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Guidelines for the Assessment of Human-Induced Soil Degradation in Central and Eastern Europe (SOVEUR Project)

G.W.J. van Lynden

(Draft for discussion)

Report 97/08

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Correct citation:

Van Lynden, G.W.J., 1997. *Guidelines for the Assessment of Human-Induced Soil Degradation in Central and Eastern Europe (SOVEUR Project).* Report 97/08, International Soil Reference and Information Centre, Wageningen.

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ACKNOWLEDGEMENTS

These guidelines form part of the project on Mapping of Soil and Terrain Vulnerability in Central and Eastern Europe (SOVEUR), which is being coordinated by ISRIC within the framework of the Food and Agriculture Organization (FAO) and Netherlands Government Cooperative Programme (GCP/RER/007/NET). The guidelines have been prepared on the basis of the Guidelines for General Assessment of the Status of Human-Induced Soil Degradation (Oldeman, 1988) and the Explanatory Note to the World map of the Status of Human-Induced Soil Degradation (GLASOD, Oldeman et al., 1991), as well as the adapted Guidelines used for the Assessment of the Status of Human-Induced Soil Degradation in South and Southeast Asia (van Lynden, 1995b). At ISRIC, Ms. J. Resink was responsible for GIS operations and printing of the maps and P. Tempel for the development of the data entry programme.

1 INTRODUCTION

A two year project on Mapping of Soil and Terrain Vulnerability in Central and Eastern Europe (SOVEUR) was signed between the Food and Agriculture Organization of the United Nations (FAO) and the Government of The Netherlands, within the framework of the FAO/Netherlands Government Cooperative Programme. The project is being implemented by FAO in cooperation with the International Soil Reference and Information Centre (ISRIC) under a sub-contract. The project calls for the development of an environmental information system for the region in close collaboration with soil survey institutes in Belarus, Bulgaria, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Moldova, Poland, Romania, the Russian Federation, Slovak Republic and the Ukraine. Using this system and auxiliary information on climate, land use and the type of soil pollution, the status of human-induced soil degradation and the areas considered vulnerable to defined pollution scenarios will be identified and mapped (scale 1:2.5 million).

Target beneficiaries are Ministries and planning bodies in the collaborating countries who can use the databases and derived maps for policy formulation at the regional and national level, for instance by identifying areas considered most at risk. The project also contributes to strengthening of the capabilities of national "environmental" organizations in Central and Eastern Europe.

The SOVEUR project activities include:

(1) Refinement of methodological guidelines for the compilation of a soils and terrain digital database for the 13 participating countries (Van Engelen and Wen, 1995; Batjes and Van Engelen, 1997).

(2) Refinement of methodological guidelines for assessment of the status of human-induced land degradation, with special focus on soil pollution status (this report)

(3) Development of methodological guidelines for assessment of the vulnerability of soils to selected categories of pollutants (Batjes, 1997).

(4) Application of the methodological guidelines, by country, in order to create georeferenced databases on:
- soil and terrain units;
- soil degradation and pollution status;

which will subsequently be used, in combination with auxiliary data sources, to:
- assess relative soil vulnerability;
- determine areas considered at risk from re-mobilization of specific contaminants.

As a part of the SOVEUR project, the assessment of human-induced soil degradation in Central and Eastern Europe at a scale of 1:2.5 M aims to produce a geographical overview of the current status of soil degradation in this region, with specific emphasis on soil pollution. In a revision of the European part of the Global Assessment of Human-Induced Soil Degradation (van Lynden, 1995a), pollution in Europe was estimated to cover a total of 18.8M ha, or 72% of all chemical deterioration in Europe. This was mainly referring to pollution by atmospheric deposition without distinguishing between the various types of pollution, their sources, pathways and different impacts. The criteria applied were qualitative and open to subjective judgment. The required background data for the studied period (about 1960-1985) were not always readily available, especially in the former East Bloc countries.

At the scale of the current assessment, it is still difficult to provide quantitative criteria, in particular for soil pollution, in view of the enormous variety not only in pollution types and impacts, but also in the criteria, in so far as they do exist. In the current guidelines the criteria for the assessment of pollution follow as much as possible the standards used earlier for the other types of degradation, but separate classes have been defined for the degree and the impact of pollution.

Like the previous assessments of soil degradation at a global (GLASOD, 1:10M) and regional (ASSOD, 1:5M) scale, the Assessment of Human-Induced Soil Degradation in Central and Eastern Europe will serve as a means to increase awareness on soil degradation matters and in this case on the status of pollution in particular. In view of the scale and the estimated available data, this inventory is, like GLASOD, based on experts' estimates. As such it will give an overall idea of the status of degradation in the region and identify priority areas ("hot spots"). Together with the soil and terrain data to be collected and the soil vulnerability assessment, the information on the status of human-induced soil degradation will facilitate the identification of specific areas at risk ("hot spots") from soil pollution. For these areas more detailed studies are then required to determine the course of action.

2 CONCEPTS AND DEFINITIONS OF SOIL DEGRADATION

2.1 Land use

Soil degradation and soil quality are related to the use (or non-use, e.g. natural areas) of the land by man. For example, a soil with low quality (or *suitability*) for annual cropping may be quite suitable for construction activities. It is thus important to indicate the type of land use under which the degradation occurs. However, changes in land use may sometimes also cause degradation, for example conversion of natural forest into cropland. Where important recent changes in land use have occurred, this should be indicated!

2.1.1 Land use type

Land use type (LUT) is defined as (van Engelen and Wen, 1995): "the type of human activities which are directly related to land, making use of its resources or having an impact upon it", broadly categorized into cropland, grazing land, forest land, mixed land and other land. The following major *Land Use Types* (and subtypes) are recognized:

C: Cropland: land used for cultivation of crops, including fallow (field crops, orchards), for instance:
Annual field cropping: Land under temporary /annual crops harvested within one year (eg maize, rice, wheat, vegetables).
Perennial field cropping: Land under perennial crops. Crops harvested more than one year after planting.
Tree and shrub cropping: producing several crops (eg fruit trees).

G: Grazing land: Land used for animal production, e.g.:
Extensive grazing land: grazing on natural or semi-natural grasslands, grasslands with trees/shrubs or open woodlands, (for livestock and wildlife):
Intensive grazing land: grass production on improved or planted pastures, including cutting for fodder materials (for livestock production).

F: Forests/woodlands: land used mainly for wood production, other forest products, recreation, protection.

M: Mixed: mixture of land use types within the same land unit: Agroforestry (trees and crops), Agro-pastoralism (crops and livestock), Agro-silvo-pastoralism (crops, trees and livestock).

O: Other: recreation, road sites, construction sites, etc...

2.1.2 Land use area

Land use area is the area (either contiguous or not) within a polygon under a given land use type. These will not be mapped separately, but the relative area for each LUT should be assessed as a percentage (rounded to the nearest 5 %) of the entire GLASOD unit. Hence the total for each polygon must be 100%!

2.2 Soil degradation

Soil degradation, as defined for the GLASOD map, is "a process that describes human-induced phenomena which lower the current and/or future capacity of the soil to support human life" (Oldeman et al., 1991). This definition of soil degradation is rather broad and requires some further refinement. In a general sense soil degradation could be described as the deterioration of soil quality, or in other words: the partial or entire loss of one or more functions of the soil (see Blum, 1988). Quality should be assessed in terms of the different potential *functions* of the soil. Three functions can be distinguished that are mainly ecological, and three functions that are more related to human activities (Council of Europe, 1990):

Ecological functions:
- *Biomass production* (nutrient, air and water supply, root support for plants), providing food, (renewable) energy, raw materials and natural features (e.g. forests provide an important habitat for many species).
- *Filtering, buffering, storage and transforming functions*. For instance buffering and storage of (rain)water, filtering, buffering and retention of pollutants.
- *Biological habitat and gene reserve*: fauna and flora in the soil are not always as apparent and spectacular as life on top of it but they are certainly rich and also indispensable for the "surface" species.

Human activity related functions:
- *Physical medium*: the soil functions as a spatial base for technical and industrial structures and socio-economic activities: buildings, roads and railways, sports fields, recreation areas, waste dumps and deposits, etc.
- *Source of raw materials*: e.g. water, gravel, sand, minerals.
- *Geogenic and cultural heritage*: soils form part of the landscape and thus hold important geological and geomorphological information. They also preserve historical information in the form of palaeontological and archaeological materials.

Soil degradation results from the competition between the aforementioned soil functions, but the excessive use of a single soil function may also be to the detriment of the others *(13)*.

A clear distinction should be made between soil degradation *status*, *rate* and *risk* (Sanders, 1994). Soil degradation *status* reflects the **current** situation while the *rate* indicates the relative decrease or increase of degradation over the last 5 to 10 years (leading to the current status). Although the rate of degradation, as indicated on the status map, also gives an indication of the danger of **further** deterioration, it does not include areas that are now apparently stable but that may be at risk of considerable degradation if for instance land use change. The degradation *risk,* defined in the broadest sense depends on several soil and terrain properties that make a soil inherently prone to soil degradation, for example as a result of a change in external conditions (climate, land use). Within the SOVEUR context, *soil vulnerability* is defined in a somewhat narrower sense with respect to pollution (see Batjes, 1997).

The emphasis in the GLASOD assessment was on degradation related to (food) productivity but the degree of degradation was mainly estimated on the basis of the intensity of the process (in particular for water and wind erosion, nutrient decline and salinization). In the Assessment of the Current Status of Human Induced Soil Degradation for S. and SE. Asia

(ASSOD), degradation was evaluated on the basis of its impact on productivity. This is rather straightforward for degradation types like erosion, compaction or fertility decline, but becomes more complicated with pollution where the main impact often is on other aspects than productivity, e.g. quality decline. For the SOVEUR project, the status of degradation will be evaluated both in terms of the intensity of the process (degree) as well as the impact of degradation on various soil functions (in qualitative terms, as for instance impact on productivity cannot be compared with impact on human health).

2.2.1 Types of soil degradation

The type of soil degradation refers to the degradation process (displacement of soil material by water and wind; in-situ deterioration by physical, chemical and biological processes). *Only degradation as a result of human activities is to be considered!* Types of soil degradation are represented in the database by a two- or three-letter code, the first capital letter giving the major degradation type, the second lowercase letter giving the subtype. A third *lowercase* letter can be used for further specification. Most of the codes are the same as the ones used on the GLASOD map, but some extra ones have been added, and for others the definition has been changed slightly. In the context of the SOVEUR project, pollution has been treated as a separate degradation type and the assessment criteria for pollution have been modified accordingly.

2.2.1.1 Pollution

Soil pollution may occur from a wide range of human activities and can be either from local (point) sources or widely dispersed from diffuse sources. Pollution may affect the soil via different "pathways", namely through the air, over land or by water. The total “accumulated load” may thus emanate from various sources and different pathways.

For the SOVEUR degradation assessment, five main types of soil pollution as identified in the Dobris report on Europe’s Environment (EEA,1995) are distinguished:

- Soil acidification **(Cpa)**
- Soil pollution by heavy metals **(Cph)**
- Soil pollution by pesticides and other organic contaminants **(Cpp)**
- Soil pollution by nitrates and phosphorus **(Cpn)**
- Soil pollution by radionuclides **(Cpr)**

Since these are major groupings and subtypes differ significantly in their impact and behaviour, it is important to indicate specific element(s) involved, in particular for Cph and Cpp.

Cpa: Soil Acidification

Atmospheric deposition on the soil of industrial and traffic emissions of sulphur dioxide (SO_2) and nitrogen (hydr)oxides (NH_x , NO_x) may be many times higher than natural emission levels (Ulrich, 1987). When deposited in excessive quantities, these substances are major contributors to soil acidification and thus usually referred to as "acid rain". The exchangeable base cations (calcium, magnesium, potassium, sodium) in the soil are mobilized under influence of the acidic inputs and leached out to the groundwater. This constitutes a loss of some important plant nutrients. As the soil buffer capacity is depleted, the pH will start to drop and with increasing acidity, aluminium ions in the soil are mobilized. These are toxic to most plants and have harmful effects on aquatic environments.

Soil acidification is also caused by acidifying fertilisers, removal of base cations through over-exploitation (soil mining), planting of acidifying vegetation (e.g. fir), or drainage of wetland soils leading to pyrite formation.

Soil acidification can be measured through the aluminium (Al) concentration and the molar ratio of Al to the base cations (Al/BC ratio) in the soil solution. For both parameters so-called "critical values" have been derived (see Table 1). These values relate to the adverse effects of acidification on fine roots.

Table 1

Parameter	*Critical value*
Al concentration	0.2 mol_c /m^3
Al/BC ratio	1.0 mol/mol

Source:EEA, 1995

The following characteristics may affect the acidification of (forest) soils (Posch and Kauppi, 1991):

- increased deposition of acid or potentially acidifying compounds
- decreased deposition of acid-neutralizing compounds; increased primary productivity
- increased rates of nitrification or sulphur oxidation; changes in land use
- reduced decomposition rate of litter and soil organic matter
- increased production and vertical transport in the soil of organic acids
- removal of cations (increased biomass production, low biomass decomposition and harvesting as in intensified forestry in N. Europe may lower the buffer capacity of the soil and so cause acidification).

Acidification may not only release important plant nutrients that are subsequently leached from the soil, but also mobilize heavy metals that were accumulated and bound in the soil under higher pH conditions.

Cph: Soil pollution by heavy metals

Soil pollution with heavy metals, e.g. cadmium, lead,chromium or copper, may emanate from various sources, such as industry, agriculture, incineration of waste and burning of fossil fuels and road traffic (EEA, 1995). Moreover, atmospheric transport may contribute considerably (in natural areas almost entirely, except where geochemical background levels are already high) to the heavy metal load in the soil. Most heavy metals tend to accumulate in soils of higher pH where they are less mobile than in acid soils. Consequently, lowering the pH will trigger a mobilization of the accumulated heavy metals, a phenomenon referred to as "chemical time bomb" (Stigliani, 1991, Batjes and Bridges, 1991, Batjes, 1997 *in prep.*). Some toxic metals will accumulate mainly in the surface layers due to their low mobility, but others may be leached lower in the soil profile. Heavy metals pose a threat to plant growth and (through the food chain) to animal and human health. Plant uptake of heavy metals is determined by factors as soil pH, texture, organic matter content and the metal concentration (EEA, 1995)

Cpp: Soil pollution by pesticides and other organic contaminants

The use of biocides (pesticides, herbicides, fungicides) and other agrochemicals in Europe is the highest worldwide (RIVM, 1992). After their application various processes modify the properties of the substances, such as degradation, sorption, plant uptake and transport (RIVM, 1992). Biocides and other organic contaminants (PCB's, PAH's, oil, tars, dioxins) have a direct negative impact on soil flora and fauna and reduce the organic matter contents of the soil (especially in the case of herbicides). Crop yields can be severely affected by residual herbicides. Deleterious effects on animal and human health may occur through the pollution of ground and surface water. In particular the slowly degradable (persistent) substances or, conversely, those that are very mobile, are likely to give problems.

The humus layer of forest soils is an important sink for PAH (polycyclic aromatic hydrocarbons). A concentration of pollutants tends to take place in the topsoil where most soil organisms live and so the pollutants may enter the food chain *(86)*. As the surface layer is also the first to be removed by erosion, it means that the transported sediment and the transporting water can be enriched in pollutants.

Cpn: Soil pollution by nitrates and phosphorus

A special type of pollution is the occurrence of excessive nutrient loads through over-application of phosphorus and nitrogen, which may lead to eutrophication of ground- and surface waters. Both elements are essential for plant growth, but can become damaging when applied in quantities that do not exceed plant requirements. The excess may be leached from the soil, eroded or simply washed off the land into the groundwater, waterways and coastal systems. The major source of nitrates is agriculture, while sewage and manure application contribute to phosporus loads. Besides direct application of phosphorus and nitrogen, atmospheric deposition emanating from decomposing manure-slurry or from intensive animal husbandry in sheds may contribute significantly to the total accumulated load (EEA, 1995). Phosphorus is rather strongly fixed in the soil and therefore first causes problems on poor sandy soils with a low adsorption capacity and high permeability.

Cpr: Soil pollution by radionuclides

Since the Chernobyl accident (1986) concern on radioactive pollution has increased. Radioactive elements occur naturally in the soil but since World War II anthropogenic additions from fall-out of nuclear bombs testing and /or spillage from nuclear power plants or waste dumps have begun to become increasingly important (van Lynden, 1995a). The most important radionuclides are Caesium (Cs^{137}) and Strontium (Sn^{90}), which have long half-lives and are strongly bound in the upper soil layers. These layers are the most prone to radioactive pollution, as most soil flora and fauna is found in these layers.

2.2.1.2 Other types of degradation

Other types of degradation not only pose environmental threats by themselves, but may also act as a trigger for sudden delayed occurrences of pollution (chemical time bombs, see above). Moreover, they often do not occur in isolation, but may enhance each other. Where more than one type or subtype of degradation is identified for a given land use type, overlaps or "associations" may exist between the different (sub)types. These should be indicated separately, e.g. Wt/Cn or Pa/Ed/Cs. This is particularly important with regard to area calculations (see below). Unless specifically stated otherwise the degree, impact, causative factor and rate for associations will be assumed to reflect the composing degradation types, so the average values for degree and rate will be taken, while the data for impact and causative factors respectively will be combined.

Water erosion

Wt *Definition:* loss of topsoil by sheet erosion/surface wash
Description: a decrease in depth of the topsoil layer (A horizon) due to more or less uniform removal of soil material by runoff water
Possible causes: inappropriate land management especially in agriculture (insufficient soil cover, unobstructed flow of runoff water, weak soil structure), leading to excessive surface runoff and sediment transport

Wd *Definition:* "terrain deformation" by gully and/or rill erosion or mass movements
Description: an irregular displacement of soil material (by linear erosion or mass movements) causing clearly visible scars in the terrain
Possible causes: inappropriate land management in agriculture, forestry or construction activities, allowing excessive amounts of runoff water to concentrate and flow unobstructed

Wo *Definition:* off-site effects of water erosion in upstream areas
Description: Three subtypes may be distinguished:
- Wos: sedimentation of reservoirs and waterways
- Wof: flooding
- Wop: pollution of water bodies with eroded sediments

Possible causes: see Wt and Wd

Wind erosion

Et *Definition:* loss of topsoil by wind action
Description: a decrease in depth of the topsoil layer (A horizon) due to more or less uniform removal of soil material by wind action
Possible causes: insufficient protection by vegetation (or otherwise) of the soil against the wind, insufficient soil moisture, destruction of soil structure

Ed *Definition:* "terrain deformation"
Description: an irregular displacement of soil material by wind action, causing deflation hollows, hummocks and dunes
Possible causes: as with Et

Eo *Definition:* off site effects of wind erosion
Description: covering of the terrain with wind borne sand particles from distant sources ("overblowing")
Possible causes: see Et and Ed

Chemical deterioration (other than pollution)

Cn *Definition:* Fertility decline and reduced organic matter content
Description: a net decrease of available nutrients and organic matter in the soil
Possible causes: a negative balance between output (through harvesting, burning, leaching, etc.) and input (through manure/fertilizers, returned crop residues, flooding) of nutrients and organic matter

Cs *Definition:* salinization/alkalinization

Description: a net increase of the salt content of the (top)soil leading to a productivity decline. Two subtypes may be distinguished:
- Csi: inland salinization
- Css: intrusion of seawater (which may occur under all climate conditions)

Possible causes: improper irrigation methods and/or evaporation of saline groundwater (Csi), groundwater extraction (Css)

Physical deterioration

Pa *Definition:* aridification
Description: decrease of soil moisture
Possible causes: lowering of groundwater tables for agricultural purposes or drinking water extraction; decreased soil cover and organic matter content; climate change.

Pc *Definition:* compaction
Description: deterioration of soil structure by trampling or the weight and/or frequent use of machinery
Possible causes: repeated use of heavy machinery, having a cumulative effect. Heavy grazing and overstocking may lead to compaction as well. Factors that influence compaction are ground pressure (by axle/wheel loads of the machinery used); frequency of the passage of heavy machinery; soil texture; climate; soil moisture.

Pk *Definition:* sealing and crusting
Description: clogging of pores with fine soil material and development of a thin impervious layer at the soil surface obstructing the infiltration of rainwater
Possible causes: poor soil cover, allowing a maximum "splash" effect of raindrops; destruction of soil structure and low organic matter.

Ps *Definition:* lowering of the soil surface
Description: subsidence of organic soils, settling of soil
Possible causes: oxidation of peat and settling of soils in general due to lowering of the water table (see also Pa); solution of gypsum in the sub-soil or lowering of soil surface due to extraction of gas/water

Pu *Definition:* Urban/industrial land conversion
Description: soil (land) being taken out of production for non-bio-productive activities, but *not* the eventual "secondary" degrading effects of these activities.
Possible causes: urbanization and industrial activities; infrastructure; mining; quarrying, etc.

Pw *Definition:* waterlogging
Description: effects of human induced hydromorphism
Possible causes: rising water table (e.g. due to construction of reservoirs/ irrigation) and/or increased flooding caused by higher peakflows.

Land without human-induced degradation

Sn Stable under natural conditions; i.e. (near) absence of human influence on soil stability, and largely undisturbed vegetation. NB: some of these areas may nevertheless be vulnerable to even small changes in conditions which may disturb the natural equilibrium.

Sh Stable under human influence; this influence may be passive, i.e. no special measures had or have to be taken to maintain stability, or active: measures have been taken to prevent or reverse degradation.

W "Wasteland": land without appreciable vegetation and with (near) absence of human influence on soil stability, e.g. deserts, high mountain zones. Natural soil degradation processes may occur!

2.2.2 Soil degradation extent

At the working scale of 1:2.5M, it is not possible to map separate areas of soil degradation within a given polygon. Therefore, the extent of soil degradation refers to the percentage of the land use area within a polygon, affected by a given type of degradation. Often different types of degradation will overlap (for the same land use area) and in some cases even enhance each other. Where such associations occur, the extent of the composite area must be indicated as a percentage of the entire land use area. For example: on the cropland in a given polygon Wt alone covers 30%, Cn alone covers 20%, while an additional 15% is covered by the association Wt/Cn (hence total Wt for that LUT is 45% and total Cn is 35%, but needs not be indicated). *NB: in case of 100% overlap of two(or more) types, the extent of the individual types is 0%, but all other attribute data should be given as applicable (see example in Annex IV).*

Furthermore, each polygon which does not show a 100% extent for degradation must by definition have some stable and/or wasteland. Clearly, overlaps do not occur here. The total percentage of all single degradation types plus associations plus stable/wasteland should thus be 100% for each land use type! Hence in the above example: Wt: 30%, Cn: 20%, Wt/Cn 15%, and Sn (or Sh, W, as appropriate) for the remaining 35%.

In the case of pollution, localized problems may exist (waste dumps, spillage). This may be indicated with the letter "*l*" instead of a percentage, while the location can be specified by giving coordinates under Remarks.

2.2.3 Degree and impact of degradation

The **degree** of soil degradation is defined here as the intensity of the process, e.g. in the case of erosion: the amount of soil washed or blown away. Relative changes of the soil properties are good indicators of soil degradation: the percentage of the total topsoil lost, the percentage of total nutrients and organic matter lost, the relative decrease in soil moisture holding capacity, changes in buffering capacity, etc. However, while such data may exist for experimental plots and pilot study areas, precise and actual information is probably lacking at a regional scale. The criteria for the assessment of pollution differ from the criteria for other degradation types and will be treated in a separate paragraph.

The **impact** of soil degradation refers to the effects of degradation on the various soil functions. Changes in soil and terrain properties (e.g. loss of topsoil, development of rills and gullies, exposure of hardpans in the case of erosion) may reflect the occurrence and intensity of soil degradation but not necessarily the seriousness of its impact. Removal of a 5 cm layer of topsoil has a greater impact on a poor shallow soil than on a deep fertile soil. Moreover, as pointed out earlier, the impact is depending on the function/use of the soil: a heavily compacted soil is unsuitable for agriculture, but an appropriate basis for road construction. Again, criteria to assess the impact of pollution will be treated separately.

2.2.3.1 Degree of pollution

One problem in assessing the "degree" of pollution is the wide variety of criteria used by different countries for various pollutants. There is no single standard for the level of all types of pollution, nor even for specific subtypes of pollution (van Lynden, 1995a; Visser,1993). This is because different soils and biota react in different ways to various pollutants. Whereas a sandy soil an be relatively unaffected by one pollution type compared to a clayey soil, this can be the opposite for another polluting substance. When assessing degradation or deterioration, a reference base is required. In many cases a natural or undisturbed situation is not a realistic reference base, as only the developments in the past 25 years are considered. The level of pollution is often referred to natural or so-called background levels, which may differ greatly from one place to another. Many concepts refer to the perceived level of urgency for remedial action and are thus influenced by national policies and prioities. Moreover, the required data for these concepts lack in many cases (EEA, 1995), or, where they are available, may have been acquired through different measurement methods.

In this study, standards for the evaluation of the degree of pollution have been derived from the original Dutch "ABC"list, because of their general applicability. In the Netherlands three generic standard values were established to determine the course of action in case of suspected soil pollution, the so-called ABC list (see Table 2). The lower "A"value represents soils that are in a multi-functional and unpolluted state. Soils with contaminant levels below the A-value are considered clean. Soils with values between the A- and B-values are not "clean" in the absolute sense but do not require further action. If the B-value is exceeded, more research is necessary and some remediation measures may already need to be taken. If the investigations reveal that the C - or *intervention* - value is also exceeded, the soil in question requires clean-up measures, depending on site-specific circumstances. The values will be used in this context only in an indicative way, so *not* related to any kind of recommended action.

L Light: concentration of pollutant(s) between A and B value
M Moderate: concentration of pollutants between B and C value
S Strong: concentration of pollutants above C value

Table 2 Original standards adopted in the Netherlands for soil contaminants A, reference value; B, value above which there is need for further investigation; C, value above which a clean-up is indicated (Moen et al., 1987)

Substance	Concentration in soil (mg/kg dry weight)		
	A-value	B-value	C-value
Metals			
Cr	100	250	800
Co	20	50	300
Ni	50	100	500
Cu	50	100	500
Zn	200	500	3000
As	20	30	50
Mo	10	40	200
Cd	1	5	20
Sn	20	50	300

Ba	200	400	2000
Hg	0.5	2	10
Pb	50	150	600
Inorganic pollutants			
NH (as N)	-	-	-
F (total)	200	400	2000
CN (total free)	1	10	100
CN (total complete)	5	50	500
S (total)	2	20	200
Br (total)	20	50	300
PO (as P)	-	-	-
Aromatic compounds			
Benzene	0.01	0.5	5
Ethylbenzene	0.05	5	50
Toluene	0.05	3	30
Xylene	0.05	5	50
Phenols	0.02	1	10
Aromatics (total)	0.1	7	70
Polycyclic aromatic compounds (PCAs)			
Naphthalene	0.1	5	50
Anthracene	0.1	10	100
Phenanthrene	0.1	10	100
Fluoranthene	0.1	10	100
Pyrene	0.1	10	100
Benzo(a)pyrene	0.05	1	10
Total PCAs	1	20	200
Chlorinated organic compounds			
Aliphatic chlor.comp. (indiv.)	0.1	5	50
Aliphatic chlor.comp. (total)	0.1	7	70
Cholobenzenes (indiv.)	0.05	1	10
Cholobenzenes (total)	0.05	2	20
Chlorophenols (indiv.)	0.01	0.5	5
Chlorophenols (total)	0.01	1	10
Chlorinated PCA (total)	0.05	1	10
PCB (total)	0.05	1	10
EOCI (total)	0.1	8	80
Pesticides			
Organic chlorinated (indiv.)	0.1	0.5	5
Organic chlorinated (total)	0.1	1	10
Pesticides (total)	0.1	2	20
Other pollutants			
Tetrahydrofuran	0.1	4	40
Pyridine	0.1	2	20
Tetrahydrothiophene	0.1	5	50
Cyclohexanone	0.1	6	60
Styrene	0.1	5	50
Fuel	20	100	800
Mineral oil	100	1000	5000

2.2.3.2 Impact of pollution

Although degree and impact of pollution are more interrelated - and often less visible - than for other types of degradation, the *types* of impact of soil pollution may vary significantly more than for those other types. Pollution may (directly or indirectly) affect plant growth and hence crop yields, animal and human health, inanimate objects (foundations, pipelines, etc.)

and may threaten entire ecosystems. Therefore separate classes are distinguished for the impact of pollution, based on a) the main target of impact and b) the magnitude of impact .

a) Target classes

- **H**: direct impact on human health
- **F**: direct impact on animal health
- **P**: direct impact on plant growth and productivity
- **E**: direct impact on entire ecosystem/biodiversity
- **O**: other direct impacts (specify under "Remarks")
- **I**: indirect impacts, e.g. through pollution of ground- and surface water

b) Magnitude

- **0** No apparent impact ("contamination" rather than pollution)
- **1** Low impact: effects of pollution can be easily countered
- **2** Moderate impact: important effects of pollution, but restoration is possible
- **3** Strong impact: damage is serious and difficult to restore
- **4** Extreme impact: intense and irreversible damage

A single pollution type may have several impact targets and magnitudes, e.g. H2,P3, but these should only be indicated if applicable to the entire affected area.

2.2.3.3 Degree of other degradation types

For the assessment of the degree of other types of degradation (water and wind erosion, other chemical and physical deterioration) qualitative indicators are used, referring to the intensity of the degradadtion process.

- **L** Light: some indications of human-induced degradation are present, but the process is still in an initial phase. It can be easily stopped and damage repaired with minor efforts.
- **M** Moderate: degradation is apparent, but control and full remediation to its current function is still possible with considerable efforts.
- **S** Strong: evident signs of degradation. Changes in soil properties are significant and very difficult to restore within reasonable limits.
- **E** Extreme: degradation beyond restoration. The soil has lost one (or more) of its functions during the past 25 years.

2.2.3.4 Impact of other degradation types

While the degree of degradation mainly refers to the degradation *process*, the impact of degradation can be manifold, depending on the current function (or use) of the soil. In many cases the impact of degradation types - other than pollution - will be on its biotic functions, or more specifically on productivity. Models that describe relationships between soil degradation and decrease in productivity are still very rare and often not suited for large scale extrapolation. A significant complication in indicating productivity losses caused by soil degradation is the variety of reasons that may contribute to yield decline. Falling productivity may be caused by a wide range of factors like erosion, fertility decline, improper nymanagement, drought or waterlogging, quality of inputs (seeds, fertilizer), pests and plagues, etc., often in combination with one another. However, if one considers a medium to long term period (e.g. 25 years), large aberrations resulting from fluctuations in the weather pattern or pests should be levelled out.

Soil degradation can be partially hidden by the effects of various management measures such as soil conservation measures, improved varieties, fertilizers and pesticides. Part of these inputs is used to compensate for the productivity loss caused by soil degradation, for instance application of fertilizers to compensate for lost nutrients. In other words, yields could have been much higher in the absence of soil degradation (and/or costs could have been reduced). Therefore productivity changes should be seen in relation to the amount of inputs or level of management. The latter may include: use of fertilizers, biocides, improved varieties, mechanization, various soil conservation measures, and other important changes in the farming system. Three levels of management are distinguished (no qualitative judgment!):

High: Fully mechanized and/or modernized, high inputs
Medium: Partly mechanized, medium inputs, not entirely modernized
Low: Low level of mechanization and inputs, more "traditional" systems

An estimation of the magnitude can be made by considering the share of the total farm expenses. Table 3 is a simplified approximation for assessing the degradation impacts on productivity.

Changes in productivity are to be expressed in relative terms, i.e. the *current average productivity compared to the average productivity in the non-degraded situation (or non-improved, where applicable),* and in relation to inputs. For instance, if previously an average yield of 2 tonnes of wheat per hectare was attained while at present only 1.5 tonnes is realized in spite of high(er) inputs - and all other factors being equal -, this would be an indication of strong soil degradation. Sometimes the impact may be ranked as negligible, even when degradation occurs, because of the capacity of the soil to resist a certain amount of degradation, in other words thanks to its "buffer capacity" (see above).

Table 3: Impact of degradation: management level and productivity

Change in production level	**Level of Management**		
	A) High	*B) Medium*	*C) Low*
1) Large increase	Negligible	Negligible	Negligible
2) Small increase	Slight	Negligible	Negligible
3) No increase	Moderate	Slight	Negligible
4) Small decrease	Strong	Moderate	Slight
5) Large decrease	Extreme	Strong	Moderate
6) Unproductive	Extreme	Extreme	Strong to Extreme

A) High management level — Impact of degradation

A1 Large productivity increase . . . . Negligible
(improvements fully benefit yields and are not required for compensation of degradation impacts)

A2 Small productivity increase . . . . Slight
(improvements partly benefit yields and are partly required for compensation of degradation impacts)

A3 No productivity increase . . . . Moderate
(major improvements necessary to fully compensate degradation effects)
A4 Small productivity decrease . . . . Strong
(degradation impacts can only partly be compensated by major improvements)
A5 Large productivity decrease . . . . Extreme
(degradation impacts cannot even be compensated by major improvements)
A6 Unproductive . . . . Extreme
(highly unsustainable situation)

B) Medium management level
B1 Large productivity increase . . . . Negligible
(improvements have large impact on yields and are not required for compensation of degradation impacts)
B2 Small productivity increase . . . . Negligible
(improvements have moderate impact on yields and are hardly required for compensation of degradation impacts)
B3 No productivity increase . . . . Slight
(minor improvements do not directly benefit yields but suffice for compensation of degradation impacts)
B4 Small productivity decrease . . . . Moderate
(degradation impacts insufficiently compensated by improvements)
B5 Large productivity decrease . . . . Strong
(degradation impacts only slightly compensated by improvements)
B6 Unproductive . . . . Extreme
(highly unsustainable situation)

C) Low management level (e.g. "traditional" systems existing for more than 25 years)
C1 Small productivity increase . . . . Negligible[1]
C2 Large productivity increase . . . . Negligible[1]
C3 No productivity increase . . . . Negligible
(equilibrium between natural and man-induced factors, "sustainable" situation)
C4 Small productivity decrease . . . . Slight
(equilibrium has been slightly disturbed by external factors)
C5 Large productivity decrease . . . . Moderate
(equilibrium has been considerably disturbed by external factors)
C6 Very large productivity decrease to unproductive . . . . Strong to Extreme
(equilibrium has been highly disturbed by external factors, unsustainable situation)

2.2.4 Rate of soil degradation

The recent past rate of degradation indicates the rapidity of degradation over the past 5 to 10 years, or in other words, the *trend* of degradation. A severely degraded area may be quite stable at present (i.e. low rate, hence no trend towards further degradation) whereas other areas that are now only slightly degraded, may show a high rate, hence a trend towards rapid further deterioration. From a purely physical point of view, the latter area would have a higher conservation priority than the former. Areas where the situation is improving (through soil conservation measures, for instance) can also be identified.

1 These categories are not really applicable for this management level, as no major improvements are supposed to have occurred in the system over the last 25 years or so and productivity is not likely to increase spontaneously.

Three classes with a trend towards further deterioration (i.e. from a lower to a higher degree) and three with a trend towards decreasing degradation (i.e. from a higher to a lower degree, either as a result of human influence or by natural stabilization) have been defined, plus one class to indicate no changes in the degree of degradation.

- **- 3**: rapidly increasing degradation, (very negative trend)
- **-2**: moderately increasing degradation
- **-1**: slowly increasing degradation
- **0**: no change in degradation
- **1**: slowly decreasing degradation
- **2**: moderately decreasing degradation
- **3**: rapidly decreasing degradation (very positive trend)

A comparison of the actual situation with that of a decade earlier may suffice, but often it is preferable to examine the average development over the last 5 to 10 years to level out irregularities.

Whereas the degree of degradation in fact only indicates the current, **static** situation (measured by decreased or increased productivity compared to some 10 to 15 years ago) the *rate* indicates the **dynamic** situation of soil degradation, namely the **change in degree** over time.

2.2.5 Causative factors

Various types of human activities may lead to soil degradation. Some degradation processes may also occur naturally, such as erosion, but in this inventory (as with GLASOD) only those degradation types are considered that are the result of the human disturbance of either a natural or anthropogenic state of equilibrium. The GLASOD classification of causative factors is adopted. They are indicated with a single lower case character:

a: *Agricultural activities*: defined as the improper management of cultivated arable land. It includes a wide variety of practices, such as insufficient or excessive use of fertilizers, shortening of the fallow period in shifting cultivation, use of poor quality irrigation water, absence or bad maintenance of erosion control measures, untimely or too frequent use of heavy machinery, etc. Degradation types commonly linked to this causative factor are erosion (water or wind), compaction, loss of nutrients, salinisation, pollution (by pesticides, fertilizers).

f: *Deforestation and removal of natural vegetation*: defined as the near complete removal of natural vegetation (usually primary or secondary forest) from large stretches of land, for example by converting forest into agricultural land (frequently leading to causative factor “a”!), large scale commercial forestry, road construction, urban development, etc. Deforestation often causes erosion and loss of nutrients.

e: *Over-exploitation of vegetation for domestic use:* contrary to "deforestation and removal of natural vegetation", this causative factor does not necessarily involve the (near) complete removal of the "natural" vegetation, but rather a degeneration of the remaining vegetation, thus offering insufficient protection against erosion. It includes activities as excessive gathering of fuelwood, fodder, (local) timber, etc.

o: *Overgrazing*: besides actual overgrazing of the vegetation by livestock, other phenomena of excessive livestock amounts are also considered here, such as trampling. The effect of overgrazing usually is soil compaction and/or a decrease of plant cover, both of which may in turn give rise to water or wind erosion.

i *Industrial activities*: includes all human activities of a (bio)industrial nature: industries, power generation, infrastructure and urbanization, waste handling, traffic, etc. It is most often linked to pollution of different kinds (either point source or diffuse) and loss of productive function..

3 IMPLEMENTATION

To facilitate implementation of the degradation assessment are enclosed:

1) a set of maps, consisting of three coloured thematic physiographic maps (respectively: major landform, hypsometry and slopeclass) and a black-and-white map, showing only the polygon boundaries, with the corresponding polygon label numbers. The scale of the black-and-white maps may be larger than the scale of the coloured prints to facilitate corrections.
3) A printed (empty) matrix table, to manually enter degradation data for each polygon, using the guidelines in the preceding chapter. See example in Annex IV. Please make additional copies of the table as required.
4) A diskette (3½", high density) with a compressed (ZIP-)file containing a data-entry programme (SOVEUR.EXE) and the country database(s). This database contains the polygon label numbers (POLY_ID) corresponding to the polygons on the country map, and physiographic information for each polygon. This information needs to be checked, and degradation data to be added.

The maps, tables and data-entry programme enable changes to be made in the physiographic map where necessary and facilitate the input of degradation data into the database.

The databases are dBaseIV files. It is strongly recommended however, to use the SOVEUR.EXE data entry programme (which will run even without DBase) for adding and editing records, since this will eliminate possible errors and guide you through the database. The data entry programme and databases can be installed by typing ***A:INST_SOV***.

Please do not change the structure of the database! You cannot use codes different from the codes mentioned in these guidelines (the programme will not accept these).

In Chapter 2, a detailed description is given of degradation parameters to be entered in the database. This information should be given for each identified land use type within the polygons on the physiographic base map. The data can be entered manually on the matrix tables prior to input into the computerized database using the SOVEUR.EXE data entry programme (see Step 1-9 below). Please send the matrix tables to ISRIC with all information clearly written or printed, especially if you cannot use the computer programme for some reason. We would also like to receive, where applicable, a black-and-white map containing modifications (in red pencil) to the physiographic map.

The following steps are suggested:

<u>Step 1</u> Check the supplied **physiographic map** for errors and/or omissions. If you are content with the polygon delineations and the physiographic codes for each unit, go to Step 2. If you want to make corrections in the delineations and/or codes, please follow the instructions in Annex II.

<u>Step 2</u> Identify the major land use types within a delineated polygon and their relative distribution (area percentage, this should be 100% for each polygon). See Chapter 2.1. Important recent changes in land use should be indicated under "Remarks".

Step 3 — Determine for each land use type within a polygon the **type(s) of soil degradation** and/or stable types occurring within that land use area. Where two or more degradation types overlap spatially, this should be indicated as "asssociation". Definitions of soil degradation types are given in Chapter 2.2.1

Step 4 — Estimate the **relative extent** of each degradation type, association and/or stable type for every identified land use within the polygon, rounded to the nearest 5%. ***NB**: the sum of all degradation types, associations and stable/wasteland should be 100% for every land use type.* See Chapter 2.2.2 for more explanation.

Step 5 — Indicate for each degradation type the **degree and impact of degradation.** Please read Chapter 2.2.3 carefully for explanation and for options given. Degree an impact need not be given for associations (only for the individual components).

Step 6 — Determine the **rate** of each soil degradation process over the past 5 to 10 years, as explained in Chapter 2.2.4. For associations, the rate needs not to be entered (only for the individual components).

Step 7 — Indicate, for each degradation type, the dominant human activities that have **caused** it (see Chapter 2.2.5). No causative factor has to be given for associations (only for the individual components).

Step 8 — Enter the attributes of soil degradation into the database by using the SOVEUR data entry programme, following the instructions on the screen (see Annex III). The various definitions or descriptions as given in Chapter 2 can be consulted (in a concise format) during data entry with the SOVEUR programme by pressing <**F2**> ("Picklist"). If you want to use the SOVEUR programme (and your computer has the required capacities, see above) but you encounter problems to run it, please contact ISRIC as soon as possible. Meanwhile, data can be entered manually on the black-and-white prints and in the matrix tables. DO NOT FORGET TO COPY YOUR DATA BACK TO THE DISKETTE!

Step 9 — Prepare a brief report, accompanying your database and/or matrix tables, to be sent to ISRIC.

Please do not hesitate to contact us if you have any problems.

ANNEX I: Draft physiographic map of Central and Eastern Europe

A 1:2.5 M physiographic map of Central and Eastern Europe has been drafted using the SOTER methodology (Batjes and van Engelen, 1997). This physiographic map provides basic mapping units to be used for the soil degradation assessment at the same scale.

Soils and terrain are two closely linked natural phenomena which together determine to a large extent the suitability of land for different uses and its resilience to degradation. An integrated concept of land has been adopted in the SOTER methodology viewing "land as being made up of natural entities consisting of a combination of terrain and soil individuals". The draft physiographic map has been prepared following this concept and is based on the hierarchy of landforms in SOTER (see below)

Terrain units were delineated on a handdrawn map and their respective physiographic codes were entered into a database. The map was then digitized and linked to the database through a GIS (ILWIS and ARC-INFO). Thematic maps have been printed for three major physiographic items, namely: Major Landform, Hypsometry and Slopeclass.

The Karta Mira topographic map at a scale of 1:2.5 M was used as a base map, while additional topographic maps of various scales and variable quality were used to obtain the required information. The criteria described below could not always be applied in a precise manner. This is particularly true for the relief intensity criteria, which are difficult to assess when using small scale maps (1:250.000 and less).

Major landforms

Table 4 Hierarchy of major landforms

1st level	2nd level	gradient (%)	relief intensity
L level land	**LP** plain	<8	<100m/km
	LL plateau	<8	<100m/km
	LD depression	<8	<100m/km
	LF low-gradient footslope	<8	<100m/km
	LV valley floor	<8	<100m/km
S sloping land	**SM** medium-gradient mountain	15-30	>600m/2km
	SH medium-gradient hill	8-30	>50m/slope unit
	SE medium-gradient escarpment zone	15-30	<600m/2km
	SR ridges	8-30	>50m/slope unit
	SU mountainous highland	8-30	>600m/2km
	SP dissected plain	8-30	<50m/slope unit
T steep land	**TM** high-gradient mountain	>30	>600m/2km
	TH high-gradient hill	>30	<600m/2km
	TE high-gradient escarpment zone	>30	>600m/2km
	TV high gradient valleys	>30	variable
C land with composite landforms	**CV** valley	>8	variable
	CL narrow plateau	>8	variable
	CD major depression	>8	variable

Notes: Water bodies are coded by the letter W.

Landforms are described foremost by their morphology and not by their genetic origin nor the processes responsible for their formation and shape. The regionally dominant slope class is the main differentiating criterion, followed by relief intensity. The relief intensity is normally given in meters per kilometre, but for distinction between hills and mountains it is more practical to use two kilometre intervals (Table 4).

At the highest level of separation, four groups of landform are distinguished. These first level units can be divided into second level units based on their position *vis-a-vis* the surrounding land.

Regional slope

The dominant (regional) slope class within a major landform is defined differently for (a) simple landforms or (b) complex landforms, as follows:

a) Simple landforms

W	0- 2 %	flat, wet[1]
F	0- 2 %	flat
G	2- 5 %	gently undulating
U	5- 8 %	undulating
R	8-15 %	rolling
S	15-30 %	moderately steep
T	30-60 %	steep
V	≥ 60 %	very steep

b) Complex landforms[2]

CU	Cuesta-shaped
DO	Dome-shaped
RI	Ridged
TE	Terraced
IN	Inselberg covered (occupying at least 1% of level land)
DU	Dune-shaped
IM	With intermontane plains (occupying at least 15%)
WE	With wetlands (occupying at least 15%)
KA	Strong karst

1 The code W for wet is used when 50 to 90% of a SOTER unit is covered by permanent water.

2 In the case of complex landforms, the protruding landform should be at least 25 m high (if not it is to be considered mesorelief) except for terraced land, where the main terraces should have elevation differences of at least 10 m.

Hypsometry

For level and slightly sloping land (relief intensity of less than 50 m), the hypsometric level gives an indication of the height above sea level of the local base level. For lands with a relief intensity of more than 50 m, the hypsometric level refers to the height above the local base (i.e. local relief).

a) Level lands and sloping lands (relief intensity < 50 m/slope unit)

1	< 300 m	very low level (plain etc.)
2	300- 600 m	low level
3	600-1500 m	medium level
4	1500-3000 m	high level
5	≥ 3000 m	very high level

b) Sloping lands (relief intensity > 50 m/slope unit)

6	< 200 m	low (hills etc.)
7	200-400 m	medium
8	≥ 400 m	high

c) Steep and sloping lands (relief intensity > 600 m/2 km)

9	600-1500 m	low (mountains etc.)
10	1500-3000 m	medium
11	3000-5000 m	high
12	≥ 5000 m	very high

ANNEX II: Corrections of the physiographic map

The polygon label numbers are centred in the map units (polygons). This means that when a number could not be printed between the polygon boundaries, it belongs to the map unit in which the number is centred. The database and printed tables, like the maps, also contain polygon numbers outside your country borders. Ignore these, since they will be checked by other countries.

The physiographic code in the database and on the printed tables contains the information for the corresponding polygon and is composed as in the following example:

SH	**R**	**6**
(Medium grad. hill)	(Rolling)	(<200m)

This physiographic information should be checked and corrected as necessary. Use a photocopy of the blank black-and-white print for corrections, as you will need a separate copy to indicate degradation codes.

When only the delineation of a map unit (polygon) needs to be corrected, draw the correct lines on the black-and-white print with a red pencil.

When an additional map unit is needed, draw the new unit on the black-and-white map with a red pencil and clearly write the physiographic code for the new map unit on the print. It is not necessary (or possible) to add the new polygon label numbers to the database (this will be done at ISRIC).

When the delineation of the map unit is correct, but the physiographic code needs to be modified, change the code for that polygon in the database and on the black-and-white map (in red pencil). In case you cannot use the computerized data entry programme, make a list of polygon label numbers for which changes have been made in the physiographic code.

To access the database, type:

A:INST_SOV <ENTER>

This will INStall the SOVEUR programme and copy all relevant SOVEUR files[1] on the diskette to a new directory C:\SOVEUR (assuming there is at least 1.5 MB capacity left on your harddisk). *NB: DO NOT REPEAT THIS STEP AFTER YOU HAVE ENTERED DATA, BECAUSE THE DATABASE WILL BE OVERWRITTEN WITH THE ONE IN THE SOVEUR.ZIP FILE on A: .*

Then type

SOVEUR <ENTER> to start the data entry programme

---

[1] SOVEUR.EXE, KEY.DBF, KEY.MDX, CONFIG.DB and your country database(s) [countryname].DBF and .DBT. All these files **must** be within the C:\SOVEUR directory to run the programme!

Choose <**Physiography**> from the menu, to modify the physiographic codes and follow the instructions on the screen. Select the SOVEUR file (database) that corresponds to your country map by pressing <**F2**>. In case you accidentally choose the wrong file (like KEY.DBF, which will also appear in the window on the screen) you will get a message "Not a SOVEUR file. Press any key to continue" (and try again). After choosing your database file, edit the respective item codes where required. For each item, you can press <**F2**> to browse through a list of permitted codes and select the appropriate one. In the memo field, which you can enter by pressing <**F9**>, you may give additional comments. After you have edited a code, *save the record with <F6>* before advancing to a new record.

WHEN ALL DATA HAVE BEEN ENTERED, DO NOT FORGET TO COPY THEM TO THE DISKETTE!

ANNEX III: Input of degradation codes into the database

You are requested to enter the required degradation code(s) in your degradation database *for each polygon* on your map, as explained below.

The matrix table (see example in Annex IV) is to be used for manual data entry (make as many copies as required) prior to, or instead of, computerized data input, as in following example.

To access the database (if you have not yet installed the programme, first follow the instructions given in Annex II), type:

CD\SOVEUR <ENTER> (if you are not in the C:\SOVEUR directory already)

followed by:

SOVEUR <ENTER>

Now choose **<Degradation>** from the menu, to add (or edit) degradation codes and follow the instructions on the screen. Select the SOVEUR file (database) that corresponds to your country map by pressing **<F2>**. Enter the respective item codes as given in Chapter 2. For each item, you can press **<F2>** to browse through a list of permitted codes and select the appropriate one. In the memo fields, which you can enter by pressing **<F9>**, you may give additional information on type (etc.) of degradation or conservation, respectively. After you have filled in a code for each item, *save the record with* ***<F6>*** before advancing to a new record. If you want to enter a second (or third, etc.) degradation code for the same polygon, press **<F5>**.

WHEN ALL DATA HAVE BEEN ENTERED, DO NOT FORGET TO COPY THEM TO THE DISKETTE!

ANNEX IV

SOVEUR MATRIX TABLE

SAMPLE (Fictitious)

Poly-id: 378-PL

LUT	Degr.type	*Pollution only: specific substance*	Extent	Degree	Impact	Cause	Rate	Remarks
Cropland	1 Wt		30%	2	A3	a	1	
Land use area:	2 Cpp	PCB	25%	1	I2	a	2	Effects on ground- and surface water
..60. % of polygon	3 Wt/Cpp		15%					NB: Enhanced downstream effect of Cpp
	4 Sn		30%					
Grazing land	1							
Land use area:	2							
..0.. % of polygon	3							
	4							
Forest land	1 Cpa	NO_x SO_2	40%	3	E2	i	2	Mainly atmospheric deposition
Land use area:	2 Sn		60%					
.15.. % of polygon	3							
	4							
Mixed land	1 Wt		0%	1	A2	a,e	-1	
Land use area:	2 Wd		0%	2	A3	f	0	
..10. % of polygon	3 Wt/Wd		100 %					Full overlap of Wt and Wd
	4							
Other land	1 Pu		20%	3	A5	i	2	Urbanisation and infrastructure
	2 Cph	Cd, Pb	l	4	H2,P3			local : 50°30'N 20°00'E
Land use area:	3 Cpr	Cs^{137}	l	2	H4			local: 55°20'N 21°30'E (dump site)
..15. % of polygon	4 Sn		80%					

SOVEUR MATRIX TABLE

(Make copies as required)

Poly-id:

LUT	Degr.type[1]	*Pollution only: specific substance*	Extent	Degree	Impact	Cause	Rate	Remarks
Cropland	1							
Land use area:	2							
.... % of polygon	3							
	4							
Grazing land	1							
Land use area:	2							
.... % of polygon	3							
	4							
Forest land	1							
Land use area:	2							
.... % of polygon	3							
	4							
Mixed land	1							
Land use area:	2							
.... % of polygon	3							
	4							
Other land	1							
	2							
Land use area: .... % of polygon	3							
	4							

1 Use additional sheets for more than 4 degradation types and/or associations per LUT

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