i.e. the ratio of soil lost from a cropped plot to that lost from bare fallow land;
- X The topographic ratio, i.e. the ratio of soil lost from a plot of length L and slope S, to that lost from the standard plot.

Figure 1 shows a schematic representation of the model.
For the same reason as mentioned in paragraph 2.1 for USLE, it is more appropriate to interpret the results of SLEMSA in terms of abstract erosion hazard units (EHU's) rather than as quantitative soil loss estimates.

For SLEMSA the program calculates the value of Z as the sum of 12 monthly values:

$$Z = \sum_{n=1}^{12} K_i * C_i * X \tag{2.11}$$

2.2.1 The K factor

The K factor in SLEMSA is a result of the interaction between erosive forces of rainfall and runoff and the erodibility of the soil. SLEMSA accounts for this interaction on a yearly basis by the following equation (Elwell and Stocking, 1982):

$$K_{ann} = e^{[(0.4681 + 0.7663 * F) * \ln(E_{ann}) + 2} \tag{2.12}$$

where

K_{ann} the K factor (ton.ha.yr^{-1}, in the current version of SWEAP constant throughout the year);
F a soil erodibility rating, that may vary from 1 (extremely erodible) to 10 (extremely resistant);
E_{ann} the rainfall energy (J.m^{-2}.yr^{-1}).

SWEAP works on a monthly basis. Therefore equation 2.12 was modified to:

$$K_i = K_{ann} * \frac{E_i}{E_{ann}} \qquad (2.13)$$

SLEMSA's F factor is a function of texture class and type of soil development. SWEAP obtains a basic F factor from table *'FTAB.CNT'* (c.f. paragraph 3.3.2), that can be modified depending on soil management, internal drainage, salinity, the presence of a lithic contact, the presence of abrupt horizon boundaries and/or the sensitivity to capping:

For soil management:
Modifiers for the F factor are read from file *'FMANMOD.CNT'* (c.f. paragraph 3.3.2). The modifier is a function of slope gradient and type of soil management. Modifiers may be positive or negative, and are added to F.

For internal drainage:

If DRAI = Imperfect then F = F + 0.5 * Drai (2.14a)
If DRAI = Poor then F = F + 0.7 * Drai (2.14b)
If DRAI = Very poor then F = F + 1.0 * Drai (2.14c)

where

DRAI the soil's internal drainage status. This information is obtained from the SOTER data input file.
Drai the basic adjustment factor, read from file FTAB.CNT, dependent on type of soil development.

For salinity:

If SAL then F = F + Sal (2.15)

where

SAL A Boolean variable that is True if the soil has salic properties or if electric conductivity exceeds 4 dS.m^{-1}. This information is obtained from the SOTER data input file.

Sal the basic adjustment factor read from file *'FTAB.CNT'*, and dependent on type of soil development.

For the presence of a lithic contact:
Apply a correction for the presence of a lithic contact if depth to parent material (BEDR) is less than 75 cm, in dependance of depth to (BEDR), and type of material below the pedon (MSUB):

If BEDR < 0.75 and MSUB unequal to Unconsolidated rock (N), Stones (S) or Unknown (U), then {
If MSUB is Petroplinthite (P) or Weathered rock (W) then Lit = Lit / 2 (2.16a)
If BEDR > 0.25 then F = F + Lit*(0.75-PDEP) / 0.5 (2.16b)
If BEDR ≤ 0.25 then F = F + Lit } (2.16c)

where

Lit the basic adjustment factor read from file *'FTAB.CNT'*, and dependent on type of soil development.
MSUB material below the pedon. MSUB is deduced from the designation of the last horizon in the representative profile: Rock (R) for an R layer, Unconsolidated rock (N) for a missing horizon designation and unconsolidated surficial lithology, Unknown (U) otherwise. MSUB is obtained from the SOTER data input file.
BEDR depth to bedrock[2]. BEDR is obtained from the SOTER data input file.

For an abrupt lower boundary of the first layer:
Apply a correction for an abrupt textural change within the upper 75 cm of the profile. Note that abruptness of horizon boundary (HBDI) not necessarily means an abrupt textural change! Also note that an abrupt textural change may occur between e.g. the 2nd and 3rd layer.

If LDEP < 75 and HBDI is abrupt or DIAP is abrupt textural change, then
If DIAP is not abrupt textural change, then Abr = Abr / 2 (2.17a)
If LDEP > 0.25 then F = F + Abr*(75-LDEP) / 50 (2.17b)
If LDEP ≤ 0.25 then F = F + Abr } (2.17c)

where

Abr the basic adjustment factor read from file *'FTAB.CNT'*, and dependent on the type of soil development.
HBDI abruptness of horizon boundary between the first and the second layer. HBDI is obtained from the SOTER data input file.
LDEP depth of the first layer (cm). LDEP is obtained from the SOTER data input file.
DIAP diagnostic property. The only diagnostic property of interest here is abrupt textural change (TC). DIAP is obtained from the SOTER data input file.

For sensitivity to capping:

If SCAP = Weak then F = F + 0.3 * Cap (2.18a)
If SCAP = Moderate then F = F + 0.5 * Cap (2.18b)

[2] Depth to bedrock is considered to be equivalent with depth to parent material

If SCAP = Strong then F = F + 1.0 * Cap (2.18c)

where

Cap the basic adjustment factor read from file *'FTAB.CNT'*, and dependent on the type of soil development.
SCAP sensitivity to capping. SCAP is obtained from the SOTER data input file.

SLEMSA is very sensitive to F modifiers, especially at high erodibility levels (Stocking, personal communication). It is therefore crucial that basic adjustment factors be established experimentally. If there is no experimental basis to define these factors, a sensitivity analysis can be useful to show the results for different assumptions.

Data on rainfall energy (E) are derived from monthly precipitation records. The regression parameters must be defined by the user in configuration file 'CONSWEAP.CNF' (c.f. paragraph 3.3.3). A few examples of regression equations obtained or derived from literature are presented in table 5. All works consulted found approximately linear relations between E and P_{month}; none of the authors referred to application in regions with freeze and thaw. Nevertheless, options for the same types of equations for rain and snowmelt as for USLE (paragraph 2.1.1) are available.

The influence of coarse fragments is calculated according to the same method as described in paragraphe 2.1.2 for the USLE model.

2.2.2 The C factor

In SLEMSA the C factor is calculated as a non linear function of rainfall interception, i.e. ground cover. This method is compatible with the method for the calculation of the C factor in USLE from leaf area and crop geometry, as described in paragraph 2.1.4. SWEAP uses the latter for both USLE and SLEMSA.

2.2.3 The X factor

The X factor in SLEMSA and the LS factor in USLE are calculated in the same way . However, there is a conversion factor of 2.147, to correct for the SLEMSA standard plot, which is of a different length and slope gradient compared to the USLE standard plot.

Table 5 Regression equations relating Rainfall energy E ($J.m^{-2}$) to amount of precipitation (P mm).

Equation	r	n	Area of application	Source
$E=18.85*P$	-	-	Zimbabwe - areas prone to drizzle	Stocking *et al.*, 1988
$E=17.37*P$	-	-	Zimbabwe - aggressive climates	Stocking *et al.*, 1988
$E=-20+41.4*P$	0.99	18	Individual rainstorms	Kowal and Kassam, 1976
$E=36.1*P$	0.99	18	Accumulated rainstorms	Kowal and Kassam, 1976
$E=27.6+24.5*P$	0.81	?	Individual rainstorms(?)	Lal, 1982 (cited by Lal, 1990)
$E=20.03*P$	0.96	21	Monthly data of Jinxian (1984) and Jurong (1985), S.E. China.	Marx, 1988

Chapter 3

INPUT DATA

SWEAP utilizes data from four different kind of input files:

1. SOTER data regarding terrain and soil characteristics, actual land use/vegetation and climate are extracted from the SOTER database and stored in files with a *'.DAT'* extension
2. Scenario data regarding hypothetical combinations of land use, management and erosion control practices are provided interactively by the user through the SWEAP menu system, and stored by the program in file *'SWEAP.CNF'*
3. Conversion tables are used to derive erosion factors from scenario data and SOTER data. Conversion tables are provided with either a *'.TAB'* or a *'.CNT'* extension
4. Configuration data control the working and output of the program. Configuration data are stored in file *'CONSWEAP.CNF'*.

All input files are plain ASCII files that can be viewed and edited with any ASCII editor.

3.1 SOTER data

Your SWEAP distribution diskette contains a dBASE IV command file that will extract all data that are required by SWEAP, from your SOTER database, for a user-specified range of SOTER units.

SWEAP requires the following data from the SOTER database:

Soil component data:

SUID	: Soter Unit_ID (33)[3], integer number	U,S[4]
TCID	: Terrain component number (34), integer number	U,S
SCID	: Soil component number (35), integer number	U,S
PROP	: Proportion of SOTER Unit (36), percentage coverage	U,S
RKSC	: Surface rockiness (40), alphanumeric code	U,S
STSC	: Surface stoniness (41), alphanumeric code	U,S
SCAP	: Sensitivity to capping (45), alphanumeric code	S
RDEP	: Rootable depth (46), alphanumeric code	U,S
AWC	: Available water capacity of the soil, in mm water height	U,S

Terrain component data:

SCGR	: Dominant slope gradient (19), percentage	U,S
SCDL	: Length of slope (20), meters	U
BEDR	: Depth to bedrock (27), meters	S

[3] Numbers between brackets refer to the corresponding numbers given in the SOTER Procedures Manual (Van Engelen and Wen Ting-tiang, 1993).

[4] Item used by USLE ("U") or by SLEMSA ("S").

Profile data:

DRAI	: Internal drainage (55), alphanumeric code	U,S
SDEV	: Soil development, alphanumeric code	S
MSUB	: Material below the pedon, alphanumeric code	S

Upper horizon data:

HBDE	: Lower depth of horizon, centimeters	S
HBDI	: Distinctness of transition (69), alphanumeric code	S
STGR	: Grade of structure (72), alphanumeric code	U
STSI	: Size of structure elements (73), alphanumeric code	U
STTY	: Type of structure (74), alphanumeric code	U
TOTC	: Total carbon (102), grams per kilogram	U
ELCO	: Electrical conductivity (92), $dS.m^{-1}$	S
MINA	: Abundance of coarse fragments (75), alphanumeric code	U,S
VFSA	: Very fine sand, 0.05-0.1 mm (81), weight percentage	U
STPC	: Silt, 0.002-0.05 mm (83), weight percentage	U
CLPC	: Clay, <0.002 mm (84), weight percentage	U
PSCL	: Particle size class (85), alphanumeric code	S
DIAP	: Diagnostic properties (66), FAO 1988, alphanumeric code (3 values)	S

Land use and vegetation data:

LUSE	: Land use (3[5]), alphanumeric code	U,S
VEGE	: Natural vegetation (3[6]) alphanumeric code	U,S
COVR	: Soil cover by vegetation, percentage	U,S

Material below the pedon (MSUB) is deduced from the lower horizon designation (67): rock if the lower horizon is an R-layer, unconsolidated rock if horizon designation is unknown and lithology of surficial material (25) is unconsolidated, unknown otherwise.
Soil development is deduced from the FAO classification (58), 1974 or 1988, of the representative profile.
SWEAP will use the default C-(cover) value form the .TAB tables in case COVR is "-1". Otherwise the program will use the COVR value from the SOTER data input file.

Additional to this data, the program requires an explicit link between every SOTER unit and a climate station. SWEAP is not capable of linking a climate station to a SOTER unit implicitly by its geographical coordinates, as described in the SOTER Procedures Manual. In the SOTER data input file an explicit link is implemented by adding the following data:

FILE	: Name of the climate data file	U,S
STID	: Identification code of the reference climate station (1)	U,S

[5] Land use classes are defined in a hierarchical system (Remmelzwaal, 1990). The codes for land use are given in table 6 and full descriptions in Annex 2 of the SOTER Procedures Manual (Van Engelen and Wen Ting-tiang, 1993).

[6] Generalized description of the physiognomy of the *present* native vegetation (Unesco, 1973). The codes for the hierarchical classification of the vegetation are given in table 7 and full descriptions in Annex 3 of the SOTER Procedures Manual (Van Engelen and Wen Ting-tiang, 1993)

Every data line in the SOTER input file represents a soil component. Data lines **must** be grouped by SOTER unit. Table 1 in the appendix shows an example of a SOTER data input file.
Climate data may be retrieved from more than one file. Each line in a climate data file must contain the following data:

STID : Climate station identification code (1)
LATI : Latitude (3) of the climate station (negative values for the southern hemisphere), degrees
ALTI : Altitude above or below (negative) sea level (5), meters
KIND : Climate characteristic (7), followed by the twelve monthly average values for that characteristic.

SWEAP may use one or more of the following climate characteristics (monthly averages):

to calculate rainfall erosivity:
RAIN : Precipitation, $mm.month^{-1}$
RDAY : Number of days with at least 1mm of precipitation ($day.month^{-1}$)
Only required for erosivity estimates according to Bols
RMAX : Maximum 24-hour rainfall in indicated month, (mm)
Only required for erosivity estimates according to Bols

to calculate growing period:
TMIN : Minimum temperature during a 24h period, (°C)
TMAX : Maximum temperature during a 24h period (°C)
RADI : Total radiation ($MJ.m^{-2}.day^{-1}$) ***or***
SUNH : Hours of bright sunshine per day
VAPP : Vapour pressure (mbar) ***or***
HUMI : Average relative humidity during 24h period (%)
WIND : Mean wind velocity at 2m during 24h. period, $m.s^{-1}$
PETP : potential evapotranspiration ($mm.month^{-1}$) according to Penman (1948), optional, ***or***
PETT : potential evapotranspiration ($mm.month^{-1}$) according to Thornthwaite, optional.

Records need not be grouped by climate station. Table 2 in the appendix shows an example of a climate data file.

SWEAP skips the first five lines, i.e. header, of each SOTER data input file and climate data file. Data values must be separated by white space (tabs, spaces). Missing values cannot be represented by blanks.

3.2 Scenario data

Scenario data are to be provided by the user through the interactive menu system of the program. The menu system stores the scenario data input by the user in a file named *'SWEAP.CNF'*. Subsequently, this file is read by the erosion modelling part of the program.

The following scenario information is to be provided by the user:

- Name of the SOTER data input file
- Name of the output file
- Method for the assessment of erosion hazard: SLEMSA, USLE
- The type of Vegetation or Land use.
- Type of erosion control practice.
- Type of residue management.
- Number of crops planted per year.
- Months of planting and harvesting of each crop.

3.3 Conversion tables

Conversion tables are plain ASCII files that can be viewed and edited with any ASCII editor. The program recognizes two different kinds of conversion tables. Files with a *'.CNT'* extension are used exclusively by the erosion modelling part of the program. All files with a *'.TAB'* extension are employed by the menu system. Some *'TAB'* files are also used by the erosion modelling part.

3.3.1 The *'.TAB'* files

The program uses the following *'.TAB'* files:

- *ANNCROP.TAB*
- *PERENN.TAB*
- *VEGETAT.TAB*
- *RESIDC.TAB*
- *EROCONT.TAB*
- *EROCAT.TAB*

Each line of a *'TAB'* file starts with a control character, followed by a descriptive name for a particular land use or vegetation type, and one or more modelling parameters. Control characters '0' and '*' denote a single line comment, all other digits represent a menu nesting level. Menus will display all successive land use or vegetation types in a *'TAB'* file at the same level of nesting, up to a type with a lower level of nesting.
Selected model parameters are written to file *'SWEAP.CNF'* and subsequently used by the erosion modelling part of the program.
Each data line or record in a *'TAB'* file must begin with a control character in column 1. The land use or vegetation type is in columns 3-67, modelling parameters are in column 68 omnward.
Tables 3 - 8 in the annex present examples of every *'.TAB'* file.

File ***'ANNCROP.TAB'*** contains the modelling parameters for land use types based on annual cropping (refer to paragraph 2.1.4). **Code** is the SOTER landuse code; $\mathbf{C_1}$, $\mathbf{C_2}$ and $\mathbf{C_3}$ are the crop coefficients for the month of planting, the first month after planting and consecutive months respectively; $\mathbf{L_{max}}$ is the leaf area index at full crop development, in $m^2.m^{-2}$; **k** is the "extinction coefficient" (dimensionless); $\mathbf{V_{resid}}$**(MAX)** is the percentage of L_{max}, left as surface crop residue, just after harvest; **I** is an integer value that refers to one of the columns in file *'INTRCPT.CNT'*.

File *'**PERENN.TAB**'* contains the modelling parameters for land use types based on perennial cropping, animal husbandry and forestry. Again, **code** is the SOTER landuse code; $\mathbf{C_{MIN}}$ is the crop coeffient; **cover** is percentage of vegetation cover; **I** is an integer value that refers to a column in file *'INTRCPT.CNT'*.

File *'**VEGETAT.TAB**'* contains identical modelling parameters for natural vegetation types.

The contents of these files can be modified easily with any ASCII editor. More detailed land use types can be added by increasing the level of nesting and adding the desired type(s) of land use. For instance, in *'ANNCROP.TAB'*

	code	C1	C2	C3	Lmax	k	Vresid	I
1 Rainfed arable cultivation	AA4	0.5	0.3	0.16	3.5	0.6	75	7
1 Wet Rice cultivation	AA5	0.6	0.2	0.08	4.5	0.7	60	7

can be refined as follows:

	code	C1	C2	C3	Lmax	k	Vresid	I
1 Rainfed arable cultivation	AA4	0.5	0.3	0.16	3.5	0.65	70	7
2 Cereals	AA41	0.6	0.3	0.18	3.0	0.70	70	7
3 Wheat	AA411	0.6	0.3	0.18	3.0	0.70	60	7
3 Maize	AA412	0.6	0.3	0.18	3.0	0.70	80	7
4 Maize, high input level	AA413	0.4	0.2	0.10	4.0	0.70	80	7
4 Maize, intermediate input level	AA414	0.4	0.3	0.18	3.0	0.70	80	7
4 Maize, low input level	AA415	0.6	0.5	0.36	2.0	0.70	80	7
3 Barley	AA416	0.7	0.5	0.35	4.5	0.70	60	7
3 Sorghum	AA417	0.6	0.5	0.35	2.3	0.60	80	7
2 Leguminosae	AA42	0.4	0.25	0.16	4.0	0.6	65	7
3 Soybeans	AA421	0.5	0.3	0.27	4.0	0.45	60	7
3 Black beans	AA422	0.4	0.2	0.10	3.5	0.85	60	7
3 Mucuna	AA423	0.4	0.2	0.08	4.0	0.80	70	7
1 Wet Rice cultivation	AA5	0.6	0.2	0.08	4.5	0.7	60	7

Note:
(1) Land use codes must be unique and at most 5 characters long. The first 3 characters must be identical to those of the higher hierarchical level of nesting.
(2) These data as well as the data in the annex are examples. They do not result from land use systems research, and different values may apply in different regions.

In case actual land use and vegetation data are provided by the SOTER data input file, one of the files *'ANNCROP.TAB'*, *'VEGETAT.TAB'* and *'PERENN.TAB'* will be scanned until the (first) matching SOTER code is encountered.
SWEAP ignores comment lines in *'TAB'* files, i.e. lines starting with an asterisk ('*'). Lines starting with a zero ('0') will be recognized by the erosion modelling part, but ignored by the menu system. Thus, highly detailed land use and vegetation types can be hidden from the user while still be recognized by the program when a scenario for actual land use and vegetation (SOTER data) is evaluated.

Each line of file *'**RESIDC.TAB**'* represents a type of residue management. The first column indicates the timing of residue management (0 = just after harvest; 1 = just before planting a new crop); **reduct** is the reduction (fraction) of ground cover due to each type of residue management; **I** refers to a column in file *'INTRCPT.CNT'*.

File *'RESIDC.TAB'* can be updated or refined in the same way as described above for file *'ANNCROP.TAB'*.

File *'**EROCONT.TAB**'* provides options for soil management and erosion control practices for annual crops. The numbers refer to slope dependent correction factors, which are defined in file *'PTAB.CNT'* for USLE, and in **'FMANMOD.CNT'** for SLEMSA.

File *'**EROCAT.TAB**'* contains an identical modelling parameter for land use systems with intensive grazing.

3.3.2 The *'.CNT'* files

SWEAP uses the following 'CNT 'conversion tables:

- *FTAB.CNT*
- *FMANMOD.CNT*
- *IDRAIN.CNT*
- *PTAB.CNT*
- *STRUCT.CNT*
- *INTRCPT.CNT*

Tables 9 - 14 in the annex present examples of every *'CNT'* file. Most of the data in these examples were obtained by combination, transformation, interpolation and extrapolation of data from available literature. Many values are quite arbitrary and therefore should be used with discretion: *'.CNT'* files should not be used without careful examination.
All *'CNT'* files are of a similar structure. Every line starts with a control character. Any line beginning with a control character other than '1' or '2' will be ignored by the program (comment lines). Control character '1' denotes a data line with exclusively values of the first independent variable. Control character '2' denotes a data line that proceeds with a value for the second independent variable, followed by a number of values for the dependent variable.
Comment lines are normally enclosed by brackets ({ .. }).

File *'**FTAB.CNT**'* contains SLEMSA F-factors (intrinsic soil erodibility ratings) dependent upon of type of soil development and texture class, as well as modifiers for sub-optimal internal drainage (Drain), salinity (Sal), presence of a lithic contact (Lit), the presence of abrupt horizon boundaries (Abr) and the sensitivity to capping (Cap).
The contents of this file may be modified except for the values of the two independent variables, texture class and type of soil development.

File *'**FMANMOD.CNT**'* contains modifiers for the SLEMSA F-factor caused by soil management and/or erosion control practices, for several slope classes.
The files *'EROCONT.TAB'* and *'EROCAT.TAB'* assign identification numbers to every erosion control practice. The number of slope classes and types of erosion control practice in *'FMANMOD.CNT'* may be extended freely. In the latter case new types of erosion control practices must also be added to *'EROCONT.TAB'* or *'EROCAT.TAB'*.

File ***'IDRAIN.CNT'*** contains the USLE permeability factor (used to calculate the K-factor, see paragraph 2.1.2) as a function of the SOTER code for internal drainage (DRAI). The number of drainage classes can be extended if desired.

File ***'PTAB.CNT'*** contains the USLE soil management/erosion control practice factor (P) for a number of erosion control practices and slope classes.
The files *'EROCONT.TAB'* and *'EROCAT.TAB'* assign identification numbers to every erosion control practice. The number of slope classes and types of erosion control practice in *'PTAB.CNT'* may be extended freely. In the latter case new types of erosion control practices must also be added to *'EROCONT.TAB'* or *'EROCAT.TAB'*.

File ***'STRUCT.CNT'*** contains the structure ratings for the USLE K-nomograph (cf. equation 2.7), as a function of structure form (STFO), structure size (STSI) and structure grade (STGR). The number of structure types and size/grade combinations can be extended freely.

File ***'INTRCPT.CNT'*** describes the relation between the crop ratio (i.e. the soil lost from covered land in proportion to the soil lost from bare fallow land) and the percentage vegetation cover (in 10% intervals, from 0 to 100). Each column refers to a different vegetation (or residue) type. The number of columns (i.e. vegetation or residue types) can be extended freely.

3.4 Configuration data

During start-up, SWEAP reads the information in file *'CONSWEAP.CNF'* to establish your working environment. You can use any ASCII editor to make changes to this configuration file. It contains the following data:

Line 1: Debug option (integer value):

- 0 : No screen output, results are written directly to the output file.
- 1-4: A higher value for debug (up to 4) sends ever more intermediate results to the screen. Press the space bar after each output screen to continue.

Line 2 Layout option for the output file (integer value, cf. chapter 4). SWEAP calculates the erosion risk for every soil component within a SOTER unit, and subsequently sorts the results. The following options are available:

- 1: Sorted by descending coverage, i.e. results for largest areas first
- 2: Sorted by descending risk, i.e. highest risks first
- 3: Sorted by ascending risk
- 4: Sorted by 10% coverage intervals, highest risks first
- 5: Sorted by 10% coverage intervals, lowest risks first

Line 3 The approximation method (ETYPE, integer value of 1 through 4) and regression parameters *a, b, c* and *d* employed by the program to calculate rain energy (E) from monthly rainfall figures for SLEMSA. Table 6 lists the currently available approximation methods (cf. paragraph 2.1.1).

Line 4 Parameters *a* and *b* of the linear regression equation (equation 4 in table 6) that calculates the contribution of snowmelt to rainfall energy (E) in SLEMSA. Though currently not used, *c* and *d* must be specified as well.

Line 5 The approximation method (RTYPE, integer value of 1 through 4) and regression parameters *a, b, c* and *d* employed by the program to calculate the rainfall and runoff factor (R) from monthly rainfall figures for USLE. Table 6 lists the currently available approximation methods (cf. paragraph 2.1.1).

Line 6 Parameters *a* and *b* of the linear regression equation (equation 4 in table 6) that calculates the contribution of snowmelt to the rainfall and runoff factor (R) in USLE. Though currently not used, *c* and *d* must be specified as well.

Line 7 Method (single character) to calculate potential evapotranspiration: **P**enman or **T**hornthwaite. Potential evapotranspiration is used in the calculation of potential growing seasons.

Line 8 Coefficients A and B of the Prescott equation (1940) that relates hours of sunshine to irradiation (cf. equation 1 in textbox 1).

Line 9 Critical mean monthly temperature $T_{cr,av}$°C, critical minimum temeprature $T_{cr,min}$°C, and critical ratio between average actual and potential evapotranspiration (E_{act}/E_{pot}) for the cultivation of annual crops (cf. textbox 1).

Line 10 This line is ignored by the program.

Line 11 Method to calculate the C-factor (integer value). This line must contain 2 values, for SLEMSA and USLE respectively (cf. paragraph 2.1.4.).

0: Calculate C from percentage cover or leaf area.
1: Get C-factors directly from file (e.g. file *'PERENN.TAB'*);

Line 12 Future releases of SWEAP will be able to display Erosion Hazard maps for each scenario. These maps are derived from SOTER maps in IDRISI raster file format. Configuration file "CONSWEAP.CNF" already contains a parameter to control the display of such maps (line 12: look for IDRISI .img file, yes or no).

Line 13: Number of result classes (NCLASS, integer value). For values less than, or equal to one, results will not be classified, and lines 14 and 15 will be skipped.

Line 14: NCLASS values for the upper class limits;

Line 15: NCLASS plus one class labels (single character). The first character label is for results less than the first upper class limit in line 14, character label NCLASS+1 is for results exceeding the last upper limit in line 13.

Table 15 is an example of configuration file *'CONSWEAP.CNF'*.

Table 6 Options and signification of parameters to relate the USLE rain erosivity factor **R** or the SLEMSA rain energy factor **E** to average monthly rainfall distribution.

Approximation method	equation
(1) Bols	$R_{Bols,i} = a * P_i^{\,b} * D_i^{\,c} * P_{\max,i}^{\,d}$
(2) Modified Fournier index	$F_{m,i} = \frac{P_i^2}{P_{ann}}$ $R_{Arnoldus,i} = a + b * F_m$
(3) Ateshian / Hargreaves	$R = c + d * R_h$ $\quad c=0, d=0$ $R_{Athesian,i} = 0.417 * (11.9 + 0.162 * (c + d * P_i))^{2.17}$
(4) Linear relation	$R = a + b * P_i$ $\quad c=0, d=0$

R	USLE	: erosivity factor R.
	SLEMSA	: rain energy factor E
P_i	Average precipitation (RAIN) in month i	
D_i	Number of days (RDAY) with at least 1mm precipitation	
$P_{\max,i}$	Maximum 24h rainfall (RMAX) in month i	
P_{ann}	Average annual precipitation, i.e. $\sum_{i=1,12} P_i$	

Chapter 4

THE OUTPUT FILE

SWEAP calculates the erosion hazard for every soil component within a SOTER unit. Subsequently, the results may be classified and sorted in various ways, and written (in a table format) to a user specified output file. This output file can be used by a Geographical Information System (or GIS, e.g. ILWIS or ARC/INFO) to create erosion hazard maps. The exact geographical location of each SOTER unit is considered a SOTER constant and therefore not used by SWEAP. The GIS must obtain this information from other sources.
SWEAP output files can be used directly as input to other programs after minor modifications. In most cases removal of the file header will already be sufficient.

4.1 Layout options

The layout option, an integer that is read from line 2 in configuration file *'CONSWEAP.CNF'*, controls the contents of the output file (cf. paragraph 3.3.3). For the current version of SWEAP five output options are available.

Example:
The SOTER units 1102 and 1103 consist of four and three soil components (or "soils") respectively, with the following percentages of occurrence and degree of erosion hazard (tons.ha^{-1}.yr^{-1}):

Soil component	Coverage (%)	Erosion hazard
1102/1/1	25	13.8
1102/1/2	40	11.0
1102/1/3	15	2.6
1102/1/4	20	48.7
1103/2/1	50	14.2
1103/1/2	20	14.2
1103/1/3	30	22.4

The next five paragraphs will show the unclassified results in the output file for every output option.

4.1.1 Sorted by descending coverage

Erosion hazards are sorted by descending coverage, i.e. the hazards of the largest soil components within a SOTER unit are listed first in the output file:

Results are sorted by descending percentage coverage within a SOTER unit.

SOTER unit	Percent coverage	Result
1102	40	11.0
1102	25	13.8
1102	20	48.7
1102	15	2.7
1103	50	14.2
1103	30	22.4
1103	20	14.2

4.1.2 Sorted by descending erosion hazard

Results are sorted by descending erosion hazard, i.e. the soil components with the largest hazards within a SOTER unit are listed first in the output file. The cover percentage is cumulative:

Results are sorted by descending risk potential (coverage in cumulative percent of SOTER unit area).

SOTER unit	Percent coverage	Result
1102	20	48.7
1102	45	13.8
1102	85	11.0
1102	100	2.7
1103	30	22.4
1103	80	14.2
1103	100	14.2

The output file demonstrates that for SOTER unit 1102 the erosion hazard is at least 2.7 units, with a maximum of 48.7 units for 20% of the unit. For SOTER unit 1103 these figures are 14.2 and 22.4 (for 30% of the SOTER unit) respectively.

4.1.3 Sorted by ascending erosion hazard

Results are sorted by ascending erosion hazard, i.e. the soil components with the smallest hazards within a SOTER unit are listed first in the output file. The cover percentage is cumulative:

Results are sorted by ascending risk potential (coverage in cumulative percent of SOTER unit area).

SOTER unit	Percent coverage	Result
1102	15	2.7
1102	55	11.0
1102	80	13.8
1102	100	48.7
1103	50	14.2
1103	70	14.2
1103	100	22.4

This output file demonstrates that for SOTER unit 1102 the erosion hazard is 48.7 units or less. However, for approximately half of the unit the hazard has already fallen to 11.0 units or less. For SOTER unit 1103 these figures are 22.4 and 14.2 units respectively.

4.1.4 Sorted by ascending erosion hazard in cumulative 10% coverage intervals

Results are sorted by ascending erosion hazard, i.e. the soil components with the smallest hazards within a SOTER unit are listed first in the output file. SOTER unit coverage is in cumulative 10% intervals.

Results are sorted by ascending risk potential (coverage in cumulative 10% intervals of SOTER unit area).

SOTER unit	Percent coverage	Result
1102	10	2.7
1102	20	11.0
1102	30	11.0
1102	40	11.0
1102	50	11.0
1102	60	13.8
1102	70	13.8
1102	80	13.8
1102	90	48.7
1102	100	48.7
1103	10	14.2
1103	20	14.2
1103	30	14.2
1103	40	14.2
1103	50	14.2
1103	60	14.2
1103	70	14.2
1103	80	22.4
1103	90	22.4
1103	100	22.4

E.g. erosion risk for 80% of SOTER unit 1102 is 13.8 units or less. For at least 50% of SOTER unit 1103 erosion risk is 14.2 units or less.

4.1.5 Sorted by descending erosion hazard in cumulative 10% coverage intervals

Results are sorted by descending erosion hazard, i.e. the soil components with the highest hazards within a SOTER unit are listed first in the output file. SOTER unit coverage is in cumulative 10% intervals.

Results are sorted by descending risk potential (coverage in cumulative 10% intervals of SOTER unit area).

SOTER unit	Percent coverage	Result
1102	10	48.7
1102	20	48.7
1102	30	13.8
1102	40	13.8

```
Results are sorted by descending risk potential (coverage in cumulative
10% intervals of SOTER unit area) Continued:
```

SOTER unit	Percent coverage	Result
1102	50	11.0
1102	60	11.0
1102	70	11.0
1102	80	11.0
1102	90	2.6
1102	100	2.6
1103	10	22.4
1103	20	22.4
1103	30	22.4
1103	40	14.2
1103	50	14.2
1103	60	14.2
1103	70	14.2
1103	80	14.2
1103	90	14.2
1103	100	14.2

E.g. erosion risk for at least 60% of SOTER unit 1102 is 11.0 units or more. For 30% of SOTER unit 1103 erosion risk is at least 22.4 units.

4.2 Classifying results

Erosion risks may be classified in any number of user-specified result classes. These classes are to be specified in configuration file 'CONSWEAP.CNF', lines 12 through 14 (cf. paragraph 3.3.3). Results will not be classified for any number of classes (NCLASS) less than, or equal to one.

The integer value on Line 12 of file 'CONSWEAP.CNF' designates the number of upper class limits that are specified on line 13.
Line 14 lists the NCLASS+1 single character labels for the classes. The first character label is for results less than the first upper class limit in line 13. Character label NCLASS+1 is for results exceeding the last upper limit in line 13.

Example:
Lines 12-14 of the example configuration file in Table 15:

```
6                       { Number of classes (0 = do not classify)         }
0 2 5 20 100 300        { 5 classes: <0; 0-5; 5-25; 25-100; 100-300; 300+  }
- A B C D E F           { One-character class labels                       }
```

define 6 result classes with the following class limits

-	result	<	0	tons.ha^{-1}.yr^{-1}
A	0	-	2	tons.ha^{-1}.yr^{-1}
B	2	-	5	tons.ha^{-1}.yr^{-1}
C	5	-	20	tons.ha^{-1}.yr^{-1}
D	20	-	100	tons.ha^{-1}.yr^{-1}
E	100	-	300	tons.ha^{-1}.yr^{-1}
F	result	>	300	tons.ha^{-1}.yr^{-1}

Class limits and labels will be included in the header of the output file. SWEAP adds the overages for equal classes within a SOTER unit.The example results from page 28 will yield the next output file for layout option 1 - sort by descending coverage :

```
Results are classified:

-: result <    0 tons\ha.
A:       0 -    2 tons\ha.
B:       2 -    5 tons\ha.
C:       5 -   20 tons\ha.
D:      20 -  100 tons\ha.
E:     100 -  300 tons\ha.
F: result >  300 tons\ha.

Results are sorted by descending percentage coverage within a SOTER unit.

 SOTER  Percent   Result
 unit   coverage
 -----  --------  ------
  1102        65       C
  1102        20       D
  1102        15       B
  1103        70       C
  1103        30       D
```

The coverages of soil components 1102/1/1 and 1102/1/2 are added, since the results for both soil components classify as **C**. For the same reason the coverages of soil components 1103/1/1 and 1103/1/2 are added. Results less than zero will be labelled with a hyphen (-).

Chapter 5

DISCUSSION

The intention of SWEAP is not to present yet another model for erosion hazard assessment, but to take advantage of existing models as a tool for the assessment of erosion risks to be used with SOTER, i.e. at small map scale (1:100,000 to 1:1M). Modifications were introduced in order to adjust the program to SOTER's facilities and limitations. The aim was to optimize the balance between refinement of the equations and the available information. The extent to which the results will be accurate depends for a great deal on the variability of factors related to erosion within SOTER units, terrain components and soils, as well as on the temporal variability of these factors. There is no sense in using "refined" models, e.g. models that work on a rainstorm basis or for segments of slopes, when much of the information needed must be generated by the model itself.
Several doubts that remain in respect to the structure of the program are:

- Should more relations be expressed as external input tables or coefficients of transfer functions?
- What is the best way to account for erosion control practices at SOTER scale: by P-factors, by modifying soil erodibility, or by modifying slope factors?
- How can one include seasonal dynamics in perennial crops and natural vegetation

There is little doubt that the most difficult and time consuming problem will be to find suitable parameter values for the tables and equations that are used by the program.

Existing research on erosion hazard at a regional scale is scarce. Most of it is qualitative, or semi-quantitative. Most models that have been used were not validated (objectively).
The data of actual erosion rates, available for the SOTER pilot areas, provide a unique opportunity to make an objective validation. Although these data were not put in quantitative terms, they were gathered by independent local experts, and will therefore provide a good qualitative indication of water erosion in the areas.
At this stage it was found too early to incorporate any relationship between monetary cost and erosion in the program. Simple models that calculate "erosion costs" are available. They generally highlight one or a few aspects of the economic effects of erosion, e.g. less productivity caused by less water storage capacity, or conversion of loss of nutrients to loss of fertilizer equivalents. Of course the (economic) effects of erosion reach far beyond these factors. Simple estimates in monetary terms, even though they lack accuracy, may have a greater impact on planners, politicians and farmers, than any qualitative statement, or even quantitative estimates expressed in tons or cm of soil loss per hectare, can ever achieve. On the other hand such quantitative results can easily be misunderstood, or even

misused, when the computer program is used by third parties. Whether the advantages outweigh this risk and how users should be warned against overinterpretation needs further discussion.
A similar problem is the introduction of "erosion tolerance". Although erosion tolerance can be defined quantitatively, in the same units as the model results, it is highly subjective. The responsibility of allocating erosion tolerance values to soil/terrain units must always be with the local planner/decision maker, who is familiar with the local peculiarities of a region. A computer program designed to help him to take decisions must either demand rational choices, e.g. by question and answer, or, at least, make very clear which boundary conditions are assumed, and which problems can be expected.

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ANNEX

Table 1 Example of SOTER data input file

SUID	TCID	SCID	SCGR	SCDL	RKSC	TSSC	BEDR	PROP	RDEP	DRAI	SDEV	SCAP	MSUB	HBDE	HBDI	STTY	STSI	TTGR	TOTC	ELCO	MINA	VFSA	STPC	CLPC	PSCL	AWC	DIAP	DIAP	DIAP	LUSE	VEGE	COVR	FILE	STID
130	1	1	12.0	150.0	V	F	1.0	35.0	S	M	CH	W	U	29	C	A	V	M	45.0	0.0	-	0.0	34.0	35.0	CL	-1	-	-	-	HI1	VC5	-1	climate.dat	UY1006
130	1	2	12.0	150.0	V	F	1.0	25.0	S	M	CH	W	U	14	G	A	M	W	37.7	0.0	-	0.0	22.0	24.0	SCL	-1	-	-	-	HE3	VC5	-1	climate.dat	UY1006
130	2	1	15.0	100.0	M	C	0.0	25.0	M	I	CH	N	U	26	G	S	F	M	0.0	0.0	-	7.0	29.0	24.0	L	-1	-	-	-	HE3	VC5	-1	climate.dat	UY1006
130	2	2	15.0	100.0	M	M	0.0	15.0	V	W	PR	N	U	18	A	A	F	S	28.0	0.0	-	6.0	28.0	16.0	SL	-1	RO	-	-	HI1	VC5	-1	climate.dat	UY1006
131	1	1	12.0	200.0	M	M	1.0	70.0	V	W	PR	N	U	5	A	S	M	M	52.0	0.0	C	0.0	32.0	29.0	CL	-1	RO	-	-	HI2	VC5	-1	climate.dat	UY1006
131	2	1	1.0	300.0	C	F	0.0	15.0	V	W	CH	N	U	12	A	S	F	S	66.3	0.0	V	0.0	42.0	44.0	SIC	-1	RO	-	-	HE2	VC5	-1	climate.dat	UY1006
131	3	1	3.0	300.0	V	V	2.0	15.0	D	M	VE	N	U	30	-	G	F	M	30.2	0.0	-	8.0	25.0	48.0	C	-1	VE	-	-	HE3	VC5	-1	climate.dat	UY1006
132	1	1	15.0	150.0	M	C	1.0	55.0	S	M	CH	-	U	25	A	S	F	M	14.5	0.0	-	0.0	17.0	19.0	SL	-1	-	-	-	HE3	VA1	-1	climate.dat	UY1008
132	1	2	15.0	150.0	F	N	1.0	25.0	S	M	CH	-	U	29	C	A	V	M	45.0	0.0	-	0.0	34.0	35.0	CL	-1	-	-	-	MP	VA1	-1	climate.dat	UY1008
132	1	3	15.0	150.0	M	M	1.0	20.0	V	W	PR	N	U	18	A	A	F	S	28.0	0.0	-	6.0	28.0	16.0	SL	-1	RO	-	-	HE3	VA1	-1	climate.dat	UY1008
133	1	1	8.0	150.0	N	N	2.0	70.0	D	W	LU	-	U	25	C	S	F	W	5.7	0.0	-	30.0	11.0	11.0	SL	-1	-	-	-	MP	VC5	-1	climate.dat	UY1007
133	1	2	8.0	150.0	N	N	2.0	30.0	D	W	LU	N	U	30	D	M	F	W	11.4	0.0	-	0.0	7.0	15.0	SL	-1	-	-	-	HE3	VC5	-1	climate.dat	UY1007
134	1	1	8.0	100.0	N	N	2.0	60.0	D	W	LI	N	U	20	D	S	F	W	9.4	0.0	-	41.0	10.0	10.0	SL	-1	-	-	-	HE3	VC2	-1	climate.dat	UY1007
134	2	1	30.0	300.0	N	F	2.0	20.0	D	W	LI	N	U	30	C	N	-	-	4.6	0.0	-	0.0	3.0	9.0	S	-1	-	-	-	PN1	VC2	-1	climate.dat	UY1007
134	3	1	1.0	700.0	M	C	0.0	20.0	V	W	PR	N	U	5	A	S	M	M	52.0	0.0	C	0.0	32.0	29.0	CL	-1	RO	-	-	PN1	VC2	-1	climate.dat	UY1007
135	1	1	8.0	200.0	C	M	1.0	40.0	S	I	CH	N	U	24	C	A	M	M	24.2	0.0	-	0.0	13.0	17.0	SL	-1	-	-	-	HE3	VC2	-1	climate.dat	UY1010
135	1	2	8.0	200.0	C	M	1.0	25.0	S	I	CH	-	U	7	C	-	-	-	26.6	0.0	-	0.0	16.0	16.0	SL	-1	-	-	-	PN3	VC2	-1	climate.dat	UY1010
135	2	1	1.0	250.0	N	N	1.0	20.0	M	M	VE	-	U	18	G	G	F	S	29.9	1.5	-	0.0	28.0	39.0	CL	-1	VE	-	-	U	VC2	-1	climate.dat	UY1010
135	3	1	3.0	300.0	N	N	2.0	15.0	M	I	ST	N	U	16	G	S	M	W	8.0	0.0	-	0.0	11.0	12.0	LS	-1	-	-	-	HE3	VC2	-1	climate.dat	UY1010
136	1	1	1.0	600.0	N	N	2.0	100.0	M	I	ST	W	U	12	C	S	M	W	15.1	0.0	-	0.0	50.0	9.0	L	-1	-	-	-	AA7	VC2	-1	climate.dat	UY1010
137	1	1	2.0	500.0	N	N	2.0	70.0	M	I	ST	M	U	25	G	S	M	M	22.0	0.0	-	0.0	60.0	20.0	SIL	-1	-	-	-	AA8	VC4	-1	climate.dat	UY1009
137	1	3	2.0	500.0	N	N	2.0	15.0	M	I	-	M	U	10	G	G	M	W	47.0	0.8	-	0.0	66.0	18.0	SL	-1	-	-	-	AA7	VC4	-1	climate.dat	UY1009
137	1	2	2.0	500.0	N	N	2.0	15.0	M	I	ST	M	U	15	G	S	V	W	18.0	0.0	-	0.0	50.0	17.0	L	-1	-	-	-	AA6	VC4	-1	climate.dat	UY1009
138	1	1	1.0	600.0	N	N	2.0	75.0	M	I	ST	M	U	15	G	S	F	M	27.1	0.0	-	0.0	61.0	26.0	SCL	-1	-	-	-	AA6	VC2	-1	climate.dat	UY1009
138	1	2	1.0	600.0	N	N	2.0	25.0	S	I	SO	S	U	7	A	M	M	M	16.9	0.0	-	0.0	75.0	3.0	SIL	-1	-	-	-	AA7	VC2	-1	climate.dat	UY1009
139	1	1	1.0	600.0	N	N	2.0	40.0	M	I	ST	M	U	25	C	S	F	M	34.3	0.0	V	0.0	52.0	21.0	CL	-1	-	-	-	AA3	VC5	-1	climate.dat	UY1006
139	1	2	1.0	600.0	N	N	2.0	20.0	S	I	ST	S	U	25	C	S	M	M	12.8	0.0	-	0.0	63.0	24.0	SIL	-1	-	-	-	AA3	VC5	-1	climate.dat	UY1006
139	2	1	2.0	400.0	N	N	2.0	25.0	M	M	CH	M	U	25	G	S	F	M	26.6	0.0	-	0.0	51.0	25.0	CL	-1	-	-	-	AA3	VC5	-1	climate.dat	UY1006
139	2	2	2.0	400.0	N	N	2.0	15.0	M	M	CH	M	U	16	C	S	M	M	14.3	0.0	-	10.0	57.0	30.0	SICL	-1	-	-	-	AA3	VC5	-1	climate.dat	UY1006

Table 2 Example of Climate data file

STID	LATI	ALTI	KIND	JAN	FEBR	MARC	APRI	MAY	JUNE	JULY	AUGU	SEPT	OCTO	NOVE	DECE
KE0023	-0.73	1500	RAIN	57.00	101.00	148.00	236.00	206.00	123.00	82.00	113.00	128.00	126.00	165.00	115.00
KE0036	-0.97	1218	RAIN	39.00	92.00	122.00	201.00	142.00	64.00	37.00	42.00	56.00	89.00	148.00	84.00
KE0037	-1.00	1370	RAIN	55.00	87.00	122.00	245.00	195.00	89.00	35.00	59.00	93.00	125.00	148.00	119.00
KE0023	-0.73	1500	RDAY	46.00	64.00	131.00	197.00	124.00	85.00	56.00	75.00	148.00	109.00	115.00	109.00
KE0036	-0.97	1218	RDAY	21.00	51.00	98.00	165.00	123.00	50.00	31.00	35.00	43.00	63.00	109.00	67.00
KE0037	-1.00	1370	RDAY	40.00	64.00	85.00	169.00	132.00	60.00	17.00	61.00	93.00	91.00	109.00	89.00
KE0023	-0.73	1500	PETP	4.40	4.70	4.50	3.80	3.20	3.30	3.20	3.50	4.20	4.50	4.10	3.90
KE0036	-0.97	1218	PETP	4.70	4.90	4.80	4.20	4.10	3.90	4.00	4.30	4.90	4.80	4.40	4.20
KE0037	-1.00	1370	PETP	4.70	4.90	4.80	4.20	4.10	3.90	4.00	4.30	4.90	4.80	4.40	4.20
KE0023	-0.73	1500	TMAX	27.50	28.10	28.40	27.20	25.10	23.90	23.20	23.70	25.10	26.30	26.90	26.00
KE0023	-0.73	1500	TMIN	8.10	8.90	9.60	11.30	11.40	10.50	10.40	10.10	8.60	9.40	9.80	8.40
KE0023	-0.73	1500	HUMI	75.00	75.00	79.00	84.00	85.00	85.00	83.00	82.00	81.00	78.00	84.00	81.00
KE0023	-0.73	1500	WIND	1.70	2.00	2.00	2.20	2.20	2.00	2.09	2.09	2.50	2.50	2.09	1.70
KE0023	-0.73	1500	SUNH	8.80	8.30	7.90	6.70	6.00	7.40	6.50	6.50	7.30	7.60	7.60	7.50
KE0023	-0.73	1500	RADI	22.30	22.30	22.00	19.40	17.30	18.60	17.50	18.50	20.70	21.10	20.60	20.00
KE0036	-0.97	1218	TMAX	30.10	30.50	30.50	29.30	28.50	28.50	28.30	28.60	30.20	31.10	29.70	29.70
KE0036	-0.97	1218	TMIN	16.10	16.70	16.80	16.80	16.50	15.50	14.50	15.30	15.50	16.10	16.30	15.80
KE0036	-0.97	1218	HUMI	77.00	76.00	78.00	85.00	85.00	82.00	79.00	76.00	72.00	72.00	79.00	80.00
KE0036	-0.97	1218	WIND	1.60	1.60	1.40	1.10	1.30	1.30	1.40	1.50	1.81	1.40	1.30	1.00
KE0036	-0.97	1218	SUNH	8.80	8.60	8.40	7.70	8.40	8.40	8.40	8.40	8.60	8.20	7.80	8.20
KE0036	-0.97	1218	RADI	22.30	22.90	22.70	20.90	20.80	20.00	20.30	21.40	22.70	22.10	21.00	21.10
KE0037	-1.00	1370	TMAX	30.10	30.50	30.50	29.30	28.50	28.50	28.30	28.60	30.20	31.10	29.70	29.70
KE0037	-1.00	1370	TMIN	16.10	16.70	16.80	16.80	16.50	15.50	14.50	15.30	15.50	16.10	16.30	15.80
KE0037	-1.00	1370	HUMI	77.00	76.00	78.00	85.00	85.00	82.00	79.00	76.00	72.00	72.00	79.00	80.00
KE0037	-1.00	1370	WIND	1.60	1.60	1.40	1.10	1.30	1.30	1.40	1.50	1.81	1.40	1.30	1.00
KE0037	-1.00	1370	SUNH	8.80	8.60	8.40	7.70	8.40	8.40	8.40	8.40	8.60	8.20	7.80	8.20
KE0037	-1.00	1370	RADI	22.30	22.90	22.70	20.90	20.80	20.00	20.30	21.40	22.70	22.10	21.00	21.10

Table 3 Example of ANNCROP.TAB file

* Example of file ANNCROP.TAB	Code	C1	C2	C3	Lmax	k	VresidMAX	I
0 Shifting cultivation	AA1	.45	.25	.20	2.5	.7	75	8
0 Fallow system cultivation	AA2	.40	.20	.10	3.0	.7	80	8
0 Ley system cultivation	AA3	.30	.10	.05	3.0	.7	90	8
0 Rainfed arable cultivation	AA4	.50	.20	.05	4.0	.7	80	8
1 Barley/wheat/oats	AA410	.22	.049	.045	4.5	.7	90	8
1 Cassava	AA411	.24	.049	.045	3.0	1.0	95	8
1 Cotton	AA412	.55	.43	.22	3.0	1.0	95	7
1 Cowpea	AA413	.30	.051	.046	3.0	.85	85	8
1 Green gram	AA414	.30	.052	.047	3.0	.85	85	8
1 Groundnut	AA415	.30	.052	.047	3.0	.85	85	8
1 Maize	AA416	.33	.053	.048	3.0	.7	95	8
1 Pearl millet	AA417	.28	.051	.047	3.5	.6	90	8
1 Phaseolus bean	AA418	.24	.051	.045	3.5	.85	90	8
1 Pigeon pea	AA419	.40	.055	.049	4.0	.45	90	8
1 Rice	na							
2 Wetland rice	AA5	.20	.050	.040	5.0	.6	85	8
2 Upland rice	AA420	.30	.053	.048	3.5	.6	85	8
1 Sorghum	AA421	.40	.055	.049	3.0	.6	90	8
1 Soybean	AA422	.40	.055	.049	4.0	.45	80	8
1 Sugarcane	AA423	1.00	.17	.062	5.0	.70	99	7
1 Potato	AA424	.18	.048	.044	4.0	.85	90	8
0 Irrigated cultivation	AA6	.30	.12	.02	5.5	.7	85	8

Table 4 Example of PERENN.TAB file

* Example of file PERENN.TAB	code	C	Cover	I
1 Perennial field cropping	AP	.05	50	1
2 Perennial, Non-irrigated	AP1	.05	50	1
2 Perennial, Irrigated	AP2	.01	80	1
1 Tree & shrub cropping	AT	.02	70	1
2 Tree crop, non irrigated (with grass undergrowth)	AT1	.02	70	1
2 Tree crop, irrigated (with grass undergrowth)	AT2	.005	90	1
2 Shrub crop, irrigated (no undergrowth)	AT3	.16	100	5
2 Shrub crop, non irrigated (no undergrowth)	AT4	.20	95	5
1 Animal husbandry	H	.027	60	1
2 Extensive grazing	HE	.027	60	1
3 Nomadism	HE1	.09	40	1
3 Semi-nomadism	HE2	.05	50	1
3 Ranching	HE3	.015	70	1
2 Intensive grazing	HI	.005	90	1
3 Animal production (meat cattle)	HI1	.005	90	1
3 Dairying	HI2	.005	90	1
1 Forestry	F	.003	50	6
2 Exploitation of natural forest and woodland	FN	.003	50	6
3 Selective felling	FN1	.001	70	6
3 Clear felling	FN2	.005	40	6
2 Plantation Forestry	FP	.06	80	10
3 Forestry; no undergrowth	FP1	.78	80	2
3 Forestry; 40% of area covered with litter or undergrowth	FP2	.06	80	10
3 Forestry; 90% of area covered with litter or undergrowth	FP3	.006	80	11
1 Mixed farming	M	-.1	-1	0
2 Agro-forestry	MF	.009	20	10
2 Agro-pastoralism (cropping & livestock systems)	MP	.047	90	8
0 Bare soil	BARE	1.0	0	1

Table 5 Example of VEGETAT.TAB file

* Example of file VEGETAT.TAB	Code	C	cover	I
1 Closed forest	I	.0001	100	6
2 Evergreen forest	IA	.0001	100	6
3 Tropical forest ombrophilous	IA1	.0001	100	6
3 (Sub)tropical forest, evergreen seasonal	IA2	.0001	100	6
3 (Sub)tropical forest, semi-deciduous	IA3	.0001	100	6
3 (Sub)tropical forest, ombrophilous	IA4	.0001	100	6
3 Mangrove forest	IA5	.0001	100	6
3 Forest, Temperate and subpolar evergreen ombrophilous	IA6	.0001	100	6
3 Forest, Temperate evergreen seasonal broad-leaved	IA7	.0001	100	6
3 Forest, Winter-rain evergreen broad-leaved sclerophyllous	IA8	.0001	100	6
3 Forest, Tropical and subtropical evergreen needle-leaved	IA9	.0001	100	6
3 Forest, Temperate and subpolar evergreen needle-leaved	IA10	.0001	100	6
2 Mainly deciduous forest	IB	.001	70	6
3 Tropical and sub-tropical drought-deciduous forest	IB1	.0005	80	6
3 Cold deciduous forest with evergreen trees or shrubs	IB2	.001	70	6
3 Cold deciduous forest without evergreen trees or shrubs	IB3	.002	60	6
2 Extremely Xeromorphic forest	IC	.41	50	9
3 Sclerophyllous-dominated extremely xeromorphic forest	IC1	.41	50	9
3 Thorn forest	IC2	.41	50	9
3 Mainly succulent forest	IC3	.41	50	9
1 Woodland	II	.055	90	10
2 Mainly evergreen woodland	IIA	.055	90	10
3 Evergreen broad-leaved woodland	IIA1	.055	90	10
3 Evergreen needle-leaved woodland	IIA2	.055	90	10
2 Mainly deciduous woodland	IIB	.060	80	10
3 Drought-deciduous woodland	IIB1	.055	90	10
3 Cold-deciduous woodland with evergreen trees	IIB2	.060	80	10
3 Cold-deciduous woodland without evergreen trees	IIB3	.060	80	10
2 Extremely xeromorphic woodland	IIC	.44	40	9
3 Sclerophyllous-dominated extremely xeromorphic woodland	IIC1	.44	40	9
3 Thorn woodland	IIC2	.44	40	9
3 Mainly succulent woodland	IIC3	.44	40	9
1 Scrub	III	.47	30	9
2 Mainly evergreen scrub	IIIA	.47	30	9
3 Evergreen broad-leaved shrubland (or thicket)	IIIA1	.47	30	9
3 Evergreen needle-leaved and microphyllous shrubland	IIIA2	.47	30	9
2 Mainly deciduous scrub	IIIB	.47	30	9
3 Drought deciduous scrub with admixture of evergreen woody plants	IIIB1	.47	30	9
3 Drought deciduous scrub without evergreen woody plants	IIIB2	.47	30	9
3 Cold deciduous scrub	IIIB3	.47	30	9
2 Extremely xeromorphic (subdesert) shrubland	IIIC	.47	30	9
3 Mainly evergreen subdesert shrubland	IIIC1	.47	30	9
3 Deciduous subdesert shrubland	IIIC2	.47	30	9
1 Dwarf scrub and related communities	IV	.47	30	9
2 Mainly evergreen dwarf scrub	IVA	.47	30	9
3 Evergreen dwarf scrub thicket	IVA1	.47	30	9
3 Evergreen dwarf shrubland	IVA2	.47	30	9
3 Mixed evergreen dwarf shrubland and herbaceous formation	IVA3	.47	30	9
2 Mainly deciduous dwarf scrub	IVB	.47	30	9
3 Facultatively drought-deciduous dwarf thicket or dwarf shrubland	IVB1	.47	30	9
3 Obligatory drought-deciduous dwarf thicket or dwarf shrubland	IVB2	.47	30	9
3 Cold-deciduous dwarf thicket or dwarf shrubland	IVB3	.47	30	9
2 Extremely xeromorphic dwarf shrubland	IVC	.47	30	9
3 Mainly evergreen subdesert dwarf-shrubland	IVC1	.50	20	9
3 Deciduous subdesert dwarf-shrubland	IVC2	.50	20	9
2 Tundra	IVD	.50	20	9
3 Mainly bryophite tundra	IVD1	.24	90	5
3 Mainly lichen tundra	IVD2	.24	90	5

Table 5 cont'd Example of VEGETAT.TAB file

2 Mossy bog formations with dwarf-shrub	IVE	.005	90	1
3 Raised bog	IVE1	.005	90	1
3 Non-raised bog	IVE2	.005	90	1
1 Herbaceous vegetation	V	.003	95	1
2 Tall graminoid vegetation (>2m; forb coverage <50%)	VA	.003	95	1
3 Tall grassland with a tree synusia covering 10-40%	VA1	.003	95	1
3 Tall grassland with a tree synusia covering less than 10%	VA2	.003	95	1
3 Tall grassland with a synusia of shrubs	VA3	.003	95	1
3 Tall grassland with a woody synusia, mainly of tuft plants	VA4	.003	95	1
3 Tall grassland, practically without woody synusia	VA5	.003	95	1
2 Medium tall grassland (0.5-2m; forb coverage <50%)	VB	.003	95	1
3 Medium tall grassland with a tree synusia covering 10-40%	VB1	.003	95	1
3 Medium tall grassland with a tree synusia covering less than 10%	VB2	.003	95	1

Table 6 Example of EROCONT.TAB file

* Example of file EROCONT.TAB	ref to PTAB.CNT/FMANMOD.CNT
1 No erosion control	0
1 Strip cropping	1
1 Contouring	2
1 Terracing	3

Table 7 Example of EROCAT.TAB file

* Example of file EROCAT.TAB	
1 No erosion control	0
1 Broad based terraces	2

Table 8 Example of RESIDC.TAB file

* Example of File RESIDC.TAB.	reduct	I
1 Stubble burnt	.0	1
1 Stubble ploughed in	.40	1
1 Stubble on surface as mulch (minimum tillage)	.70	1
1 Direct drilling (no tillage)	1.0	1

Table 9 Example of FTAB.CNT file

```
{                 Texture of toplayer                                                                         }
{                 ___________________                                                                         }
{                                                                                                             }
1      S    LS    SL    SIL   SI    L     SCL   CL    SICL  SC    SIC   C     Drain  Sal   Lit    Abr   Cap
{ ___________________________________________________________________________________________________________ }
2 AD   6.0  0.0   0.0   0.0   0.0   0.0   5.0   4.5   4.0   5.5   4.5   5.0   -1.00  -0.5  -1.00  -0.5  -0.5
2 AN   6.0  0.0   4.5   0.0   0.0   0.0   5.0   4.5   4.0   5.5   4.5   5.0   -1.00  -0.5  -1.00  -0.5  -0.5
2 CA   6.0  0.0   4.5   0.0   0.0   0.0   5.0   4.5   4.0   5.5   4.5   5.0   -1.00  -0.5  -1.00  -0.5  -0.5
2 CB   6.0  0.0   4.5   0.0   0.0   0.0   5.0   4.5   4.0   5.5   4.5   5.0   -1.0   -0.5  -1.0   -0.5  -1.0
2 CH   6.0  0.0   4.0   0.0   0.0   0.0   4.5   4.0   3.5   5.0   4.0   4.5   -1.0   -0.5  -1.0   -0.5  -1.0
2 FA   6.0  0.0   5.5   0.0   0.0   0.0   6.0   6.0   5.0   6.5   5.5   6.5   -2.0   -0.5  -1.0   -0.5  -1.0
2 FL   6.0  0.0   4.0   3.0   0.0   0.0   4.5   4.0   3.5   5.0   4.0   4.5    0.0   -0.5  -1.0   -0.5  -0.5
2 GL   6.0  0.0   4.5   3.5   0.0   0.0   5.0   4.5   4.0   5.5   4.5   5.0    0.0   -0.5  -1.0   -0.5  -0.5
2 GY   6.0  0.0   4.5   3.5   0.0   0.0   5.0   4.5   4.0   5.5   4.5   5.0    1.0   -0.5  -1.0   -0.5  -0.5
2 LI   6.0  0.0   4.5   9.0   0.0   0.0   5.5   6.0   4.5   6.0   5.0   6.5   -0.5   -0.5  -1.0   -0.5  -1.0
2 LU   6.0  0.0   4.5   0.0   0.0   5.0   5.0   4.5   4.0   5.5   4.5   5.0   -0.5   -0.5  -1.0   -0.5  -1.0
2 MO   6.0  0.0   4.5   0.0   0.0   5.0   5.0   4.5   4.0   5.5   4.5   5.0   -1.0   -0.5  -1.0   -0.5  -1.0
2 NI   6.0  0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   6.0   5.5   6.5   -1.05  -0.5  -1.0   -0.5  -1.0
2 OR   7.0  7.0   7.0   7.0   7.0   7.0   7.0   7.0   7.0   7.0   7.0   7.0    0.0   -0.5  -1.0   -0.5  -1.05
2 PO   6.0  5.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0    0.0   -0.5  -1.0   -1.0  -1.0
2 PR   6.0  0.0   4.0   3.0   0.0   0.0   4.5   4.0   3.5   5.0   4.0   4.5   -1.0   -0.5  -1.0   -0.5  -1.0
2 SA   4.0  2.5   3.0   2.0   2.0   3.0   3.0   3.0   2.5   3.0   2.5   3.0   -0.5    0.0  -1.0   -0.5   0.0
2 SO   3.5  2.0   2.5   1.5   1.5   2.5   2.5   2.5   2.0   2.5   2.0   2.5   -0.5    0.0  -1.0   -0.5   0.0
2 ST   6.0  0.0   4.0   0.0   0.0   0.0   4.5   4.0   3.5   5.0   4.0   4.5    0.0   -0.5  -1.0   -0.5  -0.5
2 VE   6.0  0.0   0.0   0.0   0.0   0.0   5.0   4.5   4.0   5.5   4.5   5.0   -0.5   -0.5  -1.0   -0.5  -0.5

{ Sources: Kassam et al., 1991, Stocking et al., 1988. Modified.                                              }
{ Data of Kassam et al., were as USLE K-factors. Extra texture-class * Soil development                       }
{ combinations were added by interpolation or extrapolation.                                                  }
{ 0.0 represents a missing value                                                                              }

{ AD: Andic        AN: Anthric     CA: Calcic      CB: Cambic      CH: Chernic                                }
{ FA: Ferrallic    FL: Fluvic      GL: Gleyic      GY: Gypsic      LI: Lixic                                  }
{ LU: Luvic        MO: Modic       NI: Nitic       OR: Organic     PO: Podzic                                 }
{ PR: Primic       SA: Salic       SO: Sodic       ST: Stagnic     VE: Vertic                                 }
```

Table 10 Example of FMANMOD.CNT file

```
{  Slope      Contouring       Contouring and      Terracing                     }
{  range                       strip cropping                                    }
{  ------------------------------------------------------------------            }
1             1                2                   3
2   0         0.0              0.0                 0.0
2   2         0.5              1.0                 1.5
2   8         0.5              1.0                 1.5
2  12         0.5              1.0                 1.5
2  16         0.5              0.8                 1.2
2  20         0.2              0.8                 1.2
2  25         0.2              0.8                 1.2

{  Table relating modifier to be summed with SLEMSA's F factor to land          }
{  slope percentage and type of erosion control measure. Values for             }
{  terracing refer to off-field sediment load.                                  }
```

Table 11 Example of IDRAIN.CNT file

```
{       DRAI     PERM                                                           }
{ -----------------                                                             }
1                 1
2         E       1
2         S       2
2         W       3
2         M       3.5
2         I       4
2         P       5
2         V       6
{ Relation between SOTER code for internal drainage (IDRN) and                  }
{ USLE Permeability factor. Source: Shields & Coote, 1989.                      }
```

Table 12 Example of PTAB.CNT file

```
{  Slope      Contouring       Contouring and      Terracing                    }
{  range                       strip cropping                                   }
1             1                2                   3
2   0         1.00             1.00                1.00
2   2         0.60             0.30                0.12
2   8         0.50             0.25                0.10
2  12         0.60             0.30                0.12
2  16         0.70             0.35                0.14
2  20         0.80             0.40                0.16
2  25         0.90             0.45                0.18
{  Table relating erosion control practice factor P to land slope               }
{  percentage and type of erosion control measure. Values for                   }
{  terracing refer to off-field sediment load.                                  }
{  Source: Wischmeier & Smith, 1978                                             }
```

Table 13 Example of STRUCT.CNT file

```
{                    <---------------- Structure form -------------------->  }
{                          pris- colum ang.  sub.  gran        mass- singl wedge}
{                    platy matic nar   block block ular crumb  ive   grain shape}
1                      P     R     C     A     S     G     B     M     N     W
{ -------------------------------------------------------------------------------}
2                N     0     0     0     0     0     0     0     5     1     0
{ Very fine: V   }
2                VW    4     2     5     2     1     2     2     0     0     4
2                VM    5     3     5     3     2     2     2     0     0     4
2                VS    5     4     5     4     3     3     3     0     0     4
{ Fine: F        }
2                FW    4     3     5     2     1     2     2     0     0     4
2                FM    5     4     5     3     2     2     2     0     0     4
2                FS    5     5     5     4     3     3     3     0     0     4
{ Medium: M      }
2                MW    4     3     5     2     1     2     2     0     0     4
2                MM    5     4     5     3     2     2     2     0     0     4
2                MS    5     5     5     4     3     3     3     0     0     4
{ Coarse: C      }
2                CW    4     4     5     3     2     2     0     0     0     4
2                CM    5     5     5     4     3     2     0     0     0     4
2                CS    5     5     5     5     4     3     0     0     0     4
{ Very coarse: X }
2                XW    4     4     5     3     2     2     0     0     0     4
2                XM    5     5     5     4     3     2     0     0     0     4
2                XS    5     5     5     5     4     3     0     0     0     4
{ Relation between structure form,size and grade as described according to SOTER }
{ manual and structure rate for USLE model (source: modified from Shields &       }
{ Coote, 1989)                                                                    }
```

Table 14 Example of INTRCPT.CNT file

```
{ Example of file INTRCPT.CNT                                                                   }
1        1      2     3     4     5     6       7     8      9     10     11      12
2    0   1.000  1.00  1.00  1.00  1.00  -1      1.00  1.000  1.00  0.066  0.0066  0.0040
2   10   0.550  0.97  0.95  0.93  0.92  -1      1.00  0.550  0.52  0.063  0.0063  0.0038
2   20   0.300  0.95  0.90  0.86  0.83  0.0090  1.00  0.300  0.50  0.060  0.0060  0.0036
2   30   0.170  0.92  0.85  0.79  0.75  0.0060  1.00  0.170  0.47  0.057  0.0057  0.0034
2   40   0.090  0.89  0.80  0.72  0.66  0.0040  0.86  0.090  0.44  0.053  0.0053  0.0032
2   50   0.050  0.87  0.75  0.65  0.58  0.0030  0.72  0.060  0.41  0.050  0.0050  0.0030
2   60   0.027  0.84  0.70  0.58  0.50  0.0020  0.58  0.056  0.39  0.047  0.0047  0.0028
2   70   0.015  0.81  0.65  0.51  0.41  0.0010  0.44  0.053  0.36  0.043  0.0043  0.0026
2   80   0.008  0.78  0.60  0.44  0.33  0.0005  0.30  0.050  0.33  0.040  0.0040  0.0024
2   90   0.005  0.76  0.55  0.37  0.24  0.0002  0.16  0.047  0.30  0.037  0.0037  0.0022
2  100   0.002  0.73  0.50  0.30  0.16  0.0001  0.02  0.043  0.28  0.033  0.0033  0.0020

{  1: Pasture, low perennials, mulch                                                            }
{  2: Trees, 4m height; no undergrowth or litter                                                }
{  3: Trees, 2m height; no undergrowth or litter                                                }
{  4: shrubs, 1m height; no undergrowth or litter                                               }
{  5: shrubs, .5m height; no undergrowth or litter                                              }
{  6: humid forest with >50mm litter                                                            }
{  7: annual crops according to Kassam et al. (1991);                                           }
{  8: annual crops according to Stocking et al. (1988)                                          }
{  9: 1-2m trees and 10% of area covered with litter or undergrowth                             }
{ 10: 4m trees and 50% of area covered with litter or undergrowth                               }
{ 11: 4m trees and 90% of area covered with litter or undergrowth;                              }
{ 12: 4m trees and 95% of area covered with litter or undergrowth;                              }
```

Table 15 Example of file CONSWEAP.CNF

```
1                          { Debug option; 0 = off, 1 .. 5 = screen output     }
1                          { Result layout; 1 .. 5                              }
4  0.0 20.0  0.0  0.0      { Method and regression coefts for SLEMSA E factor  }
   0.0  1.0  0.0  0.0      { Regression coefficients for SLEMSA's snowfall (R) }
2  0.0  5.0  0.0  0.0      { Method and regression coefts for USLE R factor    }
   0.0  1.0  0.0  0.0      { Regression coeficients for USLE's snowfall (R)    }
P                          { Pot. evapotranspiration. P=Penman, T=Thornthwaite }
0.29  0.45                 { A and B parameters of Prescott equation           }
10.0  2.0   0.6            { Critical monthly average mean temp, min temp and  }
                           { ratio EPa/EPp for crops                           }
0  0                       { Method to calculate C factor for SLEMSA / USLE    }
1                          { Look for IDRISI image: 0 = no; 1 = yes            }
6                          { Number of classes (0 = do not classify)           }
0 2 5 20 100 300           { 5 classes: <0; 0-5; 5-25; 25-100; 100-300; 300+   }
- A B C D E F              { One-character class codes                         }
```

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