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Soil Degradation Status and Vulnerability Assessment for Central and Eastern Europe — Preliminary Results of the SOVEUR Project

Proceedings of concluding workshop
(Busteni, 26-31 October 1999)

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Preface

These proceedings contain the report and papers given at an international workshop of the project GCP/RER/007/NET on *Mapping of Soil and Terrain Vulnerability in Eastern and Central Europe* (SOVEUR). The SOVEUR project calls for the development of an environmental information system for central and eastern Europe 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 have been mapped at a scale of scale 1:2.5 million.

The current workshop is the last of the three Project Workshops organized in the framework of the Cooperative Programme of the Food and Agriculture Organization of the United Nations (FAO) and the Government of the Netherlands (GCP/RER/007/NET). The first workshop, held in Wageningen (1-3 October 1997), focussed on methodological and logistical issues related to SOVEUR project implementation. The second, a technical training workshop was held at RISSAC, in Hungary (Budapest, 13-17 May 1998), with participants from Russia, Moldova, Ukraine, and Belarus. The current proceedings present a summary and the papers of the concluding workshop held in Romania (Busteni, 26-31 October 1999).

The main aims of the concluding workshop was to present preliminary results of the SOVEUR project, to reach agreement on issues of border correlation, to set deadlines for delivering the final revisions and products to ISRIC and FAO, and to formulate recommendations for future collaborative activities. An important achievement of the project has been to help strengthening cooperation between national, environmental organizations throughout Central and Eastern Europe.

During the editing, minor changes have been made to the papers to conform with the editorial policy. This has been done without interfering with the views of the authors or the professional aspects of the documents. It should be noted, however, that due to the correlation aspects discussed during the Busteni workshop the contents of some of the national databases, as described in the present country papers, may differ from those that will be presented on the final CD-ROM for the project. This CD-ROM is scheduled to be published in FAO's *Land and Water Digital Media Series* before the end of 2000.

After Part 1, with the workshop report and recommendations, the introductory papers (Part 2) and written contributions to the workshop (Part 3) are presented. For practical reasons, the national contributions have been presented in alphabetical order of the country of origin. The list of workshop participants concludes the proceedings (Part IV).

The current proceedings, and final CD-ROM, should be of interest to scientists and policy makers who are concerned with the problems of soil and environmental pollution, either at the national, European or global level. Besides discussing the present status, the proceedings may help to identify gaps in current knowledge of the status of soil and terrain resources in Central and Eastern Europe.

Acknowledgements

The workshop organisers gratefully acknowledge the inputs from all participants of the Busteni workshop for the great enthusiasm shown in realising the SOVEUR project objectives. Special thanks are expressed to the local organisers, the Research Institute for Soil Science and Agrochemistry (RISSA), notably Dr. M. Dumitru, Dr. I. Munteanu, Dr. Sorin L. Ştefănscu, and Ms. Sorina Dumitru. Many thanks are also due to all persons who provided critical inputs behind the 'screens', prior to and during the workshop. The efforts of Jacqueline Resink (ISRIC, GIS analyst) in harmonizing the various spatial databases and in preparing draft maps for presentation and discussion at the Busteni workshop, and the secretarial and administrative support of Yolanda Karpes-Liem and Jan Brussen are particularly appreciated.

PART 1: WORKSHOP REPORT

BACKGROUND

Improved data on the extent and degree of soil degradation and pollution, and establishment of monitoring networks to assess the effectiveness of measures that have been put in place, are seen as a pre-requisite to any further coordinated approach to soil protection in the whole of Europe. Some countries have started systematic recording, monitoring and clean-up programmes of contaminated sites based on established reclamation methodologies, but in others the implementation is often constrained by financial, legal and technical factors. Further there is a need to harmonise methodological procedures to allow studies at the continental level. It is in this overall context that the project on *Mapping of Soil and Terrain Vulnerability in Central and Eastern Europe* (SOVEUR) was implemented, within the framework of the Cooperative Programme of the Food and Agriculture Organization of the United Nations (FAO) and the Netherlands Government (Project GCP/RER/007/NET). In view of the specific nature of the services to be rendered, the project activities were implemented under a Contractual Service Agreement with the International Soil Reference and Information Centre (ISRIC), which includes Letters of Agreement with National Collaborators within the frame of their National Institutes representing their countries in the project (13 participatory countries).

The SOVEUR project started in October 1996 as a sequel to various international activities:

1) A feasibility workshop on soil vulnerability mapping in Europe, organised in the framework of the Chemical Time Bombs (CTB) project (Batjes and Bridges, 1991).
2) The objective of the Food and Agriculture Organization (FAO) of the United Nations, International Society of Soil Science (IUSS), International Soil Reference and Information Centre (ISRIC), and United Nations Environment Programme (UNEP) to update the information on world soil resources in a uniform digital database (see Nachtergaele, 1999; Van Engelen, 1999).
3) Updating of the information on the current status of soil degradation in the world (see Oldeman *et al*., 1991; Van Lynden, 1995; Van Lynden and Oldeman, 1997).

The project includes 13 Central and Eastern European countries: Belarus, Bulgaria, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Moldova, Poland, Romania, the Russia Federation (west of the Urals), Slovak Republic, and the Ukraine area (about 5,7 x 10^6 km^2).

WORKSHOP OBJECTIVES

The main activities undertaken during the implementation phase of the SOVEUR project included the development of:

1) A soils and terrain digital database, at 1:2.5 million scale, using the SOTER methodology (Batjes and Van Engelen, 1997; Van Engelen and Wen, 1995).

2) A database showing the current status of soil degradation, with focus on pollution (Van Lynden, 1997).
3) A methodology for assessing the vulnerability of soils to selected categories of pollutants (Batjes, 1997).

Methodologies for the three project activities enumerated above were discussed during the SOVEUR implementation workshop (Batjes and Bridges, 1997). Subsequently, experts from recognised institutes in the region applied these methodologies to their respective countries. Upon receipt of the various national contributions, between March 1998 and July 1999, these were screened and merged into a common, central database for the SOVEUR region at ISRIC. Meanwhile, awareness of the project was increased via FAO and ISRIC, and through paper presentations at international congresses and workshops (Batjes, 1999a, b; Mashali, this volume). Actual results of the project were presented and discussed during the concluding workshop in Busteni, Romania. The current report summarises the discussions and recommendations of this workshop.

DISCUSSIONS AND RECOMMENDATIONS

Country presentations

Following words of welcome by Dr. M. Dumitru, Director of the host institute RISSA, and by Dr. L.R. Oldeman, Director of ISRIC, a paper on the projected uses and users of the SOVEUR project was presented by Dr. M.A. Mashali of FAO (see Part II, this volume).

From the start, the organisers stressed that in order to conclude the SOVEUR project successfully, and in a timely manner, three steps would have to be undertaken during the workshop: (a) discussion and border-correlation of the harmonised SOTER database, (b) discussion and border-correlation of the soil degradation/pollution status database, and (c) presentation and discussion of the procedure for mapping the vulnerability of soils to pollution, as basis for identifying areas considered at risk from Chemical Time Bombs.

Subsequently, the national SOVEUR project co-ordinators presented the findings for their respective countries as oral presentations. These so-called "country papers", plus the introductory presentations, will be published as separate workshop proceedings by ISRIC, RISSA, and FAO, upon their editing at ISRIC (see Part III, this volume).

Preliminary results and border-correlation

General

After the country presentations, the focus was on presentation and discussion of the preliminary results of the project. First, ISRIC staff members gave brief summaries of the present status of the various databases, while pointing at possible gaps in the various data sets. Initial plenary discussions were followed by intensive working group sessions during which issues of cross-border correlation were discussed in 4 groups, using copies of the preliminary maps and databases (Group I: Estonia, Latvia and Lithuania; Group II: Poland, Belarus, Ukraine, and Russia; Group III: Bulgaria, Romania, and Moldova; and, Group IV: Czech Republic, Slovakia, and Hungary).

SOTER database

The SOTER-related discussions focussed on correlation issues concerning thematic information on landforms, parent material, and major soil groupings according to the revised legend of (FAO, 1988), using print-outs of the SOTER database for the respective regions. Whenever necessary, the actual contents of the attribute database were consulted also in order to propose modifications for the composition of selected SOTER units (see Table 1). Once the correlation between two neighbouring countries had been completed, new groups were formed so that all issues related to cross-border correlation could be discussed in a systematic manner during the duration of the workshop. The attribute databases were consulted digitally during these discussions, when appropriate.

Table 1. Overview of data held in the SOTER attribute file for the SOVEUR area

Attribute	N
SOTER units	8635
Terrain components	9257
Soil components	13988
Soil profiles	661
Average No. of horizons by soil profile	3.8

Note: Status prior to the border correlation session in Busteni.

Soil degradation status database

Following the discussions relating to the SOTER database, considerable time was spent on harmonizing the soil degradation status database. Like for the SOTER database, it appeared that several of the collaborating agencies had difficulties in applying the guidelines. For example, when they had to estimate the impact associated with certain types/degrees of soil degradation/pollution (See Van Lynden, 1997). During the plenary discussion, it followed that some of the “presumed” discrepancies on the preliminary maps were in fact associated with natural features as well as with historical differences in land use patterns between neighbouring countries. Several misinterpretations occurred with respect to the base maps.

Other “blanks” on the maps were related to data entry/screening errors. Alternatively, some “blanks” will remain with respect to certain degradation types where data are lacking at the national level.

With reference to a preliminary analysis of the data at ISRIC (Figure 1), the main types of soil degradation encountered in Central and Eastern Europe were identified (For abbreviations see Van Lynden, 1997). These were identified as being: physical deterioration, in particular compaction (Pc) and crusting (Pk); water erosion (Wt), acidification (Cpa); and, fertility decline (Cn). Subsequently, small working groups focussed their attention on issues of cross-border correlation with special reference to the main degradation issues of regional concern.

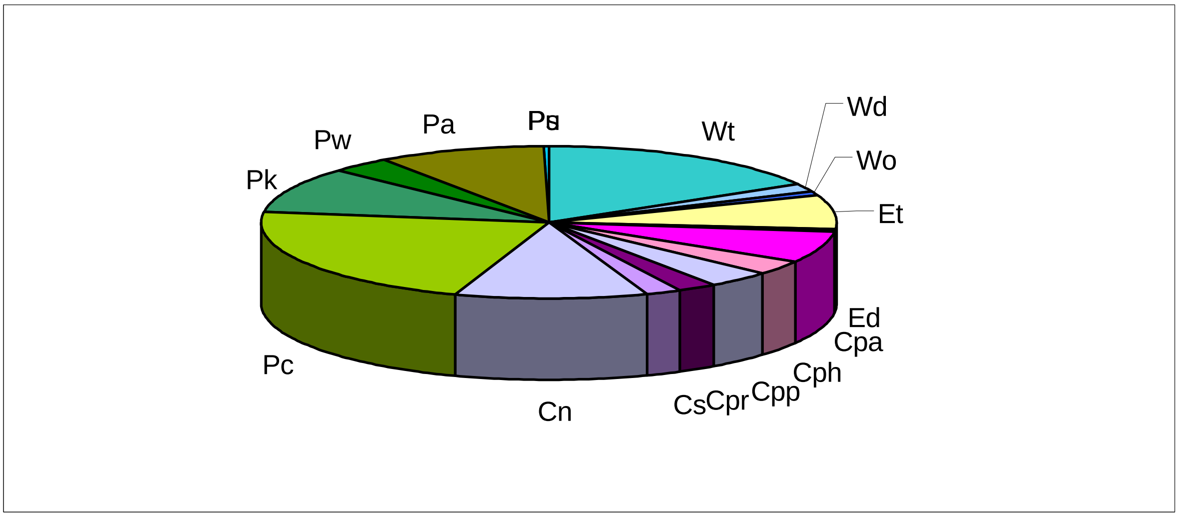

Fig. 1 Preliminary distribution of main soil degradation types in Central and Eastern Europe. (*Note: Status prior to the border correlation session in Busteni*)

In view of their largely technical nature, changes to the databases annex maps that followed from the different correlation sessions will be made directly into the relevant national databases at ISRIC. Thereafter, ISRIC staff will merge the updated national files into a revised database for the SOVEUR project area, after which the maps and interpretations will be updated.

Soil vulnerability mapping

Procedures for assessing the relative vulnerability of soil to pollution were presented orally, with special reference to the mobilization of heavy metals, inducible by acid deposition (see Batjes, 2000 a, b). The methodological framework is considered applicable at larger scales as well, as the same principles will apply. The methodology considers soil properties, or so-called “capacity controlling properties”, such as pH, CEC and organic matter content that can be changed by changes in land management/policy, and as a such can be used in scenario studies for policy makers and other users.

Concluding session

Aims

The concluding session focussed on: (a) agreeing on the contents of the workshop proceedings, (b) setting tight time-schedules for submitting modifications to the national databases, (c) proposing a time schedule for incorporating these changes into a revised, common database for the SOVEUR area, (d) reaching a consensus with respect to the SOVEUR project deliverables, (e) submission of project deliverables to FAO, (f) preparation and distribution of final CD-ROM by FAO, and, last but not least, (g) identification of follow-up actions, including methodology development and formulation of project ideas.

Workshop proceedings

– All participants will receive a copy of the draft workshop report for comments (1 week response time).

– The workshop report and edited "country papers" will be published as proceedings of the Busteni workshop by ISRIC, RISSA, and FAO. Compilation and editing of the final proceedings will be done by the SOVEUR project co-ordinator.

Deadlines for submitting revisions

– The mutually agreed deadline for submitting final corrections for the SOTER geographic and attribute databases - in addition to those made during the workshop proper - is November 15, 1999.

– The mutually agreed deadline for submitting final corrections for the Soil Degradation Status database - in addition to those made during the workshop - is November 30, 1999.

– After these deadlines, ISRIC project staff will finalize the various national databases based on the then available data, and otherwise best available knowledge, in order to generate revised versions of the databases and maps for the SOVEUR region.

– The draft reports on "derived soil properties" and "vulnerability mapping with respect to heavy metal mobilization, inducible by acid deposition" will be finalised, with reference to the revised SOTER geographic and attribute data (Batjes, 2000 a, b). Similarly, a concluding technical report will be prepared to accompany the maps of soil degradation status (Van Lynden, *in prep.*).

Project deliverables

– ISRIC will send a digital copy of the project-deliverables, as described in Box 1, to FAO by April 30, 2000. In accordance with the Contractual Services Agreement, these deliverables will be accompanied by a Terminal Report.

Box 1 Proposed contents of final CD-ROM for SOVEUR project.

– Technical Documentation (in PDF format)
  - Methodological guidelines (SOTER database compilation, Soil degradation status, Soil vulnerability mapping)
  - Workshop proceedings (Wageningen, October 1997; Busteni, October 1999)
  - Project reports with results (SOTER; Soil degradation status; Soil vulnerability mapping)

– Databases (as DBF and ArcInfo/View files)
  - SOTER (1:2,500,000 scale)
  - Soil degradation status (1:2,500,000 scale)

– Thematic layers (as DBF and ArcInfo/View files)
  - Selected parametric overviews of soil properties (e.g., pH, organic carbon, texture)
  - Selected maps of soil degradation status (e.g., water erosion, wind erosion, compaction)
  - Selected maps of soil vulnerability to pollution (e.g., Cd, Zn)

– Upon formal acceptance of the Terminal Report, FAO will take care of the publication of the project deliverables on a CD-ROM in the *Land and Water Media Series*. The flyer will show the logos and list the names of the 13 national institutes, the implementing agency (ISRIC), and FAO. *(Note: all national institutes have been requested to provide ISRIC with digital copies or clear hard copies of their logos before the end of 1999).*

– FAO will publish the definitive CD-ROM before July 30, 2000. Subsequently, FAO will provide the implementing agency and all collaborating institutes with copies of the CD-ROM. Subsequently, the results of the SOVEUR project will also be made available via the FAO (www.fao.org) and ISRIC (www.isric.nl) websites.

Methodology development and follow-up actions

Methodological issues

– The workshop agreed that a “great piece of work” has been accomplished during the SOVEUR project, and that the reports, databases, maps and proceedings should be made available to all contributors and their governments.

– Workshop participants agreed to update the SOVEUR results nationally, and continue with cross-border harmonization, and within-unit correlation of neighbouring polygons. This revised version should be presented at the next World Congress of Soil Science of the International Union of Soil Sciences (IUSS, Thailand, 2002).

– The interest and feasibility to expand the present study and methodology to other countries in Europe should be assessed.

– In addition, this type of work should be continued at more detailed scales, and include soil monitoring in a regional framework.

– Policy makers should take into account soil related issues, as addressed by the SOVEUR project, in legal provisions.

– The project can contribute to the standardization of profile descriptions, soil classification, soil analysis, and development of transfer rules for analytical results by organizing regular workshops in Central and Eastern Europe (FAO to look for partners/funding). This type of activity would lead to an improvement of the national pedon databases linked to SOTER (see Van Engelen and Wen, 1995, p. 20).

– Participants agreed that continued refinement of the SOTER methodology is desirable to ensure its continuation, and that this should encompass:
  a) A general assessment/review of the SOTER product and methodology, including a revision of the definitions and criteria used (e.g., the classification system for lithology, *sensu* parent material). *(Editors note: such a review is currently ongoing, and all SOVEUR participants will receive a copy of the relevant questionnaire. Results of the questionnaire will be discussed during a special SOTER session organized in conjunction with the XIXth Congress of the International Society of Photogrammetry and Remote Sensing (ISPRS 2000, Amsterdam)).*
  b) Adapt the SOTER software to allow inclusion of soil units that account for less than 15% of a map unit. This is considered particularly important for spatially minor, yet agriculturally or otherwise important soils such as Histosols and Fluvisols.
  c) Development of the SOTER methodology to permit work at more detailed scales.
  d) The SOTER system should allow for incorporation of new methodologies and tools, such as Digital Elevation Models (DEM) to delineate landforms, whereby new versions can be prepared on a regular basis.
  e) A WINDOWS-operated version of SOTER is direly needed to replace the current DOS-operated system (*Editors note: Version 1.0 has been tested during an Expert Consultation on Soil Degradation Assessment and Mapping, Pretoria, October 1999*).
  f) Make models and algorithms available to collaborating agencies.

– Concerning the guidelines for mapping the "current status of soil degradation and pollution" (see Van Lynden, 1997) there is a need for:
  a) More precise definitions so as to permit for a better differentiation between human-induced impacts of land degradation versus natural processes of soil degradation (i.e., podzolization).
  b) More precise definitions and criteria for pollution, also with reference to ISO standards. In addition, the difference between soil contamination and soil

pollution should be made more explicit in the text. This is particularly important for areas where the natural, geochemical background levels encountered in soils are high.
d) More attention needs to be paid to organic pollutants.
e) Assess if data on pollution-related degradation should be accommodated as a separate data layer.
f) Assessing possibilities for using of remote sensing technologies for monitoring soil degradation.

– In general, the procedure for mapping soil vulnerability was well received. One participant indicated he would provide ISRIC with additional algorithms. The project co-ordinator from Poland indicated he would try to provide ISRIC with national data sets on Cd-loads and acid deposition, so as to allow for the identification of broad areas considered at risk from CTBs.

Follow-up activities

– Several project proposals, aimed at improving the soil and terrain resources knowledge bases and possibilities for their management, have been formulated by the workshop participants. These proposals take into account that the adverse effects of events such as drought, flood, pollution usually are of a trans-border nature.
  a) Development of a project concerning land-use optimisation, in connection with the current status of and trends in human-induced soil degradation and predicted climate changes in Central and Eastern Europe. Such a project could well be linked with studies concerning terrestrial carbon sinks (*cf.* Kyoto Protocol), and the conservation of biodiversity.
  b) Promoting a project concerning rehabilitation and protection measures of severely degraded lands, and mitigation of human-induced pressures in areas at risk. Results of such a project would be of interest to national governments as well as international organizations, such as the World Bank, FAO, and UNEP. In addition, such a proposal could provide a good basis for harmonising national strategies in the field of soil and terrain resources conservation, biodiversity conservation and environmental protection. This type of work would be complementary to the activities of the *World Overview of Conservation Approaches and Technologies* (WOCAT, 1998).
  c) There is a need to highlight the importance of the “stable lands”, the so-called “cold spots”, to initiate soil protection programmes at an early stage (i.e., adopt a pro-active approach to soil conservation).
  d) A possible follow-up action could be to develop a 1:500,000 scale SOVEUR database for large physiographic units, such as the Lower Danube Plain (Romanian-Bulgarian cooperation), the Moldovian and Podolian table land (Romanian, Moldovian, and Ukrainian cooperation), the Panomian and Transylvanian basin (Hungarian-Romanian cooperation). This type of activities could precede the development of a 1:250,000 soil map as foreseen in the framework of the European Soil Information System (EUSIS).

e) Use of SOTER databases for evaluation of water and wind erosion risk, and other applications, at more detailed scales.

– Participants were urged to prepare short project outlines for possible submission to funding agencies, such as the Fifth Framework Programme (EU). Basically, these project overviews should include 7 headings: (1) title; (2) aims; (3) expected results or deliverables; (4) background; (5) phases of work; (6) partners and roles; and, (7) estimated budget and duration (months). Each project-outline should be self-standing and not exceed 1 page in length. Once a donor has expressed its interest for a given project-outline, a full proposals may be written.

– Finally, the is a need to market the SOVEUR product so as to create a demand from different categories of users (e.g., management field, policy, education, science, etc.).

CONCLUSIONS

– Working at the scale of 1:2.5 million proved an excellent exercise for integrating data and expertise from a wide group of countries. The fact that the vast range of tasks embedded in the SOVEUR project could be completed in the relatively short time frame of 2 years, following the implementation workshop, is largely due to the great enthusiasm which the various national collaborators, and their project staff, showed for implementing the SOVEUR project.

– The SOVEUR project is the first attempt to bring together in one single, harmonized database information on the soil and terrain resources for the whole of Central and Eastern Europe. For many of the Eastern European countries represented, the SOVEUR project provided the first opportunity to work with international standards as developed by ISRIC, FAO, UNEP and IUSS.

– The SOVEUR project provided an excellent basis for identifying gaps in current knowledge with respect to soil resources and their degradation status, or resilience to processes of change, in the region. Ideally, these knowledge gaps should be updated in successive releases of the 1:2,500,000 scale databases, upon the identification of adequate donor support.

– The feasibility of expanding the SOVEUR approach to other countries in Europe should be investigated.

– A wide range of soil vulnerability interpretations, including pollution, water and wind erosion and their possible impacts on food production and human health, can be generated using the SOVEUR-derived list of ‘derived soil properties’ combined with auxiliary databases on climate, land use, and chemical loadings complemented with expert knowledge of the various processes. This type of information can then be translated into scenarios, the results of which will be useful for planning and policy making.

– Quality control is a major issue in spatial and point data handling, particularly when disparate sources are used; despite being based on the 'best' available data, some of the data held in the SOVEUR databases may be patchy and of uncertain quality (Batjes, 1999b).

– It is recognized that uncertainties related to data and models are prone to be significant at the considered scale of 1:2,500,000. The various types of uncertainties are difficult to evaluate and they will vary amongst the various data sets and models used. As such, results will mainly be applicable to large areas as a whole, increasing awareness of (adverse) effects of human intervention on the quality of soil resources in Central and Eastern Europe.

– Integration with a soil monitoring system will permit analysis of changes in the driving-forces of soil processes in relation to specific degradation processes, thereby providing a better scientific basis for model development, evaluation, and risk assessment. This information can then be translated into possible management options for land use planners and policy makers.

– Concerted action is needed at the pan-European level on sampling methods, analytical methods, methods for harmonizing disparate data sets, model approaches, and ultimately on how to link information obtained at different scales.

– Possibilities for identifying areas considered most at risk from re-mobilization of selected types of contaminants will strongly depend on the *availability of, and unrestricted access to*, auxiliary databases of the main socio-economic and bio-physical driving forces of environmental change (see Naff, 1999; Webster, 1997).

– For the future, there is a need to refine and apply the various methodologies at larger scales (≈ 1:250,000) of relevance to planning at the national level.

– Improved data on the extent and degree of soil degradation and pollution, and establishment of monitoring networks to assess the effectiveness of measures that have been put in place, are seen as a pre-requisite to any further coordinated approach to soil protection in the whole of Europe. As such, policy makers must be made aware of the results of the SOVEUR project, possibly via a brochure, so that these aspects may be included in legal provisions.

REFERENCES

Batjes, N. H. (1997) Methodological framework for assessment and mapping of the vulnerability of soils to diffuse pollution at a continental level (SOVEUR project), Report 97/07, pp. 34. International Soil Reference and Information Centre (ISRIC), Wageningen.

Batjes, N. H. (1999a) Soil degradation and vulnerability mapping in Central and Eastern Europe: the SOVEUR project. In: *Proceedings International Congress on Soil Vulnerability and Sensitivity (Florence, 18-21 October 1999)* (Ed. by P. Sequi), pp. (in press). European Soil Bureau and Italian Society of Soil Science, Florence.

Batjes, N. H. (1999b) Soil vulnerability mapping in Central and Eastern Europe: Issues of data acquisition, quality control and sharing. In: *Data Sharing for International Water Resource Management: Eastern Europe, Russia and the CIS*, NATO Science Series 2: Environmental Security (Vol. 61). (Ed. by T. Naff), pp. 187-206. Kluwer Academic Publishers, Dordrecht.

Batjes, N. H. (2000a) Soil data derived from SOTER for environmental studies in Central and Eastern Europe (SOVEUR Project; Version 1.0), Report 2000/02, pp. 30. International Soil Reference and Information Centre, Wageningen.

Batjes, N. H. (2000b) Vulnerability to diffuse pollution of soils in Central and Eastern Europe (SOVEUR project; version 1.0), Report 2000/03. ISRIC, Wagenigen.

Batjes, N. H. and Bridges, E. M. (1991) Mapping of Soil and Terrain Vulnerability to Specified Chemical Compounds in Europe at a Scale of 1:5 M. In: *Proceedings, International workshop held in the framework of the Chemical Time Bomb (CTB) Project*, pp. 178. Chemical Time Bombs (CTB) Project and International Soil Reference and Information Centre (ISRIC), Wageningen.

Batjes, N. H. and Bridges, E. M. (1997) Implementation of a Soil Degradation and Vulnerability Database for Central and Eastern Europe, Proceedings of an international workshop (Wageningen, 1-3 October 1997), pp. iv + 81. ISRIC, Wageningen.

Batjes, N. H. and Van Engelen, V. W. P. (1997) Guidelines for the compilation of a 1:2,500,000 SOTER database (SOVEUR Project), Report 97/06, pp. 58. ISRIC, Wageningen.

FAO. (1988) *FAO-Unesco Soil Map of the World, Revised Legend (with corrections and updates)*. ISRIC, Wageningen, 140 pp.

Mashali, A. M. (in press) Anticipated uses of results of SOVEUR project. In: *Soil Degradation Status and Vulnerability Assessment for Central and Eastern Europe - Preliminary Results of the SOVEUR Project. Proceedings of concluding workshop (Busteni, 26-31 October 1999)*, (Ed. by N. H. Batjes). FAO, RISSA and ISRIC, Wageningen.

Nachtergaele, F. O. (1999) From the Soil Map of the World to the Digital Global Soil and Terrain Database: 1960-2002. In: *Handbook of Soil Science*, (Ed. by M. E. Sumner), pp. H5-17. CRC Press, Boca Raton.

Naff, T. (1999) Data Sharing for International Water Resource Management: Eastern Europe, Russia and the CIS, *NATO Science Series 2: Environmental Security (Vol. 61)*, pp. 187-206. Kluwer Academic Publishers, Dordrecht.

Oldeman, L. R., Hakkeling, R. T. A. and Sombroek, W. G. (1991) World Map of the Status of Human-Induced Soil Degradation: An explanatory Note (rev. ed.), , pp. 35 (with maps). UNEP and ISRIC, Wageningen.

Van Engelen, V. W. P. (1999) SOTER: The World Soils and Terrain Database. In: *Handbook of Soil Science*, (Ed. by M. E. Sumner), pp. H19-28. CRC Press, Boca Raton.

Van Engelen, V. W. P. and Wen, T. T. (1995) Global and National Soils and Terrain Digital Databases (SOTER): Procedures Manual, *(Published also as FAO World Soil Resources Report No. 74)*, pp. 115. UNEP, IUSS, ISRIC, FAO, Wageningen.

Van Lynden, G. W. J. (1995) European soil resources, Nature and Environment No. 71. Council of Europe Press, Strasbourg.

Van Lynden, G. W. J. (1997) Guidelines for the assessment of soil degradation in Central and Eastern Europe (SOVEUR Project), Report 97/08b (rev. ed.), pp. 20. International Soil Reference and Information Centre (ISRIC), Wageningen.

Van Lynden, G. W. J. and Oldeman, L. R. (1997) The Assessment of the Status of Human-induced Soil Degradation in South and Southeast Asia, , pp. 32 (with maps). UNEP, FAO, ISRIC, Wageningen.

Webster, F. (1997) Threat to full and open access to data. *Science International*, **65**, 11-12.
WOCAT. (1998) World Overview of Conservation Approaches and Technologies: programmes, profiles, soil and water conservation approaches database (ver. 1), Land and Water Digital Media Series 3. FAO, Rome.

PART II: INTRODUCTORY PAPERS

Welcome by host institute, RISSA

M. Dumitru

Research Institute for Soil Science and Agrochemistry (RISSA), Bucharest, Romania

Dear Guests, Dear Colleagues,

Welcome in Romania and thank you for accepting to organize this workshop in Romania. It is a real pleasure for me to host the concluding SOVEUR workshop here in Busteni. I should like to warmly greet you the representatives of Central and Eastern European countries, participants at this workshop. Special greetings to Dr. Amin Mashali and Dr. Freddy Nachtergaele, the FAO representatives and sponsors of the SOVEUR project. And last, but not least, I should like to express my gratitude to Dr. L.R. Oldeman, the ISRIC director, and his staff for their presence here and for their indefatigable effort to implement this project. Indeed the goal of the SOVEUR project, "Assessment of Soil and Terrain Vulnerability to Pollution in Central and Eastern Europe", has a great importance taking into account that the quality of Europe's environment has decreased as a result of pollution, notably in the former centralised economies of Central and Eastern Europe. As concerns Romania, we tried to do our best in accomplishing our part of the project and I hope that these three days of talks and scientific discussions will contribute to improve the work already done and what I believe to be very important, to find out the best way to develop a follow-up to SOVEUR. We must identify together the best solutions to improve our international cooperation, having as a base our common interest to safeguard the soil and terrain resources and environment quality for us and for our children. The SOVEUR project is a very good example of such a cooperation. I hope you will enjoy this nice mountain resort-Busteni, and keep a sweet memory of your stay in Romania.

I wish full success to your work for prosperity of our countries.

M. Dumitru
Director, RISSA

Introductory statement on behalf of implementing agency

L.R. Oldeman

International Soil Reference and Information Centre (ISRIC), Wageningen, the Netherlands

Dear Colleagues,

On behalf of ISRIC, I am pleased to welcome you at the second regional SOVEUR workshop. You will recall that the main objectives of SOVEUR were formulated as follows: "to strengthen regional awareness of the significant role soils play in protecting food and water supply, and to demonstrate (to policy-makers) the need for environmental protection". Unfortunately this significant role of soils is often not well understood by the non-soil science community.

As the former President of the International Society of Soil Science (Prof. A. Ruellan) and the Secretary-General of the International Union for Soil Sciences (Prof. W. Blum) stated in their foreword for a proposal for a Convention on Sustainable Use of Soils: "soils are unknown to human beings because they are hidden under their feet and because they cannot use soils in the same way as they use air, water and biota". It is our task and duty as soil scientists to show to the outside world that soils are of vital importance to mankind and the maintenance of a healthy environment. The SOVEUR project can make a significant contribution.

Two years ago (September 1997) we made a number of important decisions and recommendations for the implementation and execution of the SOVEUR project. We all agreed that three steps in subsequent order must be undertaken for a successful implementation.

The first step would be the creation of a standardized soil and terrain database following the internationally adopted SOTER approach. The project staff at ISRIC prepared a first draft physiographic map of Central and Eastern Europe. Country delegates would check the delineations on this draft map in order to update and further subdivide SOTER unit boundaries. Secondly, the present status of human-induced soil degradation/pollution would be documented for each polygon on the base map following the prepared guidelines as closely as possible. In a final exercise the vulnerability of soils would be assessed and mapped.

Although it was concluded that sufficient information at country level was available to execute the first two steps and that the proposed SOTER methodology was adequate to handle the necessary soil geographic and attribute data, we all agreed that careful boundary correlation would be necessary for soil geographic data and for the expert-based interpretations of the status of soil degradation.

We have been very optimistic in our time schedule developed at the 1997 workshop. All participants agreed that the first two steps could be completed on or before April 1998. It was soon realized, however, that this date was too optimistic. An additional technical (training) workshop was needed with participants from Russia, Moldova, Ukraine, and Belarus attending. This took place in Budapest, at the Research Institute for Soil Science and Agricultural Chemistry (RISSAC) of the Hungarian Academy of Sciences (13-17 May, 1998).

The initial materials and databases arrived at ISRIC between May 1998 and July 1999. We realize that all of you had gone through great efforts to put together the required information. Once the materials were received ISRIC staff began to put together all information and prepared some first draft maps. Only when you see the information on the map it becomes possible to spot inconsistencies, gaps in the databases provided, and correlation problems between countries. You have been asked by our soil geographic correlator (Koos Dijkshoorn), by our soil degradation correlator (Godert Jan van Lynden) and by our SOVEUR project coordinator (Niels H. Batjes) to clarify information, to provide additional information, and to fill gaps in the database. On top of that, in some cases, different base maps were used for compiling the SOTER and soil degradation databases. At this stage I would like to give also a lot of credit to our GIS technical staff (Jacqueline Resink) who prepared all the maps based on information you have provided. A display of these maps is shown on the walls of this conference room.

Much to our regret we had to inform FAO that the final regional correlation workshop had to be postponed until fall 1999. We are very pleased that both Dr. Mashali and Dr. Nachtergaele of FAO are with us this week to witness the joined efforts of all national participants and ISRIC staff to execute the project activities.

We were very pleased that Dr. M. Dimitru, Director of the Research Institute for Soil Science and Agrochemistry of Romania (RISSA), and Dr. I. Munteanu, national SOVEUR project leader for Romania, were willing to host this final workshop. They arranged the venue of the meeting here in Busteni and prepared all the logistic arrangements for a successful workshop.

The coming week we will discuss any remaining problems both within each country, and perhaps more importantly, between countries. This border correlation requires intensive discussions. We must reach satisfactory refinements, corrections and compromises in the information provided so far. This will not be an easy job, but I am sure that together we will succeed. I am convinced that by the end of the week we will look back on a fruitful, constructive, inspiring workshop.

Roel Oldeman
Director ISRIC

Anticipated uses of results of SOVEUR project

A.M. Mashali

Food and Agriculture Organization of the United Nations (FAO), Rome, Italy

Dr. Mihail Dumitru, Director, Research Institute for Soil Science and Agrochemistry,
Dr. Roel Oldeman, Director, International Soil Reference and Information Centre
Distinguished Participants,
Ladies and Gentlemen,

On behalf of FAO, I feel privileged and honoured to address the distinguished participants and guests of this Concluding International Workshop at its Opening Session, after listening to the wisdom of the preceding speakers.

FAO feels particularly honoured in sharing the organization of this Concluding International Workshop in cooperation with the International Soil Reference and Information Centre (ISRIC) and the host institute, the Research Institute for Soil Science and Agrochemistry (RISSA) of the Academy of Agriculture and Forestry Sciences of Romania. As you are aware, this Concluding International Workshop is being organized in the framework of "Project GCP/RER/007/NET: Mapping of Soil and Terrain Vulnerability in Central and Eastern Europe (SOVEUR)", as the concluding workshop of the project.

This three-year Sub-Regional Project has been initiated between FAO and the Government of the Netherlands, within the framework of the FAO/Netherlands Government Cooperative Programme, with the objective to establish a geo-referenced database with associated map at 1:2.5 million scale on the status of human-induced soil degradation and soil vulnerability for Central and Eastern Europe as a test for targeting appropriate corrective actions, as well as strengthening public awareness of the significant role of soils in protecting food and water and environmental protection. In view of the specific nature of the services to be rendered, the project activities are being implemented under a Contractual Service Agreement with the International Soil Reference and Information Centre (ISRIC), which included Letters of Agreement with national collaborators within the frame of their national institutes. The national collaborators representing their national institutes, from the 13 participating countries in the project (i.e. Belarus, Bulgaria, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Moldova, Poland, Romania, Russia (west of the Urals), Slovak Republic and the Ukraine) are contributing to the compilation of the following project outputs:

– A soil and terrain digital database at 1:2.5 million scale for the 13 participating countries in the project, based on the uniform methodology developed for the Global Soil and Terrain Database (SOTER) by ISRIC, FAO, UNEP and IUSS, with modifications necessary for the 1:2.5 million scale.
– Assessment of the status of soil degradation, with special focus on soil pollution.

– Assessment of the vulnerability of soils to selected categories of pollutants, with a view to identifying broad areas of soils considered at risk from re-mobilization of specific contaminants subsequent to environmental changes.

In the present workshop the results of the mentioned outputs are to be discussed, including the merged SOTER database for the "Central and Eastern Europe" sub-region, maps of selected types of soil degradation, interpretation of soil vulnerability, issues such as cross-border correlation, issues related to missing soil (degradation) attribute and/or spatial data. It is also expected that the participants will formulate a realistic time frame for finalizing the various outputs for ultimate presentation to a wider user-community. The concluding report of the project, with copies of the databases and selection of thematic (digital) maps, is expected to be officially submitted to FAO by the end of April 2000 (see part I, this volume).

One of the recommendations of the first international workshop of the SOVEUR project, held in Wageningen (1-3 October, 1999), was as follows: "there is a need to improve communication between different groups working on similar topics". Thus awareness on SOVEUR project activities including project objectives, with possible reference to methodological aspects and anticipated outputs, should be increased through newsletters, publication, workshops and enhanced communications both within and outside the participating national institutes of the SOVEUR project. However, at this stage, no actual data or maps, outputs or results from the project should be included in such awareness efforts before the final products of the project are officially endorsed by participating national institutes (countries) and the final report submitted and cleared by FAO.

In this respect, the following actions were undertaken by FAO. The testing of the basic methodologies at the heart of the SOVEUR project, i.e. the Global Soil and Terrain Database (SOTER) and the land degradation assessment has been ongoing in different regions and countries since the inception of the SOVEUR project, for example:

1. The Expert Consultation on Integrated Soil Management for Sustainable Agriculture and Food Security in the Southern and East Africa Sub-Region was held in Harare, Zimbabwe, December 1997, with the participation of FAO and ISRIC, and ten countries of the Sub-Region (Eritrea, Ethiopia, Kenya, Malawi, Namibia, South Africa, Tanzania, Uganda, Zambia and Zimbabwe). The participants discussed in a participatory manner the issues related to assessment of human-induced soil degradation, proposals, methodologies for assessment of soil vulnerability to different degradation processes with reference to the SOVEUR project (as an early warning system) and how it can be used for the Sub-region (data availability to carry out such assessment).

2. As a follow-up of the above mentioned Expert Consultation a Network entitled "MATSUI-NET" (Management of Degraded Soils in Southern and East Africa) has been established with the participation of eight countries in the Sub-Region (Ethiopia, Kenya, Malawi, South Africa, Tanzania, Uganda, Zambia and Zimbabwe). In the first meeting of the Network held in Harare, December 1998, the members endorsed the

need for similar SOVEUR methodologies for the assessment of land degradation as it is a serious problem in the Sub-Region.

3. Last year FAO published SOTER-shells for Northeast Africa, and together with ISRIC and UNEP a continental SOTER for Latin America and the Caribbean was finalized. Results were published as CD-ROMs in the FAO *Land and Water Digital Media Series*.

4. A SOTER-shell product is under preparation for the whole of Northern and Central Eurasia at 1:5 million scale, covering China, Mongolia and all countries of the former Soviet Union. Part of this data will be replaced by the SOVEUR database.

5. A SOTER product is also under preparation for Southern Africa and parallel with the present SOVEUR Workshop, an Expert Consultation is now running in Petrolina, South Africa on Land Resources Inventories/SOTER, National Soil Degradation Assessment and Mapping and its Impact on Soil Productivity (SOTER and NSDAM). Participating countries are Botswana, Kenya, Lesotho, Malawi, Namibia, South Africa, Swaziland, Zambia and Zimbabwe. Reference to the SOVEUR project with its activities, objectives and expected outputs will be a subject of discussion. A guideline integrating the various methodologies involved, including SOVEUR, will be presented at that workshop.

6. Early last month in a meeting held at FAO in Rome, where several Eastern European countries participated, the European Soil Bureau pledged to deliver a SOTER product at 1:5 million scale for the whole European region.

7. The assessment of the land degradation status has received considerable attention with several workshops illustrating the methodology originally developed under ASSOD and refined further in the SOVEUR project. These workshops include:
   a) The 6th International Meeting on Soils with Mediterranean Type of Climate (ISMTC), held in Barcelona, Spain, 4-9 July 1999, and organized by the University of Barcelona, the International Union of Soil Sciences, the Spanish Society of Soil Science and the European Society for Soil Conservation (ESSC). During the presentation of a FAO paper and a special session devoted to present the related activities of FAO, ESSC and European Soils Bureau, the SOVEUR activities, objectives and expected outputs were mentioned.
   b) The International Workshop on Rehabilitation and Management of Polluted Soils, as one of the activities of the FAO project TCP/ROM//8822: Rehabilitation of Polluted Soils in Romania. During the workshop a new FAO Network on Protected Soils in Central and Eastern European Countries (PRO SOIL in CEEC) was established, with the membership of Bulgaria, Czech Republic, Lithuania, Poland, Romania and Slovak Republic, with Canada, England and USA as associate members. One of the suggested activities of the Network is the development of a uniform methodology based on results from the SOVEUR

project for assessment of soil vulnerability and the status of soil pollution in participating countries, with a view to identifying broad areas of soils considered at risk form re-mobilization of specific contaminants subsequent to environmental change.

c) The International Workshop (third meeting) of the FAO Global Network (SPUSH) on Integrated Soil Management for Sustainable Use of Salt Affected Soils (30 countries from different regions of the world are members of this Network), held in Izmir, Turkey, 6-9 September 1999. In the workshop a guideline integrating the various methodologies including SOVEUR as available methodology for assessment of salinity/sodicity and vulnerability of soils to salinity/sodicity (warning system) was discussed with reference to the activities and objectives of the SOVEUR project.

d) The recently held EU-sponsored meeting on combatting desertification in Sardinia (9-12 October 1999).

e) The International Congress on Soil Sensitivity and Vulnerability in Florence (18-21 October 1999), Italy, organized by the Italian Society of Soil Science (ISSS) and European Soils Bureau (ESB). FAO and ISRIC presented papers with the objective to increase awareness of the SOVEUR project.

8. National and land degradation assessment projects were started in South Africa and Zambia, while ISRIC and UNEP tackled a similar exercise in a pilot project in Zimbabwe.

9. Publications and Newsletters. The FAO is preparing three FAO Soils Bulletins on:
   a) Management and Rehabilitation of Polluted Soils
   b) Guidelines on Integrated Soil Management for Sustainable Use of Salt-Affected Soils
   c) Integrated Management of Degraded Soils in Sub-Saharan Africa.

   In each of the mentioned FAO publications a chapter is being devoted, according to the title, to discuss the available predicting methodologies to assess soil vulnerability and status of soil pollution or soil salinity/sodicity or soil degradation.

   FAO is also preparing Newsletters and Web Page sites for each of the three mentioned Networks (SPUSH, PRO SOIL in CEEC and MADSEA Networks) where reference to the SOVEUR Project's activities, objectives and expected outputs will be included.

The target beneficiaries and expected users of the SOVEUR project outputs depend on the mapping scale of these outputs and associated information and database. However, as a general conclusion in the first workshop of the SOVEUR project held in Wageningen, October 1997, it was observed that working at the scale of 1:2.5 million is an excellent exercise for integrating data and expertise from a range of countries. Therefore based on the project activities, expected outputs and decided level of detailed information or mapping scale, the following users can be anticipated:

1. The immediate users will be the *Ministries in the Participating Countries* which will utilize the produced geographic database and maps in their decision-making process. This will also result in their increased awareness of the significant role of soil in protecting the food and water supply.

2. The *Ministries of Planning and Development* in the participating countries will also use the produced database and maps for policy and strategy formulation at the regional, as well at national level. For example, by identifying areas considered most at risk and to decide on corrective action at national or regional level.

3. Some countries in Europe have started systematic recording, monitoring and clean up programmes of contaminated soils, as well as rehabilitation of degraded soils based on established reclamation methodologies. Improved data on the extent of soil degradation and pollution and establishment of *Monitoring Networks* to assess the effectiveness of measures that have been put in place, are seen as a pre-requisite to any further coordinated approach to soil protection in the whole of Europe. The outputs of the SOVEUR project are expected to be a good reference and base for any suggested national *Soil Quality Monitoring System*.

4. The FAO carried out assessment of land resources and production constraints in Africa. The method used is based on soil data from the FAO GIS, using the FAO/Unesco Soil Map of the World, the Fertility Capability Classification (FCC) developed by the North Carolina State University, and agro-climatic data from FAO's Global Agro-ecological Zones Study. The SOVEUR methodology can be used to support such efforts in *Identifying the Production Constraints* in different regions of the world.

5. In case of point-sources pollution or degradation process from other countries sharing borders, *Inter-Governmental Decisions for Corrective Measures* can be undertaken to protect any negative effects on crop quality and quantity and ultimately on human health and biodiversity.

6. It is also anticipated that the project will contribute to *Strengthening of the Capabilities and Information of National Environmental Organization in Central and Eastern Europe*. The maps and database created by the project can serve to increase general awareness of soil vulnerability to specific types of pollution of public health concern, allowing problem areas to be identified for subsequent environmental protection studies and measures to be undertaken.

7. *International Organizations and Societies like FAO, UNEP, IUSS, ISRIC*, etc., will benefit from the outputs of the project to decide on priorities, corrective actions, future programmes or projects in specific countries or areas. Selection of pilot farms for such projects concerning introduction of appropriate rehabilitation and management technologies of degraded soil, polluted soil or salt affected soil, etc., should be based on similar database/maps produced by the SOVEUR project.

8. As mentioned before, one of the activities of the three FAO Networks (SPUSH, PRO SOIL in CEEC and MADSEA Networks) is the *Development of a Uniform Methodology for Assessment of Soil Degradation*, including human-induced degraded soils, salt affected soils or polluted soils with a view to identifying the extent of the problems. This method can be based on that developed for the SOVEUR project.

9. The types of maps produced by the SOVEUR project could be an *Introduction for Papers, Lectures in Workshops related to Soil Degradation including Salinity and Pollution*, etc., to discuss methodologies, severity and extent of the problem. As mentioned, a chapter will be devoted in each of the three FAO publications under preparation, to discuss the available methodologies for predicting soil vulnerability and status of human-induced soil degradation including soil salinity/sodicity and soil pollution.

10. *Soil Degradation and Soil Quality are related to the Use of the Land*. Land use has a profound influence on "dynamics", soil characteristics such as pH and redox conditions. Therefore, the project, when assessing the soil system's vulnerability, considers distinguishing between types of land use as an important parameter in producing relevant maps. However, the status of land degradation, particularly pollution, should be considered as the base for *Appropriate Land Use Decisions*. Land users in areas where improvements are accompanied by appropriate land use, particularly where soils are polluted, are indirect anticipated users of the SOVEUR outputs.

11. These database/maps can be considered as a *National Resource Information System* and base to find a timely, lasting solution and integrated, management technological package appropriate to the problem of environmental degradation to stop degradation processes and to increase productivity of such degraded soils and environmentally accepted, safe standards for the production of goods for human consumption. *Availability of such database/maps will assist in defining the additional fundamental research which should be executed to arrive at better remediation technologies*.

12. The project also contributes to strengthening of the capabilities of national research institutes and in general soil science communication. Based on methodologies and guidelines developed to compile a soil and terrain digital database and assess land degradation and soil vulnerability, many *Other Research Fields can be developed for Different Research Institutes* according to their field of interest, for example, producing maps of potential land capability, land suitability, nutrient movement and groundwater interaction.

13. The participating countries are of very different sizes, so in future, smaller countries may wish to prepare large-scale maps for more detailed information, particularly soil profile references, hot spots (point resource pollution) or areas considered at risk from mobilization of specific contaminants. The *Larger Scale Maps* may be developed especially for the smaller countries following similar methodology. Also based on

methodologies and guidelines developed by the project, larger scale and more detailed maps can be produced for other purposes such as legislation, land evaluation and pricing, taxation, etc.

PART III: COUNTRY PAPERS

Belarus in SOTER database

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Introduction

In order to facilitate decisions about inter-state problems on rational use of soil resources and on soil conservation, the creation of an automated soil and terrain (SOTER) database is rather urgent.

Methodological aspects

Compilation of SOTER database

Having familiarized ourselves with the guidelines for compiling a SOTER database, the methodology and the short-term and long-term tasks, the Republic of Belarus was connected to the realization of the SOVEUR project at the end of 1997. We created a digital database of current soil resources in Belarus, including information on the type and degree of their pollution and degradation.

In accordance with the "Guidelines for the Compilation of a 1:2, 500,000 SOTER Database (SOVEUR Project)" (Batjes and Van Engelen, 1997), we compiled a soil and terrain database for Belarus. We used all necessary references, and accessed materials from a number of institutes in the Republic (Belorussian Research Institute of Soil Science and Agrochemistry, State Committee on Land Management and its institutes - national and regional, Belorussian Agricultural Academy, etc.). We also used cartographical materials of various types and scales.

Taking into account all available information on the subject at hand, the territory of Belarus was divided into 495 Terrain Components which, according to the characteristics shown by their soil individuals, coincide with the Terrain Units. Each Terrain Component was characterized by its Soil Components. There are 863 Soil Components in Belarus which have been characterised by 95 representative soil profiles.

The source of each profile (profile database and laboratory where it was analysed), and information about the sites altitude, latitude/longitude, height above a sea level, and the soil classification (FAO, 1988, and national system) are given in the data base.

Each soil profile has been characterized in terms of its horizons. All mandatory attributes for horizons have been filled-in on forms, in accordance with the Guidelines. Missing analytical data, have been coded "-1" and "-0.1".

Information about the source of the soil profiles, laboratory, and analytical methods has been documented on the forms, conforming with the guidelines.

Compilation of soil degradation status and pollution database

The database on pollution and degradation of Belarus soils was compiled according to the “Guidelines for the Assessment of Human-Induced Soil Degradation in Central and Eastern Europe" (Van Lynden, 1997). In Belarus, soil degradation prevails above soil pollution (except for radioactive pollution, which forms a separate, yet important issue). The processes of water and wind erosion are especially important. With reference to the type and degree of these and other degradation processes, we mapped 32 soil degradation status units for Belarus.

Each individual polygon was characterized by its combination of degradation types, their degree and relative extent, and also the inferred impact on the environment. In addition, the main causes of soil degradation were taken into account, as well as the rate of degradation over the last decade or so. All these data were entered in the SOVEUR “Degradation Matrix Table".

Soil pollution in Belarus is mainly local and mainly associated with large industrial centres. As such, it has been entered into the database using the geographical coordinates of the relevant sites. The monitoring system, of the State Committee of Hydro-Meteorology of Belarus, includes the 36 largest cities of the Republic. However, the monitoring data we received show that the analysed concentrations for soil pollution do not exceed the “A-levels” (see Van Lynden, 1997, p. 11) around the majority of cities. Thus, in order to create the database on soil pollution and degradation for Belarus we used materials from the Belorussian Research Institute of Soil Science and Agrochemistry, the State Committee of Hydro-meteorology of Belarus, and data held in the Ecological Bulletin.

Professor Smeyan was in charge of the scientific management of all work related to compiling the SOVEUR databases for Belarus.

Conclusions

We obtained rather interesting and objective information about current soil conditions, which are now used in work on complex cadastrical matters to estimate soil resources of the Republic, to develop remediation schemes and anti-erosion measures in selected agro-ecological areas, and to create national parks and reserves. This information can be used to develop scientifically proven options for conserving the ecological stability of the soil cover of Belarus.

The SOTER database for Central and Eastern Europe can be used in the near future to aid in decision making with respect to questions that are to be considered at the International scientific conference "Europe - our common house".

In the future SOTER may be used, for example, to develop forecasting systems for both national and interstate protection of the environment as well as conservation management, in which soil conditions deserve careful consideration.

The inconvenience of inputting and viewing of data by means of the SOTER software must be mentioned. As there currently is no built-in capability for viewing stored data in a tabular format, this complicates the checking, updating, and analysis of the entered data.

References

Batjes, N. H. and Van Engelen, V. W. P. (1997) Guidelines for the compilation of a 1:2,500,000 SOTER database (SOVEUR Project), Report 97/06, pp. 58. ISRIC, Wageningen.

FAO (1988) *FAO-Unesco Soil Map of the World, Revised Legend (with corrections and updates)*. ISRIC, Wageningen, 140 pp.

Van Lynden, G.W.J., 1997. Guidelines for the assessment of soil degradation in Central and Eastern Europe (rev. ed.). Report 97/08b, pp. 22, ISRIC, Wageningen.

Bulgarian contribution to the project: Mapping of Soil and Terrain Vulnerability in Central and Eastern Europe (SOVEUR)

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Introduction

Following the instructions and guidelines from ISRIC, as general coordinator of the SOVEUR project, the N. Poushkarov ISSA team with the help of two external specialists (I. Nikolov a GIS expert, and D. Vangelov a geologist) prepared the SOTER and SOVEUR databases for Bulgaria. The first step was to collect the sources of information for all items in SOTER and SOVEUR databases. It was established that the geoinformation is available on maps in different scales and only two of them, the physiographic map provided by ISRIC and the soil map provided by INRA, were digitized. So the second step was to evaluate the existing information and to apply GIS technology for delineation of SOTER and SOVEUR units.

Development of a SOTER database

A geology map, at scale 1:2,500,000, was compiled according to the specified lithology classes (see Batjes and Van Engelen, 1997) using the 1:500,000 engineering-geology map of Bulgaria (Kamenov, 1963) and the 1:1,000,000 scale geology map of Bulgaria (Bonchev *et al.*, 1973). This map was digitised and overlaid by the digital version of the physiography map provided by ISRIC, using GIS technology. The criterion for delineation of a SOTER unit was that its area should be at least 159 km^2. As a result 146 SOTER units (SU) were delineated, numbered from 2 to 147, and a digital map of the SOTER units was prepared. This procedure was used also for determining the terrain components in each SOTER unit, which occupied more than 15% of the SOTER unit. An exception to this criterion were some water bodies, such as dams, lakes and other water reservoirs with smaller extents.

The proportion of the soil components in each SOTER unit was determined using overlaying of the digital version of the SOTER map and a digital version of the soil map of Bulgaria in the scale 1:1,000,000, provided by INRA. The latter was the final result of the project CESD N 392 EHL/SW (Kolchakov *et al.*, 1994). The restriction of the SOTER methodology that each soil component should be more than 15% of the area of the given SOTER unit, leads to omitting of soil units, the extent of which is not so small in cases of large SOTER units. Sometimes the omitted soil units are very important for describing the degradation status of the territory and/or for environment impact assessment. Typical cases for Bulgaria are Fluvisols which usually cover small areas of the territory, but have leading agricultural and ecological significance.

The attribute data for the SOTER database were obtained from the following sources. The terrain units and components characteristics were defined using description of the units delineated on the physiographic map and the compiled geological map, map of horizontal distribution of the relief at 1:500,000 (Gulubov, 1973), map of the vertical distribution of the relief (Danchev, 1973), hypsometric map at 1:1,000,000 (Atlas of Bulgaria, 1973), hydrogeologic map at 1:1,500,000 (Gulubov *et al.*, 1973), information of the groundwater of Bulgaria (Antonov and Danchev, 1980), Geography of Bulgaria (1997), and expert assessments.

The presented information concerning groundwater level is not very reliable as there are no systematic data for the whole country. More precise data exist for groundwater in the river terraces and of the mineral water springs. This parameter has very high spatial and time variability. The groundwater level in the consolidated hard bed rocks could not be determined and these cases are indicated with 0 (zero) in the database. Groundwater level below 100 m is coded as 99 in the database.

The soil components characteristics were determined using the attributes of the digital soil map of Bulgaria (scale 1:1,000,000) provided by INRA, the soil genetic map of Bulgaria at 1:400,000 (Koinov, 1968), and expert assessments.

The data of the 20 representative profiles used in the geographic database for CEE countries (Kolchakov *et al.*, 1994) were used for the SOTER profile database. The soil components are characterised using 19 of these 20 profiles. Some of the soil components, such as Chromic Luvisols, were characterised with different profiles from other SOTER units, because of their specificity which could not be expressed by the proposed soil unit codes. Infiltration rate is determined on the basis of experimental data (Dilkova, 1985).

The horizon attributes were determined by the methods applied in N. Poushkarov Institute of Soil Science and Agroecology (Penkov and Mincheva, 1976). The soil particle size distribution is determined by the method of Katchinski (1956). These data are presented in Appendix II of the Technical Report for the SOVEUR project. In the SOTER database are stored graphically interpolated data in order to obtain silt (0.05-0.002 mm) and clay (<0.002 mm) size- fractions, which allow to assess the texture class according to the Soil Survey Staff (1993). This interpolation is used for the European map and it gives almost the same results as the transformation proposed by Rousseva (1997). The carbonates were distributed in proportion given at the end of the Appendix II of the Technical Report.

Compilation of soil degradation status database

The SOVEUR database of the status of soil degradation for delineated SOTER units of Bulgaria was created according to the guidelines of Van Lynden (1997), using the available information.

Industrial soil pollution

The list of places, area of the affected soils, type of pollutants and sources of polluting emissions published in the Government Decree No. 50 (1993) are used as input data for determining the industrial soil pollution.

Acidification, pollution by pesticides, organic matter and nutrient status changes, eutrification

During the last 10 years the country was not monitored for soil acidification, soil pollution by pesticides and other organic contaminants, organic matter and nutrient content changes. There are point data obtained in the long-term controlled field experiments, which are used for scientific investigations. There are monitoring data for pH, NPK covering the arable territory of the country before 1990, which are not published. The available information does not indicate such problems for larger territories.

Water and wind erosion

The methodology used in CORINE (1992) and MARS-MERA (1995) is applied for water and wind erosion risk assessment (Land Degradation Mapping, 1997). The estimation of the erosion status in each SOTER unit is done according to Van Lynden (1997) and expert evaluations on the basis of risk assessment and the information of the Map scheme of regions with dominant degree of water erosion in Bulgaria at scale 1:1,000,000 (Biolchev *et al.*, 1957) and map of regions with different degree of potential wind erosion at scale 1:1,000,000 (Georgiev *et al.*, 1985).

Physical deterioration

The current status of the soil physical degradation was estimated on the basis of a comparison of soil structure between the cultivated and the analogues virgin profiles of the main soil units in Bulgaria (Dilkova, 1985; Dilkova and Kerchev, 1985; Dilkova *et al.*, in press). The relative deterioration of the soil structure is assessed as per cent of decrease of the aggregate stability, the volume of pores with drainage-aeration functions, pores of available water, and infiltration and filtration rates in arable soils. These scientific results were combined with the information presented by the Bulgarian participants in the GLASOD project (Oldeman *et al.*, 1990).

Conclusions

The Bulgarian participants find the SOVEUR project methodology an extremely useful approach for systematisation and presentation of the information obtained till now, and as a framework for organising future monitoring programs. This will accelerate and facilitate solving of actual agroecological problems, both at international and national levels. The Bulgarian team hopes that the applied SOTER and SOVEUR methodologies and the high density of the analytical soil characteristics data in N. Poushkarov ISSA is a valuable precondition for further successful collaboration in projects and studies at a larger scale.

References

Antonov, H. and D. Danchev, 1980. *Groundwater of Bulgaria*. Publ. house "Tehnika", Sofia.

Atlas-environment of the Republic of Bulgaria, 1995. Third Ministerial conference, Environment for Europe, Sofia (23-25 October 1995).

Batjes, N.H., 1997. Methodological framework for assessment and mapping of the vulnerability of soil to diffuse pollution at a continental level. Report 97/7, ISRIC, Wageningen.

Batjes, N.H. and V.W.P. Van Engelen (eds.), 1997. Guidelines for the Compilation of a 1:2,500,000 SOTER Database (SOVEUR Project), Report 97/06, ISRIC, Wageningen.

Biolchev, B. *et al.*, 1957. *Map scheme of regions with dominant degree of erosion in Bulgaria*, Bulgarian Academy of Sciences, Institute of Soils, Sofia.

Biolchev, A. *et al.*, 1973. Soil erosion areas map (1:2,000,00)0. In *Atlas of* Bulgaria. p.84.

Bonchev, B. *et al.*, 1973. "Geologic map of Bulgaria (1:1,000,000)". In *Atlas of Bulgaria*, pp. 24-25. Bulgarian Academy of Science, Sofia.

CORINE, 1992. CORINE soil erosion risk and important land resources in the southern regions of the European Community EUR 13233 EN. Commission of the European Communities, ECSC-EEC-EAEC, Brussels.

Danchev, D., 1973. "Map of the vertical distribution of the relief of Bulgaria (1:500,000)". In *Atlas of Bulgaria*, p. 37. Bulgarian Academy of Science, Sofia.

Dilkova, R. 1985. *Structure and aeration of the main Bulgarian soil units*. Habil. diss., Sofia, p. 272.

Dilkova, R., D. Stoichev, and M. Nikolova, 1993. "Soil monitoring in Bulgaria". *Report at the International Workshop on Harmonisation of Soil Conservation Monitoring System*, 14-17 September 1993, Budapest.

Dilkova, R. and G. Kerchev, 1985. "Impact of the agricultural activities on soil physical degradation". *Roczniki Gleboznawcze*, t. XXXVI, No 1, s. 79-83, Warszawa.

Dilkova, R., M. Kirova, G. Kerchev, in press. "Evaluation and grouping of soils in accordance with their susceptibility to anthropogenic degradation".

Djodjov, H., 1988. Soil wind erosion scheme (1:2,000,000) with a 3-digital code.

Galabov, Zh. *et al.*, 1973. "Hydrogeologic map (1:1,500,000)". In *Atlas of Bulgaria*. p.32.

Galabov, Zh., 1973. "Map of the horizontal distribution of the relief of Bulgaria (1:1,500,000)". In *Atlas of Bulgaria*, p. 36. Bulgarian Academy of Science, Sofia.

Georgiev, G., Hr. Djodjov, and Iv. Djilianova, 1985. *Instructions for designing activities and technologies for wind erosion control*. Agropromprekt, Sofia.

Ganev, S. , and A. Arsova, 1980. "Method for determining the strongly acid and weakly acid cation exchange in soil". *Soil Sci. and Agrochemistry*, 3, 22-33.

General geographic map of Bulgaria (1:1,000,000), 1973. In *Atlas of Bulgaria*, pp. 5-6. Bulgarian Academy of Science, Sofia.

Yordanov, M. and D. Donchev (eds), 1997. *Geography of Bulgaria*. Academic Publishing House "Prof. Marin Drinov", Sofia.

Government Decree N 50, March 10, 1993. "List of polluted lands by industry". State Newspaper N 24.

Hypsometric map of Bulgaria (1:1,000,000), 1973. In *Atlas of Bulgaria*, pp. 20-22. Bulgarian Academy of Science, Sofia.

Hypsometric map of Bulgaria (1:300,000), 1981. Ministry of Building and Architecture, Department of geodesy, cartography and cadastre, Sofia.

Kamenov, B., 1963. *Engineering-geological map of Bulgaria*. Bulg. Acad. of Sciences. Kartproekt, Sofia.

Katschinski, N.A., 1956. “Die Mechanische Bodenanalyse und die Klassifikation der Boden nach ihrer Mechanischen Zusammensetzung”. *Rapports au Sixieme Congres International de la Science du Sol, Paris*, B, 321-327.

Kirilov, M., 1973. “Morphographic map of Bulgaria (1:2,000,000)”. In *Atlas of Bulgaria*, p. 46. Bulgarian Academy of Science, Sofia.

Kolchakov, I., 1994. *Project CESD-Communataree and N. Poushkarov Institute of Soil Science and Agroecology*, N 392 EHL/SW.

Koynov, V., 1968. *Soil genetic map 1:400,000 with field description, laboratory data, explanatory booklet*, Sofia.

Land Degradation Mapping, 1997. *PHARE-MERA Project - Bulgaria, Final report*, JRC, Ispra, 1997, Sofia, Bulgaria.

Marinov, V., 1957. *Hydrological reference book of Bulgarian rivers*. Bulgarian Academy of Science, Publ. house “Nauka i izkustvo”, Sofia.

MARS-MERA Project, MERA Land Degradation Subproject - Bulgaria, 1995. “Description of the existing information and methodology for assessment of the water and wind erosion of the soils in the Republic of Bulgaria”, *Interim report*, November 1995, Sofia.

Oldeman, L.R., R.T.A Hakkeling and W.G. Sombroek (eds.), 1991. *World Map of the Status of Human-Induced Soil Degradation*. *An Explanatory Note*. Second revised edition, ISRIC, Wageningen, UNEP, Nairobi.

Penkov, M.. and M. Mincheva, 1976. *Manual for soil science practice*. Zemizdat, Sofia.

Rousseva, S., 1997. “Data transformation between soil texture schemes”. *European Journal of Soil Science*, December 1997, 48, pp. 749-758.

Stoichev, D. A. and I. H. Kolchakov, 1997. “Degradation status of Bulgarian Soils. Overview of the available information”. In: Batjes, N.H. and E.M.Bridges (eds) *Implementation of a soil degradation and vulnerability database for Central and Eastern Europe*. Proceedings of an international workshop (1-3 October 1997). ISRIC, Wageningen.

Stoichev, D. and I.H.. Kolchakov, 1996. “Vulnerability of the main Bulgarian soils to acidification”, *EU Workshop on Land information systems developments for planning the sustainable use of land resources*, 20-23 November, Hannover, Germany.

Stoichev, D., I. Kolchakov, and B. Nikolov, 1995. “Development of the SOTER in Bulgaria”. Report at the Seminar (Training Course on the SOTER database in the Central and Eastern European regions, 13-17 June, Budapest.

Tempel, P.., 1997. Global and National Soil and Terrain Digital Databases (SOTER) Scale 1:2,500,000. Attribute database user manual adapted for SOVEUR. Report 97/09. ISRIC, Wageningen.

Tjurin, I.V., 1965. ‘*Agrochemical methods of soil analysis’*, Nauka, Moscow.

Van Lynden, G.W.J., 1997. Guidelines for the assessment of the status of human-induced soil degradation in Central and Eastern Europe. Report 87/08, ISRIC, Wageningen.

Vaptzarov, I., 1973. “Geomorphological map (1:1,000,000)”. In *Atlas of Bulgaria*, pp. 44-45. Bulgarian Academy of Science, Sofia.

Yolevski, M. *et al.*, 1973. Soil map (1:1,000,000). In *Atlas of Bulgaria*. pp. 80-81.

Contribution of the Czech republic to the SOVEUR project

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A soil map in accordance with the SOTER methodology has been compiled in the framework of the SOVEUR project. The following strata of the national PUGIS system have been used at scale 1:500,000: geomorphological maps (typological classification of the relief, slope aspects, vertical dissection of the landscape); the map of soil parent materials; and the map of soil associations. The SOTER map has been compiled at scale 1:1,000,000, and then adapted to the scale of 1:2,500,000. It has been designed in two versions. The first version, which has been submitted to ISRIC for use in the SOVEUR project, comprises 22 SOTER units (Table 1). The second version, which reflects more adequately the SOTER methodology (geomorphology (more details); parent materials; soil associations), has 38 SOTER units.

Attribute data for terrain units, terrain components, soil components and soil profile characteristics exist for all 22 SOTER units considered on the first version. Soil profile descriptions and laboratory data are presented for the prevailing part of SOTER units by statistically processed data, and for some units we used data of single profiles.

All delineated SOTER units are accompanied with data, which concern the most important degradation types. All kinds (types) of degradation are assessed from the view-point of the extent (% of the area of a polygon type), degree, impact and cause of the degradation. All remarks are focussed mainly on the geographic localization of degradation phenomena. Especially erosion and contamination, but also acidification and deterioration of landscapes by coal mining. Whereas the assessment of erosion is a vulnerability assessment, the assessment of contamination includes three kinds of data (with localization): soil contamination (exceeding of the upper boundary of background values); geogenic concentration of trace elements; vulnerability assessment, which depends upon soil immobilization potential.

For the second version of the SOTER map, which reflects more adequately the SOTER principles, as has been observed earlier, it was not necessary to process the separate characteristics of all SOTER units for the database, in cases where the same soil component dominates (from the viewpoint of soil taxonomy and parent materials). This second version of the database, however, has not been submitted to ISRIC.

Table 1 Legend for SOTER database

SOTER unit	Major landforms	Soil parent materials	Soil associations (dominants)
1.	river flood plain	fluvial sediments	Fluvisols
2.	river terraces and flood plains	gravelly sands, sands with loessic admixture or covered with loess, fluvial sediments	arenic Chernozems, Regosols(Arenosols)
3.	river terraces and flood plains		arenic Regosols (Arenosols), Luvisols and Chernozems
4.	plains, depressions	loess	Chernozems (calcic, luvic)
5.	plains, depressions	loess like sediments, polygenetic loams	Luvisols (haplic, glossalbic)
6.	depressions, plains	loess like sediments, polygenetic silty loams, tertiary loams and clays; mining areas (NW Bohemia)	Stagnosols (luvic, haplic), Anthrosols (NW-Bohemia mining areas)
7.	depressions, plains	marls, tertiary carbonaceous clays	Vertisols (haplic), Phaeozems (calcaric, stagnic)
8.	medium-gradient hills	sediments in landscapes with soil parent materials derived from transported weathering products of consolidated rocks	Luvisols (haplic) and Cambisols (eutric)
9.	medium-gradient hills		Stagnosols (haplic, luvic) and Cambisols (eutric, dystric)
10.	medium-gradient hills	sands, sandstones	Cambisols (dystric, eutric) Podzols (arenic)
11.	medium-gradient hills	marls, tertiary clays, limestones; mining areas	Cambisols (eutric) and Pelosols, Luvisols, Leptosols (rendzic), Anthrosols (mining areas A-Bohemian area)
12.	medium-gradient hills	transported weathering products of schists, shales	Cambisols(eutric, dystric)
13	medium – gradient hills	transported weathering products of acid (intermediate) igneous and metamorphic rocks	Cambisols (eutric, dystric)
14	rolling highlands	transported weathering products of consolidated rocks	Dystric Cambisols (= Alochrisols)
15.	high-gradient hills, highlands	transported weathering products of consolidated sedimentary rocks	Cambisols (dystric)
16.	high-gradient hills, highlands	mafic	Eutric Cambisols
17.	high-gradient hills, highlands	metamorphic, igneous	Cambisols (dystric)
18.	medium-gradient mountains	transported weathering products of consolidated rocks sedimentary	Cambic, haplic Podzols, (hyper) dystric Cambisols
19.	medium-gradient mountains	metamorphic, igneous	
20.	high-gradient mountains	transported weathering products of consolidated rocks sandstones	
21.	high-gradient mountains	sedimentary	
22.	high-gradient mountains	metamorphic, igneous	

The vulnerability of soils to pollution, which is the main problem of the SOVEUR project is a soil quality, which reflects the potential of soil to decrease the hazards of pollutants inputs by means of the limitation of their transfer into organisms or hydrosphere by immobilization (sorption, degradation of organic xenobiotics).

The vulnerability to soil pollution manifests itself in regions or localities with increased inputs of pollutants. In the Czech republic three large regions – the North-, North-West Bohemia, and North Moravia – are endangered by industrial emissions (power plants, different industries), mainly due to the combustion of fossil fuels and small areas in the vicinity of some metallurgic or chemical industries of variable kinds of emissions. Fluvisols downstream from industrial cities are affected by flooding of the low terraces by waster waters. Big cities, such as Praha and Brno, are characterized by traffic emissions and old loads.

Soil vulnerability and degradation in Estonia

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Introduction

The soil cover of Estonia was mapped at scale 1:10,000 up to 1992, and this includes surveys of arable land, forests and other civil territories completed in 1989–91. After 1992, the remaining former Soviet military areas were studied also. On the basis of this large-scale survey, generalized medium-scale maps (1:50,000; 1:100,000) were compiled for all counties and for some natural regions during 1954–1990. At the same time, small-scale maps (1:200,000; 1:500,000, and 1:1,500,000) were produced as well (Rooma and Reintam, 1976; Kokk and Rooma, 1989; Rooma and Voiman, 1996; Rooma, 1996). In line with the activity of European Soil Bureau in 1995, a digitised “Soil Map of Estonia, 1:1,000,000” was compiled on topographic basis with FAO–1990 nomenclature as Legend (Rooma and Reintam, 1998). Within the SOVEUR project, co-ordinated by ISRIC (Batjes, 1997; Batjes and van Engelen, 1997), a soil map at scale 1:2,500,000 served as the basis of preparing a “Soil Degradation Map of Estonia” using the methodology of Van Lynden (1997). This map has been presented at the 10th ISCO Conference (Reintam *et al.*, 1999).

Material and methods

Large-scale soil maps were used for compiling both maps with scales of 1:500,000 and 1:1, 000,000 which served as a basis for compiling the 1:2,500,000 map. Thirteen soil map units (SMU) with various combinations of associated soils were distinguished for Estonia. Calcaric Regosols (RGc) and/or Stagnic Luvisols (LVj) are predominant in two, Eutric Gleysols even in four SMUs. Since Gleysols and Histosols cover 34 and 23% of the territory, respectively (Reintam, 1995), and they are represented in all SMUs with the exception of sandy massifs of Haplic Podzols, and large mire areas where Gleysols are lacking. Except for Histosol polygons, all SMUs consist of 3–4 soil taxonomic units (STU) while their relative minimum area was estimated at 15% (see Batjes and van Engelen, 1997).

The map of soil vulnerability and degradation was compiled using the same scale with initial polygons of SMUs as the basis. Soil pollution with heavy metals (Cph), water erosion (Wt), alkalinization (Cs), acidification (Ca), fertility decline and reduced organic matter content (Cn), compaction (Pc), urban and industrial land conversion (Pu), water logging (Pw) as well

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Proceedings of an international workshop (Busteni, 26-31 October 1999). ISRIC-RISSA-FAO, 2000.

as their impacts, degrees, causes and rates were assessed and described using the methodology elaborated by Van Lynden (1997a, b). Land without human-induced degradation was estimated as being stable under natural conditions (Sn). Proceeding from the territorial percentage of natural stability on a territory (0% in urban, mined, polluted and/or contaminated areas up to 100% on wetlands, in nature reserves and more or less virgin forest areas, *etc*.), generalized soil degradation units (SDU) were distinguished on the map of soil vulnerability and degradation. In most cases they correspond completely with SMUs, but in North-Eastern Estonia the latter are divided into several SDUs.

Results and discussion

Most Histosol and Gleysol expanses as well as large forested areas on different soil associations, are almost entirely (> 70%) natural, stable lands. Areas where the share of naturally stable soil situation is 50–70 (80) % can be divided into two categories: a) western lowland areas with current increase in both water logging of drained arable land and industrial or urban conversion, and b) southeastern end-morainic hills with water erosion, compaction, acidification and/or reduced organic matter content in the rest of the territory. Within other SDUs, the percentage of natural stable area is less than 50%.

Poorly functioning drainage systems have led to continuation of gleying and progress of initial water logging in large drained areas. This kind of physical degradation tends to have a negative impact even on neighbouring forested and arable lands. Long-time use of heavy machinery resulted in topsoil compaction, but also subsoil compaction for certain soil types (Nugis and Lehtveer, 1992). As a result of land privatization and the advent of new type tractors and other agricultural machinery, a decrease in soil compaction and accompanied seasonal surface over-moistening has occurred. Only Stagnic Luvisols and Planosols of Southern Estonia, and clayey Gleysols of the western lowland are still compacted.

Erosion-endangered areas with an inclination of the terrain larger than 3° make up 105,800 ha, which is about 10% of the arable land and 2.7% of the total territory (Kokk, 1977). Eroded and deluvial soils form 5.5% of the arable land. Eroded soils on the terrain with an inclination larger than 10°, accompanied by corresponding deluvial formations, occupy an area of more than 4,000 ha. In Haanja and Otepää-Karula Uplands about two thirds of SDUs are endangered by erosion. The share of erosion-endangered area in the peripheral part of these elevations is 10–30% per SDU. On the South-Eastern Tilly Plateau, water erosion (<10% per SDU) occurs only on valley verges. In the islands of the West-Estonian archipelago and in the sandy coastal areas of some mainland counties 77,400 ha of land may be endangered by wind erosion (Kokk, 1978). As the major part of Estonia is plain and soil texture is loamy, water and wind erosion do not present a natural hazard. Changes in land use, towards decrease in tillage and annual crop cultivation, have brought about decline of erosion even in the hilly topography of South-Eastern Estonia.

Over the last decades, towns, town-like rural settlements and industrial enterprises have rapidly spread at the expense of fields and forests, causing increase in urban and industrial land conversion. As a result, ecosystems have been destroyed on more than 200,000 ha of productive arable soils (Kokk, 1992a). However, the area covered by stone and asphalt can even be twice as large as that. Urban land conversion is characteristic not only of Northern industrial Estonia, but also of fast developing rural areas in the whole country. Several local points of industry as well as former Soviet military objects (airports, submarine nuclear bases, storage of nuclear residues, *etc*.) play an important role in soil contamination and pollution in urban-conversed (degraded) SDUs. Local soil pollution with fuels and other oil products, as well as with nuclear residues, is also characteristic of former military and military-industrial areas. Soil degradation, induced by both chamber-and-pillar and open-pit-quarry mining of oil shale and phosphorite, has deformed the entire soil cover and deteriorated soil physical, chemical and moisture relationships (Reintam and Leedu, 1994).

The chemicals used in Estonian agriculture do not usually act as pollutants for soils because some of them (nitrates) cannot be fixed and accumulated in soil, while others such as phosphates and heavy metals are able to form relatively stable complexes within solid soil structures. Their behaviour as Chemical Time Bombs, however, is plausible. Although inadequate agrotechnology and non-utilization of nutrients from manure and fertilizers cannot induce chemical degradation and/or pollution of soils, they give rise to contamination of soil water and natural water bodies with nitrogen. Sewage is the main source of water contamination with phosphorus. The present reduced use of fertilizers is evident. Pesticides have never been a problem in Estonia. In 10–12% of cases, the concentration of lead, uranium, cadmium and some other heavy metals is above the maximum permissible limit in the industrial regions of North-Eastern Estonia (Petersell and Ressar, 1993; Petersell *et al.*, 1997). In 2–3% of cases, these concentrations are twice as high. Geochemical mapping shows that on most of the territory metal relationships are far below the level of MPC (Petersell *et al.*, 1997).

Besides acid deposition (Frey, 1988, 1989) and slight acidification of sandy Podzols in Southern Estonia, alkaline deposition *via* the atmosphere is characteristic of the region of oil-shale and cement industry (Kokk, 1988, 1992b; Rajaleid and Tuuga, 1989; Mandre, 1995). At the same time, neutralization of acid contaminants has occurred largely because Rendzic Leptosols, Calcaric Regosols, Calcaric Cambisol–Luvisol complexes and different Gleysols on calcareous deposits form about 50% of the soil cover. About 75% of soil parent materials and 50% of bedrock are calcareous in Estonia.

Conclusions

Changes in the political and economic situation in Estonia, as well as the departure of Soviet troops have had a favourable impact on soil status and contemporary soil processes. More than half of the country's is naturally stable. Due to the decline in tillage intensity, soil erosion has slowed down even in the hilly end-morainic areas. Changes in mechanization of agriculture have resulted in an evident decrease in soil compaction. The fallowing of some arable land has led to stabilization and/or improvement of humus status, although the quality of humus is still reduced in Stagnic Luvisols, some Calcaric Regosols and sandy Gleysols. Urban and industrial land conversion is the main cause of soil degradation, not only in the surroundings of towns and mines but also around large rural settlements. Pollution with heavy metals and soil alkalinization too are related to urbanization and the influence of power, cement and oil-shale industry.

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References

Batjes, N.H. 1997. *Methodological Framework for Assessment and Mapping of the Vulnerability of Soils to Diffuse Pollution at a Continental Level (Version 1.0)*. Report 97/07, International Soil Reference and Information Centre, Wageningen.

Batjes, N.H. and Engelen van, V.W.P. 1997. *Guidelines for the Compilation of a 1:2,500,000 SOTER Database (SOVEUR project).* Report 97/06, International Soil Reference and Information Centre, Wageningen.

Frey, T. 1988. Acid Rains in Estonia. *Estonian Nature*, 1–12 (inside the back cover); 1989, 2.

Kokk, R. 1977. Spread of slopes and eroded soils on arable land in Estonia. In *Land Reclamation*, **II**, 8 (Ellermaa, E., ed.). Ministry of Agriculture, Dept. of Informatics. Tallinn, 24–30 (in Estonian).

Kokk, R. 1978. About the deflation dangerousness of arable land in Estonia. In *Land Reclamation*, 9 (Ellermaa, E., ed.). Ministry of Agriculture, Dept. of Informatics. Tallinn, 15–17 (in Estonian).

Kokk, R. 1988. Alkalinization of soils in North-Eastern Estonia. In *Estonian Soils in Numbers*, **VII**. Infocentre of Agroindustrial Committee. Tallinn, 87–93 (in Estonian).

Kokk, R. 1992a. Losses of fertile soils in the national economy. In *Problems of Soil Protection in Estonia* (Reintam, L., ed.). Valgus, Tallinn, 36–42.

Kokk, R. 1992b. Alkalisation of soils in North-East Estonia. In *Problems of Soil Protection in Estonia* (Reintam, L., ed.). Valgus, Tallinn, 103–107.

Kokk, R. and Rooma, I. 1989. A new map of Estonian soils. *Estonian Nature*, 10, 636–640, 684, 686.

Lynden van, G.W.J.1997a. *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.

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

Mandre, M. (Ed.) 1995. *Dust Pollution and Forest Ecosystems. A Study of Conifers in an Alkalized Environment*. Institute of Ecology. Publication **3**, Tallinn.

Nugis, E. and Lehtveer, R. 1992. On spreading of soil degradation by machines in Estonia. In *Problems of Soil Protection in Estonia* (Reintam, L., ed.). Valgus, Tallinn, 63–75.

Petersell, V. and Ressar, H. 1993. Heavy metals in Estonian soils. *Estonian Nature*, 4, 151–153, 160.

Petersell, V., Ressar, H., Carlsson, M., Mõttus, V., Enel, M., Mardla, A. and Täht, K. 1997. *The Geochemical Atlas of the Humus Horizon of Estonian Soils* (with 39 maps). Geological Survey of Estonia, Geological Survey of Sweden. Tallinn–Uppsala.

Rajaleid, A. and Tuuga, V. 1989. Contaminated Dystric Histosols in Kohtla-Järve region. In *Estonian Soils in Numbers*, **VIII** (Sarv, E., ed.). Infocentre of Agroindustrial Committee. Tallinn, 77–85.

Reintam, L. 1995. Soils in Estonia. In *Boden und Düngung* (E. v. Boguslawski, P. Limberg *et al*., eds.) Mitteilungen der Internationalen Arbeitsgemeinschaft für Bodenfruchtbarkeit der Internationalen Bodenkundlichen Gesellschaft, ISSS. Tartu, 122–131.

Reintam, L. and Leedu, A. 1994. Soil degradation induced by oil-shale mining. In *Conserving Soil Resources. European Perspectives* (Rickson, R. J., ed.). CAB International, University Press, Cambridge, 36–43.

Reintam, L., Rooma, I. and Kull, A. 1999. Map of soil vulnerability and degradation in Estonia. In *Abstracts. 10th International Soil Conservation Organization Conference* p. 66. West Lafayette, Indiana, USA.

Rooma, I. 1996. Soil Cover of Estonia, 1:1,500,000. In *Atlas of Estonia for schools*. (Aunap, R., ed.). Avita Press. Tallinn, 16–17.

Rooma, I. and Reintam, L. 1976. Soil map of the Estonian S.S.R. In *Transactions of the Tartu State University,* **393**. *Publications on Geography XIII,* 77–82. On the Occasion of the XXIII International Geographical Congress. Tartu.

Rooma, I. and Voiman, V. 1996. Soil Map of Estonia, 1:1,400,000. In *Estonia. Nature*. (Raukas, A., ed.). Valgus PH and Estonian Encyclopedic Press. Tallinn, 16–17.

Rooma, I. and Reintam, L. 1998. Soil Map of Estonia, 1:1,000,000. In *Soil Geographical Data Base of Europe at Scale 1:1,000,000. Version 3.28*. INRA, France.

Soil vulnerability assessments in Hungary: Country report on the activities and main results of the SOVEUR Project

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Introduction

The efficient prevention of undesirable (harmful) soil degradation processes and soil pollution requires *adequate* information on the soil/land, including their sensitivity/ susceptibility/vulnerability against various natural and human-induced stresses. The exact definition and quantification of soil vulnerability was the main objective of the present SOVEUR Project, using the internationally accepted SOTER concept, SOTER database and proving its multipurpose applicability.

Primary data sources in Hungary

In Hungary a large amount of information is available on the various natural factors as a result of long-term observations, survey and mapping activities (meteorological, hydrological, geological and geomorphological data: data, maps, descriptions, and evaluations).

During the last decades a considerable amount of soil and terrain (land site) information has accumulated in Hungary. This was the result of various national, regional and local programmes related to the inventory, mapping, monitoring and evaluation of soil conditions, land use and environmental problems.

A great number of thematic soil maps were prepared in various scales, with various content and accuracy. The most important maps are summarized in Table 1.

For the registration of soil changes three systematic monitoring systems were established:
- Soil fertility control systems (AIIR);
- Microelement survey;
- Soil information and monitoring system (TIM).

Table 1. Thematic soil maps in Hungary

Map	Scale	Date of preparation	Prepared for	Content	Author(s)
Practical soil maps	1:25,000	1935-1955	the whole country per topographical map sheets	thematic soil maps, field and laboratory data	Kreybig and coll.
Large-scale genetic soil maps	1:10,000	1960-1975	60% of the agri-cultural land of Hungary, per farming units	thematic soil maps, field and laboratory data	Coll.
Large-scale maps for amelioration projects	1:5,000-1:10,000	1960-	amelioration projects (occasionally)	thematic soil maps, field and laboratory data	Coll.
Large-scale maps of land evaluation	1:10,000	1980-1990	approx. 20% of the whole country per topographic map sheets	thematic soil maps, field and laboratory data	Coll.
Soil erosion	1:75,000	1960-1964	the whole country per topographical map sheets	soil map	Stefanovits and Duck
Soil factors determining the agro-ecological potential	1:100,000	1978-1980	the whole country per topographical map sheets	thematic soil maps	Várallyay *et al.*
Agro-topographical map	1:100,000	1987-1988	the whole country per topographical map sheets	thematic soil maps	Várallyay and Szücs
Susceptibility of soils to acidification	1:100,000	1985-1988	the whole country	soil map	Várallyay *et al.*
Hydrophyiscal properties of soils	1:100,000	1978-1980	the whole country per topographical map sheets	soil map	Várallyay *et al.*
Limiting factors of soil fertility	1:500,000	1976	the whole country	soil map	Szabolcs and Várallyay
Susceptibility of soils to physical degradation	1:500,000	1985-1988	the whole country	soil map	Várallyay and Leszták

Because of various reasons at present only TIM is functioning. TIM includes 1200 representative observation points: 800 points on agricultural land; 200 points in forests and 200 points in environmentally threatened "hot spots", where all important soil parameters are measured regularly: in 1-, 3- or 6-year cycles, depending on their changeability.

Integrated GIS data

In the last years the various existing Hungarian soil data were organized into a computerized geographic soil information system by the RISSAC GIS laboratory:

Agrotopographical System (AGROTOPO)
A regional scale computerized information system was developed in a scale of 1:100,000 for Hungary to provide many users with useful information on soils, land use and environmental protection problems.

Establishment of soils and terrain database for sustainable agriculture and environmental protection in Hungary (HunSOTER)
The HunSOTER provides an orderly arrangement of natural resource data through the creation of a computerized database containing available attributes on physiography, soils, vegetation, land use and climate. This database is linked to a geographic information system which contains the digitized map units. The Hungarian version of SOTER has been built up with various modifications to fit the methodology to Hungary.

Environmental conflict maps
The Land Degradation Mapping subproject of the PHARE-MERA/MARS project was to provide satellite-based land cover maps and digital databases at regional scale, showing the extent of land degradation (soil erosion by water and wind; development of extreme soil reaction; physical soil degradation; biological degradation; decrease in the buffering capacity of soil (soil pollution, toxicity)) in Hungary, and identifying those areas at risk from land degradation.

Case studies were implemented for demonstration of the multipurpose applicability of SOTER concept and the HunSOTER database for the evaluation of the vulnerability of land and susceptibility of soils to various degradation processes in Hungary at 1:100,000 scale:
- soil erosion by water;
- soil erosion by wind;
- soil acidification;
- soil salinisation/alkalization;
- physical degradation (compaction, structure destruction, sealing).

Control of soil pollution

The transport and transformation of various elements in the soil are controlled by abiotic and biotic soil processes. Most of the elements occurring on Earth can be found in the soil. Their quantity, quality, solubility, mobility; availability for micro-organisms, plants, animals and human-beings show extremely wide spectra. Most of these elements are essential for the living organisms, but - over a certain "threshold concentration" - a great part of the same elements can be harmful or even "toxic" for the same organisms. Consequently, the term "toxic elements" is not precise and not specific enough. A given element over its critical concentration can be toxic for certain soils (or more exactly for their biota), for certain plants, for certain animals, and for certain people. The identification of these relationships is a challenging task for future multidisciplinary researches. Their final result can be an imaginative "super-matrix" showing the potential "toxicity-pathways" under the given circumstances (from the total content, through solubility and mobility, up to the availability for various plants, animals and human-beings), and indicating the potential bio-deteriorations, their symptoms and further consequences.

According to this concept and the available soil database a series of maps were prepared on the vulnerability of soils (and groundwaters) to various potentially harmful chemical pollutants as nitrates, phosphates, heavy metals, other metals and other inorganic elements. The GIS-based territorial comparison of these vulnerability maps with the actual emission/imission and actual load maps exceedance maps will be prepared, representing a good scientific basis for the assessment of the pollution hazard and its prevention or control.

Hungarian activities in the SOVEUR Project

1. Compilation of the geometry of 1:2.5M SOTER database.
   - As a starting point, the Micro-region Cadaster of Hungary was used.
   - In the first approximation: SOTER unit = micro-region landscape unit.
   - Polygons representing units with small area (<160 km^2) were generalized, they were merged into their appropriate neighbour with the most similar physiography.
   - The final number of SOTER units is 173.
   - The spatial elements were transformed from the working projection system (Hungarian Unified Map Projection System, HUMPS) to the final UTM system.

2. Determination of the non-mappable SOTER elements.
   - The formerly eliminated small(er) units (with area < 160 km^2) were identified as terrain components.
   - The number of terrain components is 216.
   - Based on AGROTOPO database we identified the spatial extension of various genetic soil types under the terrain components. With the full knowledge of spatial ratios among different soil types and according to the SOTER rules (number of maximum components, minimum spatial ratio etc.) soil components were determined.
   - The number of soil components is 383.
   - The representative soil profiles were then selected from TIM database (Hungarian Soil Information and Monitoring System). The selected profiles represent the most typical Hungarian soil types.
   - The number of representative profiles is 40, with descriptions for 155 horizons.

3. Compilation of attribute data of 1:2.5M SOTER database according to codes given in SOTER manual and allocated in the predefined file structure.
   - Data on terrain units and terrain components were derived from partly the National Atlas of Hungary and partly from existing digital databases (groundwater, hydrography, DTM, HunSOTER etc.). In the course of the latter suitable GIS operation were applied.
   - Data on soil components were derived based on the full knowledge of the representative soil profiles assigned to each soil components.
   - Data on soil profiles and horizons were converted from the attribute data of TIM database.

4. Compilation of soil degradation information related to the polygons of the 1:2.5M SOTER database according to codes given by ISRIC.
   - Various degradation factors were evaluated partly based on MERA Land Degradation Database.
   - From the available part of AIIR microelement data set information on five heavy metals (cadmium, copper, lead, nickel, zinc) was queried. The coordinates of point locations were transformed into UTM system.

5. Materials provided to SOVEUR Program Coordinator include:
   - Geometry of 1:2.5M SOTER database, transformed to UTM system.
   - Attribute data of 1:2.5M SOTER database according to codes given in SOTER manual and allocated in the predefined file structure.
   - Soil degradation information related to the polygons of the 1:2.5M SOTER database according to codes given by ISRIC.
   - Relevant data of AIIR microelement database: heavy metal content for five elements (cadmium, copper, lead, nickel, zinc) in 3619 points given with their UTM coordinates.

Conclusions

1. Soil vulnerability against various natural and human-induced stresses is an increasingly important parameter of "soil quality".
2. Soil vulnerability is a stress-, site- and soil-specific parameter.
3. Soil vulnerability assessment(s) of various influences have to be based on a comprehensive and quantitative analysis of the relationships among the natural conditions, soils and "stress factors".
4. The SOTER concept and methodology presents an efficient tool and a good scientific basis for such analysis.
5. For the high-probability prognosis, an "early warning system", and for the efficient prevention of human-induced soil deterioration information are necessary on soil vulnerability (which can be given even on small-scale maps). On the contrary, the assessment of the present (or actual) level of soil pollution requires more detailed information (which cannot be indicated on small-scale maps).
6. The preparation of these medium- or large-scale maps cannot be uniform, but their certain harmonization is necessary - even on "continental" scale.

7. The preparation of this "harmonized" guidelines has to be the priority-objective of further researches and international cooperation.

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The list of Hungarian SOVEUR contributors includes:

Name	Institute	Tasks
György Várallyay	RISSAC	project co-ordinator
László Pásztor	RISSAC GIS Lab	GIS, data management
József Szabó	RISSAC GIS Lab	GIS, soil correlation
Erika Michéli	Gödöll Agr. University	FAO based characterization of soil profiles
Balázs Zágoni	RISSAC GIS Lab	software development
Zsófia Bakacsi	RISSAC GIS Lab	soil correlation
Csilla Farkas	RISSAC	soil correlation
Péter László	RISSAC	non-GIS based terrain component characterization
Éva Ivits	Gödöll Agr. University	data entry

References

Csillag, F., Szabó, J., Várallyay, Gy., Zilahy, P., Vargha, M., 1988. Hungarian Soil Information System (TIR): a thematic geographical information system for soil analysis and mapping. Bull. of the Hung. Nat. Comm. for CODATA. No. 5. pp. 1-13.

Pásztor, LO., Szabó, J., Várallyay, G. 1995. The Hungarian soil and terrain digital database (HunSOTER). Proc. Int. Conf. on Environmental and Informatics. Budapest, pp. 62-69.

Pásztor, L., Szabó, J., Várallyay, G., 1996. Digging deep for global soil and terrain data. GIS Europe. 5 (8): 32-34.

Pásztor, L., Szabó, J., Németh, T., Várallyay, Gy. 1997. Case study for regional scale soil susceptibility mapping in Hungary. Application of the Hungarian Soil and Terrain Digital Database (HunSOTER).

Pásztor, L., Szabó, J., Várallyay, Gy., Michéli, E., 1995. HUNSOTER, as a tool for evaluation of vulnerability of soils to various soil degradation processes in Hungary. Proc. ESSC Meeting on "The soil as a strategic resource: degradation processes and conservation measures", Tenerife (Canary Islands, Spain) 12-17 July, 1995.

Pásztor, L., Suba, Z., Szabó, J., Várallyay, G. 1998. Land degradation mapping in Hungary. Proc. MARS-MERA 1994-1996. Results Conf. (Bratislava, 10-11 Dec. 1996). EC Joint Res. Centre, pp. 43-54.

Pásztor, L., Szabó, J., Várallyay, Gy., Suba, Zs., 1997. Land degradation mapping in Hungary. "Soil Monitoring". Proc. III. Conf., Brno, 3-4 June, 1997. pp. 49-51.

Szabó, J., Várallyay, G., Pásztor, L., 1996. HUNSOTER - a digital database for monitoring changes in soil properties in Hungary. Proc. 2nd Int. Conf. on Soil Monitoring in the Czech Republic, Brno. pp.150-156.

Szabó, J., Pásztor, L., Suba, Zs., Várallyay, Gy., 1998. Integration of remote sensing and GIS techniques in land degradation mapping. Agrokémia és Talajtan, 47: 63-75.

Szabó, J., Várallyay, Gy., Pásztor, L., Suba, Zs., 1999. Talajdegradációs folyamatok térképezése országos és regionális szinten térinformatikai és távérzékelési módszerek integrálásával. Agrokémia és Talajtan, 48: 3-14.

Várallyay, Gy., 1989. Soil degradation processes and their control in Hungary. Land Degradation and Rehabilitation, 1: 171-188.

Várallyay, Gy., 1989. Soil mapping in Hungary. Agrokémia és Talajtan, 38: 696-714.

Várallyay, Gy., 1991. Soil vulnerability mapping in Hungary. In: Proc. Int. Workshop on "Mapping of soil and terrain vulnerability to specified chemical compounds in Europe at a scale of 1:5 M" (Ed. N.H. Batjes and E.M. Bridges). ISRIC, pp. 83-89.

Várallyay, Gy., 1993. Soil data-bases for sustainable land use: Hungarian case study. In: Soil Resilience and Sustainable Land Use (Eds.: D. J. Greenland and I. Szabolcs). CAB International, pp. 469-495.

Várallyay, Gy., 1994. Soil data-bases, soil mapping, soil information and soil monitoring system in Hungary. FAO/ECE Intern. Workshop on Harmonizaton of Soil conservation Monitoring Systems (Budapest, 14-17 Sept, 1993). RISSAC. Budapest, pp. 107-124.

Várallyay, Gy., 1994. Soil data-bases for long-term field experiments and sustainable land use. Agrokémia és Talajtan, 43: 269-290.

Várallyay, Gy., 1995. Soil data-bases for sustainable land use in Hungary. In: Conservation Tillage for Sustaining Soil and Water Quality (Eds.: T. Bartalos, R. Lal, T. Németh) 45-68. Ministry of Environment. Budapest.

Várallyay, Gy., 1996. Soil pollution management in Hungary. In: McBean, E. A., Balek, J., Clegg, B. (Eds.): Remediation of soil and groundwater. Opportunities in Eastern Europe. NATO ASI Series 2. Environment. Vol. 17. Kluwer Academic Publishers, Dordrecht - Boson - London. Part II/5, pp. 87-112.

Várallyay, G., 1997. Soil and landsite databases for sustainable land management in Hungary. Proc. of ITC-ISSS Conf. on Geo-information for Sustainable Land Management. ITC Journal, 3/4. (CD-ROM), p. 324.

Várallyay, G., 1998. Multifunctional soil management for sustainable development in Hungary. Agrokémia és Talajtan, 47(1-4): 7-22.

Várallyay, G., Michéli, E., Pásztor, L., Szabó, J., 1997. Multipurpose applicability of soil and terrain digital databases (SOTER concept) for sustainable soil management in Hungary. Publ. S.N.R.S.S. (Lucrarile XV. Conf. Nat. pentru Stiinta Solului), Bucuresti, Nr. 29D, pp. 97-107.

Várallyay, G., Szabó, J., Pásztor, L., Michéli, E., 1998. A database for sustainable agriculture and environmental protection in Hungary. In: Land Information Systems. Developments for planning the sustainable use of land resources”. European Soil Bureau. Research Report 164. Ispra, pp. 151-164.

Mapping of Soil and Terrain Vulnerability in Latvia – Project implementation

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Introduction

Currently, Latvia is in the process of developing different information systems related to natural resources inventory and monitoring. These systems are designed to promote planning and support decision making for sustainable economic development and environment management.

The main programs currently carried out in Latvia are: (1) Program of Regional Development including sub–programs of Administrative Reform of Latvia, Program of National Planning and Program of Rural Development, and (2) National Environmental Policy Plan for Latvia. Other important activities are fast growing international cooperation and integration of Latvia in the European Union. This calls for standardization of processes and systems in technology and science. The development of harmonized georeferenced information for the European environment, standardization of methods for the assessment and monitoring and harmonization of Latvia data into the European information systems are also stated as Latvian priority. Soil information is essential in all the above–mentioned programs, therefore the conception of Development of Latvia Integrated Soil Information System was elaborated in 1999.

This conception summarizes the current situation in soil related information availability and quality, as well as the expected future needs. The assessment of information acquisition methods related for the use of modern technology in natural resources inventory and data applications. In this document, the development of georeferenced information about soil and terrain degradation (current situation, vulnerability, and risk assessment) is foreseen.

Currently, activities related to the assessment and management of environmental quality and sustainable development in Latvia are quite separated, for example soil mapping, soil geochemical mapping, soil fertility testing, agricultural land monitoring, integrated environmental monitoring, and survey of soil pollution. Therefore the final information is not well coordinated, it does not use a uniform format, and creates limitations for the end-users.

The SOVEUR Project could be easily merged into the overall scheme of Latvia Integrated Soil Information System, giving possibility to evaluate the current situation in the field of soil and terrain degradation and to provide the tools for risk assessment. Due to the working scale (1:2,500,000), where the minimum delineated area should be more than 156 km^2, at

Soil Degradation Status and Vulnerability Assessment for Central and Eastern Europe (SOVEUR Project).
Proceedings of an international workshop (Busteni, 26-31 October 1999). ISRIC-RISSA-FAO, 2000.

the current stage it is mainly suitable for evaluation of Latvia situation in an international context. At the same time, however, the approach used for SOVEUR makes it possible to develop products that fit the Latvian situation: at scale 1:50,000 for regional level, and 1:500,,000 at the national level. This map resolution is also selected and approved for elaboration of all projects in the framework of programs of Regional Development and program of National Environmental Policy Plan for Latvia. At such scales, a more detailed survey of the situation in Latvia will be possible, but this falls outside the scope of the current project. These situations, for example, include pollution caused by industrial units, large animal farms, waste disposal sites, old military bases, aspects which are important to consider on a national level.

Development of SOTER database

The approach of SOTER, integral mapping of terrain and soil components, is expected to be included in other applications of the Latvia Integrated Soil Information System. This approach provides more sophisticated possibilities for data acquisition and interpretation, and therefore it is better fit for natural resources inventory, planning and management for sustainable use. For example, in the Program of National Planning which is realized at the three levels – national, regional and for local municipalities, among another factors land and its component – soils are considered when the possible use and development of the territory are worked out. This information is necessary to match the following.

1. Territories of prime agricultural land, the transformation of which to other land use types is not desirable.
2. Area of agricultural land which is recommended for afforestation or transformation in other land use.
3. Agricultural land with some limitations, for example use of fertilizers and soil management , in respect of environmental considerations. Vulnerable areas.

For the assessment of these situations, soil and terrain vulnerability should be considered in different aspects and scale. Therefore SOVEUR products could be used for the assessment of Latvia situation in the international context as well as to promote the development of applications suitable for use at the national level.

Soil degradation status in Latvia

The main type of soil degradation is expected to be erosion. Sandy and organic (peatlands) soils, which are used for field crop production as well as regions bordering on Baltic Sea are at risk from wind erosion. Another important soil degradation process is water erosion, as a substantial part of the Latvian territory comprises hilly moraine landforms. The total extent of water-eroded soils is estimated at 17.3% of the total agricultural land, of which 12.5% falls into slight and 4.8% into medium and strong erosion classes (Boruks, 1982). There are significant variations among administrative regions of Latvia with respect to the extent of water-eroded soils, with ranges from 0% (Jelgava) up to 45% (Kraslava).

Besides erosion, soil degradation factors which can influence soil productivity and are considered in Latvia include: soil acidification (approximately 63% of agricultural lands potentially has low soil reaction for the major crops, and it should be periodically limed. The current need for liming is for 42% of the agricultural land, of which 19% need s basic liming, and 23% maintenance liming), decrease in soil organic matter, and soil compaction.

Pollution by heavy metals only occurs locally around large cities, such as Riga, Olaine, Liepaja, and Daugavpils, and it is caused by industrial activities and urban factors. Locally, polluted spots are also found at former military bases of the Soviet Army and in waste disposal areas.

There is no pollution with radionuclides caesium (Cs^{137}) and strontium (Sn^{90}).

Loads of hazardous substances

Sulfur and nitrogen compounds are deposited by precipitation (wet deposition) or by dust (dry deposition). As it is estimated, the average annual depositions in Latvia in 1993 – 1995 were 10 – 14 kg N ha^{-1} and 8 – 29 kg S ha^{-1}. Wet deposition amounts to about 70 – 80% of the total (Latvia Environment Survey, 1996).

The survey by Nikodemus and Brumelis (1994) shows that the pattern of deposition of pollutants in the Baltic countries is determined by meteorological conditions, local point sources, and long- range transport. Much of the region receives precipitation with a neutral pH, due to the presence of numerous cement and building- material industries, and basic fly ash from fuel combustion. Major point sources of pollution which influence Latvia are the Narva oil-shale burning region (Estonia), the steel industry in Liepaja (Latvia), and the Mazeikiai oil refinery (Lithuania), as well as large thermal-electrical power facilities that utilize fossil fuel (Nikodemus and Brumelis, 1994).

Heavy metals in agricultural soil

There were quite large activities during the last decades to survey Latvia agricultural land for heavy metals and to study the influence of natural (soil parent material, mineralogy etc.) and human-induced factors on heavy metal concentrations. These were performed to obtain a better understanding of the natural background level and pollution, and to get information about regional differences and local variations.

Heavy metal concentration in the agricultural soils of Latvia agricultural land were determined by Filipovics and Pinke between 1991 and 1996 in 248 rural municipalities, covering all regions of Latvia. Data represent averages for 28 thousand soil samples and the tested area covers about 20% of the agricultural land of Latvia (Filipovics and Pinke, 1997).

Based on their investigations, the authors conclude that heavy metal concentrations in agricultural soils in general do not exceed the natural background level of the parent material. Concentrations are mainly influenced by the soil type, texture and the degree of cultivation, the content of soil organic matter and the pH level. Soils which are naturally rich in organic matter, such as semi-hydromorphic and hydromorphic soils, are 1.5 to 2 times higher in heavy metal content compared with mineral soils low in organic content. Generally, higher concentration of heavy metals that could be considered as pollution was found in alluvial soils (Fluvisols), orchards, and fields near main roads (Filipovics and Pinke, 1997)].

Possible follow–up actions at national and/or international level

Results of the SOVEUR project should be used for follow-up activities. The product, and its possible applications, should be made known to institutions and persons working on environmental protection, natural resources management, and territory planning. This can be achieved by means of publications and demonstration activities. Secondly, the product should be updated on a regular basis as new, more sophisticated data become available. At this stage, cross-border correlation and data validation are possible between the different countries. This type of work, inherently, will improve the quality and applicability of the data. In a next stage, products need to be devolved at a scale that is suited for use at the country level.

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References

Boruks A., 1982. Efficiency of land use. – Riga: Zinatne. *(In Latvian).*

Filipovics J. and Pinke D, 1997. Heavy metals in Latvia agricultural soils. *In*: SSPE "Raziba" Yearbook '96, p. 37-41 *(In Latvian)*.

Latvia Environment Survey, 1996. – Riga: Environmental Consulting and Monitoring Centre.

Nikodemus, O. and Brumelis G., 1994. The spatial dynamics of atmospheric pollution in Latvia and Baltic Republics, as measured in mosses, topsoil and precipitation. *GeoJournal*, 33: 71 - 80.

Filipovics J. and Pinke D, 1997. Heavy metals in Latvia agricultural soils. *In*: SSPE "Raziba" Yearbook '96, p. 37-41 *(In Latvian)*.

Soil degradation, contamination and pollution status in Lithuania

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Introduction

Lithuania is situated on the eastern coast of the Baltic Sea and covers an area of 65,300 km^2. It has 99 km of sea coastline. The country is bordered to the North by Latvia (610 km frontier), to the East and South by Belorussia (724 km) and Poland (110 km), to the southwest by Kaliningrad Region of the Russian Federation (303 km). The country is divided into the following administrative units: 10 counties, 44 districts, and 12 municipalities. The total number of inhabitants is 3,704,800 (as of 01/01/1998), of which 32% is rural and 62% urban. Population density is 56.7 people per km^2. Major cities are Vilnius, the capital of Lithuania (578,600 inhabitants), Kaunas (415,800), Klaipeda (202,300), Siauliai (147,100), and Panevezys (133,600). Average life expectancy is 65 yr for men and 76 yr for women.

Total agricultural land in Lithuania covers 3,496,761 ha (as of 01/01/1999), according to data of the State Land Cadastre. The total area under private ownership is about 1,605,690 ha.

Lithuania is progressing towards integration into the European Union's political and economic structures, with expected membership. One of the conditions of EU membership will be the need to harmonise the country's environmental policies and legislation with those of the EU. Many of the Lithuanian environmental standards, set by the Ministry of Environment, already meet some of the EU requirements, and in several cases they are even more stringent. Specific environmental goals or objectives to address the environmental problems currently facing Lithuania are identified for the short- and medium-term Environmental Action Programmes. Lithuania participates in conventions which play important roles in shaping environmental policy, including the Convention on Transboundary Air Pollution, the Convention on Climate Change, the Convention on Biological Diversity, and the Convention to Combat Desertification. A seven-year strategy for the development of sustainable agriculture in the environmentally sensitive Karst region in Northern Lithuania was adopted by the Government in 1993 and started the same year.

Both national policies and the need to meet the obligations arising from participation in the international project on Mapping of Soil and Terrain Vulnerability in the Central and Eastern Europe (SOVEUR Project) in the first place were to compare existing Lithuanian standards to those of the SOVEUR Project.

Soil degradation and pollution in Lithuania

Contaminated sites

There are statements from all around Europe that during recent years significant damage, in some areas, has been caused to the environment. Some sites and places are contaminated with different materials. One of the priorities in many countries is to estimate the danger to the environment from these sites, to identify the polluting materials, and to develop measures to decontaminate the affected sites.

The State Environmental Report and analysis of soil pollution showed that about 1% of Lithuania's territory is polluted. These pollutants include oil products, heavy metals and other substances as occurring in former Soviet Army military bases and polygons. These territories are of major concern to local and regional authorities in terms of their rehabilitation and cleaning. In some small areas soils are polluted by oil. In the future, it should be possible to show all small, polluted sites of Lithuania at the country level by using the SOTER database and methodology of the SOVEUR project.

Chemical pollution of soils

The amount of major elements, soil contamination with heavy metals of forest soils of Lithuania, topsoil of agricultural and other landscapes has been investigated in some areas (Vaicys, 1975; Pauliukevicius, 1988; Sleinys and Rimselis, 1993; Lubyte et. al., 1994; Adomaitis et. al., 1996). Very little attention, however, has been paid to the spectrum of trace elements although they are important for plants, animals and human beings as nutrients or on the other hand, and may be poisonous at high or very low concentrations (Kadunas et. al., 1999).

According to State Monitoring Data of 1993-1997 (Table 1), the average concentration of heavy metals in the topsoil (0-20 cm) is: chrome (10.7 mg kg^{-1}); cadmium= 0.46 mg kg^{-1}; lead= 11.9 mg kg^{-1}; nickel= 9.9 mg kg^{-1}; copper= 6.9 mg kg^{-1}; zinc= 28.5 mg kg^{-1}; iron= 8,209 mg kg^{-1} of soil.

Table 1. Soil contamination with heavy metals

Depth of sample (cm)	Amount of elements (mg kg^{-1})					
	Cr	Cd	Pb	Ni	Cu	Zn
0-20	1.6-38.8	0.2-1.0	4.4-23.0	1.8-32.6	0.8-56.0	6.6-58.8
20-40	2.2-36.4	0.2-1.0	4.0-18.0	2.4-31.0	2.4-31.0	6.6-56.8
40-60	1.6-33.6	0.2-1.0	2.6-17.0	2.4-31.6	2.4-31.6	6.6-60.2

Source: Lithuania, MoE 1996

Parent material and soils of Lithuania

The parent material of soils in Lithuania varies in age and genesis. Most common are Quaternary deposits. The thickness of Quaternary deposits varies from less than 10 m in North Lithuania up to 200-300 m in Zemaiciai and Baltija Heights. In the larger areas, it reaches 80-120 m. Prevailing glacial deposits are: moraine, fluvioglacial, and limno-glacial. In some places, there are plots covered by alluvial, aeolian and organic deposits. There is a great diversity of soils in Lithuania (Buivydaite and Vaicys, 1996). Preliminary data show that Albeluvisols occupy 30% of the whole territory, Luvisols 27% consisting mainly of Cal(car)ic Luvisols (35%) and Gleyic Luvisols (34%). Quite extensive areas are comprised of Cambisols (13%), Arenosols (12%), and Podzols (11%). In the depressions (5.3%), there are smaller occurrences of Gleysols and Histosols.

Soil degradation and contamination by agriculture

Major constraints for agricultural production in the country are land physiography, acidification and low fertility. One third of the agricultural land is hilly, and some of it is not suitable for agriculture nor for production of the main agricultural crops. The major cropping systems in Lithuania include the following crop rotations: barley plus under-sowing of perennial grasses of the 1st year, of perennial grasses of the 2nd year, winter crops and earthing-up crops (sugar beet, potatoes, vegetables). Monoculture is seldom used. Sometimes, “earthing-up “crops sometimes are grown on hilly slopes without consideration for the risk of water erosion occurring.

Pollution by organic pollutants and use of fertilisers

At present the quantity of fertilisers (Table 2) and chemicals used in agriculture has been reduced, but there is potential for it to increase again in the future.

Table 2. Mineral fertilisers consumed in 1996 (kg ha^{-1} of crop area; 100% by active material)

Crops	Fertilisers used for agricultural crops by:	
	private farms	agricultural companies
winter crops	58	66
summer crops	54	79
flax	67	91
sugar beets	89	318
rape	66	144
potatoes	74	134
vegetables	103	247
fodder crops	49	31

Source: Agriculture of Lithuania 1996. Department of Statistics. Vilnius 1997.

According data of the State Plant Protection Agency, about 1,567 tons of pesticides were used in Lithuanian agriculture in 1998. These include herbicides (≈72.5%), rest fungicides (≈12%), insecticides (≈1.9%), and other types of chemicals. In the last decade, the use of pesticides fluctuated greatly. According to State Environmental Monitoring data, herbicides exceeded the critical-limit for herbicides in only one soil sample. Data show that only at very few point-locations there is a high degree of pollution by pesticides, such as Simasin. Only in a very small number of soil samples, significant amounts of insecticides like DDT and other pollutants were found, while in other samples only traces of such materials were observed. The principal measure for reducing the environmental impact of pesticides should be through the development of a control system for hazardous materials and products. The framework for a control system for hazardous materials in Lithuania should encourage not only to control the use of chemicals, but also a more efficient use of fertilisers and development of low-impact application techniques, and a search for more efficiency of fertilisers.

Acidification of soils

A significant danger for soils and the natural environment is caused by the gradual intensification of the acidification process, which results from reduced inputs of lime. This process has intensified in Lithuania as the area of limed soils declined. Table 3 shows the status of soil acidity.

Table 3. Soil acidity in Lithuania

Investigated area (ha and %)	Groups soil reaction of pH_{KCl}						Acid soils
	<4.5	4.6-5.0	5.1-5.5	5.6-6.0	6.1-6.5	>6.6	<5.5
2631	23.5	113.9	286.8	453.2	535.6	1217.8	424.2
%	0.9	4.3	10.9	17.2	20.4	46.3	16.1

Source: Lithuania, MoE 1996

In Lithuania Gleyic Albeluvisols and some Dystric soils are formed on less carbonated and deeply washed out loamy deposits, and they dominate in western Lithuania. In the east of Lithuania, Albeluvisols are dominant on soil parent material of light texture and distinct erosion processes are going on. In the mid Lithuania the soil parent material, and the soil surface, contain more carbonate and are less leached so that soil reaction in this part of Lithuania is mostly close to neutral (pH= 6.6-7.0). In this area, Calcaric Cambisols, Cal(ca)ric Luvisols, Gleyic Luvisols and locally Eutric Gleysols on loam, clay loam and clays are widely distributed.

Data show that soil reaction in Lithuania mostly is close to neutral (46.3%), but more than 16% of soils are under "accelerated acid conditions" and must be limed. According to the State Environmental Report of 1998 during the last 5 years the increase in acid soils was 3.1%. Thus it is necessary to adopt measures to identify pilot-areas located in areas prone to acidification, to start monitoring these territories and to apply lime if required.

Anthropogenic influence on soils

The anthropogenic impact and especially diverse reclamation activities such as cultivation of Terric Histosols, drainage of Gleysols or gleyic soils, liming, application of mineral fertilisers have been and in some places are now among the most active soil forming factors changing the chemical composition and other properties of natural soils. Histosols are particularly sensitive to this impact.

The amount of phosphorus and potassium in the soil depends on its application. In the investigated areas, the concentrations of these substances vary greatly. The western part of Lithuania is supplied with low amount of phosphorus, while the central part of Lithuania is enriched by phosphorus. The central part of the country is well supplied; the eastern part has low amount of potassium.

Another agricultural problem in previous years has been caused by intensive cattle breeding, particularly wastes from major breeding complexes. The Ministry of Agriculture is encouraged to regulate and reconstruct these complexes, also to include collection of animal wastes, discharge or land spreading of these wastes, and technologies for their use.

Estimation of soil degradation and pollution in Lithuania

For the SOVEUR project, we have provided all required data from the geochemical mapping of the administrative districts (Table 4), carried out between 1994-1997 by the Geological Survey of Lithuania. Soil samples (total 2700) were collected in the fields of Lithuania (which has been divided into 10 x 10 km squares, 696 in total) during the summers of 1995 and 1996 from the topsoil (A horizon).

Laboratory methods for analysis of sampled soils

After topsoil samples were transported to the laboratory, their pH_{H2O} value was measured with a J-200 ionometer. Then the samples were dried at room temperature and sieved trough a 1 mm Kapron sieve. Analytical work has been done at the laboratory of the Geological Institute of Lithuania. The following analytical methods were used:

- DC-Arc Emission Spectrometry, using the DFS-13 spectrograph, MD-1000 micro-densitometer (for Co, Cr, Cu, Mo, Ni, Pb, Sn and Zn concentrations);
- XRF using ARF-6 X-ray-spectrophotometer (for As concentrations);
- AAS-ES using a Varian 300/400 spectrophotometer (for Ca, Mg, K, Na, Al, Fe and Mn concentrations).

Concentrations of (micro)elements in topsoil of Lithuania

Geochemical data of topsoils in Lithuania show that the concentration of metals in places reasonably distant from the bigger towns do not exceed the B-value of the original standards adopted in the Netherlands for soil contaminants (Moen and Brugman, 1997).

Table 4. Median values of (micro)elements in topsoil of administrative districts of Lithuania(as ppm; Kadunas et. al., 1999)

	District	As	Co	Cr	Cu	Mo	Ni	Pb	Sn	Zn
1	Alytus	2.8	6.0	36.9	10.1	0.75	17.4	16.1	2.35	40.6
2	Anyksciai	2.8	4.4	29.6	8.0	0.65	11.1	15.2	1.87	28.4
3	Birzai	2.2	5.6	36.8	8.9	0.74	14.0	17.3	1.96	30.9
4	Ignalina	1.8	4.9	29.7	9.3	0.62	11.8	13.0	1.86	31.9
5	Jonava	2.4	5.0	33.2	11.5	0.75	14.8	14.7	2.03	35.2
6	Joniskis	3.7	5.9	37.3	8.4	0.67	15.2	12.6	1.95	25.8
7	Jurbarkas	3.3	5.7	50.9	12.0	0.65	17.2	15.0	2.33	31.6
8	Kaisiadorys	3.0	5.5	35.7	12.3	0.71	13.0	16.1	2.05	32.6
9	Kaunas	3.3	5.2	34.9	8.6	0.65	14.6	16.8	1.96	32.2
10	Kelme	3.0	5.5	36.4	10.6	0.70	16.7	17.7	2.13	29.1
11	Kedainiai	3.2	5.8	44.6	10.5	0.81	18.1	13.6	2.31	35.0
12	Klaipeda	2.8	4.8	37.3	9.7	0.68	14.3	19.8	2.35	30.7
13	Kretinga	2.8	4.2	39.3	8.8	0.66	13.3	16.4	2.36	32.4
14	Kupiskio	3.7	4.8	31.3	9.1	0.66	13.2	13.5	2.02	25.4
15	Lazdijai	2.8	4.1	33.6	8.1	0.68	13.4	12.3	2.07	23.3
16	Marijampole	3.1	4.5	39.5	11.2	0.67	15.1	12.9	2.01	26.5
17	Mazeikiai	3.4	5.8	37.2	8.7	0.69	15.2	14.1	2.02	27.0
18	Moletai	1.6	4.5	26.5	9.9	0.68	12.6	13.9	1.95	26.1
19	N. Akmene	3.0	5.3	33.7	9.6	0.64	14.4	14.8	2.00	28.7
20	Pakruojis	3.4	5.2	37.3	11.8	0.72	14.9	14.1	2.20	29.8
21	Panevezys	3.3	4.4	29.8	9.0	0.62	12.2	13.4	1.93	26.2
22	Pasvalys	4.6	6.4	43.2	9.6	0.63	18.1	16.5	2.18	37.9
23	Plunge	3.0	4.9	38.1	10.0	0.71	14.7	17.7	2.35	35.2
24	Prienai	3.5	5.7	38.7	9.4	0.70	14.7	17.0	2.21	33.1
25	Padviliskis	2.9	5.2	38.4	9.9	0.70	15.9	14.7	1.99	26.8
26	Raseiniai	2.6	5.7	45.9	12.4	0.64	16.7	13.9	2.32	32.5
27	Rokiskis	1.7	4.7	29.0	7.0	0.74	12.2	16.0	1.96	24.8
28	Skuodas	3.3	5.9	43.5	10.7	0.69	16.0	16.6	2.29	30.1
29	Sakiai	2.9	6.4	47.3	12.5	0.69	17.0	17.1	2.16	31.3
30	Salcininkai	2.1	3.4	21.5	5.6	0.57	8.1	15.8	1.92	22.5
31	Siauliai	3.1	4.5	34.4	10.5	0.76	12.9	15.2	2.05	26.0
32	Silale	2.5	5.4	39.4	11.1	0.78	14.9	18.7	2.27	35.2
33	Silutë	2	4.3	34.0	8.9	0.64	13.1	17.7	2.29	32.4
34	Sirvintos	1.2	4.6	30. 4	10.4	0.73	11.2	14.5	1.98	28.7
35	Svencionys	1.3	3.9	25.2	7.7	0.70	11.3	15.2	1.87	25.0
36	Taurage	2.3	4.7	39.1	10.3	0.60	13.9	17.5	2.20	30.6
37	Telsiai	2.9	5.3	38.3	11.2	0.71	16.0	15.0	2.27	33.6
38	Trakai	2.2	4.5	30.1	8.0	0.75	12.9	16.3	2.18	27.3
39	Ukmerge	2.5	5.0	32.9	11.3	0.65	12.9	13.1	1.98	29.3
40	Utena	2.2	5.5	33.1	9.3	0.67	13.9	15.0	2.10	36.4
41	Varena	1.6	2.6	16.2	3.9	0.49	7.6	14.3	1.59	21.8
42	Vilkaviskis	3.4	5.5	42.3	12.2	0.70	17.4	13.1	2.17	29.6
43	Vilnius	2.5	4.8	32.9	8.8	0.71	12.3	16.0	2.07	30.9
44	Zarasai	3.5	5.5	30.4	8.3	0.73	15.6	13.1	1.83	33.3

Source: V. Kadunas, R. Budavicius, V. Gregorauskiene, V. Katinas, E.Kliaugiene, A. Radzevicius, R. Taraskevicius. ***Geochemical Atlas of Lithuania*.** Geological Survey of Lithuania, Geological Institute. Vilnius 1999

Concentrations are greater in the heavier soils than in similarly fertilised soils with a lighter soil texture. On the average, concentrations are 2-3 times greater in heavy loam and clayey soils than in sandy soils. In soils with a similar soil texture (the concentrations are smaller) however all elements (Cr, Pb, Ni, Cu, Zn) are sufficiently represented.

Conclusions

Monitoring and treatment of contaminated land and soil is a very urgent issue and is very costly to implement. For the SOVEUR project, data have been provided from the geochemical investigations and mapping of Lithuania (Kadunas et. al., 1999) which focussed on environmental protection.

The international project on Mapping of Soil and Terrain Vulnerability in the Central and Eastern Europe (SOVEUR Project) helps to evaluate the natural geochemical patterns and changes caused by anthropogenic and technogenic activities in Lithuania.

There is a need to continue the mapping of soil and terrain vulnerability in Lithuania at country level by using the SOTER database and methodology of SOVEUR Project.

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References

Batjes, N.H. (1997). Methodological Framework for Assessment and Mapping of the Vulnerability of Soils to Diffuse Pollution at the Continental Level (SOVEUR Project). Report 97/07, International Soil Reference and Information Centre, Wageningen.

Batjes, N.H. and V.W.P. Van Engelen (eds). (1997). Guidelines for Compellation of a 1:2,500,000 SOTER Database (SOVEUR Project). Report 97/06, International Soil Reference and Information Centre, Wageningen.

Bi-Annual Report 1997-1998 (1999). International Soil Reference and Information Centre, Wageningen..

Buivydaite, V.V., Vaicys, M. (1996). Lietuvos dirvozemiu klasifikacijos derinimas su Pasaulio dirvozemio zemelapio legenda (Conformation of Soil Classification of Lithuania to the World Soil Map Legend). Geografija T. 32: Vilnius. pp. 43-57.

Kadunas, V., Budavicius, R., Gregorauskiene, V., Katinas, V., Kliaugiene, E., Radzevicius, A., Taraskevicius, r. (1999). Geochemical Atlas of Lithuania. Geological Survey of Lithuania, Geological Institute. Vilnius. pp. 89.

Lubyte, J., Eitminavicius, Ll, Vaisvila, Z., Tamulis, t., (1994). Ilgalaikio tresimo mineralinemis NPK trasomis itaka radionukliidu ir sunkiuju metalu kiekiui dirvozemyje ir augaluose. Tresimo

sistemos ir dirvozemio derlingumas. Vilnius. pp. 301-308.
Ministry of Economics (1994). Forecasts for the Development of Lithuania, 1995-1997.
Ministry of Economics (1995). Public Investment Programme.
Pauliukevicius, G. (1988). Cheminiu elementu kiekiai landsafte. Vilnius. pp. 128.
Sleinys, R. and Rimselis, J. (1993). Sunkiuju metalu kiekis ir aktyvumas Rytu Lietuvos dirvozemiuose. Zemetvarka ir melioracija, 1-2: 64-70.
Tempel, P. (1995). Global and National Soils an Terrain Digital Databases (SOTER). Database Structure. International Soil Reference and Information Centre, Wageningen.
Van Lynden,W.J. (1997). Guidelines for the Assessment of Soil Degradation in Central and Eastern Europe (SOVEUR Project). Report 97/08b, Revised edition. International Soil Reference and Information Centre, Wageningen.

Soil cover and terrain vulnerability in the republic of Moldova

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Introduction

Implementation of the SOVEUR project gave an opportunity to resolve a number of methodological and practical problems for Moldova. On the basis of the SOTER methodology, a pedo-geographical regionalisation of the territory of Moldova was made.

Project implementation

Using the SOTER inventory, 30 terrain components and 45 soil components have been distinguished within 12 terrain units. A full characterization of these units may be found in the SOTER database. The main soil types and subtypes occurring within each terrain component have been characterized using representative soil profiles.

In accordance with the "Guidelines for Assessment of Human-induced Soil Degradation", using the available data for Moldova, the different types of soil degradation (e.g., sheet and linear erosion, compaction, dehumification) have been characterized using the specified criteria for degradation extent, degree, impact and rate.

The extent of soil degradation was determined separately in every rural locality, using data of the land cadastre, with further calculations for each polygon. Schemes of soil degradation extent and generalized tables on soil degradation assessment for different regions of Moldova were elaborated.

Materials on soil degradation were presented at several conferences:
- International Conference on Subsoil Compaction (Kiel, 1999).
- International Conference on Genesis, Geography and Ecology of Lands (Llov, 199).
- Anniversary Scientific Symposium "65th anniversary of the Agrarian State University of Moldova" (Chisinau, 1998).
- Scientific conference :Soil Science in the Republic of Moldova on the Eve of the XXI Century" (Chisinau, 1999).
- Scientific conference "State of Agrochemical Service for the Republic of Moldova in 35 years" (Chisinau, 1999).

Results on the degree of soil degradation process manifestation in Moldova were used in the National Programme on Desertification. Data from the SOVEUR project are also used in lectures and courses on "Soil Geography", "Terrain Evaluation", and "territory Monitoring".

Possible follow up activities

Possible follow up actions in our view consist in regionalisation of land resources and elaborating directions for their agricultural uses, based both on the obtained materials and new guidelines (to be elaborated) for use at more detailed scales as well as elaboration of regional atlases and field-guides for soil determination.

It is possible to develop recommendations on land resources utilization in conditions of land reform, taking into account National programmes on sustainable development for the period 2000-2002, developed in all countries in accordance to Rio UNCED.

In conclusion, it should be noted, that for compilation of a soil and terrain database and for the assessment of the status of soil degradation, the following published and initial analytical data were used: materials of Scientific Research Institute for Pedology, Agrochemistry and Hydrology: N. Dimoi"; Agrarian State University of Moldova; Scientific Centre for Agrochemical Service production; Moldova State University. Data of fundamental monographs by I.A. Krupenicov, V. Ch. Ungurean and V.P. Graty, as well as the monograph in 3 volumes on "Soils of Moldova".

List of published materials based on SOVEUR project data

Ciumac, A.I., Ungurean, V. Gh, Andriuca, V.P., 1999. Soil deformation in the republic of Moldova. International Conference on Subsoil Compaction (Kiel, March 1999), pp. 18-19.

Ungurean, V. Gh., Andriuca, V.P., Ciumac, A.I., 1999. Characteristic of soil compaction in the republic of Moldova (Kiel, March 1999), p. 24.

Ungurean, V. Gh., Ciumac, A.I., and Bacean, I.R., 1999. Anthropogenic soil degradation and soil protection problems fore the territory of Moldova. Scientific Conference "Genesis, Geography and Ecology of lands", Llow, Ukraine, p. 216-218.

Ungurean, V. Gh., 1999. Assessment of soil degradation manifestation on the territory of Moldova. Scientific Conference :"Soil Science in the republic of Moldova on the eve of the XXI century". Chisinau, p. 132-133. (*In Romanian*)

Ungurean, V. Gh.,and Ciumac, A.I., 1999. About humus monitoring of soils in the Republic of Moldova. Scientific Conference "State Agrochemical Service of the Republic of Moldova". Chisinau, p. 88-99 (*in Romanian*).

Ungurean, V. Gh., 1999. Actual problems and agricultural lands assessment. Land and Aquatic Resources. Scientific - Practical Conference dedicated to the 175th year of birth of N.A. Dimo, Chisinau, Vol. 1, p. 67-80 (*in Romanian*).

List of monographs

Graty, V.P., 1997. Forest soils of Moldova and their rational utilization. Ed. Stiinta, Chisinau, pp. 128

Krupenicov, I.A., 1967. Chernozems of Moldova. Ed. Cartea Moldovenseasca, Chisinau, 427 pp. (*in Russian*)

Krupenicov, I.A., 1997. Soil cover of Moldova. Ed. Stiinta, Chisinau, pp. 264.

Ungurean, V. Gh., 1979. Soil and grape wines. Ed. Stiinta, Chisinau, pp. 211 (*in Russian*)

Soils of Moldova, 1984. Vol. 1. Genesis, Ecology, Classification and Systematic Description of Soils. Ed. Stiinta, pp. 351 (*in Russian*)

Soils of Moldova, 1986. Vol. 3. Use, Conservation and Improvement. Ed. Stiinta, pp. 333 (*in Russian*)

Prospects for Polish SOTER/SOVEUR implementation and use

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Introduction

Integrating information is a crucial problem when managing environmental resources at different levels. Developing international projects related to strategies for environmental protection requires common tools to characterize the spatial variability of soil, water, and landscape status. An excellent example of such an integration effort is the SOVEUR project to develop a soil and terrain database for Central and Eastern Europe using a standardized methodology. This is the first attempt to characterize soil resources of the region using one set of criteria and approaches. The SOTER methodology provided the background to develop a soil and terrain database, and soil vulnerability models at a scale of 1:2,500,000. A vast amount of spatial information was used to delineate SOTER units and soil degradation polygons. Some methodological aspects and the potential use of this product are discussed in this report.

Methodology

The first step of the SOTER database development was to adopt a different concept of soil mapping approach. The traditional methodology is focussing on a soil layer itself while SOTER requires integrating three different layers characterizing terrain units (landform and lithology), properties of local surface forms (terrain components), and soil components within SOTER units. This hierarchy provides a different structure for aggregating soil information which is no longer reflecting traditional soil complexes or units, but instead derives a combined indicator of soil and terrain properties. The main challenge in generating the SOTER database was to integrate the required information into one system. Difficulties arose from the fact that available information regarding landforms, lithology, terrain features, and soil components was in a format that did not exactly fit the criteria required by SOTER. The geographical information used, consisted of over 13 maps characterizing general physiography (including hydro-geology). It is important to emphasize that these were analog maps with different scales and projections. The list of background materials is included in the reference section. Processing these maps involved a manual analysis by a group of soil scientists, geographers, ecologists, hydrologists, and GIS specialists. The required criteria for the SOTER database included very detailed and strictly defined parameters. In many cases, the available geographical and environmental characteristics did not correspond to these requirements. Therefore, a number of assumptions and conversion models (expert knowledge and mathematical algorithms) had

Soil Degradation Status and Vulnerability Assessment for Central and Eastern Europe (SOVEUR Project).
Proceedings of an international workshop (Busteni, 26-31 October 1999). ISRIC-RISSA-FAO, 2000.

to be applied to derive the required data. The main problem with the SOTER database was associated with the fact that the Polish soil classification system is not correlated with a global methodology according to FAO/UNESCO. A number of mandatory soil profile properties were not characterized by the National Soil Survey and we had to generate them using theory, algorithm, and expert knowledge. It is important to emphasize that soil components as characterized by these derived parameters produce a certain level of uncertainty. It is critical that future representative soil profiles reflecting the soil cover of Poland are fully analysed using complete procedures for soil analysis according to FAO methodology.

Developing the soil degradation status database was relatively easier as most of the required criteria were available from existing geo-referenced databases characterizing soil pollution with heavy metals, soil acidification, and contamination by sulfur, nitrates, phosphorus, organic xenobiotics, including pesticides, PCBs, and PAHs. The major difficulty was related to the assessment of degradation impacts depending on management level and productivity. The categories described in the manual are difficult to apply since spatial information regarding the management level is not available, thus we used our 'best judgement'. Also, a non-quantitative judgement was used to rate the amount of soil degradation.

Anticipated uses of SOVEUR product

The scale of the SOVEUR databases allows a very general assessment of degradation types and trends. However, there is a potential to continue this work to generate a larger scale product. A database meeting 1:500,000 scale requirements offers a great potential for developing a useful decision support tool. The methodology was widely demonstrated within the soil science and environmental community and generated a strong, positive feedback. There is a proposal to initiate a larger scale project, using the SOTER/SOVEUR concept, as a component of an integrated agricultural information system being developed at IUNG for government agencies. The experience gained during this project encouraged us to use the methodology to develop local databases. Pilot studies have been initiated as a part of the masters program at the Maria Curie-Sk odowska University.

Aspects of project implementation

Implementation of the SOTER/SOVEUR project requires a broad demonstration of the concept and methodology to encourage potential users to include this SOTER/SOVEUR product as a common tool of environmental assessment and as decision support to environmental management. We decided that the SOTER/SOVEUR approach will be included in the Polish Soil Forum activities since, as project coordinators, we are involved in organizing the format for this panel. This project has generated a substantial interest of the Ministry of Environment Protection of Natural Resources and Forestry. The Ministry is considering using SOVEUR as a tool for developing environmental policy and protection strategy. SOTER/SOVEUR is now included in teaching programs at the University level which hold promises for more extensive use and implementation.

Possible follow-up action

It is well established that more coordination is needed to develop a SOTER/SOVEUR regional database. The current exercise coordinated by ISRIC should be considered as a preliminary program to be followed by a more detailed project with more extensive coordination, to produce a large scale product. For example, trans-boundary coordination is urgently needed as the current project produced inconsistent data without a proper transition and matching to boundaries. The procedures need to be developed with precisely defined criteria which are easily generated. The inconsistencies are partially related to the origin of source information using a format existing in different countries. However, we believe that methodology guidelines may be better defined to avoid inconsistency problems. This should be a topic for further discussion and clarification by project participants. We suggest that follow-up actions may be organized as a proposal submitted to the 5th EU Framework or other agencies potentially interested in developing a global approach to soil and environmental quality management, such as FAO, UNESCO, UNDP, and the World Bank.

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References *(sources consulted)*

1. Physical map of Poland 1:1 M, PPWK Warsaw, 1996.
2. Soil map of Poland 1: 1.5 M, according to FAO UNESCO, S. Bia ousz, PPWK Warsaw 1994.
3. Hydrogeological map of Poland 1:1 M, C. Kolago, Wyd. Geolog. Warsaw 1970.
4. Occurrence of first underground water layer 1:3 M, C. Kolago, Wyd. Geolog. Warsaw 1970.
5. Use of underground water 1:3 M, C. Kolago, Wyd. Geolog. Warsaw 1970.
6. Geomorphology of the first underground water layer 1:3 M, C. Kolago, Wyd. Geolog. Warsaw 1970.
7. Relief classification for agriculture 1:1 M, H. Kern, K. Budzynska, IUNG Pulawy 1996.
8. Soil stoniness of Poland 1:1 M, H. Kern, K. Budzynska, IUNG Pulawy 1993.
9. Tertiary deposits 1:1 M, E. Ruhle, Wyd, Geol. Warsaw 1956.
10. Quaternary deposits 1:3 M, H. Kern, K. Budzynska, IUNG Pulawy.
11. Geological map of Poland 1:1 M, E. Ruhle, et. All, PPWG Warsaw 1954.
12. Geological map of Poland 1:1 M, (without quaternary deposits), E. Ruhle, et. all, PPWG Warsaw 1956.
13. Physiographic regions of Poland according to Kondrcki 1:1 M.
14. Soil Agriculture map of Poland 1: 0.5 M, IUNG Pulawy 1998 (digital map and database).

15. Map of potential water erosion of Poland 1:1 M, IUNG Pulawy 1979.
16. Map of potential wind erosion of Poland 1:1 M, IUNG Pulawy 1979.
17. Map of potential gully erosion of Poland 1:1 M, IUNG Pulawy 1979.
18. Land use and landscape forms map of Poland 1:1 M, GRID Warsaw 1995.
19. Map of forests in Poland 1:1 M, IGiK Warsaw 1992.
20. Map of land uses and hazards to geographical environment 1:2 M, Geographical Atlas of Poland, IGiPZK PAN, Warsaw 1998.
21. Yearbook of Environmental Protection, Main Bureau of Statistics (GUS), Warsaw 1996.
22. Environmental and Soil Database of Institute of Soil Science and Plant Cultivation, IUNG, Pulawy 1994-1999.
23. Atlas of Oxidation and Redox Properties of Polish Soils, IA PAN, Lublin 1997.

Main issues resulting from the application of the SOVEUR-project, at 1:2.5 million scale, in Romania

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Introduction

In Romania the implementation of the SOVEUR project has been undertaken in the framework of Contract No. 97842 signed between ISRIC, the Netherlands, and RISSA, Romania. A large number of scientists has been involved in the execution of the project. The working period lasted about six months, from 11 January 1997 until 30 April 1998. The work has been carried out according to the special guidelines/methodologies elaborated at ISRIC.

Problems of project implementation

Generally speaking there were no serious problems to implement the SOVEUR project in Romania. The main one was that of the geographical projection type. In Romania a particular projection called "STEREO - 70" is used while that required by the project is "LAMBERT". Finally the conversion from the "STEREO - 70" projection to the "LAMBERT" one has been done by ISRIC's GIS staff, using the parameters provided by the Romanian team.

Methodological aspects

SOTER database

- The SOVEUR physiography map at scale 1:2,500,000, supplied by ISRIC as a background for delineating SOTER units, proved to be about 60% correct. The changes introduced by us concern mostly the hilly and tableland regions where hypsometry, relief intensity and slope given by the map present a high degree of approximation. In all these cases it was necessary to use cross sections made on a larger scale topographic maps (1:200,000).
- The criteria used for identification and characterization of major landforms and to define SOTER units were found to be generally acceptable for the Romanian

physiography. The resulting map comprises 41 SOTER units divided into 103 polygons. The largest polygon corresponds with 32,825 km^2 and the smallest one with less than 156 km^2. Taking into account the scale used and the physiographyic diversity of the Romanian territory this map is considered to be a good one. Some objections arose from the fact that SOTER polygons do not always fit the known geomorphological units. Sometimes they overlap, or do not correspond with, the concepts used in Romanian physical geography. For example, some areas known as mountains became hills as shown in Table 1. In this context, one may wonder if it not advisable to revise the values range of some landform parameters, especially those for hypsometry. The lower limit of 600 m relative altitude for mountains is the main cause of the transformation of some Romanian mountains to hills.

– As concerns the number of representative soil profiles and horizons, for a country with such a high pedological diversity like Romania, a single soil profile for a given soil component seems to be not enough, especially for soils that show a large variability in their basic properties (e.g., texture of parent material) which are not always included in the definition of soil type.

Table 1. SOTER units areas as compared with classical physiographic conventional data sources in Romania.

Types of Physiographic Units	Types of data sources					
	SOTER		Microzones		Ecoregions	
	Area (10^3 km^2)	%	Area (10^3 km^2)	%	Area (10^3 km^2)	%
Plains	116.6	48.9	133.3	55.9	137.0	57.5
Hills	73.8	30.9	46.6	19.6	33.2	13.9
Mountains	47.1	19.8	57.7	24.2	68.2	28.6

Human induced soil degradation database

The criteria used for defining human-induced soil degradation types proved to be generally satisfactory, but the evaluation of their impact is highly approximative and predisposed to subjective reasoning.

– Based on our experience, we recommend that a maximum number of soil degradation types be allowed for each polygon. In Romania we stopped at six types, although polygons with 7-8 degradation types are not infrequent.
– A similar problem occurs where several degradation types overlap within the same area. We found that a maximum of three of degradation types may be reasonably recorded as overlapping, per polygon. A special case of this problem concerns diffuse soil pollution which, theoretically, may overlap almost all the remaining degradation types. To avoid difficulties in data recording and handling we suggest that diffuse soil pollution be recorded separately so that it may later be combined, if applicable, with other types of soil degradation using GIS.

– More difficulties were met with the compilation of maps of accumulated loads for Cd, Pb, and Zn. Because the SURFER package used in Romania for processing the point data for heavy metals is not designed for generating maps in classical sense, additional time was needed to process the data to make them compatible with ARC/Info.

Present and future use of the SOVEUR products in Romania

As a whole, the implementation of the SOVEUR project in Romania was a good opportunity for many Romanian scientists (soil scientists, geographers, geologists, informaticians) to work together on a common methodological base and to improve their experience in the field of soil and terrain resources data gathering, processing and interpreting as well as in the environmental problems.

Although made at a scale smaller than those of other types of nation-wide maps concerning soils and terrain resources (e.g., 1: 200,000 soil map, 1:500,000 soil erosion map, 1:500 ,000 pedological microzones, 1:500 ,000 ecoregions) for Romania, owing to its integrative nature (terrain, soils degradation types and its intensity together) the results of the SOVEUR project improved the perspectives on the strategy of the natural resources use and management.

Using the data obtained in the SOVEUR project, two scientific papers have been compiled (in press). The first one refers to the use of the SOTER units to improve the strategy of soil resources conservation and protection (Table 2), and the second one deals with the present day status and future trends of the human-induced soil degradation in Romania.

Table 2. Approach of land-use optimization in Romania using SOVEUR data.

Land use type	Area	
	10^3 km^2	%
Intensive agriculture (+ forest (10-15%)	57.4	24.1
Semi-intensive agriculture (+ forest (15-25%)	37.6	15.8
Extensive agriculture (+forest (20-35%)	26.5	11.1
Agriculture, forestry (35-50%), pasture	31.1	13.1
Forestry (>60%), pasture, agricultural inclusions	32.5	13.6
Forestry (>75%), pasture, agrotourism	48.3	20.3
Danube Delta Biosphere Reserve	4.1	1.7

Further, a soil and terrain map of Romania at scale 1:1,000,000 will be completed before the end of 1999. The future use of experience gained, envisages the development of a nation-wide project to compile a 1:2,00,000 SOTER database using the 1:200,000 soil map of Romania, and additional topographical, geomorphological, geological and land use type information. For this project we have already compiled a methodological guide called ROMSOTER 0.2-1.0 M (see Munteanu *et al.*, 1998).

Follow-up to SOVEUR project

- Development of a project concerning land-use optimization, in connection with the present day status and trends of human induced soil degradation and global climate changes in Central and Eastern Europe. Such a project could be well correlated with those of the atmospheric carbon sink and biodiversity conservation.
- Promoting of a project concerning rehabilitation and protection measures of the severely degraded lands and mitigation of human pressure in areas considered at risk. The results of such a project could later be submitted to attention of national governments or to international organization, such as World Bank, FAO, or both. It could be also a good basis to harmonize the national strategies in the field of soil and terrain resources conservation, biodiversity conservation and environment protection.
- At the regional level, a possible follow-up activity could be the development of regional 1:500,000 SOVEUR data bases for large physiograpic units such as the Lower-Danube Plain (Romanian-Bulgarian cooperation), the Moldavian and Podolian table land (Romanian-Moldavian and Ukrainian cooperation), and the Panonian and Transilvanian basin (Hungarian-Romanian cooperation). This activity could precede the 1:250,000 soil map foreseen in the frame of European Soil Information System (EUSIS).

All these project are aimed to improve knowledge of soil and terrain resources and their management, and take into account that the negative phenomena (e.g. drought, flood, pollution, etc.) have usually transborders effects.

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The national contributors to the SOVEUR project Romania included:

- Research Institute for Soil Science and Agrochemistry:

Dr. I. Munteanu	National coordinator; SOTER database, soil correlator, soil degradation database
Dr. Radu Lacatuºu	Accumulated loads for Cd, Pb, Zn
Dr. A. Canarache	Soil crusting, soil compaction, soil aridification
Dr. Elisabeta Dumitru	Soil compaction, soil crusting
Marcela Jalbã	Soil erosion, profiles and horizons data base
Georgeta Untaru	Profiles and horizons data base
L. Latis	Soil acidification
C. Ciobanu	Soil pollution with biocides
Maria Drãcea	Fertility decline
Sorina Dumitru	GIS
Victoria Mocanu	Digital storage and processing
Irina Moise	Digital storage

Daniela Popa	Digital processing
Ruxandra Vintilã	GIS
George Cojocaru	GIS

- *Geological Institute:*

P. Andãr	Accumulated load for Cd, Pb, Zn.

Mapping of soil and terrain vulnerability in Central and Eastern Europe: Russia country report

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Introduction

Russia has fulfilled a twofold task within the framework of the SOVEUR project: (1) the compilation of the Soil and Terrain digital database (SOTER) for the whole European part of the Former Soviet Union (SU) and, (2) establishing of soil degradation status attributes.

The European part of Russia occupies about 23% of the country area. It is a unique area comprising a great diversity of natural features and cultural media. The territory is relatively densely populated, with about 60-100 persons/km^2. In fact, the population density at the Asian part of Russia is about 1-2 persons/km^2. This territory plays an important role in the country's land resources use and suffering from the severe anthropogenic pressure. Since development of GLASOD (Oldeman, 1991), Russia has accumulated a lot of new data on soil degradation, which should be analysed in order to set up appropriate land use policy and sustain economic development.

Russia moves towards the understanding of the importance of establishing international environment regulations, which incorporate nature-societal interactions into the pan-European context. This led to the recognition that the existing soil information system, which is based on traditional paper formats, is not sufficient. There is an urgent need to create a modern soil information space allowing sustainable use of the land resources in Russia.

Project history

Two past activities are relevant to the SOVEUR project:

1) The GLASOD project (Oldeman, 1991), indicated the urgent need for common soil information systems and for updating of the Soil Map of the World for the Former Soviet Union;
2) SOTER development for the FSU and Mongolia at the scale of 1:5,000,000 (Stolbovoi, et al, 1997; FAO, 1999). Complete soil correlation with FAO revised legend (Stolbovoi, 1998; Stolbovoi and Sheremet, 2000) has been achieved for this huge area. First, a SOTER based inventory (at the scale of 1:5,000,000) has been completed and presented as a new digital georeferenced database (Stolbovoi and Savin, 1996). This

Soil Degradation Status and Vulnerability Assessment for Central and Eastern Europe (SOVEUR Project).
Proceedings of an international workshop (Busteni, 26-31 October 1999). ISRIC-RISSA-FAO, 2000.

database has been combined with abundant land characteristics (vegetation, land use, etc.) and associated with a new Integrated Land Information System of Russia (at IIASA).

Compilation of the SOVEUR Soil Information System

The main goal is to identify the problems of the transformation of Russian soil data into international standards:

1) Tested materials: the State Soil Map (SSM) at scale 1:1,000,000 of the USSR. Relevant soil and other maps, explanatory notes, publications.
2) Problems identified: conceptual, age, methodological inconsistency between different sheets of the SSM.
3) Solutions found:
   - To use the State Soil map for creation of soil polygons;
   - To use recent soil maps for unification of the legend content;
   - To apply soil map at the scale of 2,500,000, as a bridge for legend translation into a unified language;
   - To use the “2,500,000 soil legend” for translation into the FAO Revised Legend (FAO, 1988).

Compilation of the SOVEUR Soil Degradation Database

Soil physical degradation attributes and chemical contamination have been compiled following the SOVEUR Guidelines (Van Lynden, 1997). The physical soil degradation contains data on degradation type and extent and indicates the severity of impacts on productivity, rate of change, causative factor, and rehabilitation or protection measures. Degradation types include water and wind erosion, secondary salinisation, desertification, under-floods and compaction.

The attributes listed above were created by compiling and coding of information from several unpublished, paper-map legends into digital format. Preparation of these maps had been contracted by Committee of Russian Federation on Land Resources and Land Planning, and compiled by different authoritative organizations for the government (national) report on the status and use of land in the Russian Federation (Government (National) report …, 1993). Maps were transferred by the Committee to Dokuchaev Soil Institute for creating a digital database. The following source maps have been used:

- Map of Soil Water and Wind Erosion in Russia, at scale 1:4,000,000, compiled by Dokuchaev Soil Institute, 1992;
- Map of Recent Land Status of Forest Fund of Russia, at scale 1:4,000,000, compiled by All Russian Research Institute of Forest Resources, 1993;
- Map of Natural Grassland Degradation in Russia, at scale 1:4,000,000, compiled by the All Russian Research Institute of Fodder, 1992;
- Map of Soil Salinisation in Russia, at scale 1:4,000,000, compiled by Dokuchaev Soil Institute, 1992.

Data on soil contamination were derived from official sources published by ROSKOMHYDROMET (Russia Committee for Meteorological and Hydrological Service). The organization carries out soil sampling for the upper 0-5 cm for natural soils and 0-20 cm for cultivated sites (Malakhov, 1964). Soil pollution is determined for points only; no areal survey was performed. Monitoring of industrial cities is made for the surrounding area (5-20 km). However, the data are associated with the geographical coordinates of the city. Data on soil contamination originate from the yearbooks (Yearbook on soil contamination of Russia Federation by pollutants of the industrial origin in 1996, 1997; Yearbook "Monitoring pesticides in the natural objects of Russia Federation", 1997). Analyses of the content of heavy metals in soils were made in 23 cities in the European part of Russian Federation in 1996. The database identifies those sites where the soil pollution has been found. It also contains other records/measurements, which were done during 1991-1995, but were not repeated later. The impact of soil contamination on the population health has been identified for main cities of the European part of Russia. The assessment is based on the total soil contamination index (Zf) for 1986-96.

The ROSKOMHYDROMET reports the contamination by pesticides for agricultural land in 1996. These observations have been made for 32 administrative regions (oblasts) across the country (total amount 89). Total sampling area was 21000 ha in spring and 20 000 ha in autumn. From this amount 27 administrative regions are situated in the European part of Russia.

Conclusions

The SOVEUR project provides several direct and indirect benefits for Russia:

- Continental scale soil resources inventory in European part of the FSU as a basis for its sustainable development;
- Improvement of land use planning, agricultural and forest production systems and implementation of the European Crop Growth Monitoring System (CGMS);
- Understanding of land qualities and the severity of the human-induced land degradation that are affecting the region;
- Identification of fragile soils in diverse ecosystems, including tundra, forest tundra, deserts, and wetlands;
- Establishment of common pan European framework for introduction of modern land management, detection of "hot regions", i.e. Kaspii, Kalmykia desert, as well as an inventory of "cold regions" such as frontier forests and virgin ecosystems.

References

FAO-Unesco. Soil Map of the World. Revised Legend, 1988. World Resources Report No. 60, FAO, Rome.

FAO-IIASA-China-Dokuchaev CD ROM on Soil and Terrain Database for North and Central Eurasia (Version 1.0), FAO, Rome, 1999.

Government (National) report on status and land use of land of Russia, 1993. Moscow.

Malakhov S.G, 1964. Temporary guidelines for the control for the soil contamination. Hydrometizdat, vol. 2, Moscow, 61 p.

Oldeman, L.R., R.T.A. Hakkeling and W.G. Sombroek, 1991. World Map of the Status of Human-Induced Soil Degradation. An Explanatory Note, *second revised version*. Global Assessment of Soil Degradation.

Stolbovoi V.S., 1998. Soils of Russia Correlated with the Revised legend of the FAO Soil Map of the World. Interim Report, IR-98-037/December, IIASA, Laxenburg, Austria, 83 p.

Stolbovoi, V., G. Fischer, B. Sheremet, I. Savin, S. Rozhkova (Kravetz), 1997. The IIASA-LUC project Georeferenced Database of Russia, Vol.1-2: . Soil and Terrain digital database (SOTER). Interim Report, IR-98-0113/September, IIASA, Laxenburg, Austria, 43 p.

Stolbovoi V.S., I.Y. Savin, 1996. Experience of RUSOTER Digital Database Compilation. Pochvovedenie, No 11, p. 1295-1302. [in Russian]

Stolbovoi, V., and B. Sheremet, 2000. On Common Soil-Information Space of the Former Soviet Union Countries (practical correlation of the 2.5M Soil Map of the USSR legend and a New Version of The Soil Map of the World Legend, FAO). Pochvovedenie, No. 1. [in press]

Van Lynden, G.W.J., 1997. Guidelines for the assessment of soil degradation in Central and Eastern Europe (SOVEUR Project). Report 97/08b (rev. ed.), International Soil Reference and Information Centre, Wageningen.

Yearbook on “Soil contamination of Russia Federation by pollutants of the industrial origin in 1996", 1997. Federal service of mete hydro-meteorology and environment monitoring, Institute of experimental meteorology by the science-practical community “Taifun”, Obninsk.

Yearbook “Monitoring pesticides in the natural objects of Russia Federation”, 1997. Federal service of mete hydro-meteorology and environment monitoring, Institute of experimental meteorology by the science-practical community “Taifun”, Obninsk.

SOVEUR project for Slovakia

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Introduction

Slovakia is a relatively small country situated in the centre of Europe, with an extent of 49,000 km^2. Most of the territory is occupied by mountains (about 50 %, with 41 % under forestry). The lowlands and hills are situated mainly in the southern part of Slovakia. This area is intensively used for agriculture. Generally, Slovakia is characterised by great variability of morphological, lithological and pedological conditions.

Aspects of project implementation

SOTER database

The methodological guidelines for compilation of a soil and terrain digital database (Batjes and Van Engelen, 1997) were the basis for compiling the terrain and soil database, and for constructing SLOVSOTER units. We have delineated 41 SLOVSOTER (terrain) units for Slovakia on the basis of several source map:

- Soil map of Slovakia in the scale 1:400,000 (Hraško *et al.*, 1993)
- Hypsography map in the scale 1:500,000 (SAV, 1980)
- Relief energy map in the scale 1:750,000 (SAV, 1980)
- Sloping of territory map in the scale 1:1,000,000 (SAV, 1980)
- Geology map in the scale 1:500,000 (SAV, 1980).

Also other auxiliary sources we reused to compile used SLOVSOTER units. Terrain units have been subdivided into terrain components which have been specified by similar combinations of local surface form, slope, mesorelief and lithology of surficial material. In the terrain and soil database, 69 terrain components have been characterized, and 126 soil components were described within the set. Soil components have been described by 28 representative soil profiles, characterized by their FAO soil unit name. Representative soil profiles have been chosen from the comprehensive database of the Complete Soil Survey of Agricultural soils carried out in the period 1960-1972 and the Partial Monitoring System of Soils established in 1993. Soil horizons were described mainly with respect to the mandatory soil attributes.

Soil degradation status database

The methodological guidelines to assess the current status of land degradation (Van Lynden, 1997) have been used. The map of SLOVSOTER units, with its 75 polygons, formed the basis for a detailed description of the necessary degradation parameters. The following types of soil degradation have been defined in Slovakia:

- *Soil pollution (Cp)*: Soil acidification (Cpa) – the main sources of acidification are depositions of SO_x and NO_x emanated by chemical industry, power generation, oil refinery, aluminium industry, heavy and metallurgy industry, and road/city traffic. Soil pollution by heavy metals (Cph) – heavy metals, e.g. cadmium, lead, chromium or copper emanate from various sources as chemical industry, power generation (incineration of fossil fuels), road traffic, agriculture, mining activities and others. Soil pollution by pesticides is localized only in some irregular sites of Slovakian lowlands as orchards, gardens, vineyards. Eutrophication by nitrates and phosphorus (Cpn) – the major source of nitrates and phosphorus is agriculture, through application of manure and fertilizers first of all in lowlands of Slovakia, however after 1990 it was substantially reduced.

- *Water erosion (W) and wind erosion (E)* is one of the most enormous degradation impact on soil in Slovakia, the assessment of eroded soils is about 55 % of agricultural land. Inappropriate land management, especially in agriculture and insufficient protection by vegetation in wind erosion areas contributes to unfavourable state of eroded land. The main problem is water erosion.

- *Chemical deterioration (other than pollution)*: Alkalization (Csa). Construction of the dam is one of the causative factors increasing mineralized groundwater table in the south-eastern part of the Danubian lowland.

- *Physical deterioration*: Compaction (Pc): This soil degradation type is recognized almost in all agricultural soils, mainly with higher clay content. They occupy lowlands and inter-mountains basins. Urban/industrial land conversion (Pu) – our biggest settlement agglomerations – Bratislava, Košice, ilina, Banská Bystrica, etc., represent this land, which is being taken out of production for non-bio-productive activities.

All information was listed for each polygon and then written on matrix tables prior to being entered into the computerized database using the SOVEUR.EXE data entry program. Both the SLOVSOTER units database and soil degradation status database were linked to the digitized map, using ARC INFO 7.1 software under UNIX.

Methodological considerations

Most of pedological databases in our institute are manipulated using ACCESS software. There were no problems to choose the required information. We encountered difficulties in some aspects of SOTER units compilation:

- Sometimes there were problems in delineation of terrain units with respect to all morphological, lithological and pedological attributes.
- With respect to landforms, for example, we could not find the right coding for inter-mountains basins. After common consulting, we choose code CD "complex depression" as the most suitable alternative, but we are not sure.
- Sometimes we were hesitating during degradation database construction (in percentage assessment of soil degradation and pollution status).

Concluding remarks

A very good monitoring system has been established in our country. There are many maps on soil acidification, soil contamination, soil erosion, etc. in Slovakia. On the basis of several source materials, we recognized 12 hot spots in Slovakia in terms of soil "contamination".

Some uses of SOVEUR project are proposed:

- The methodology of the SOVEUR project is suitable for database development and GIS implementation at the international level or multi-national level;
- It will be the first map of degraded regions, showing all types of soil degradation for Slovakia;
- Border correlation with respect of soil and degradation database will be useful for other international projects.

Possible follow-up actions include:

- At a larger scale (e.g., 1:400,000), this methodology will be use in "Vulnerability assessment project" at national level in Slovakia,
- Map of water and wind erosion assessment in Slovakia in the project: "Physical soil degradation retardation".
- In project of land and soil conservation of Slovakia.

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Ass. Prof. Dr. Pavol Bielek (SSCRI Bratislava) - soil degradation: Cpn;
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Mgr. Martin Granec (SSCRI Bratislava) - GIS activities.

References

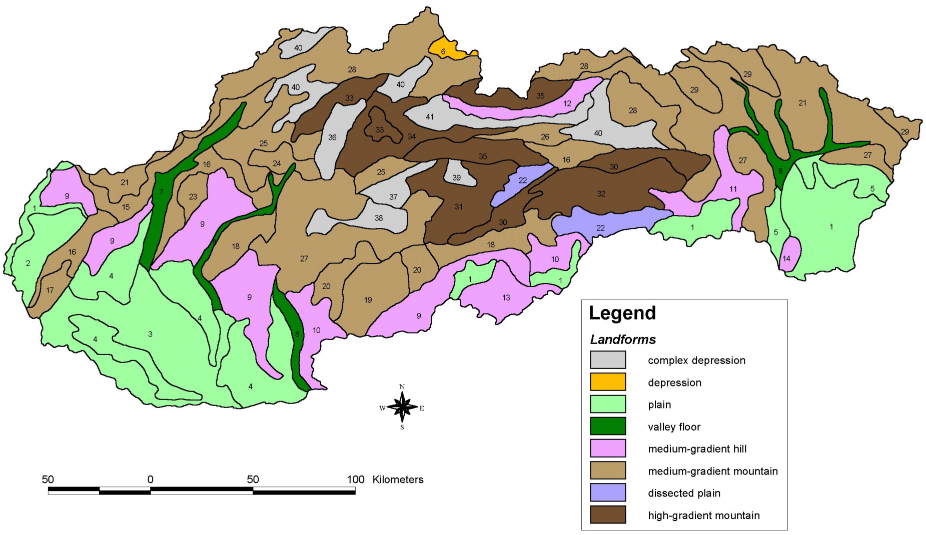
SAV, 1980. Atlas of SSR. SAV, Bratislava.

Batjes, N. H. and Van Engelen, V. W. P. (1997) Guidelines for the compilation of a 1:2,500,000 SOTER database (SOVEUR Project), Report 97/06, pp. 58. ISRIC, Wageningen.

Van Lynden, G. W. J. (1997) Guidelines for the assessment of soil degradation in Central and Eastern Europe (SOVEUR Project), Report 97/08b (rev. ed.), pp. 20. ISRIC, Wageningen.

Hrasko, J. *et al.*, 1993. Soil Map of Slovakia (1:400,000). SFRI, Bratislava.

Terrain (SLOVSOTER) Units of Slovakia



SOVEUR project for Ukraine

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Regionalisation

Among the existing approaches in Ukraine for the regionalisation of land resources, the most important ones for addressing practical tasks are the physico-geographical (1968) and agro-soil (1969) approaches. Both of these permit to give a complex view of any territory. The main difference is that the first approach characterizes the main properties of natural territories(landscapes), while the second approach specifies the agronomic value of the soil cover. Both types of regionalisation have a complex hierarchy of taxonomic units, of which the "district" is the smallest. In total, 281 physico-geographical and agro-soil districts are shown for the Ukraine at 1:2,500,000 scale.

At the same time, on the basis of materials of large-scale soil investigations and agro-soil regionalisation, other types of cartographic materials were created. Different natural indices which are agronomically important, were represented on these maps. On the basis of three natural indices, relief, lithology and dominant soil, so-called "agricultural types of lands" were delineated. Such units are generally larger than the agro-soil districts.

Regionalisation according to the SOTER methodology for Ukraine is as an intermediate variant between the geographical and agro-soil regionalisation. The criteria for delineating SOTER suit best the main criteria for defining "agricultural types of land". It is important that information about the soil cover is taken into consideration when demarcating both the terrain units and their terrain components. When describing the soil components, information about soil properties is used for all-round characteristic of the agricultural territory.

In view of the above let us determine the main advantages (in our opinion) and shortcomings of the SOTER methodology:

– Advantages: hierarchical simplicity; a small number of terrain units; generalization of a great volume of different information; suitable for further usage for different purposes.
– Shortcomings: predominance of geological and geomorphological criteria; insufficient registration of soil indices, especially in those situations where it is necessary to use reclamation or other cultivation practices.

Soil Degradation Status and Vulnerability Assessment for Central and Eastern Europe (SOVEUR Project).
Proceedings of an international workshop (Busteni, 26-31 October 1999). ISRIC-RISSA-FAO, 2000.

Seventy seven SOTER units are delineated on the map of Ukraine (59 Terrain Units (TU), half of which include 2 of 3 Terrain Components (TC), as well in Polessye zone (10), Forest-Steppe and Steppe (50), Carpathian (7), in the Crimea (10) SOTER - units).

Soil degradation database

During a second stage, the database of soil cover degradation was compiled using separate special soil polygons, which correspond to soil type. Anthropogenic soil degradation in Ukraine is recognized today as a widely occurring problem. Some types of processes, which may cause problems, are studied rather well. Water erosion, dehumification (loss of soil organic matter), soil pollution by heavy metals, and some other processes can be considered to be more or less well studied. Knowledge about the types of soil degradation, their prevalence and intensity in different regions, and impacts of industrial activity, which are related to land resources and the state of a landscape, still are not systematized. That is why the methodology for compiling the soil degradation database could be fully acceptable for elaborating the national system of evaluation of the state of the soil cover state. From the perspective of those who are elaborating the national system, the methodology has a number of advantages and shortcomings:

– Advantages: the same for many countries, unified methodological approach for the estimation;
– Shortcomings: absence of clear criteria (indices) for delineating/identifying degraded soils; absence of uniform rating parameters that would permit defining territories with a given degree of degradation in a really unified form for different countries. For example, the limit-value of actually exceeding soil bulk density to estimate Pc, and the thickness of soil crust or possibly the frequency of crusting manifestation, for the estimation of Pk. While working on the database, the participants have come to the decision that lands of Ukraine, evidently, should be divided into two categories: arable and others. The arable lands are simultaneously exposed to a great number of negative impacts.

Of course, a high degree of development of the lands in Ukraine causes a high prevalence of negative phenomena. These negative phenomena are the result of intensive agrarian land use. Besides, a high degree of agrarian land use of the territory of Ukraine resulted in all more or less suitable soils being tilled/cultivated. However, the resilience of the soils to agricultural loading varies; similar loadings can cause different reaction depending on the soil type under consideration.

The main problem of the ploughed land of Ukraine is the loss of nutrients and humus, Chernozem acidification in the region of intensive sugar-beet and other row-cultures, compaction of the arable layer of soils of medium and heavy granulometric composition, crusting on the surface, water erosion because of showers at the beginning of summer, wind erosion, and pollution by heavy metals.

Anticipated uses of SOVEUR products

- Presently, the system of agriculture in Ukraine is differentiated according to natural zones, that is the technologies of crop cultivation are worked out with the regard to general indices of climate and soils of natural zones. SOTER regionalisation is a good stimulator for beginning the reorganization of the system of agriculture in Ukraine from a zonal base to regional and further to micro-regional basis.
- SOTER regionalisation can provide good basis for national and regional soil protection programmes.
- Results of the current work have already been used in the development of the works on estimation of the ecological conditions of lands in Ukraine within two contracts: (a) national level which purpose is to estimate soil degradation and to identify appropriate remediation techniques, and (b) Ministry of Agriculture and the regional level with the purpose to develop a monitoring system (Kharkiv Regional Department of Land Resources).
- Follow-up actions at national and/or international levels.

Conclusions

One can say with certainty that our work on the SOVEUR project has served as a catalyst for the further development, detailization and systematization of the national rating base and estimation capability. We hope that the database annex map of regionalisation (SOTER) and the database on soil degradation status will be used to study the stability of land resources to technogenic pressure, and for other purposes as well.

The rating of soil resilience to mechanical and chemical loadings is most interesting, as it seems. The later can be derived from the assembled information and results of modelling experiments of the behaviour of various soils to growing loading (for example, compaction, pollution or salinisation). These materials will allow mapping of the soils of Ukraine according to their degree of sustainability to loadings, and for the first time to take into account this parameter in the national and regional programs of land protection.

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PART IV: APPENDIX

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